

# PRICE CONVERGENCE IN THE REGIONAL HOUSING MARKETS IN POLAND<sup>1</sup>

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## Abstract

Average prices of residential real estate usually show significant variation on a regional basis. This reflects different social, economic or historical conditions for the development of these markets. In addition, research so far has not provided strong evidence supporting convergence in the level of property prices in the regional dimension. The lack of price convergence, however, does not exclude convergence in the direction and strength of price changes.

The article is an attempt to answer the question of whether price trajectories in the regional housing markets in Poland show long-term similarity. To this end, econometric analysis of the dynamics of relative prices in the voivodship markets with the use of quarterly data from the years 2002-2016 has been conducted.

**Key words:** *Polish housing market, price convergence, SURADF test, panel unit root tests.*

**JEL Classification:** *C01, R10, R32.*

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## 1. Introduction

Housing markets are usually characterised by a distinct spatial segmentation. Regional and local markets differ in the level and dynamics of development, the quantitative and qualitative structure of housing resources, the scale of undertaken housing investments, and, above all, in the average level of housing prices. A comprehensive overview of the sources and mechanisms of regional differentiation of real estate prices can be found in the literature. This issue has been discussed, among others, in the works of VAN NIEUWERBURGH and WEILL (2010), GALATI and TEPPA (2010), as well as MURPHY and MUELBAUER (1994). The differentiation of housing prices in the domestic housing market has been the subject of research of, e.g.: NYKLA (2007), DITTMANN (2012), as well as LESZCZYŃSKI and OLSZEWSKI (2014).

Among the factors that have a major impact on the level and dynamics of housing prices, the following are most often mentioned (ŻELAZOWSKI 2011, p. 99):

- economic factors, including the general economic situation (measured by the GDP growth rate, value added, industrial output index or wholesale and retail sales index), the labour market situation (the unemployment rate and the average level of remuneration), and the situation in the financial markets (the level of interest rates, the cost and availability of bank loans and other external sources of financing),
- demographic factors, taking into account, above all, changes in the population, balance of migration between regions, changes in the structure of households and, consequently, also their

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- housing needs, and the scale of the problem of an ageing population,
- institutional determinants, including legal regulations regarding investment activities in the housing market, real estate transactions, and real estate taxation, along with the quality of the spatial policy, as well as directions and instruments of the housing policy at the central and local level,
- technical and resource-related determinants, which are associated with, among others, the quantitative and qualitative structure of existing housing stock or the availability and condition of accompanying technical infrastructure (road, water, sewage, etc.).

It should be emphasized, however, that the price determinants mentioned above are, to a varied extent, responsible for regional price differentiation. Therefore, they can be classified into two basic categories of factors. The macroeconomic conditions affect all regional housing markets with similar strength and to a similar extent, and, as a consequence, are the main determinants of the direction of changes in property prices. Regional determinants, on the other hand, shape the specificity of individual regional markets and the corresponding trajectory of house prices; they are therefore the main source of price differences between regions.

The analysis of price convergence is a natural complement to research on the causes and mechanism of price differentiation in housing markets. It allows one to verify whether the cross-section variability of property prices shows a tendency to fall or whether it has a lasting or deepening character. However, price convergence can be perceived in multiple ways. It may concern convergence of price levels in regional markets. It may also, taking into account the regional and local dimension of housing markets, verify convergence of the direction and dynamics of price changes.

The aim of the article is to identify long-term price convergence in the regional housing markets in Poland. The analysis covered changes in relative prices in 16 voivodship markets in the years 2002-2016. To assess the occurrence of convergence, univariate and panel tests of the stationarity of time series were used.

## 2. Convergence of housing markets – literature review

The concept of economic convergence appeared in the 1950s in the context of comparative analyses of the systems of capitalist and centrally planned economies. Since the 1980s, the term in a narrower sense refers to the processes of reducing disparities in measures of the economic activity of economies (JABŁOŃSKI 2008, p. 25). Convergence in the general sense means the concurrence or coherence of specific processes or phenomena (KUSIDEŁ 2013, p. 15). It is a multidimensional concept describing the correspondence or similarity of selected socio-economic variables, economic structures, actions and mechanisms both in international and regional terms. Moreover, in addition to strictly economic processes, it also refers to legal rules, social norms as well as the institutional environment (GŁODOWSKA 2012, p. 175).

The types and methods of identifying convergence also vary. Literature mentions, among others, beta, sigma and gamma convergence. Beta convergence allows us to diagnose the occurrence of the catch-up effect due to which poorer countries (regions) developing faster than richer countries (regions) are able to reduce the initial differences in the level of prosperity (BARRO, SALA-I-MARTIN 1990). Sigma convergence occurs when the variation of the adopted diagnostic variable between economies or regions decreases over time (ŁAŻNIEWSKA, GÓRECKI 2012, p. 2). Sigma convergence is measured using statistical measures of variation such as standard deviation or the coefficient of variation. The successive decrease in the diversity of economies (regions) in relation to the studied phenomenon confirms the occurrence of sigma convergence. At the end of the 1990s, Boyle and McCarty proposed the concept of so-called gamma convergence (BOYLE, MCCARTY 1999). It occurs when a significant change in the position of the examined economies (regions) can be observed in the ranking prepared on the basis of a selected economic variable (DITTMANN 2014, p. 200).

Housing markets have been a popular area for identifying convergence for many years. The lack of one universal measure of the development of these markets means that housing convergence research can be multifaceted. Convergence analysis may therefore include: the size and quality of housing resources, the purchasing power of households in the housing market, the system of financing the housing sector, the institutional environment of the housing market, and rents as well as prices of residential real estate.

Particular attention has been paid in the literature to price convergence of housing markets. It has been verified in two basic forms (GHIRALDO et al. 2013, p. 64):

- convergence understood as the concurrence or diminishing differentiation of housing prices in cross-sectional terms,
- convergence understood as a tendency of prices to respond to emerging market shocks to a similar extent.

The occurrence of price convergence of the first type with the use of classical measures (beta convergence, sigma convergence) has been verified, among others, in the works of NISSAN, PAYNE (2013), or WONG and DE SILVA (2015). Price convergence of the second type concerns the identification of the ripple effect, i.e. the spread of shocks between regional housing markets, the consequence of which is long-term price convergence in these markets (the steady state in the trajectory of their changes). The ripple effect in regional housing markets has been tested, among others, by MEEN (1999), COOK (2003), LEE and MEI-SE (2011), or GUPTA and MILLER (2012).

Price convergence has been also analyzed in the area of the domestic housing market. GNAT has verified the occurrence of beta, sigma and alpha convergence in the housing market in Szczecin (in the years 2006-2016) (GNAT 2016, 2017) as well as in the local housing markets of the Szczecin agglomeration (in the years 2008-2013) (GNAT, 2014). The conducted research does not confirm price convergence in the Szczecin market, however, it indicates its existence within selected satellite towns of the Szczecin agglomeration. The results of the analysis of price changes in the primary and secondary residential real estate markets in the voivodship cities (in the years 2007-2012) conducted by Dittmann I. allow us to reject the hypothesis assuming the occurrence of the gamma convergence phenomenon. The study has confirmed, therefore, a clear and lasting price segmentation of housing markets and a significant impact of local factors on the differentiation of property prices (DITTMANN 2014).

### 3. Data and methodology

The article attempts to verify long-term price convergence in the regional housing markets in Poland in accordance with the methodology presented by HOLMES (2007). The identification of convergence is based on the analysis of time series of relative prices that are the relation (difference) between average prices of residential real estate from the regional markets and the selected benchmark, which is most often the average domestic price of flats or the average price from the leading market (1). When relative prices demonstrate long-term stability, this allows us to conclude the occurrence of convergence, in other words, regional housing markets strive for long-term equilibrium.

$$y_{i,t} = p_{i,t} - p_t^* \quad (1)$$

where:

- $y_{i,t}$  – the relative price level for the  $i$ -th market in the time period  $t$ ,
- $p_{i,t}$  – the average price of residential properties in the  $i$ -th market in the time period  $t$ ,
- $p_t^*$  – the value of the benchmark (e.g.: the average domestic price of residential real estate) in the time period  $t$ .

The use of stationarity tests of time series is a method popular in literature for assessing the stability of relative prices. The study included both univariate stationarity tests and panel data tests. In the first stage, the Augmented Dickey-Fuller test (ADF test) was used based on the following regression:

$$\Delta y_t = \alpha + \delta y_{t-1} + \sum_{j=1}^k \gamma_j \Delta y_{t-j} + \varepsilon_t \quad (2)$$

where:

- $y_t$  – the relative price level in the time period  $t$ ,
- $\delta$  – autoregressive parameter,
- $k$  – lag order,
- $\varepsilon_t$  – random component.

In the test procedure, the null hypothesis assumes the existence of a unit root (non-stationarity of the time series), while the alternative hypothesis assumes that the tested series is stationary:

$$H_0: \delta = 0, H_1: \delta < 0 \quad (3)$$

The rejection of the null hypothesis in favour of the alternative hypothesis allows us to conclude the occurrence of price convergence in a given housing market. In addition, it is possible to determine its rate on the basis of half-life (H-L) statistic defining the time horizon within which the deviation of regional prices from long-term equilibrium will be reduced by half (4) (CHAN 2008, p. 5). The main benefit of using the ADF test is the ability to detect convergence independently for each regional market, while its limitation is the lower power of the test.

$$HL = \frac{\ln(0,5)}{\ln(1+\delta)} \quad (4)$$

where:

$HL$	– half-life statistic,
$\delta$	– autoregressive parameter.

In the next stage of the analysis, panel tests of stationarity, the so-called first generation tests, were used: LEVIN, LIN and CHU test (2002) - LLC; IM, PESARAN and SHIN test (2003) - IPS as well as the HADRI test (2000). In the case of the first two tests, due to the different forms of their auxiliary regression, the model in the following form was used in the verification of the occurrence of price convergence (5):

$$\Delta y_{it} = \alpha_i + \delta_i y_{it-1} + \sum_{j=1}^k \gamma_{ij} \Delta y_{it-j} + \varepsilon_{it} \quad (5)$$

where:

- $y_{it}$  – the relative price level for the  $i$ -th object in the time period  $t$ ,
- $k$  – lag order,
- $\delta_i$  – autoregressive parameter for the  $i$ -th object,
- $\varepsilon_{it}$  – random component.

The LLC test assumes the homogeneity of the autoregressive parameter in both the null and the alternative hypotheses. In the null hypothesis, the non-stationarity of each series in the panel is assumed, while in the alternative hypothesis, time series are stationary (STRZAŁA 2009, p. 59):

$$H_0: \delta_1 = \delta_2 = \dots = \delta_N = 0 \quad H_1: \delta_1 = \delta_2 = \dots = \delta_N < 0 \quad (6)$$

In the IPS test, the heterogeneity of the autoregressive parameter is allowed, which means that the alternative hypothesis takes into account the possibility that only some of the series in the panel are stationary (DAŃSKA-BORSIAK 2012, p. 77):

$$H_1: \begin{cases} \delta_i < 0 & dla i = 1, 2 \dots N_1 \\ \delta_i = 0 & dla i = N_1 + 1 \dots N \end{cases} \quad (7)$$

The Hadri test is a generalization of the KPSS test for panel data. It differs from the previous tests in terms of the construction of tested hypotheses. The null hypothesis assumes the stationarity of all series in the panel, while the alternative hypothesis assumes the existence of a unit root in the panel (STASZCZYK 2017, p. 135).

As shown by Breuer, McNown, and Wallace, increasing the precision of the stationarity assessment of panel data is possible by determining the ADF test statistics using the method of seemingly unrelated regressions (BREUER et al. 2002). The use of the SURADF procedure in the stationarity testing process allows for taking into account the existing relationships between the random components. It is based on the following system of equations (HOLMES 2007, p. 6):

$$\begin{aligned} \Delta y_{1t} &= \alpha_1 + \delta_1 y_{1t-1} + \sum_{j=1}^k \gamma_{1j} \Delta y_{1t-j} + \xi_{1t} \\ \Delta y_{2t} &= \alpha_2 + \delta_2 y_{2t-1} + \sum_{j=1}^k \gamma_{2j} \Delta y_{2t-j} + \xi_{2t} \\ &\dots\dots\dots \\ \Delta y_{Nt} &= \alpha_N + \delta_N y_{Nt-1} + \sum_{j=1}^k \gamma_{Nj} \Delta y_{Nt-j} + \xi_{Nt} \end{aligned} \quad (8)$$

- $y_{it}$  – the relative price level for the  $i$ -th market in the time period  $t$ ,
- $k$  – lag order,
- $\delta_i$  – autoregressive parameter for the  $i$ -th object,
- $\xi_{it}$  – random component in the SUR method.

Similarly to the ADF test, the null hypotheses assume the existence of a unit root in individual panel series, while alternative hypotheses assume the stationarity of series for subsequent objects. The importance of autoregressive parameters is tested on the basis of critical values determined individually for each panel object as part of the Monte Carlo simulation (SHU-YI et al. 2011, p. 683). An undeniable benefit resulting from the use of the SURADF test is the ability to indicate for how many and which objects the tested series are stationary, as well as the greater power of the test compared to the univariate test (HOLMES 2007).

PKO BP bank's housing reports were the source of data on housing prices used in the study. The average unit prices of flats from the secondary market for the individual voivodships (quarterly data for the years 2002-2016) have been included in the logarithmic form. The average national price, according to the adopted methodology, is the weighted average of voivodship prices. The share of a given voivodship in the total number of residential premises in the whole country was used as a weight.

#### 4. Empirical results

For each of the 16 voivodship markets, the series of relative housing prices were determined. The average housing price in Poland was used as the benchmark. Changes in relative prices in the individual regional markets are presented in Fig. 1

In accordance with the adopted methodology, the univariate ADF test was used in the first stage of convergence analysis. The stability of relative prices, and consequently, the existence of price convergence, was confirmed in 4 out of 16 regional markets. At the 5% level of significance, striving for the steady state was diagnosed for Małopolskie, Podkarpackie and Warmińsko-Mazurskie Voivodships, while at the 10% significance level, also for the Zachodniopomorskie Voivodship. Half-life statistics were also estimated for the selected markets. However, despite some differences, it is important to emphasise their low values, usually not exceeding two quarters. The short-term deviations from long-term equilibrium within these regions disappeared relatively quickly (Table 1).

**Table 1**

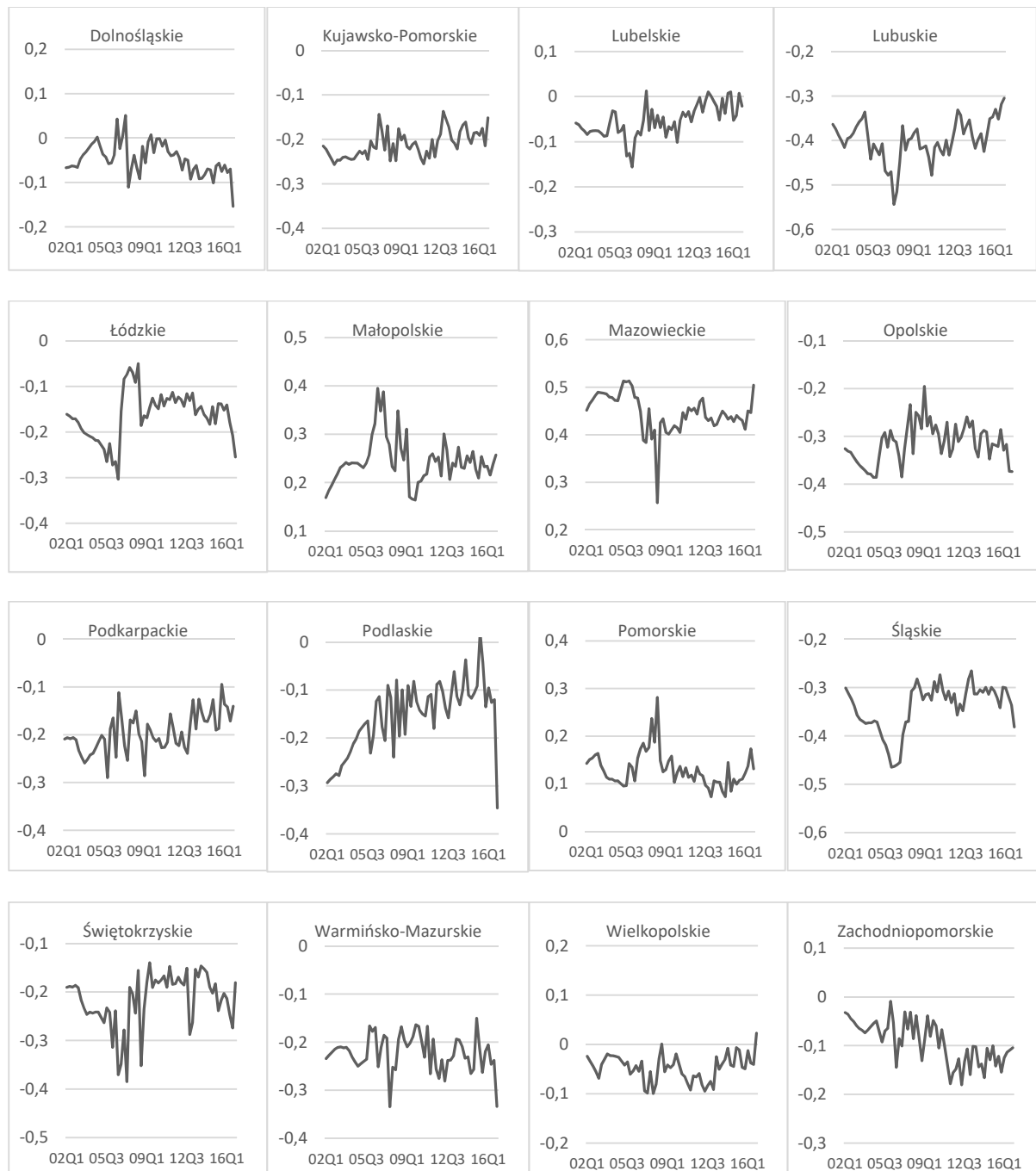
Results of the Augmented Dickey-Fuller test (ADF)

Voivodship	ADF (with absolute term)	Half-life (in quarters)
Dolnośląskie	-1.862	-
Kujawsko-Pomorskie	-2.366	-
Lubelskie	-2.193	-
Lubuskie	-2.438	-
Łódzkie	-1.995	-
Małopolskie	-2.978**	1.68
Mazowieckie	-2.402	-
Opolskie	-2.582	-
Podkarpackie	-3.517**	0.94
Podlaskie	-2.293	-
Pomorskie	-2.373	-
Śląskie	-1.739	-
Świętokrzyskie	-1.820	-
Warmińsko-Mazurskie	-3.841***	0.59
Wielkopolskie	-1.993	-
Zachodniopomorskie	-2.663*	2.01

The lag order in individual regressions was selected on the basis of AIC.

\*\*\*, \*\*, \* Rejection of the null hypothesis at the level of significance: 1%; 5%; 10%

Source: own elaboration



**Fig. 1.** Trajectories of relative prices in the regional housing markets in Poland. *Source:* own elaboration.

The stationarity of panel data covering all the voivodship housing markets was also verified. In the test procedure, three first generation tests were included: the LLC test, the IPS test and the Hadri test. The results obtained are not conclusive. In the LLC test, with a 1% significance level, the value of the test statistic allowed us to reject the null hypothesis in favour of the alternative hypothesis assuming the stationarity of the price series constituting the panel. Thus, there is price convergence in the regional markets (the LLC test assumes the same rate of convergence for all the markets). In the case of the IPS test, the rejection of the null hypothesis (assuming the existence of a unit root in the examined series) only allowed us to conclude that, for some of the studied regions, the unit root did not exist. In the Hadri test, however, the stationarity of the whole panel was not confirmed (rejection of the null hypothesis at the significance level of 1% and less).



**Table 2**

Results of panel stationarity tests

Test	Test statistics	p-value
Levin, Lin & Chu	-3.016***	0.0013
Im, Pesaran & Shin	-5.401***	0.0000
Hadri	7.724***	0.0000

\*\*\*, \*\*, \* Rejection of the null hypothesis at the level of significance: 1%; 5%; 10%

Source: own elaboration

In the last stage of the study, the stationarity of the regional price series was verified using the SURADF test (Table 3). Taking into consideration the dependencies occurring between the panel objects (covariance matrix of random components) influenced the results of the analysis to a significant degree. At the 5% level of significance, price convergence was diagnosed for Mazowieckie, Podkarpackie, Pomorskie and Warmińsko-Mazurskie Voivodships, while at the 10% significance level, also for the Łódzkie, Śląskie and Zachodniopomorskie Voivodships. Half-life statistics also indicated a fairly rapid pace of return to the equilibrium of regional prices. In most cases, it did not exceed two quarters.

**Table 3**

SURADF test results

Voivodship	SURADF	Critical values			Half-life (in quarters)
		1%	5%	10%	
Dolnośląskie	-3.817	-5.442	-4.482	-4.060	-
Kujawsko-Pomorskie	-2.502	-5.083	-4.150	-3.704	-
Lubelskie	-3.220	-4.724	-3.925	-3.470	-
Lubuskie	-3.348	-4.694	-3.903	-3.449	-
Łódzkie	-4.023*	-5.175	-4.318	-3.905	2.07
Małopolskie	-3.745	-5.373	-4.433	-4.004	-
Mazowieckie	-6.597***	-6.369	-5.558	-5.105	1.71
Opolskie	-3.316	-4.910	-4.055	-3.638	-
Podkarpackie	-5.726***	-4.867	-3.992	-3.574	0.57
Podlaskie	-2.775	-5.210	-4.283	-3.855	-
Pomorskie	-4.879**	-5.359	-4.505	-4.051	1.69
Śląskie	-4.076*	-5.182	-4.343	-3.893	3.21
Świętokrzyskie	-2.623	-4.870	-4.023	-3.569	-
Warmińsko-Mazurskie	-5.011**	-5.025	-4.113	-3.708	0.62
Wielkopolskie	-3.086	-5.056	-4.155	-3.720	-
Zachodniopomorskie	3.798*	-5.020	-4.201	-3.758	1.82

The lag order in individual regressions was selected on the basis of AIC. Critical values determined on the basis of Monte Carlo simulation (10,000 repetitions).

\*\*\*, \*\*, \* Rejection of the null hypothesis at the level of significance: 1%; 5%; 10%

Source: own elaboration

Despite the increased number of regional markets for which price convergence was confirmed, it still does not exceed 50% of all the analyzed objects. This proves a noticeable segmentation of regional housing markets, an important role of regional factors in shaping their development and a weak tendency of the studied markets to achieve the steady state.

## 5. Conclusions

Convergence is understood as the concurrence or coherence of socio-economic processes. In addition to its traditional application in the field of comparative analyses of the effectiveness of individual economies, it is increasingly sought for in other economic areas. In the case of the real estate market, the analysis of convergence is used for the main indicators of its activity, including primarily property prices.

This study verifies the existence of the convergence of relative prices in voivodship housing markets. This is understood as a tendency of housing markets to achieve a steady state, while maintaining their regional specificity. Stationarity tests used as the basic research method, however, do not provide an unambiguous picture of price convergence. The SURADF test, which is more powerful and which is considered to be one of the second-generation stationarity tests, has indicated that price convergence occurs in 7 of the 16 analyzed markets. The half-life statistics determined for these markets also confirm the relatively fast rate of return of regional prices to steady states.

However, some caution should be exercised in the interpretation of the results obtained due to the use of average house prices in the calculation procedure for the regional markets and the weighted average price of residential premises for the domestic market. According to the literature, the analysis of price trends in the real estate market using these measures (based on the average) does not take into account changes in the quantitative and qualitative features of real estate traded in subsequent periods. Therefore, it may be a source of potential bias of the results of the study.

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