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## Drivers of Subregional Housing Markets in Poland

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**Abstract:**

**Purpose:** The paper investigates how sustainable city development factors impact housing price levels in subregional cities, on basis of 14 thousand real transactions in three Polish cities in the years 2006–2014.

**Design/Methodology/Approach:** The multiple regression analysis with hedonic approach was used.

**Findings:** The three-equation model has proven that economic development factors affect housing price levels in subregional cities while social progress and environmental responsibility do not always explain the change in the housing prices. Additionally the analysis of data allowed to conclude that the smaller the local market is, the more it is responsive to changes in external conditions.

**Practical implications:** The housing market in subregional cities is different to big cities, prices change slower and do not respond to changes in the macro-environment factors as quickly and strongly as in large cities. Moreover, the situation on the local housing markets depends largely on the scale of sustainable development of the city. The study outcomes can be readily used to help more accurately plan housing investments for real estate developers or planning authorities responsible for housing policy.

**Originality/ value:** We indicated what types of sustainable development factors affect the level of housing prices in subregional cities.

**Keywords:** Regional economics, housing market, prices, sustainable city development.

**JEL codes:** R11, R30, R31, Q01, Q56.

**Paper type:** Research article.

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## **1. Introduction**

The basic characteristic of a housing market is its local character. Market features such as prices, demand and supply depend on time, but also on spatial location. The level of market determinants are influenced by various global, national and local factors, but their magnitude, influence, direction and intensity, vary within time and space (Liu 2020; Hochstenbach and Arundel, 2019). Real estate markets are also linked to local development. Some studies have additionally demonstrated that the housing market is not only affected by sustainable development factors, but by a city's attractiveness. Green, ecological and affordable flats attract investors; in varying degrees. The real estate market cannot be sustainable without complying with criteria of sustainable development (Vanags and Butane, 2013; Kauškale and Geipele, 2017).

This paper discusses the local character of the housing market in the context of sustainable city development. It aims to show that sustainable development factors can indeed be used to differentiate housing markets. The detailed objectives are as follows:

- Theoretical objective; explaining the local character of the housing market.
- Cognitive objectives; recognising the features of local housing markets, their similarities and differences.
- Practical objectives; assessing the effect of sustainable development factors on local housing markets.

This study was conducted on local housing markets in three subregional cities, (City A – Kalisz, City B – Konin and City C – Leszno), in the Wielkopolskie (Greater Poland) Province in Poland. The prices of transactions were comprehensively researched on the housing market for all flats sold between 2006-2014. This concerned all transactions within a defined time period collected from a database of about 14 thousand transactions. All non-market transactions were rejected, for example due to: compulsory purchase, delayed payment time or real estate delivery, intra-corporate transactions etc. The final analysis was thus performed on a whittled down subject group of over 8 thousand market transactions.

The first part of this paper consists of a literature review explaining the local characteristics of housing markets and their likely consequences, as well as the impact of sustainable city development factors on housing prices. Secondly, we analysed sustainable city development factors influencing the prices in selected subregional cities. It was shown that local markets are conditioned by various sustainable development factors, (external and internal), through using multiple regression models.

Housing market locality is one of the most significant economic features widely described in the literature. According to previous research (Bernstein and Mellon,

2013), not only is capital stability a vital feature of the residential real estate market, but also the observed characteristics of the local market. Locality refers to living in a defined geographical area of a somewhat small size (Torben, 2018). Due to the location of a given permanent place of residence, it can prove impossible to move this real estate to another market priced at different levels. The housing market also reacts to social, demographic, economic or policy changes within particular areas, so the factors of importance thence become, population, inhabitants' age breakdown, family background (ie. the number of households), employment, wage levels, earnings stability, savings levels, loans availability, shape and structure of the real estate resources, rent levels, vacancy rates, availability and value of new building investments, price and availability of building materials (Stover, 1986; Łaszek, 2011; Nappi-Choulet and Maury, 2011; Wilson *et al.*, 2011; Lund, 2014; Ranci, Brandsen, and Sabatinelli, 2014; Dziauddin, Ismail, and Othman, 2015; Lim, 2017; Mach and Rączka, 2018; Sun and Tsang, 2018; Cellmer, Bełej, and Konowalczyk, 2019; Abelairas-Etxebarria and Astorkiza, 2020).

The locality of housing markets is noticeable especially in the CEE Europe countries, where private ownership is the dominant form of housing ownership, and thus the mobility of the population is limited (Rączka, Palicki, and Kostov, 2015; Widłak and Łaszek, 2016). Home ownership is highly favored over rental in most countries, and Western governments are making long efforts to increase the homeowner rate (Chen, 2013).

The literature broadly describes the impact of various factors on prices (and also value) of residential real estate. Studies very often focus on those real estate features affecting price (Dziauddin, Ismail, and Othman, 2015; Kazak, Chruściński, and Szewrański, 2018; Batóg *et al.*, 2019; Cellmer and Trojanek, 2020; Kempa *et al.*, 2015; Mora-Garcia *et al.*, 2019; Kisiała and Rączka, 2021), and are as follows:

(1) individual features of flats: flat size area, number of rooms, type of kitchen; floor on which the flat is located; location of an apartment within a building; style; furnishing; and decoration standard; (2) location; (3) a building's technical state: construction technology and year built; number of floors; architecture; frequency of renovation work; type and quality of installations etc. Other variables crucial for the price level are (Isaac 2002; Cheng, Dagsvik, and Han, 2014): the international economic situation and interest rates; investment trends and the state of the national economy; fiscal and financial policies; local economy; geographical environment and placement; fashion and local demand trends (demand for housing within given locations); leaseholding (property values under leasehold may differ from freehold); opportunities for building extensions and renovation; ease of disposal (the time necessary to perform a transaction); and availability of relevant property details.

Following our literature review of various housing market factors that affect the final price of a property (Liu *et al.*, 2020; Bernstein and Mellon, 2013; Nappi-Choulet and Maury, 2011; Sun and Tsang, 2018; Wilson *et al.*, 2011; Abelairas-Etxebarria and

Astorkiza, 2020; Stover, 1986; Łaszek, 2011; Lund, 2014; Ranci, Brandsen, and Sabatinelli, 2014; Rącka, Palicki, and Kostov, 2015; Dziauddin, Ismail, and Othman 2015; Cellmer, Belej, and Konowalczyk, 2019; Mach and Rącka, 2018; Dziauddin, Ismail, and Othman, 2015; Kazak, Chruściński, and Szewrański, 2018; Batóg *et al.*, 2019; Cellmer and Trojanek, 2020; Kempa *et al.*, 2015; Mora-Garcia *et al.*, 2019; Isaac, 2002), the study author has proposed a classification, based on seven separate groups of factors as follows (Table 1).

**Table 1.** *Housing market development factors.*

No.	Level	Group of factors	Factors
1	Local and national	Economic situation	X <sub>1,1</sub> – Wage level (average gross remuneration)
			X <sub>1,2</sub> – Number of construction businesses
			X <sub>1,3</sub> – Construction production
			X <sub>1,4</sub> – Gross Domestic Product
			X <sub>1,5</sub> – Gross Added Value
			X <sub>1,6</sub> – Capital expenditure value
			X <sub>1,7</sub> – Inflation rate
			X <sub>1,8</sub> – Capital expenditure in enterprises
			X <sub>1,9</sub> – Employment
2	Local	Economic activity of the population	X <sub>2,1</sub> – Number of registered businesses
			X <sub>2,2</sub> – Registered unemployment rate (%)
			X <sub>2,3</sub> – Demographic burden indicator
			X <sub>2,4</sub> – Foundations and social organizations
3	Local	Demographic factors	X <sub>3,1</sub> – Migration
			X <sub>3,2</sub> – Population
4	Local	Environmental factors	X <sub>4,1</sub> – Registered cars
			X <sub>4,2</sub> – Pollution levels
			X <sub>4,3</sub> – Green spaces
5	Local	Local government activity	X <sub>5,1</sub> – Urban infrastructure
			X <sub>5,2</sub> – Roads
			X <sub>5,3</sub> – Investing incentives
			X <sub>5,4</sub> – Community incomes
			X <sub>5,5</sub> – Community expenses
			X <sub>5,6</sub> – Amount of paid housing allowances from community resources
			X <sub>5,7</sub> – Amount of paid housing allowances from private resources
6	Local	Residential real estate resources	X <sub>6,1</sub> – Size of housing resources
			X <sub>6,2</sub> – Ready to move into flats
			X <sub>6,3</sub> – Quality of the resources (installations)
			X <sub>6,4</sub> – Quality of the resources (individual usable floor area)
			X <sub>6,5</sub> – Tourist potential (the number of overnight accommodation in hotels)
			X <sub>6,6</sub> – Tourist potential (provided accommodation)
			X <sub>6,7</sub> – Number of delivered communal housing
			X <sub>7,1</sub> – Residential real estate price level in big cities (average prices of flats on secondary market in 10 cities)
7	Local and national	Housing market	X <sub>7,2</sub> – Pricing of various residential local market sectors (houses, I and s with building permission),
			X <sub>7,3</sub> – Volume of turnover in particular sectors of the local real estate market
			X <sub>7,4</sub> – Real estate pricing

*Source:* Own study.

Defining sustainable city development is difficult and consequently many definitions for it exist. Sustainable development is multidisciplinary and therefore diversified. It

affects various fields such as science, engineering, environment, ecology, economics, business, sociology, philosophy and others, and also influences various markets, including real estate market (Rosen, 2017). The dissimilarity of cities results from the impact of not only national, but also local factors on their development. Sustainable development of each city takes into account both the basic goals of sustainable development and the problems specific to individual cities, including the complexity of the existing functional relationships. Factors which affect the housing market can be considered in the context of sustainable city development (Turcu, 2012) of which there are three groups (Rosen, 2017; Strezov, Evans, and Evans, 2017; Rodrigues and Franco, 2020):

- Economic development.
- Social progress.
- Environmental responsibility.

In the above three groups, there are many different factors influencing both the sustainable development of the city and the local housing market. The groups of indicators presented in Table 1 may constitute an integrated set of indicators of sustainable city development for the purposes of determining the impact on the local housing market. This set of indicators for sustainable city development is based on the analysis of various indices – China Urban Sustainability Index (2020), City Blueprint (2020), EEA Urban Metabolism Framework (2020), European Green Capital Award (2020), European Green City Index (2020), European Green City Tool (2020), European Green Leaf Award (2020), Reference Framework for Sustainable Cities (RFSC) (2020), Urban Ecosystem Europe – Informed Cities (2020). For each of the indices, we determined to which group of housing market development factors (Table 1) the Indicator belongs to and which of the three dimensions of sustainable development it is related to. Thus, a set of 36 indicators divided into 7 groups was built.

Table 2 summarizes the factors according to 9 different sustainable development indices in relation to the housing market development factors and sustainable city development factors. In the study we aim to show the impact of factors responsible for sustainable city development on housing prices in subregional cities. The novelty of the paper is the indication of whether sustainable development factors affect the level of housing prices. So far, the other authors have focused mainly on the analysis of factors influencing real estate prices in large cities (capitals or provincial cities), which were considered to represent the entire states. Till now, few studies have examined the links between the sustainable development of the cities and the housing markets. However, the research we conducted shows that the housing market in subregional cities is different to big cities, prices change slower and do not respond to changes in the macro-environment factors as quickly and strongly as in large cities. Moreover, the situation on the local housing markets depends largely on the scale of sustainable development of the city. Hence, we decided to show what

types of sustainable development factors affect the level of housing prices in subregional cities and whether there are differences between these cities.

Our main research hypothesis was, changes in local housing markets are caused by similar sustainable city development factors, however the scale of their effects and response times depend on local conditions.

**Table 2.** *Links between the housing market and Sustainable city development factors.*

Research/ Toolkit	Indicator	Housing market development group of factors	Sustainable urban development factors
China Urban Sustainability Index (2020)	Environment cleanliness	(4)	ER
	Living space	(6)	ED
	Resources efficiency	(4)	ER
City Blueprint (2020)	Co <sub>2</sub> emissions	(4)	ER
	Energy efficiency of transport	(4), (5)	ER, SP
	GDP per capita	(1)	ED
	Green space access	(4)	ER
	L and use efficiency	(5), (7)	ED, ER
	NO <sub>2</sub> PM <sub>10</sub> concentrations	(4)	ER
	Public transport network	(5)	ER, SP
	Registered cars	(4)	ER
	Resources efficiency	(4)	ER
	Unemployment rate	(1)	ED
EEA Urban Metabolism Framework (2020)	Urban I and take	(5), (7)	ED, ER
	Climate change: mitigation and adaptation	(4)	ER
	GDP per capita	(1)	ED
	Green space access	(4)	ER
	NO <sub>2</sub> PM <sub>10</sub> concentrations	(4)	ER
	Resources efficiency	(4)	ER
	Unemployment	(1)	ED
Waste intensity	(4)	ER	
European Green Capital Award (2020)	Air quality	(4)	ER
	Energy performance	(4)	ER
	Governance	(5)	SP
	Green growth and eco-innovation	(4)	ER
	Noise	(4)	ER
	Sustainable I and use	(5), (7)	ED, ER
	Sustainable urban mobility	(3)	SP
Waste	(4)	ER	
European Green City Index (2020)	Air quality	(4)	ER
	Buildings	(6)	ED
	CO <sub>2</sub>	(4)	ER
	Energy	(4)	ER
	Environmental governance	(4), (5)	ER, SP
	Transport	(4), (5)	ER, SP
	Waste and I and use	(4),(5),(7)	ED, ER
Water	(4)	ER	
European Green City Tool (2020)	Climate change adaptation	(4)	ER
	Climate change: mitigation	(4)	ER
	Energy	(4)	ER

	Governance	(5)	SP
	Green growth and innovation	(4)	ER
	L and use	(5), (7)	ED, ER
	Mobility	(3)	SP
	Noise	(4)	ER
	Waste	(4)	ER
European Green Leaf Award (2020)	Air quality and noise	(4)	ER
	Climate change and energy performance	(4)	ER
	Nature, biodiversity and L and use	(5), (7)	ED, ER
	Sustainable urban mobility	(3)	SP
	Waste and circular economy	(4)	ER
	Water	(4)	ER
Reference Framework for Sustainable Cities (RFSC) (2020)	Air quality	(4)	ER
	Complete neighbourhood/ compact city	(5)	ER, SP
	Economic growth	(1)	ED
	Education	(3)	SP
	Green spaces	(4)	ER
	Housing	(6)	ED
	Mobility	(3)	SP
	Quality public space	(5)	ER, SP
	Reduce greenhouse gases/ energy efficiency	(4)	ER
	Sanitation	(5)	ER, SP
	Unemployment rates/ jobs	(1)	ED
	Waste/ reuse/ recycle	(4)	ER
	Water quality/ availability	(4)	ER
	Urban Ecosystem Europe – Informed Cities (2020)	Air quality: NO <sub>2</sub> and PM <sub>10</sub> concentrations	(4)
Amount of municipal waste produced		(4)	ER
Climate and energy saving policies		(4)	ER
Cycle paths and lanes availability		(4), (5)	ER, SP
Demographic and old age dependency		(3)	SP
Domestic water consumption		(4)	ER
Electric consumption variation		(4)	ER
Energy balance and CO <sub>2</sub> reduction target		(4)	ER
Green public procurement, procedures and purchasing		(4), (5)	ER, SP
Inhabitants connected to district heating system		(5)	ER, SP
Inhabitants served by water treatment plants		(4)	ER
Noise map and noise reduction plan		(4)	ER
Number of registered cars		(4)	ER
Passengers travelling on public transport		(3), (4), (5)	ER, SP
Public green areas availability		(4)	ER
Solar power generation in public buildings		(5)	ER, SP
Underground/tram lines in the urban area		(4), (5)	ER, SP
Air quality		(4)	ER
Citizen participation		(2)	ED
Economic urban sustainability		(1)	ED
Ecosystem toxification	(4)	ER	
Energy consumption	(4)	ER	
Global climate	(4)	ER	
Green, public space and heritage	(4)	ER	
Housing quality	(6)	ED	
Social justice	(5)	SP	
Unique sustainability	(5)	ED, ER, SP	

Urban mobility/clean transport	(3), (5)	ER, SP
Urban safety	(5)	SP
Waste management	(4)	ER
Water consumption	(4)	ER

**Note:** (1) – economic situation, (2) – economic activity of the population, (3) – demographic factors, (4) – environmental factors, (5) – local government, (6) – residential real estate resources, (7) – housing market; ED – economic development, ER – environmental responsibility, SP – social progress.

**Source:** Own study.

Three supporting sub-hypotheses were then postulated.

*Hypothesis 1: Local housing market changes correlate with changes to the economy; regardless of market size, but to varying degrees.*

It not however sufficient to be solely restricted by economic factors at the national level in order to determine housing market development. If housing market development is to be solely influenced by macro-economic factors, then neither single market stakeholders nor single product or l and markets can so be accounted for, thus the effect of housing market locality would be excluded from any such consideration. Micro-economic and non-economic factors should therefore be also studied, which leads to two new hypotheses:

*Hypothesis 2: The smaller the local housing market, the more sensitive it is to changes in external conditions.*

*Hypothesis 3: Housing markets are to the greatest degree conditioned by local economic factors.*

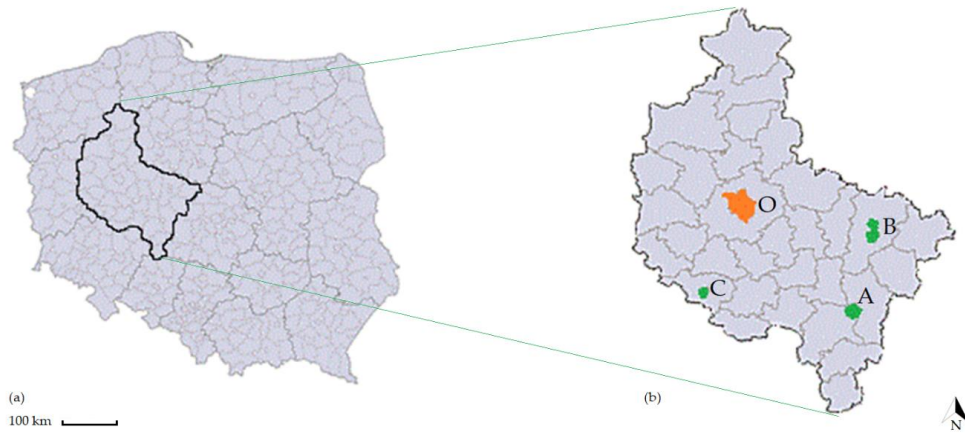
Our research allows us to find out which housing market development groups of factors and sustainable city development factors affect the housing price level in subregional cities. The analysis has proven that not all groups of sustainable development factors affect the level of housing prices – factors in the field of Economic development affect the price level in all analyzed cities, while Social progress and Environmental responsibility only in two out of three cases.

## 2. Materials and Methods

Local markets in subregional Polish cities were thus analysed in order to prove these hypotheses. The cities selected were from the Wielkopolskie Province (Figure 1), situated in north – western Poland whose entire area is 29,825.59 km<sup>2</sup> (9.5% of the country's total area). The provincial capital is Poznan, where dwell 15. 7% of the province's inhabitants. The province is divided into 35 districts (including 4 cities with district rights, such as Poznan, Kalisz, Konin and Leszno) and 226 sub-districts (19 urban, 91 urban-rural and 116 rural sub-districts). There are 111 towns in the Wielkopolskie Province, including 20 with more than 20 thousand inhabitants.



**Figure 1. (b)** Analysed cities in the Wielkopolskie Province within (a) the territory of Poland.



**Note:** O – Poznan (regional city), A – Kalisz (subregional city), B – Konin (subregional city) and C – Leszno (subregional city).

**Source:** Own study.

## 2.1 The Characteristics of Analyzed Local Markets

### 2.1.1 City A (Kalisz)

Kalisz city is seated in mid-western Poland. It is the second largest urbanised centre of the Wielkopolskie Province, and is the main city of the Kalisz–Ostrow conurbation, with over 350 thousand people. The following industries predominate: electrotechnical, electronic, precision-tool, mechanical, metal products, foodstuff, chemical, textile and clothing and construction materials. Other branches of industry deal with supplying electricity and mining. Service and retail trade industries are also well developed within the conurbation, since there are several large shopping centres with total leased surface areas of about 18 to 33 thousand m<sup>2</sup>, located in both city centres and outskirts. The city covers an area of almost 70 km<sup>2</sup> and constitutes a service – industrial centre, of great cultural interest, often going beyond the local and even regional scope and character of the city and province. Its spatial layout can be described as: many compact but ruined World War II tenement buildings in the city centre that have been rebuilt or restored (most often infill buildings) within the last decade.

Another existing zone of building complexes is not that compact, consisting of small housing estates from the 1960s, a few single-family areas and some manufacturing plants and storage facilities. The next zone comprises of housing estates, the so called dormitory zones in the western part of the city and lastly there are the outskirts; consisting of fragmented single – family housing, with farmlands (to the east, south and west) which also includes woodlands (mainly to the east).

### **2.1.2 City B (Konin)**

Konin is a city located in the middle part of Poland. It is the third largest city in the Wielkopolskie Province. Konin and its district make up a conurbation inhabited by over 200 thousand people. The mining industry (lignite) and electricity provider industry are predominant (Konin is Poland's second largest supplier of electricity obtained from lignite). Close proximity to a motorway offers convenient travelling. The city covers over 82 km<sup>2</sup> and is divided by a river into two functionally unrelated parts arising from an urban concept developed from the 1950s. Because of its lignite reserves, the city became an important industrial centre after World War II. In 1950 there were 12, 145 inhabitants and its territory was expanded in 1968, when small adjoining townships joined on. By 1970 there were 40, 744 inhabitants and the number of flats in the city was growing in keeping with the city's pace of development as witnessed by: in 1950 there were 4, 573 residential flats, in 1960, 301 flats, in 1970 11, 699 flats whilst in 1978 almost 16, 744 flats (Statistics Poland 1985).

### **2.1.3 City C (Leszno)**

Leszno also possesses district rights and is situated in western Poland. It is the seventh largest city in the Wielkopolskie Province with over 64 thousand inhabitants, covering an area of nearly 32 km<sup>2</sup>. Like the provincial capital (Poznan), the city provides many kinds of services, however the cultural fare on offer is rather poor. Throughout recent years, there has been a significant and continuous growth of the city as a trade centre of subregional character. The city has expanded after the World War II, where in 1950, 22,572 people were living in 6,021 flats whilst industries consisted of foodstuffs, metal products, mechanical and clothing and textiles. New housing estates were then built. In 1978, the city had 45 thousand inhabitants and 12,510 flats (Statistics Poland 2020). The main urban problem was a barrier created by a railway network separating the eastern and western (housing) parts of the city, thereby making access to the city centre inconvenient for most inhabitants.

### **2.1.4 A Comparison of the Analysed Cities**

As aforementioned, these cities are one of the largest in the Wielkopolskie Province, but all possess a subregional character and serve different functions: Cities A and B – industry and service, City C – only service. City A is the oldest city whilst City C is the youngest, where in contrast to the others, the population is rising; mainly due to the rate of natural increase. The populations are differentiated according to age: in Cities A and B >65 years-olds predominate, whilst those aged between 25-34 years are the most common dwellers in City C. Moreover, the old age indices in Cities A and B are much higher than in City C. The demographic situation found in these cities undoubtedly affects the development of the housing markets. Basic data is presented in Table 3.

**Table 3.** Basic data from the analyzed cities in 2014.

Category	Indicator	City A	City B	City C
Basic	Population	103,373	76,547	64,616
	Area in m <sup>2</sup>	69.42	82.20	31.86
	Population density (person/km <sup>2</sup> )	1,489	931	2,028
	Average monthly gross salary (PLN)	3,396	3,653	3,363
	National average salary = 100	84.8	91.2	84.0
	Unemployment rate (%)	6.8	12.4	6.7
Demography	Live birth	851↓	660↑	647
	Deaths	1,156↓	689↑	541↑
	Birth rate	-305↓	-29↑	106
	Marriages	405↑	451	288
	Divorces	220↓	189↑	142↑
	The old age index	133.5	136.4	106.8
Infrastructure	Community and district for 100 km <sup>2</sup>			
	Surfaced roads	282.8	185.6	430.3
	Dirt roads	121.3	16.7	184.2
	Community and district for 1 thousand inhabitants			
	Surfaced roads	19.0	19.9	21.2
	Dirt roads	8.1	1.8	9.1
Entrepreneurship	The number of enterprises	1,894.5	1,734.4	2,231.0
	For 1000 inhabitants in working age			
	The enterprises share in the total number of enterprises (%)			
	of employment			
	up to 9 people	95.1	94.8	94.4
	10-49 people	3.8	3.9	4.4
	50-249 people	0.9	1.1	1.0
	more than 250 people	0.1	0.1	0.1
Economy	The sales in industry (PLN/person)	23,288	34,355	27,958
	Number of the employed for 1000 inhabitants	317	304	341
	The average salaries rate	3395.84	3653.29	3362.89
Education	The number of students for 1000 inhabitants	55.6	42.0	48.0
Crime	Crime against life, health and property for 1000 inhabitants	20.9	12.5	12.2
Housing	The number of flats 2014	42,945	29,203	23,731
	Flats availability (flats for 1000 inhabitants)	415	382	367
	Flats deficit (the number of flats; thousand s)	1.5	2.0	1.8
	Average floor space (m <sup>2</sup> )	62.2	63.5	73.2
	Average floor space per capita (m <sup>2</sup> )	258	24.2	26.9
	Flats facilities:			
	Bathroom	94.2	97.8	96.7
	Water supply system	99.2	99.2	99.7
	Central heating	79.0	94.1	86.1
	People using the installations in % of total population:			
	Gas	70.5	33.1	88.4
	Sewage system	89.3	92.2	98.0
	Water supply system	97.3	97.4	98.6

**Note:** ↑ growing, ↓ decreasing.

**Source:** Own study on the data of (Statistics Poland, 2020).

## 2.2 Assumptions Adopted for the Research Method

Econometric methods are very often used to analyse housing markets (Meen, 2001; Mach, 2008; Foryś, 2014). This is a branch of economics that uses mathematical statistics models to find ways for describing and analyzing economic phenomena.

The role of econometrics can be described as an economic hypothesis for verifying and discovering new dependencies, which are created through constructing econometric models that describe the relationships between random variables with the help of stochastic equations. Such economic variables are always referred to as endogenous (dependent) variables, whereas independent variables may be non – economic in nature (Baltagi, 2007).

Explaining the influence of many independent variables on an dependent variable can be performed via multiple regression. The multiple regression equation is linear and is defined by the general equation:

$$Y = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \dots + \alpha_k X_k + \varepsilon \quad (1)$$

where:

Y – dependent variable (price per sq. m.),  
 $X_k$  – independent variables ( $k=1, 2, \dots, n$ ),  
 $\alpha_0$  – constant,  
 $\alpha_k$  – structural parameters of the model,  
 $k$  – the number of independent variables,  
 $\varepsilon$  – random component.

Multiple regression can be performed by the classical method of least squares but is conditioned by the following assumptions (Baltagi 2007):

- The model is linear (or has been reduced to a linear form).
- Independent variables (market features) are not randomly sized.
- No collinearity between independent variables.
- The random component is a variable, where mathematical expectation equals zero and the variance is constant.
- Observations are independent.
- The random component is not correlated with the independent variables
- The number of independent variables are smaller than the number of observations.
- There are no correlations between the random components of particular model equations.

These aforementioned methods and conditions were used for the analytical part of our study.

### 2.3 Factors Affecting the Housing Prices Level

We gathered data from the subregional cities during 2006-2014:

- Dependent variable (i.e., price per sq.m.) – primary data: 14 thousand transactions (of which there were about 8 thousand market ones),

- Independent variable – secondary statistical data on factors from the seven groups found to affect housing prices (Table 1).

We then removed those independent variables showing low variance (coefficients  $V \leq 0.10$ ), as well as those that insignificantly correlated with the dependent variable from the set of grouped factors. Next a correlation matrix was set up to eliminate mutually shared and strongly correlated independent variables. A time series model was developed for every analysed city, which shows the effect of independent variables on housing prices per given city during the study period, and are based on authoritatively choosing a maximum of two factors from the variables selected using the graphical method; preferably representing the groups highly significantly correlated with the dependent variable. The average price (PLN/m<sup>2</sup>) per given year, (representing the pricing in a particular city) is referred to as the dependent variable in the models created below. The study time unit is taken as one year throughout 2006 to 2014. By devising such econometric models using multiple regression, a linear correlation between single average property unit price and independent variables were thus postulated.

Multiple regression was then performed for each of the tested cities. A regression function was thereby calculated, where the price (understood as being the average unit price of residential real estate per annum) was treated as the dependent variable whilst the factors representing particular groups were treated as independent variables. The process for estimating model parameters used the method of ordinary least squares (OLS). Coefficients can be interpreted as how variables affect changes on price levels; if the average unit price changes (grows or declines), whilst the independent variable itself grows by a unit (to which the coefficient refers to). Verifying the model was performed by:

- Verifying the statistical significance of the effect of independent variables on the dependent variable.
- Calculating the coefficient of determination (i.e.,  $R^2$ ),
- Correcting  $R^2$  (i.e., corrected  $R^2$ ), non-withstanding the growing number of independent variables.
- Graphical examination of the model's values process.

### **3. Results**

The econometric models, explaining the tested cities' housing prices found on the secondary market during 2006 and 2014, were prepared after removing those factors strongly correlated with each other and choosing factors representative for a given group. Tables 4, 6, and 8 present correlation coefficients calculated between the independent variables in particular cities, whereas Tables 5, 7, and 9 present parameters and basic statistics from the constructed models. Additionally a variance

inflation factor (VIF) was calculated to detect multicollinearity in regression analysis.

In the final model created for the market in City A, the correlation relationship found between the variables was:

$$P(A) = -94.56X_{a_{2,2}} - 0.001X_{a_{5,6}} + 1.21X_{a_{6,5}} + 2.39X_{a_{6,7}} + 0.34X_{a_{7,1}} + 2679.78 \quad (2)$$

The absolute term can be interpreted as follows: the average price of residential real estate during the study period, assuming that the independent variables bear no influence; this being 2679.78 PLN/m<sup>2</sup>. The regression function parameters achieved statistical significance (at  $\alpha=0.05$ ) and corrected R<sup>2</sup> was 0.9891 (Tables 4 and 5):

**Table 4.** Correlation coefficient matrix variables for housing secondary market in City A from 2006 to 2014.

	P (A)	X <sub>a<sub>2,2</sub></sub>	X <sub>a<sub>5,6</sub></sub>	X <sub>a<sub>6,5</sub></sub>	X <sub>a<sub>6,7</sub></sub>	X <sub>a<sub>7,1</sub></sub>
P (A)	1.0000					
X <sub>a<sub>2,2</sub></sub>	-0.7642*	1.0000				
X <sub>a<sub>5,6</sub></sub>	-0.8093*	0.4394	1.0000			
X <sub>a<sub>6,5</sub></sub>	0.7523*	-0.3506	-0.5057	1.0000		
X <sub>a<sub>6,7</sub></sub>	-0.7569*	0.6548	0.6272	-0.4459	1.0000	
X <sub>a<sub>7,1</sub></sub>	0.9130*	-0.6143	-0.6291	0.5949	-0.5966	1.0000

**Note:** P (A) – housing price level in City A, 2006-2014; X<sub>a<sub>2,2</sub></sub> – the registered unemployment rate (%) in City A (Statistics Poland 2020); X<sub>a<sub>5,6</sub></sub> – the amount of paid housing allowances from community resources (Statistics Poland 2020); X<sub>a<sub>6,5</sub></sub> – overnight accommodation in hotels (Statistics Poland 2020); X<sub>a<sub>6,7</sub></sub> – the number of delivered communal housing (Statistics Poland 2020); X<sub>a<sub>7,1</sub></sub> – average prices of flats on secondary market in 10 cities (National Bank of Poland 2020);

\* statistically significant correlation for  $\alpha=0.05$ .

**Source:** Own study.

**Table 5.** Method of least squares estimation, the observations used 1-9, dependent variable: the housing price level (PLN/m<sup>2</sup>) on the secondary market in City A between 2006-2014,  $\alpha=0.05$ .

	Coefficient	Standard error	t- Student	Value p	VIF
const	2679.78	539.84	4.9640	0.0157	
X <sub>a<sub>2,2</sub></sub>	-94.5580	20.4573	-4.6222	0.0191	2.0690
X <sub>a<sub>5,6</sub></sub>	-0.0010	0.0001	-7.6930	0.0045	2.0584
X <sub>a<sub>6,5</sub></sub>	1.2050	0.1966	6.1292	0.0087	1.6365
X <sub>a<sub>6,7</sub></sub>	2.3910	0.8784	3.4000	0.0425	2.3769
X <sub>a<sub>7,1</sub></sub>	0.3390	0.0821	4.1291	0.0258	2.5452

**Note:** P (A) Arithmetic mean = 2466.68; P (A) Standard deviation = 446.74; Residual sum of squares = 6510.67; Standard residual error = 46.59; R<sup>2</sup> = 0.9980; Corrected R<sup>2</sup> = 0.9891; F (5, 3) = 146.54; Value p for test F = 0.0009;

**Source:** Own study.

The constructed model led to the conclusion that housing prices on the secondary market in City A between 2006 and 2014 were influenced by the following:

1. *Boosters:*

- Prices in City A rose by 2.39 PLN/m<sup>2</sup>, (group 6 indicator; residential real estate resources), when linked to the increasing number of rooms put into use as housing community units. The latter may have stimulated the housing prices on the secondary market, even though not applying to such people creating an effective demand for residential real estate on the free market. Account should be made of the relationship between the improvement to poor people's life conditions, (as and when the city authorities built or bought new flats), with the will to improve living conditions by those people not receiving financial support because of their better level of earnings. This may have stimulated the purchase of flats, thereby increasing prices due to such a demand. Nevertheless, other contributing factors can be also assumed to be responsible for this occurrence. Because there are no unequivocal explanations for the correlation between this phenomenon with the dependent variable (ie. price/m<sup>2</sup>), another factor was selected from the aforementioned group; the number of overnight accommodation units from City A, which were considered to enhance this effect. When including the increasing amounts of these units, prices grew by 1.21 PLN/m<sup>2</sup> on average. Thus the increasing amounts of overnight accommodation considered as an investment may be the driver that meets the demand for such services, thereby leading to increased overall demand for flats. It should be noted that overnight accommodation services are attractive not only for tourists or people on business trips, but also for students who make use of such facilities, especially during weekends.
- On average, unit prices in City A rose by 0.34 PLN/m<sup>2</sup>, when linked to residential real estate unit price increases in the secondary market (10 cities); this rate being slower than those cities used as reference. This factor belongs to group 7; the housing market, which when taken at the national level, stimulates prices at the local level. Such details on prices are generally available in publications inter alia from the National Bank of Poland (NBP). Market stakeholders are thus well acquainted in the situation of large housing markets. The decisions made by buyers to accept purchase offers depends to some extent on the situation of housing markets in the bigger cities.

2. *Inhibitors:*

- On average, prices decreased by 94.56 PLN/m<sup>2</sup> (group 2 indicator; economic activity of people at the local level), when linked to the rise of registered unemployed (%) per unit. This unemployment rate, changes the potential demand (ie. the more unemployed people, the lower the potential demand) or supply (job and livelihood losses leading to some flat owners (especially those mortgaged) to sell up because of unaffordable maintenance costs. In both situations prices would fall.

- On average, prices decreased by 0.001 PLN/m<sup>2</sup> (group 1 indicator; economic factors) when linked to paid housing allowances (per unit) from community resources in City A. It so refers to people who do not own their flat and potentially create a demand for flats. The poorer this group is, the greater is the need to lend assistance in financing flat maintenance costs, whilst at the same time their chances for buying their own flat are thus lower; this being directly related to the decrease in potential demand.

The model described herein does not take into consideration the effect of the following factors between 2006 and 2014: from group 3; demographic factors, from the group 4; environmental factors and from the group 5; local government. These factors were not differentiated much according to the period's duration and were removed during the first stage, including those significantly correlated with the factors from the other groups; accepting these as independent variables could lead to the wrong conclusions about real estate prices.

The final model created for the market in City B, gives a correlation between the variables as follows:

$$P(B) = 186.61 X_{02.2} + 1.13 X_{07.1} - 4811.47 \quad (3)$$

Parameters in this regression model showed statistical significance at  $\alpha < 0.05$  and the corrected  $R^2$  was 0.9092 (Tables 6 and 7):

**Table 6.** Variables correlation coefficient matrix for housing secondary market in City B from 2006 to 2014.

	P (B)	Xb <sub>2.2</sub>	Xb <sub>7.1</sub>
P (B)	1		
Xb <sub>2.2</sub>	0.7305*	1	
Xb <sub>7.1</sub>	0.7148*	-0.5060	1

**Note:** P (B) – housing price level in City B, 2006-2014; Xb<sub>2.2</sub> – the registered unemployment rate in City B (Statistics Poland 2020); Xb<sub>7.1</sub> – average prices of flats on secondary market in 10 cities (National Bank of Poland 2020);

\* statistically significant correlation for  $\alpha = 0.05$ ;

**Source:** Own study.

**Table 7.** Method of least squares estimation, the observations used 1-9, dependent variable: the housing price level (PLN/m<sup>2</sup>) on the secondary market in City B between 2006-2014,  $\alpha = 0.05$ .

	Coefficient	Standard error	t-Student	Value p	VIF
const	-4811.47	895.7941	-5.3712	0.0030	
Xb <sub>2.2</sub>	186.6100	35.8558	5.2045	0.0035	1.3442
Xb <sub>7.1</sub>	1.1300	0.1344	8.4214	0.0004	1.3443

**Note:** P (B) arithmetic mean = 2446.84; P (B) Standard deviation = 496.36; Residual sum of squares = 297,332.8; Standard residual error = 153.69;  $R^2 = 0.9352$ ; Corrected  $R^2 = 0.9092$ ;  $F(2, 5) = 36.0540$ ; Value p for test  $F = 0.0011$ .

**Source:** Own study.



On the basis of the constructed model it is possible to conclude that the residential real estate price on the secondary market in City B between 2006 and 2014 was influenced by:

1. *Boosters:*

- On average, prices increased by 186.61 PLN/m<sup>2</sup> in City B when linked to rising unemployment rates (%) (group 2 indicator: people's economic activity). Increased unemployment rates, especially in the long term, may result in decreased demand but in contrast this may contribute to the trend of downsizing (ie. changing a flat to a smaller one, with lower maintenance costs), which can keep demand at the same level. Nonetheless, supply increased when prices rose. The rate of growing unemployment may also decrease investment, shifting the demand from the bigger and more expensive houses sector or the flats sector, also resulting in rising prices.
- On average, prices grew by 1.13 PLN/m<sup>2</sup> when linked to increased unit prices of flats (per unit) on the secondary market in 10 cities (group 7 indicator; the housing market). Rises in the housing market prices in Poland may have resulted in setting higher and acceptable offer prices in City B.

This model does not take into account the effect of the following factors between 2006 and 2014: from group 1: economic factors, from group 3: demographic factors, from group 4: environmental factors, from group 5: local government and from group 6: housing resources. These factors were not differentiated greatly according to the period's duration and were removed during the first stage, including those significantly correlated with the factors from the other groups – once again, accepting these as independent variables could lead to wrong conclusions about real estate prices.

The final model created for the market in City C, gives a correlation between the variables as follows:

$$P(C) = 0.65 X_{c1.1} + 9.69 X_{c2.1} - 0.61 X_{c5.7} + 0.03 X_{c6.5} + (0.13 X_{c7.1}) \quad (4)$$

The absolute term for the City C expression does not exist because it was statistically insignificant. Parameters for the regression function showed statistical significance at the level of  $\alpha=0.05$  and the corrected  $R^2$  was 0.9939 (Tables 8 and 9):

**Table 8.** Variables correlation coefficient matrix for housing secondary market in City C from 2006 to 2014.

	P (C)	X <sub>c1.1</sub>	X <sub>c2.1</sub>	X <sub>c5.7</sub>	X <sub>c6.5</sub>	X <sub>c7.1</sub>
P (C)	1					
X <sub>c1.1</sub>	0.6711*	1				
X <sub>c2.1</sub>	-0.9526*	-0.5919	1			
X <sub>c5.7</sub>	0.7460*	0.4553	-0.6253	1		
X <sub>c6.5</sub>	0.8086*	0.3994	-0.6192	0.4845	1	

$$\frac{X_{c7.1} \quad -0.7122^* \quad -0.1412 \quad 0.2048 \quad 0.0094 \quad -0.6176 \quad 1}{}$$

**Note:**  $P(C)$  – housing price level in City C, 2006-2014;  $X_{c1.1}$  – Wage level (PLN) in City C (Statistics Poland 2020);  $X_{c2.1}$  – number of registered businesses (Statistics Poland 2020);  $X_{c5.7}$  – the amount of paid housing allowances from private resources (Statistics Poland 2020);  $X_{c6.5}$  – quality of the resources – individual usable floor area (Statistics Poland 2020);  $X_{c7.1}$  – average prices of flats on secondary market in 10 cities (National Bank of Poland 2020); \* statistically significant correlation for  $\alpha=0.05$ ;

**Source:** Own study.

**Table 9.** Method of least squares estimation, the observations used 1-9, dependent variable: the housing price level (PLN/m<sup>2</sup>) on the secondary market in City C between 2006-2014,  $\alpha=0.05$ .

	Coefficient	Standard error	t-Student	Value p	VIF
const	653.50	633.25	1.0320	0.3780*	
$X_{c1.1}$	0.6538	0.0691	9.4653	0.0025	2.4909
$X_{c2.1}$	9.6898	1.8720	5.1761	0.0140	1.9884
$X_{c5.7}$	-0.6088	0.0642	-9.4836	0.0025	3.1504
$X_{c6.5}$	0.0327	0.0051	6.3759	0.0078	2.0459
$X_{c7.1}$	0.1330	0.0668	1.9732	0.1403*	1.5722

**Note:**  $P(C)$  Arithmetic mean = 2435.40;  $P(C)$  Standard deviation = 602.25; Residual sum of squares = 6681.42; Standard residual error = 47.1926;  $R^2 = 0.9988$ ; Corrected  $R^2 = 0.9939$ ;  $F(5, 3) = 259.97$ ; Value p for test F = 0.0004;

\* lack of statistical significance on significance level  $\alpha=0.05$ .

**Source:** Own study.

Using the constructed model it can be concluded that the residential real estate price on the secondary market in City C between 2006 and 2014 was influenced by:

#### 1. Boosters:

- Prices increased by 0.65 PLN/m<sup>2</sup> per unit linked to a rise in average earnings (PLN), (group 1 indicator; economic factors) This increase in purchasing power may cause a rising demand and at the same time rising prices. On average, prices rose by 9.69 PLN/m<sup>2</sup> when linked to the growing (per unit) number of enterprises newly registered into REGON (National Business Registry Number) per 10 thousand inhabitants in City C (group 2 indicator; people's economic activity). Such increased economic activity elevates purchasing power, which may generate a higher demand for flats and subsequently increased prices.
- Prices rose by 0.03 PLN/m<sup>2</sup> when linked to the growth (per unit) of floor area put individually into use in City C (group 6 indicator; housing resources). The trend for increased individual investments may lead to these being improved or be imitated according to purchasing abilities. As a consequence this may lead to a rising demand for flats and thereby increased prices.
- Prices in City C grew by 0.13 PLN/m<sup>2</sup> when linked to the increased unit average prices of flats on the secondary market in 10 cities (group 7 indicator; housing market). Despite achieving statistical significance ( $p < 0.05$ ), it was included in the model (on the basis of taking  $\alpha=0.05$ , to be at a 85% confidence

level). The market price growth in Poland's big cities resulted in disproportionate price increase in City C.

2. *Inhibitors:*

- On average, prices decreased by 0.61 PLN/m<sup>2</sup> when linked to the growth of paid housing allowances (per unit) from private resources in City C, (group 5 indicator; local government). Having to pay housing allowances reflects an adverse economic situation for flat owners, probably caused by decreased earnings, which may result in falling demand and decreased prices.

The above model does not account for the effect of the following factors between 2006 and 2014: demographic factors from group 3 and environmental factors from the group 4. These factors were not differentiated greatly according to the period's duration and were removed during the first stage, including those significantly correlated with the factors from the other groups; accepting these as independent variables could again lead to wrong conclusions about real estate prices. Results were statistically significant at the  $\alpha=0.05$  level, meaning there was a 5% error. Referring to sustainable city development factors, our three-equation model has proven that Economic development factors affect housing price levels in all the analyzed cities while Social progress and Environmental responsibility explain the change in the housing price level only in two out of three cases (City A and City C).

The model coefficients determined for the respective cities were:  $R^2(A)=0.9980$ ,  $R^2(B)=0.9352$ ,  $R^2(C)=0.9988$ . All the constructed models account for over 90% of the transactional price level variation. Corrected determination coefficients, (resistant to the growing number of independent variables) were respectively: Corrected  $R^2(A)=0.9891$ , Corrected  $R^2(B)=0.9092$ , Corrected  $R^2(C)=0.9939$ . The constructed models account for over 90% of the transactional price level variation. A variance inflation factor (VIF) was calculated to detect multicollinearity in regression analysis. VIF range from 1 upwards (1 – not correlated, between 1 and 5 – moderately correlated, greater than 5 – highly correlated). The results show that VIFs are between 1.34 and 3.15, so we can rely on regression results.

#### **4. Discussion**

Our study has indeed verified that changes arising in local housing markets share in common the same Sustainable city development factors (Vanags and Butane, 2013; Kauškale and Geipele, 2017), however the scale of their effects and response times depend on local conditions. This has been shown by identifying seven groups found to impact local markets in terms of unit price change, these being: economic circumstances, people's economic activity, demography, environmental factors, local government, housing resources and the housing market. In most groups, these factors strongly and significantly correlated with the price levels in the cities investigated. Price levels were correlated to the economic factors group in terms of average gross earnings (PLN). In respect to people's economic activity, the

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association between the registered unemployment rate (%) and businesses freshly incorporated into the REGON registry were significant. It was found that some demographic and environmental factors correlated with price levels, however they were not included in models explaining the price levels in the tested cities. The prices were also influenced by local government paying housing allowances.

Housing resources also explained city prices; the number of rooms per flat, the size area and overnight accommodation were significant factors. An effect of housing market factors on the housing prices on the secondary market was linked with housing prices in the biggest cities. It was proven that prices in markets from the largest cities made a positive impact on prices in our studied subregional cities.

Our analysis confirms the research carried out earlier, which indicates the impact of sustainable city development factors of 'geographically bounded' small urban areas on housing prices. However, it is important that the sustainability of an area cannot be examined in isolation, but in relation to wider aspects of sustainability and cities (Rosen, 2017).

Research conducted in Polish biggest cities show that increase in housing prices are driven by fundamental factors such as an increasing number of marriages, rising incomes, and accelerated migration to cities. In small and medium-sized cities the spread of high prices is not so common, the expectations related to the situation in major markets are delayed (Łaszek, 2011). Our study has confirmed that changes in subregional housing markets are influenced by common factor groups, however the scale of each factor varies. The smaller the local market is, the more it responds to changes in external conditions.

Moreover, the response time of local markets is different, which is especially noticeable in changing prices within intervals of less than a year (quarters): in City A, prices grew rapidly from the third quarter of 2006 to approximately mid- 2008, followed by a readjustment and then a price rise again. In City B, prices grew rapidly from the first quarter of 2006 to mid-2008, followed by a small readjustment and then an insignificant increase from 2012. Finally in City C, prices grew rapidly from the first quarter of 2007 to the beginning of 2008 and afterwards stabilised.

We found that our postulated hypothesis 1 was valid; ie. that changes in local housing markets are positively correlated with changes in the economy; regardless of market size. Price levels in our tested cities were correlated with the gross domestic product, average gross monthly salary, sales in industry, the goods and services price indicator, construction firm building and mounting production, along with other contributing factors. Additionally, it can be noticed that in the analyzed subregional cities, the influence of local economic factors varies in degrees. The influence of local economic factors is the largest in city B, which is in a poor economic condition, and the smallest in city C, with good economic condition.

Economic factors at the national level, are not however just solely responsible for determining housing market development. If this development had been only influenced by macro-economic factors, then factors such as single market stakeholders, single products or 1 and markets would be omitted and thus it would not be possible to talk about any housing market locality. Micro-economic and non-economic factors should be also studied, which leads onto hypothesis 2. i.e., the smaller the local housing market, the more it reacts to the changes in external conditions; likewise, this has been positively verified. A detailed analysis of transactions within the housing secondary market showed that the housing market in City B is the smallest and is the most influenced by external factors. In contrast, the housing market in City C constitutes the biggest sector of the secondary market and here, the influence of external factors is the weakest.

Finally, hypothesis 3 was also positively verified, i.e., housing markets are conditioned to the greatest extent by local economic factors. The most highly significant correlation with housing prices was found in the following local economic factors: level of earnings, peoples' economic circumstances, working activity and unemployment rate, and sales in industry. Moreover, the created models demonstrated that these economic factors bear the strongest influence on prices.

A correlation between housing prices and non-economic factors was also observed as follows: a changing population according to birth rates and migrations, natural environment quality, the size and growing number of housing resources and price levels in other local housing market sectors as well as in the local markets of big cities. The housing market is also affected by the real estate sale prices, however access to detailed and reliable information is limited, thus any comprehensive description cannot be made.

In order to gain a deeper and broader understanding of residential real estate markets and their governing mechanisms, further studies are possible on local housing markets in all the cities with district rights over a long period of time. This would both help to determine the housing situation of particular cities and discover the underlying trends in local markets by employing various methodologies. Comparing several cities would enable cluster analysis to identify those markets which are the most similar and diversified as well as providing statistical data and spatial econometrics (econometric models for panel data). This would also include using other methods for analysing the ongoing processes in local markets. Finding mutual spatial correlations between the neighbourhood units would also be interesting, i.e. the interaction between city housing markets with the district rights and neighbouring communities.

## **5. Conclusions**

Our study has determined the characteristics of the local housing market, however its detailed analysis is a complex matter. The limited access to the necessary

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information and overcoming all kinds of obstacles would incur huge costs and are time consuming in order to correctly establish what the prices are of residential real estate and its surroundings. Furthermore, stakeholders are not always willing to share detailed information and just provide the bare minimum as required by law.

The literature on this subject area, as well as our own studies show that the housing market cannot be treated as being homogenous at a national level. This market possesses local characteristics and therefore should be analysed at the level of cities, communities and districts. Some correlations have been found between the local markets; usually the larger markets especially influence the smaller ones, shaping, amongst other things, the price level. Moreover, factors that impact certain markets are many and varied, but the same ones will not necessarily be of the same critical significance. Some factors are common to local markets, and are often factors of supra-local (national) character, such as, interest rates, loans availability, national housing policy, peoples' expectations and propensities (such as making investments) and general levels of real estate prices. They are often the determinants of demand and supply and indirectly prices. The effects of macro scale factors is, however, not decisive to the situations in local markets, otherwise they would all react in identical fashion. This study has thus identified those local factors, that typically impact on particular housing markets.

Our models however have several limitations. The basic problem we face when analyzing housing prices is limited access to reliable information, high cost and the difficulty of obtaining it. This means that the theoretically applicable research methods will not work in practice. This study examined the impact of the previously identified groups of Sustainable city development factors on the housing prices level in local markets. The price level was defined as the arithmetic mean of unit prices. A good way to determine the housing price level would be a hedonic price, but the inaccessibility of information about the features of apartments (especially the Standard and equipment, layout, view from the window, noise level, etc.) make hedonic prices not always reliable.

Another limitation is the relationship between the sustainable development factors and the level of housing prices in thin markets. In case of few transactions, it is difficult to say that the average price, median or hedonic price represents a reliable price level. Our research can be therefore conducted in the markets of medium and large cities, but not necessarily in small cities. Moreover, the applied method assumes that there is a linear dependence between the unit housing price level and the sustainable development factors in subregional cities. It is difficult to assess if this assumption is correct. In further research, we can build other models, such as log-linear, and check whether they explain the volatility of housing prices to a greater extent. Nevertheless, the study outcomes can be readily used to help more accurately plan housing investments for real estate developers or planning authorities responsible for housing policy.

In future research, we will extend the area of analysis to other subregional cities in Poland to check whether our hypotheses can be positively verified in other local markets, including cities located in provinces characterized with a different level of economic development. Perhaps interesting conclusions can also be drawn from the analysis of local cities that are smaller than subregional ones.

Looking at the results of multiple regression, it can be seen that the assumptions we made regarding the model, allowing to select a maximum of two factors representing a each group of housing market development factors, may distort the image of the impact of individual groups of factors on the price level. We can consider the construction of synthetic indicators describing each of the groups of housing market development factors and check whether a the group of factors has an impact on the price level. Then we should log the indices and prices. We can also consider using other methods, including: Multivariate Adaptive Regression Splines (MARSplines), Generalized Additive Methods, Multilayer Perception (MLP) or Radial Basic Function.

## **References:**

- Abelairas-Etxebarria, P., Astorkiza, I. 2020. Space-Time Analysis of Migrations, Employment, and Housing as A Basis for Municipal Sustainable Urban Planning. *Sustainability*, 12, 2473.
- Baltagi, B.H. 2007. *Econometrics*. Springer Science and Business Media.
- Batóg, J., Foryś, I., Gaca, R., Głuszak, M., Konowalczyk, J. 2019. Investigating the impact of airport noise and I and use restrictions on house prices: Evidence from selected regional airports in Poland. *Sustainability*, 11, 412.
- Bernstein, S.J., Mellon, W. G. 2013. *Selected Readings in Quantitative Urban Analysis*. Pergamon Press, Oxford, New York, Toronto, Sydney, Paris, Frankfurt.
- Cellmer, R., Belej, M., Konowalczyk, J. 2019. Impact of a Vicinity of Airport on the Prices of Single-Family Houses with the Use of Geospatial Analysis. *ISPRS Int. J. Geo-Inf.*, 8, 471.
- Cellmer, R., Trojanek, R. 2020. Towards Increasing Residential Market Transparency: Mapping Local Housing Prices and Dynamics. *ISPRS Int. J. Geo-Inf.*, 9, 2.
- Chen, J. 2013. Housing Tenure, Residential Mobility and Adolescents' Education Achievement: Evidence from Sweden. *Annals of Regional Science*, 50(1), 275-294.
- Cheng, Y., Dagsvik, J.K., Han, X. 2014. Housing policy and housing demand. *Pacific Economic Review*, 19, 237-253. doi:10.1111/1468-0106.12062
- China Urban Sustainability Index, Urban China Initiative. Available online: <http://www.urbanchinainitiative.org/en/resources/report.html>.
- City Blueprint Waternet Amsterdam, KWR Water Cycle Research Institute. Available online: <https://www.kwrwater.nl/en/toolsproducten/city-blueprint/>.
- Dziauddin, M.F., Ismail, K., Othman, Z. 2015. Analysing the Local Geography of the Relationship Between Residential Property Prices and Its Determinants. *Bulletin of Geography, Socio-economic Series*, 28(28), 21-35.
- EEA Urban Metabolism Framework, European Environment Agency. Available online: <http://ideas.climatecon.tuberlin.de/documents/wpaper/CLIMATECON-2011-01.pdf>.

- European Green Capital Award, European Commission. Available online: <http://ec.europa.eu/environment/europeangreencapital/about-the-award/>.
- European Green City Index, Economist Intelligence Unit, Siemens. Available online: [http://www.siemens.com/press/pool/de/events/corporate/2009-12-Cop15/European\\_Green\\_City\\_Index.pdf](http://www.siemens.com/press/pool/de/events/corporate/2009-12-Cop15/European_Green_City_Index.pdf).
- European Green City Tool, European Union. Available online: <http://ec.europa.eu/environment/urban/tool.htm>.
- European Green Leaf Award European Union Available online: <http://ec.europa.eu/environment/europeangreencapital/europeangreenleaf/>.
- Foryś, I. 2014. Selected Demographic Aspects of Buyers' Activity on the Local Housing Market. *Real Estate Management and Valuation*, 22(4), 92-104.
- Hochstenbach, C., Arundel, R. 2020. Spatial housing market polarisation: National and urban dynamics of diverging house values. *Trans Inst Br Geogr.*, 45, 464-482. <https://doi.org/10.1111/tran.12346>.
- Isaac, D. 2002. *Property Valuation Principles*, Publisher: Palgrave, London.
- Kauškale, L., Geipele, I. 2017. Integrated approach of real estate market analysis in sustainable development context for decision making. *Procedia Engineering*, 172, 505-512.
- Kazak, J.K., Chruściński, J., Szewrański, S. 2018. The Development of a Novel Decision Support System for the Location of Green Infrastructure for Stormwater Management. *Sustainability*, 10, 4388.
- Kempa, O., Krajewska, M., Palicki, S., Rącka, I., Wójta-Kempa, M. 2015. Students' preferences on the residential real estate market in polish cities. *Real Estate Management and Valuation*, 23(1), 90-102.
- Kisiała, W., Rącka, I. 2021. Spatial and Statistical Analysis of Urban Poverty for Sustainable City Development. *Sustainability*, 13, 858.
- Lim, J. 2017. Out-migration from the epicenters of the housing bubble burst during and in the aftermath of the Great Recession in the USA. *Annals of Regional Science*, 59 (2), 297-319.
- Liu, F., Min, M., Zhao, K., Hu, W. 2020. Spatial-Temporal Variation in the Impacts of Urban Infrastructure on Housing Prices in Wuhan, China. *Sustainability*, 12, 1281.
- Lund, B. 2014. *Understand Housing Policy*, Second Edition, Publisher: Policy Press, Bristol.
- Łaszek, J. 2011. Recent Developments in the Housing Market in Poland. *Housing Finance International*, 25(4), 6-15.
- Mach, Ł. 2008. Econometric model structure as a support tool in real property market parameters featuring, *Annals of DAAAM and Proceedings*, 771-773.
- Mach, Ł., Rącka, I. 2018. An analysis of the impact and influence of the global economic crisis on the housing market in European post-communist countries, *Proceedings of the 32nd International Business Information Management Association Conference (IBIMA)*, Seville Spain, 15-16 November 2018. Publisher: International Business Information Management Association (IBIMA), 2018, 2573-2584.
- Meen, G. 2001. *Modelling Spatial Housing Markets. Theory, Analysis and Policy*. *Advances in Urban and Regional Economics*, 2.
- Mora-Garcia, R.T., Cespedes-Lopez, M.F., Perez-Sanchez, V.R., Marti, P., Perez-Sanchez, J.C. 2019. Determinants of the Price of Housing in the Province of Alicante (Spain): Analysis Using Quantile Regression. *Sustainability*, 11, 437.



- Nappi-Choulet, I., Maury, T.P.A. 2011. Spatial and Temporal Autoregressive Local Estimation for the Paris Housing Market. *Journal of Regional Science*, 51, 732-750. doi:10.1111/j.1467-9787.2011.00713.x.
- National Bank of Poland. Available online: <http://nbp.pl>.
- Ranci, C., Brandsen, T., Sabatinelli, S. (ed.). 2014. *Social Vulnerability in European Cities: The Role of Local Welfare in Times of Crisis (Work and Welfare in Europe)*. Palgrave Macmillan, London.
- Rączka, I., Palicki, P., Kostov, I. 2015. State and Determinants of Real Estate Market Development in Central and Eastern European Countries on the Example of Poland and Bulgaria. *Real Estate Management and Valuation*, 23(2), 77-90.
- Reference Framework for Sustainable Cities (RFSC), RFSC. Available online: <http://www.rfsc.eu/>.
- Rodrigues, M., Franco, M. 2020. Measuring the urban sustainable development in cities through a Composite Index: The case of Portugal. *Sustainable Development*, 28, 507-520. <https://doi.org/10.1002/sd.2005>.
- Rosen, M.A. 2017. Sustainable Development: A Vital Quest. *European Journal of Sustainable Development Research*, 1, 2.
- Statistics Poland. Available online: <https://stat.gov.pl/>.
- Statistics Poland. 1985. *Zmiany administracyjne miast 1945-1984 (Administrative changes of the cities 1945-1984)*, Warszawa.
- Stover, M.E. 1986. The Price Elasticity of the Supply of Single-family Detached Urban Housing. *Journal of Urban Economics*, 20(3), 331-340.
- Strezov, V., Evans, A., Evans, T.J. 2017. Assessment of the Economic, Social and Environmental Dimensions of the Indicators for Sustainable Development. *Sustainable Development*, 25, 242-253. doi: 10.1002/sd.1649.
- Sun, X.J., Tsang, K.P. 2018. The impact of monetary policy on local housing markets: Do regulations matter? *Empirical Economics*, 54(3), 989-1015. DOI: 10.1007/s00181-017-1255-0.
- Torben, K. 2018. Housing is local: Applying a dynamic unobserved factor model for the Dutch housing market. *Economics Letters*, 170, 79-84. DOI: 10.1016/j.econlet.2018.05.037.
- Turcu, C. 2012. Local experiences of urban sustainability: Researching Housing Market Renewal interventions in three English neighbourhoods. *Progress in Planning*, 78, 101-150.
- Urban Ecosystem Europe - Informed Cities, International Council for Local Environmental Initiatives (ICLEI), Ambiente Italia. Available online: <http://informedcities.eu/>.
- Vanags, J., Butane, I. 2013. Major Aspects of Development of Sustainable Investment Environment in Real Estate Industry. *Procedia Engineering*, 57, 1223-1229.
- Widłak, M., Łaszek, J. 2016. Milestones of Housing Finance in Poland. In: *Milestones in European Housing Finance*, eds, J. Lunde, C. Whitehead. doi:10.1002/9781118929421.ch17.
- Wilson, P., White, M., Dunse, N., Cheong, C., Zurbruegg, R. 2011. Modelling price movements in housing micro-markets: Identifying the long-term and short-term components in local housing market dynamics, *Urban Studies*, 48(9), 1853-1874. DOI: 10.1177/0042098010380960.