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SPATIAL ANALYSIS OF RESIDENTIAL RETURN RATES IN THE LARGEST CITIES OF POLAND

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Summary

The rate of return on residential property is determined by a number of factors of a diverse nature, including macroeconomic conditions, the level of investment risk, the specifics of the local market and the structural characteristics of the property in question. One of the key elements influencing the spread of returns at the local level is location. However, the consideration of the impact of location in rate of return analyses faces significant methodological difficulties due to limitations in traditional calculation methods and analytical models, which generally do not relate to space. This research concerns the spatial analysis of residential property rates of return in Poland's largest cities using geographically weighted regression. The method used allowed the spatial heterogeneity of the relationship between income and price to be identified, which formed the basis for the development of maps showing the spatial distribution of rates of return for the local market area.

Methods

The study used a log-linear mixed geographically weighted regression model. Simple GWR model can be represented as:

$$y_i = \beta_0(u_i, v_i) + \sum_{k=1}^{p} \beta_k(u_i, v_i)\, x_k + \varepsilon_i$$

where (u_i, v_i) defines the location expressed in terms of the coordinates u_i and v_i.

Local GWR regression coefficients may have varying degrees of variability across the study area. Some may be viewed as constant, while others may be local (non-stationary). A mixed model of the MGWR can be expressed as follows:

$$\mathrm{y} = \mathrm{X}_a \mathrm{a} + \mathrm{X}_b \mathrm{b} + \varepsilon$$

where y is a vector of the explained (dependent) variable, X_a is a matrix of global variables and a is a vector of global coefficients, X_b is a matrix of local variables and b is a matrix of local coefficients.

In the MGWR model, some of the coefficients are treated as global (constant throughout the area under analysis) and some as local (location-specific variables).

Data

The data for the analyses comes from the website oferty.net and concerns both flats offered for sale (approx. 28,000) and for rent (approx. 5,000). Data extracted January 2025.

Model

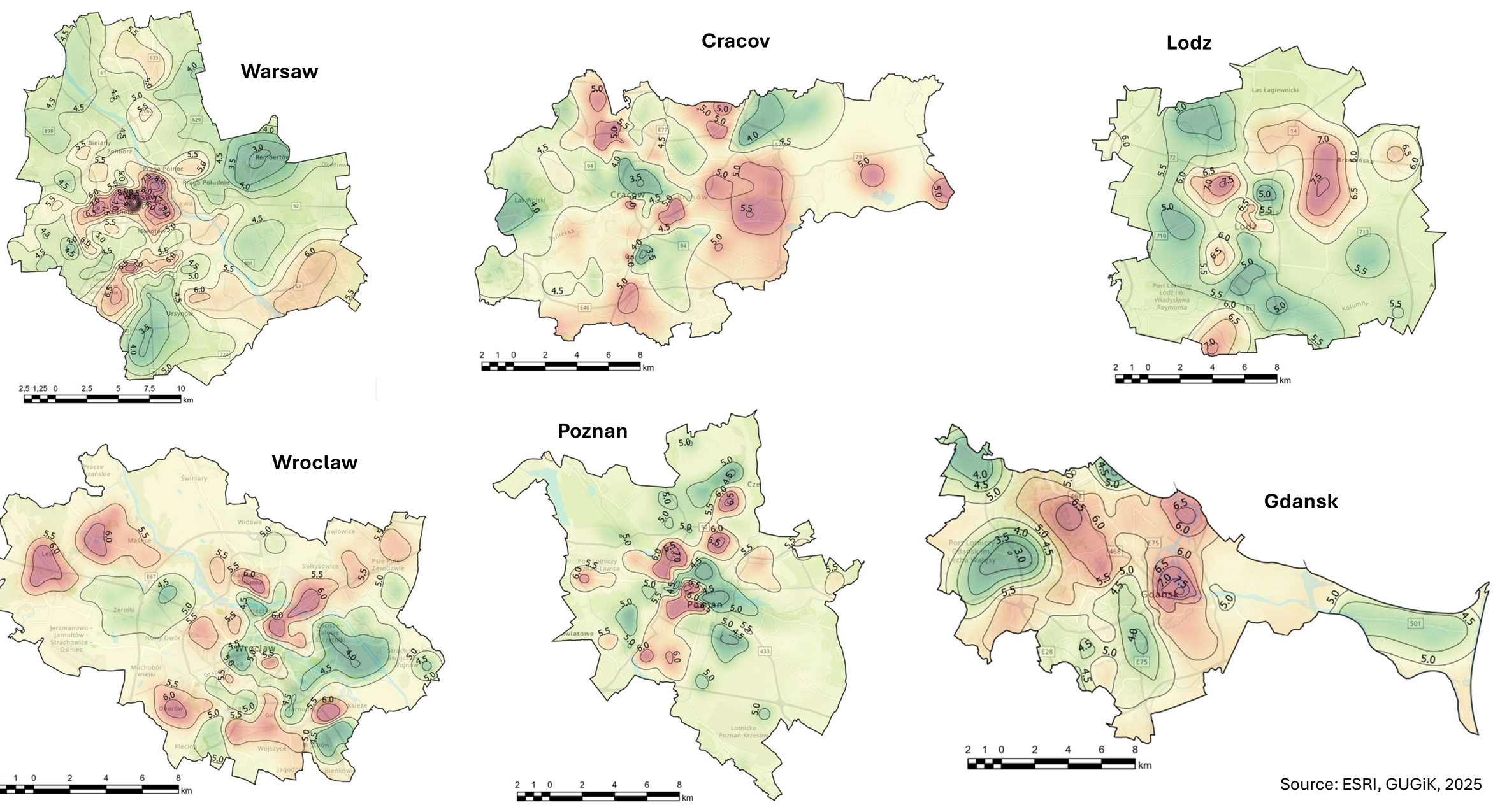
A MGWR model of the following form was used for the study:

$$\ln Y = \beta_0 + \beta_1 \cdot AREA + \beta_2 \cdot YEAR + \beta_3(u_i, v_i) \cdot RENT + \varepsilon$$

where Y is the sale price or the annual rent, *AREA* is the area of the property (global variable), *YEAR* is the year of construction (global variable), and the binary variable *RENT* indicates whether the property is offered for rental (local variable). The coefficient β_3, when recalculated: R = exp(β_3) directly indicates the rate of return as the relationship between income and property price.

Results

Residential real estate rates of return in the largest cities in Poland



Conclusions

The use of a geographically weighted mixed regression model (MGWR) enabled local variations in the relationship between rental income and property price to be captured. The observed local differences indicate that the level of investment risk and the profitability of residential investment can be influenced by factors such as demographic structure, housing density and local regulations.

Models based on listing data, despite their limitations, provide important information on market trends, especially in the context of limited access to actual transaction data. The analysis points to the need for micro-spatial snapshots of profitability that can better support investment decisions than traditional analyses aggregated at the city or regional level.