

THE EFFECT OF MACROECONOMIC FACTORS ON CHANGES IN REAL ESTATE PRICES – RESPONSE AND INTERACTION

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Abstract. In most European real estate markets, in the last decade, rapid changes in property prices, both upward and downward, were observed. Those fluctuations can be attributed to changes in economic and social factors that affect the property market. The aim of this study was to determine how housing prices are changing under the influence of macroeconomic factors. A multiple regression model was developed for a quantitative analysis of correlations between control variables and the market state variable. The model was modified by accounting for lag values determined for each variable. The results of the study suggest that during periods of instability, the real estate market is a driver of social and economic changes.

Key words: real estate market, macroeconomic factors, lag

INTRODUCTION

The fulfillment of housing needs is one of the fundamental human desires. According to Maslov's hierarchy of needs, housing satisfies the basic physical requirements for safety and survival as well as the need for social contact, esteem and self-actualization. Housing fulfills a broad spectrum of needs, which implies that the property market, where housing resources are transferred, affects the behavior of individuals as well as the entire society.

The real estate market is a system of cross-correlated market participants who offer and exchange properties by transferring the rights to own and use that property under specific market conditions [Kałkowski 2003]. The property market is connected to the business and social environment by a system of communicating vessels. Stagnation in one of the segments and lack of communication between the sectors have a negative

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impact on the remaining elements of the system [Foryś 2011]. As a recipient of signals generated in the market environment, the property market also generates signals that affect the environment. This leads to mutual feedback, and both the property market and its environment respond strongly to changes in those signals. This process is inseparably connected with time: signals of different type and strength as well as different responses of the property market and its environment are encountered in every unit of time. The above implies that the property market is an open system capable of exchanging signals with other open systems. It is also a dynamic system which indicates that its evolution over time can be described mathematically [Ott 1997].

By sending signals to the environment and receiving feedback, the real estate market undergoes structural transformation in time. If the system's sensitivity threshold to external stimuli is exceeded, it becomes destabilized and moves from a nearly balanced state to a state that is far from equilibrium. This behavior is indicative of market instability: in the process of adapting to environmental stimuli, the market rapidly changes its structure.

Considerable changes in real estate prices were observed on the Polish housing market within relatively short time intervals. Those fluctuations can be attributed to changes in economic and social factors that affect the property market. This study analyzes variations in housing prices to investigate the lag in the market's responsiveness to changes in selected environmental stimuli. The possibility of building mathematical models which describe fluctuations in property prices based on macroeconomic data was also examined. The analysis covered the housing market in the city of Olsztyn, in the north-eastern part of Poland. The discussed research problem and the adopted methodology can be related to any local market operating on free market principles.

The aim of this study was to determine how housing prices are changing under the influence of macroeconomic factors and measure the level of delays in these changes. The value of that lag relative to the market state variable was analyzed for every control variable

DETERMINANTS OF REAL ESTATE MARKET GROWTH – DATA DESCRIPTION

The real estate market is connected to the social and economic environment by a system of communicating vessels. The market responds to changes in macroeconomic and demographic indicators, and it receives stimulatory feedback. Dynamic changes in key market parameters can influence the basic parameters describing the market environment. The main problem in research studies investigating the market's vulnerability to environmental changes is the selection of market state variables and control variables.

Selection of market state variables

Market state variables may include the value of real estate, rent prices, return rate, number of property transactions, time required to sell the property and property price indicators. The price of real estate is most often selected as the market state variable. The price, the dynamics of price changes and change trends are robust indicators of market situation, and those variables are popularly used for analytical purposes. Gatzlaff and

Ling [1994] investigated the determinants of variability in housing prices, whereas Qiu [2009] performed a similar analysis on the market of commercial property. The correlations between property prices and fiscal and monetary policies were studied by Darrat and Glascock [1993]. The causes of price bubbles in real estate were investigated by Gros [2007], whereas Ito and Iwaisako [1995] observed that sudden fluctuations in property prices on the Japanese market result from changes in the fundamentals, such as growth of the real economy or interest rates.

Based on a review of the referenced studies, the price of 1 m² of an apartment (dwellings) was adopted as the market state variable for analyses of relationships between the real estate market and its environment. The prices were quoted in Olsztyn – a regional capital city with a total area of 88.33 km², estimated population of 180,000 and population density of 1,986 people per 1 km². The Register of Prices and Values kept by the City Administration Office in Olsztyn was the source of data representing 11,997 residential property transactions (apartments). The register combines information about all types of transactions including non-market transactions therefore, the database had to be filtered to produce data for market transactions only. In the filtering process, non-market transactions were eliminated from the database based on the following criteria: transactions identified as non-market transactions, transactions involving the Municipality of Olsztyn (including real estate sold both outside and during public auctions, granted discounts), donations, sale of fractional ownership of property, real estate with easements, semi-detached houses, conditional sale of property. The filtered database comprised 9,212 property transactions concluded in Olsztyn between January 2001 and November 2011. The aforementioned, data was used to calculate the average prices per 1 m² of apartments in monthly intervals (Fig. 1).

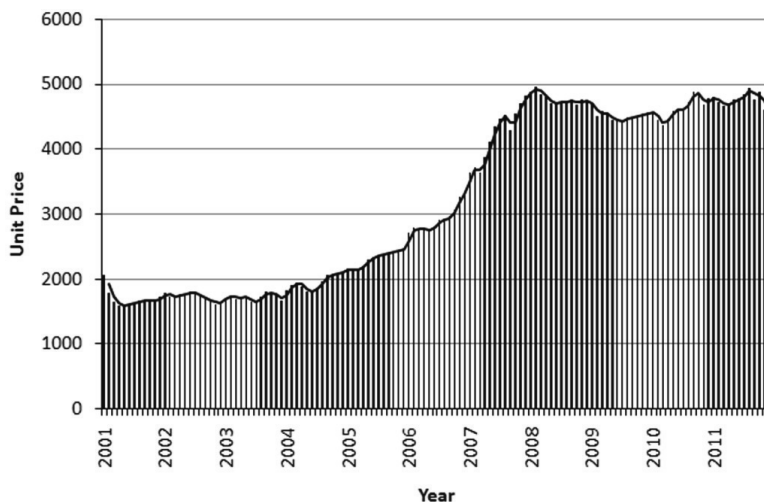


Fig. 1. Average per square meter prices changes of apartments in Olsztyn between January 2001 and November 2011

Source: Own study.

Several phenomena observed in the analyzed period could point to the instability of the property market. Due to changes in the system's control variables, the market leaves the trajectory of its evolutionary path (defined by the market state variable – P). The sudden changes in property prices noted between January 2007 and the first months of 2008 do not adjust the existing trend because the system has to search for a new state of equilibrium that corresponds to new market conditions, as determined by control variables. The aforementioned period was characterized by the highest differences between minimum and maximum prices which reached PLN 4,500 and an estimated 10% monthly increase in apartments prices. The local property market was stable in 2001–2006 and 2008–2011, minor variations in real estate prices were noted where an upward trend was followed by a downward trend.

Selection of control variables

The choice of control variables is more complex because the selection of factors that determine variations in property prices in time and space continues to be a subject of debate in scientific publications. Adams and Füss [2010] investigated the long-term effect of dynamic changes in selected macroeconomic factors on variations in property prices in 15 countries. Their empirical results indicate positive effects on house prices arising from an increase in economic activity, construction costs and the short-term interest rate and negative effects stemming from an increase in the long-term interest rate. In a study analyzing the significance of factors that lead to variations in property prices, Żelazowski [2011] examined economic indicators (GDP, construction costs, household incomes) and demographic factors (population, age structure, migration balance). Kasparowa and White [2001] studied the responsiveness of house prices to macroeconomic forces and found that real estate prices are driven by income growth and interest rates. Iacovello and Minetti [2003] argued that the availability of mortgage loans and liberal lending procedures drive demand and increase property prices. Quigley [1999] analyzed the correlations between economic cycles and real estate prices, while Sornette and Woodard [2010] observed that the situation on the financial market is the underlying cause of rapid changes in real estate prices. According to the European Central Bank [2003], changes in interest rates on financial markets affect property prices and business cycles on the real estate market (number of construction and upgrading projects), cost and availability of loans (for households and businesses, thus influencing the demand for loans), debt servicing costs and decrease consumer spending. In a study of the Polish housing market, Foryś [2011] examined economic (GDP, performance of construction and assembly markets, unemployment rate, number of new apartments, availability of loans, state spending on housing) and social drivers of growth (demographic factors, marriage rates, divorce rates, natural population increase, migration balance).

The following control variables were adopted for the study: gross domestic product (GDP), inflation rate (IR), average interest rate quoted by the central bank (ARN) which comprises the reference rate, the lombard rate and the rediscount rate, unemployment rate (UR) and the number of new dwellings (NND). The sources of aforementioned data were the Central Statistical Office and the National Bank of Poland. Relations between the state variable (P) and selected macroeconomic indicators (GDP, IR, ARN, UR, NND) is shown in Figure 2.

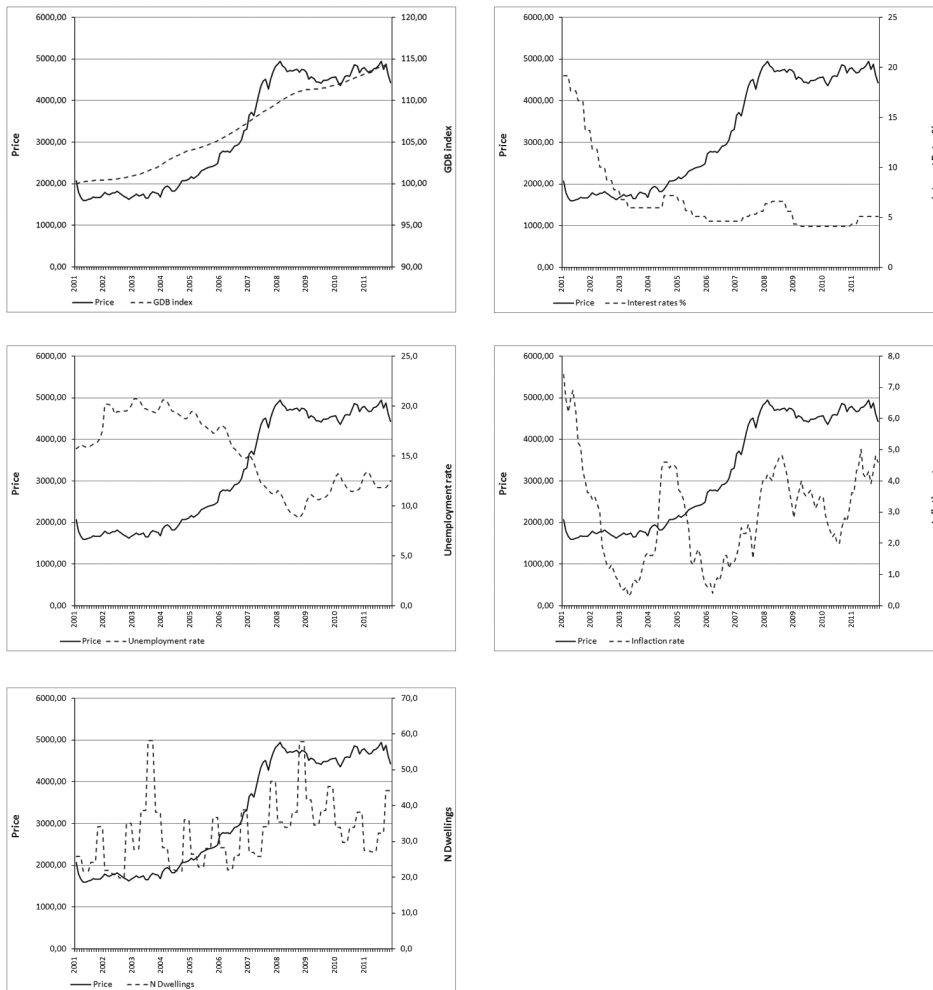


Fig. 2. Selected macroeconomic indices and average apartments prices

Source: Own study.

A graphic interpretation of the relationships between control variables and average prices of 1 m² of residential property reveals cyclic changes in NND (number of new dwellings) and IR (inflation rate), and in both cases, the drop in variable values was preceded by a rise in property prices in 2007. In the following years, an increase in the number of new apartments, i.e. excess supply over demand, and rising inflation which increased the cost of foreign capital for housing investments halted the increase in property prices and led to their gradual decrease. Unemployed and interest rates have a negative relationship with changes in real estate prices and a drop in UR and ARN values leads to an increase in housing prices. A high positive relationships was observed between GDP and P (price of 1 m² of an apartment).

RESULTS AND DISCUSSION

In the first part of the study, the suitability of selected control values was investigated relative to the applied market state variable. The variables are described in detail in section 2 of chapter 2. Preliminary research has shown that the distributions of the variables are similar to the normal distribution. The analyzed variables were used to build a linear correlation matrix (Table 1).

Table 1. Matrix of correlations between the analyzed variables

Specification	GDP	ARN	UR	IR	NND	P
GDP	1.000	-0.637	-0.864	0.196	0.378	0.967
ARN	-0.637	1.000	0.301	0.505	-0.342	-0.551
UR	-0.864	0.301	1.000	-0.404	-0.422	-0.933
IR	0.196	0.505	-0.404	1.000	-0.054	0.233
NND	0.378	-0.342	-0.422	-0.054	1.000	0.400
P	0.967	-0.551	-0.933	0.233	0.400	1.000

Source: Own study.

All of the adopted variables are correlated with transaction prices at a significance level below 0.001. A very strong positive correlation was observed between transaction prices and GDP. Transaction prices were also positively correlated with the inflation rate (IR) and the number of new dwellings (NND). The discussed variable showed a strong negative correlation with unemployment rate (UR). A negative correlation between transaction prices and interest rates (ARN) was also reported. Macroeconomic indicators are cross-correlated due to the existence of complex economic mechanisms, but the above should not significantly affect correlation modeling with the use of regression models. A multiple regression model was developed for a quantitative analysis of correlations between control variables (explanatory variables) and the market state variable (explained variable) and to determine whether the selected control variables adequately describe the market state variable. The results of multiple regression analysis are shown in Table 2.

Table 2. Results of multiple regression analysis ($R^2 = 0.976$, $R^2_{adj} = 0.975$, $F = 1,024.1$, $p < 0.0001$, standard error of estimate = 208.47)

Specification	β	Standard error β	t	p
Intercept	-9 234.57	1 858.888	-4.968	0.000
GDP	145.01	15.033	9.646	0.000
ARN	-21.59	14.175	-1.523	0.130
UR	-174.58	14.021	-12.452	0.000
IR	-32.80	21.542	-1.523	0.130
NND	-3.99	2.412	-1.652	0.101

R^2 – determination coefficient, R^2_{adj} – adjusted determination coefficient, F-value of F-test, β – regression coefficients, t – value of Student's test, p – significance.

Source: Own study.

The results of the Fischer-Snedecor test (F-test) indicate that the developed model describes significant statistical relationships (at a significance level below 0.0001). The key variables were gross domestic product (GDP) and unemployment rate (UR). The significance level for interest rates (ARN), inflation rate (IR) and the number of new dwellings (NNR) exceeded 0.1. That could be attributed to cross-correlations between explanatory variables. The value of the determination coefficient (R^2) was reported at 0.975, which indicates that variation in the explained variable (P) is very well explained by explanatory variables (GDP, ARN, UR, IR, NND).

In the multiple regression model, control variables successfully explained the variation in the prices of residential property in Olsztyn in 2001–2011 due to the high significance of two explanatory variables: GDP and UR. Since they are highly correlated with transaction prices, those variables explain nearly the entire variance of the explained variable. A simple regression relationship between the analyzed variables and transaction prices is presented in Figure 3.

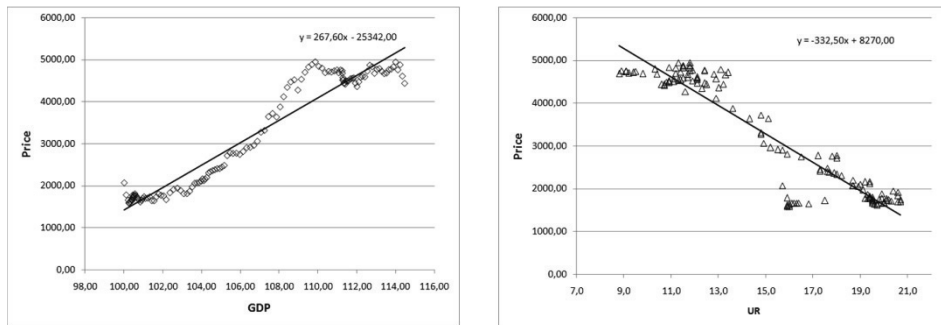


Fig. 3. Regression relationship between gross domestic product – GDP (left side), unemployment rate – UR (right side) and apartments price – P

Source: Own study.

Previous studies were carried out on the assumption that a change in the control variable in a given time interval generates a direct change in the market state variable. The real estate market is characterized by low liquidity of real estate as commodity, therefore, property prices change slowly, and the market does not respond instantly to changes in economic and social factors.

At successive stages of the experiment, the lag in cross-correlations between control variables and market state variables was determined. An attempt was also made to answer the following question: Do changes in control variables contribute to changes in the market state variable or does the reverse apply?

Linear correlation coefficients were determined for average prices after the introduction of a time lag to examine the delay in the responsiveness of average housing prices to the adopted macroeconomic factors. Implementation of so-called lags can support the explanation of the cause and effect relationship between the variables. If we increase the lag and if the value of correlation coefficient is changing too, one can assume, that the

dependent variable (in this case apartments price) respond to the change in the independent variable values with some delay or in advance. It justifies the importance of determination of cause and effect. If it is possible to determine the lag level for which the correlation coefficient reaches a maximum, then we get the response time between cause and effect.

The correlation coefficients for time lags of 6, 12, 18, 24 and 36 months are presented in Table 3. The correlation coefficients for different lag values, both positive and negative, are shown in Figure 4.

Table 3. Correlation coefficients between lagged macroeconomic indicators and average prices

Lag in months	GDP	ARN	UR	IR	NND
0	0.967	-0.551	-0.933	0.233	0.400
6	0.961	-0.601	-0.900	0.113	0.348
12	0.946	-0.649	-0.845	-0.014	0.352
18	0.924	-0.700	-0.761	-0.093	0.315
24	0.896	-0.733	-0.675	-0.134	0.319
30	0.865	-0.749	-0.575	-0.133	0.261
36	0.833	-0.770	-0.459	-0.135	0.215

Source: Own study.

The coefficient of correlation between GDP and transaction prices decreases with an increase in lag values. This implies that in the value of the analyzed variable become smaller as more time elapses between the increase in GDP and the survey of transaction prices. In this case, changes in GDP occur simultaneously with changes transaction prices, and a strong correlation for zero lag clearly points to the simultaneity of the studied phenomenon. The adopted index of changes in GDP values is based on lagged property prices, and despite the noted synchronicity, the presence of a causal relationship can be postulated.

An analysis of changes in interest rates (ARN) points to specific correlations between lag and the value of the correlation coefficient. An increase in lag values is accompanied by a clear increase in the absolute value of the correlation coefficient. That could suggest that changes in the analyzed factor lead to delayed changes in the prices of property. The results of the analysis suggest the presence of a cause-and-effect relationship where changes in interest rates drive changes in property prices after several months or even years. It takes approximately 22 months for interest rates to change in response to price changes. A change in interest rates is strongly felt on the market only after around 36 months. The aforementioned mechanisms point to the existence of mutual interactions.

The nature of correlations between unemployment rate and transaction prices is similar to that between GDP and prices. Changes in unemployment rate occur simultaneously with changes in transaction prices. At the maximum correlation strength, the nature and the sign of the time lag can indicate that after a certain time, changes in prices lead to changes in unemployment rate. The strongest correlation between unemployment rate and prices is observed when the dependency between these two variables is analyzed with a time lag of approximately seven months. That implies that changes in prices preceded changes in unemployment rate by around six months.

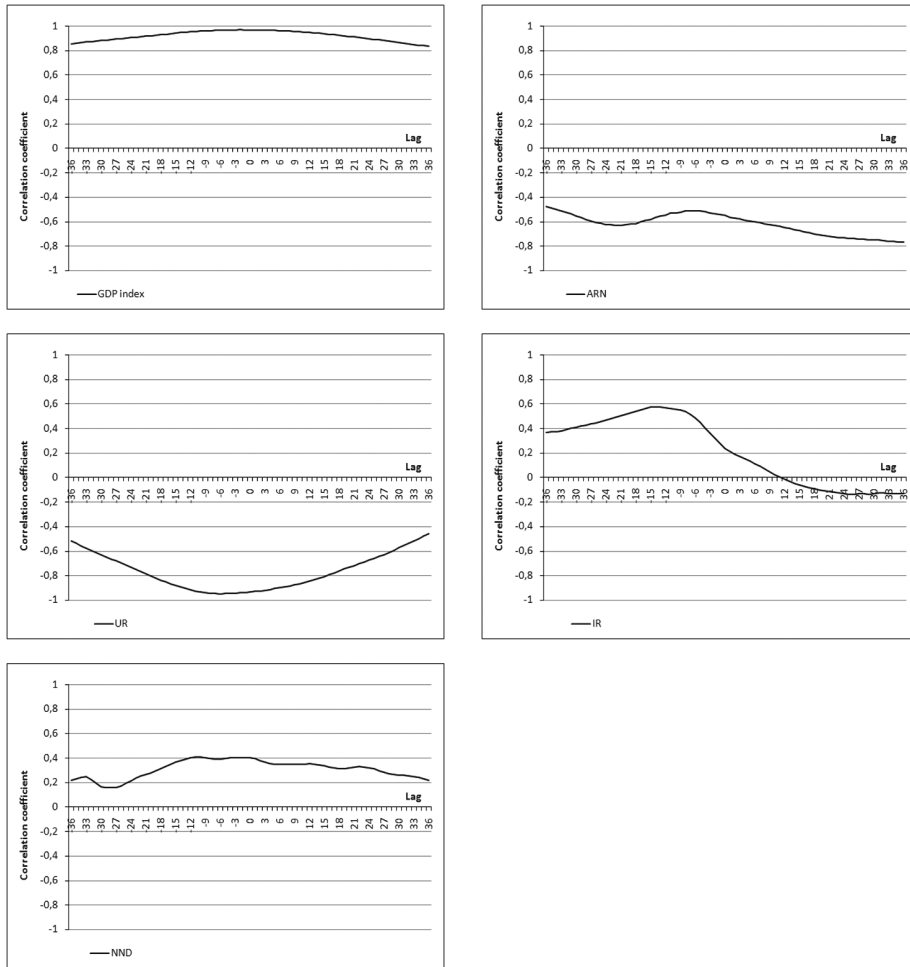


Fig. 4. Correlation coefficients for different lag values

Source: Own study.

With an increase in lag values, inflation rate is transformed from a variable with a stimulating influence into a variable with a destimulating influence. At the same time, correlation coefficients point to an insignificant dependency between inflation rate and prices. The strongest correlation between inflation and prices was observed for a lag of approximately 15 months. It can, therefore, be assumed that changes in prices precede changes in inflation rate by around 18 months.

The number of new dwellings can be expected to be significantly correlated with transaction prices. Authors' analysis indicate, however, that the greater the lag between changes in NND values and property prices, the smaller the variation in prices. Prices can also affect the number of new dwellings, although in this case, we are probably dealing with simultaneous changes.

Casuality on the property market is difficult to investigate due to the complexity of interactions between market elements. Simultaneity analyses of various phenomena, in particular when the values of two variables are compared for different time intervals, support the formulation of hypotheses to explain whether prices respond with a delay to changes in macroeconomic indices or whether indices respond to price changes.

The results of the study supported the development of a new model of correlations between macroeconomic factors and transaction prices. The values of variables were lagged to produce the best fit of the model. Prices were lagged relative to interest rates by 36 months. Unemployment rates were lagged relative to prices by five months, and inflation rates – by 13 months. The values of GDP and NND were not lagged. The modeled results are presented in Table 4.

Table 4. Results of multiple regression analysis for lagged explanatory variables ($R^2 = 0.983$, $R^2_{adj} = 0.982$, $F = 901.9$, $p < 0.0001$, Standard error of estimation = 150.28)

Specification	β	Standard error β	t	p
Intercept	-15 102.90	1 330.17	-11.35	0.000
GDP	189.08	11.80	16.02	0.000
ARN	27.79	7.43	3.74	0.000
UR	-167.34	11.84	-14.13	0.000
IR	31.87	19.86	1.60	0.113
NND	8.20	2.58	3.18	0.002

R^2 – determination coefficient, R^2_{adj} – adjusted determination coefficient, F- value of F-test, β – regression coefficients, t – value of Student's test, p – significance.

Source: Own study.

The developed model better explains the variation in transaction prices than the model where variable values are not lagged. The value of Fischer-Snedecor distribution increased from 901.9 to 1,024.1 at a significance level below 0.0001. When control variables were lagged relative to the market state variable, the percentage variation in prices (P), explained by determination coefficient R^2 , increased from 97.5 to 98.2%. An increase in significance levels (p) was also reported for selected variables (ARN, IR, NND). The model's standard error decreased significantly from 208.47 to 150.28.

CONCLUSIONS

The results of the experiment validated authors' initial hypothesis. The calculated values of lag in the responsiveness of property prices to selected macronomic indicators in the analyzed time intervals are not identical for all variables. The highest lag was observed for interest rates (ARN) at 36 months and inflation rate (IR) at 13 months. The lag for unemployment rate was calculated at only seven months, which indicates that property prices quickly respond to changes in potential demand for real estate because an increase in unemployment leads to a drop in demand. The results of the experiment also indicate that the stimulating effects of selected variables may be transformed into

destimulating effects, implying that in certain periods a property price may be regarded as an explanatory variable and macroeconomic indices – as explained variables. The results of the experiment demonstrate that the lag between control variables and the market state variable should be taken into account in regression models to obtain a better fit to empirical data.

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WPLYW CZYNNIKÓW MAKROEKONOMICZNYCH NA ZMIANY CEN NIERUCHOMOŚCI – REAKCJA I INTERAKCJA

Streszczenie. W większości krajów europejskich na rynkach nieruchomości, w ostatniej dekadzie, były obserwowane gwałtowne zmiany cen nieruchomości, zarówno wzrosty, jak i spadki. Przyczyn takich zachowań upatruje się w zmieniających czynnikach ekonomicznych i społecznych w otoczeniu rynku nieruchomości. Celem badań było określenie, w jaki sposób zmieniają się ceny nieruchomości pod wpływem czynników makroekonomicznych.

W celu ilościowego ujęcia związków między przyjętymi w badaniach zmiennymi kontrolnymi a przyjętą zmienną stanu rynku zbudowano model regresji wielorakiej, który następnie ulepszono, uwzględniając obliczone w pracy wielkości opóźnień dla poszczególnych zmiennych. Dodatkowym efektem pracy jest wykazanie, że w okresach niestabilności to rynek nieruchomości staje się przyczyną zmienności otoczenia ekonomicznego i społecznego.

Słowa kluczowe: rynek nieruchomości, czynniki makroekonomiczne, opóźnienia

Accepted for print – Zaakceptowano do druku: 24.04.2014