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Bidirectional dependencies between the residential market in voivodeship cities and the mortgage loans market in Poland

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ABSTRACT

Purpose – The purpose of the article is to study the relationships between the residential market and the mortgage market in Poland. The main aim of the paper is to verify if direct dependence between the dynamics of prices of secondary residential premises in voivodeship cities and both the number and the value of newly granted mortgage loans, can be found in Poland. Moreover, we are to investigate if there is only one direction of this dependence or it can be bidirectional.

Design/methodology/approach – To verify the two hypotheses stated four econometric models were formulated based on the basic regression and vector auto-regression approach. Also, the Granger causality tests were conducted.

Findings – The dependencies between the dynamics of the price of secondary housing in voivodeship cities and both the number and the value of newly granted mortgage loans were indicated in all three parts of the study. However, the results regarding the direction of the relationships are not unambiguous. As far as the basic regression models and the Granger causality tests are concerned only one direction of the dependency is found. In turn, the VAR models indicate the bidirectional dependencies between the residential market and the mortgage loans market.

Research limitations – The data used in the study covers the period starting in the first quarter of 2007 and ending in the second quarter of 2020. The period includes two peaks of the residential market, one downturn phase, and one phase of the gradual growth of the residential market cycle. This may imply that the results may indicate the specificity of the relationship between the residential market and the mortgage market, typical for the peak and downturn phases of the cycle.

Research implications – The obtained results may serve in the future as a basis for modelling the residential market in Poland.

Keywords:	residential market; mortgage market; housing price; the vector auto-regression; the Granger causality test
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INTRODUCTION

The factors influencing the residential market are usually divided into micro and macro determinants. The micro factors commonly relate to the local neighbourhood of properties as well as characteristics of the individual properties. This also refers to socio-economic factors at the local level such as wage levels, unemployment, etc., in the area. In turn, the macro determinants consider indicators at the whole market level. The condition of the mortgage market together with inflation, dynamics of GDP, etc., without any doubt, can be assigned to the last group. Apart from factors that relate to the economy and finances, one can also list here demographic, environmental, and spatial factors (Tomal, 2019). The macro determinants affect both demand and supply in the residential market. When it comes to demand crucial role is also played by preferences of housing buyers, as housing "preferences are reflected in the housing choices made on the market, and then in the demand in individual market segments" (Głuszak, 2008, p. 27). However, one has to distinguish between potential demand and real demand. The first can be defined as a demand that results from the preferences of potential housing buyers, who intend to purchase residential real estate. The real demand, on the one hand, is based on the buyers' preferences, while, on the other hand, it is based on the income of a household. The latter shall be at a sufficient level to buy housing with or without the use of a mortgage loan. Therefore, the mortgage market, at a macro level, acts as a filter that transmits demand to the residential market. However, stylized facts suggest that the relationships may also work the other way around. High dynamics of housing prices may in fact limit demand for mortgages. Accordingly, the study of the relationships between the residential market and mortgage market in Poland stays as the subject of the article. The main aim of the paper is to verify if direct dependence between the dynamics of prices of secondary residential premises voivodeship cities and both the number and the value of newly granted mortgage loans, can be found in Poland. Furthermore, we are to investigate if there is only one direction of this dependence or it can be bidirectional. To achieve the goals two hypotheses were stated:

1. The dependencies between the dynamics of prices of secondary housing in voivodeship cities and both the number and the value of newly granted mortgage loans in Poland can be indicated by regression models.
2. The relationships between the dynamics of prices of secondary housing in voivodeship cities and both the number and the value of newly

granted mortgage loans in Poland, take the form of mutual interdependence.

To verify the above hypotheses four econometric models were formulated based on the basic regression and vector auto-regression approaches. Moreover, the Granger causality tests were conducted. In the following section of the paper literature review is presented. Afterwards, the research methodology is presented, as well as the time series used in the study. Next, the results of the three stages of the study are presented, followed by a critical discussion. In the end, the conclusion section gives a synthetic summary of the article.

LITERATURE REVIEW

The strong linkages between the residential market and the mortgage market – what enables significant fluctuations in housing demand (Łaszek, 2006) - and their importance, seems to be indisputable. On this account, in most studies that aim to explain the working of a residential market or credit flows, the econometric models usually include variables representing the mortgage market, along with several others. In literature most often this is the mortgage rate or interest rate that is considered as impacting housing prices (e.g. Chancellor; Abbott, Carson, 2016; Chow, Xie, 2016). The rise of mortgage rates limit the accessibility of credit capital and thence reduce housing demand. Yet, it should be noted that the structure of the mortgage market may notably differ between particular countries, also when it comes to the prevailing form of the mortgage rates (i.e., fixed or variable), what can alter this impact (Calza, Monacelli & Stracca, 2013). As far as research of the Polish residential market is concerned Leszczyński and Olszewski (2017) built a regression model indicating significant dependence of primary and secondary housing prices in 17 polish cities on real interest rates. Cellmer, Bełej and Cichulska (2019) concentrated on the Granger causality between secondary market housing prices and the number of new residential premises that have been handed over as well as few other variables, among others the reference rate determined by the National Bank of Poland. However, no significant relationships have been found in the case of the latter variable. Chaney and Hoesli (2015) signalized that there are long-run and short-run linkages between the residential market and long term as well as short term interest rates in Switzerland. What important, they emphasized that in the second case the nature of these relationships was bidirectional. This means that not only the mortgage market can affect housing prices but also the state of a residential market can influence the mortgage market.

One should bear in mind that the mortgage rates alone do not reflect the whole picture though when it comes to credit accessibility. Changes of the institutional factors like changes in banks' internal lending policy as well as rules under which banks conduct lending activities (e.g. the Recommendations S and T set by the Polish Financial Supervision Authority[1]) also, via mortgage market, do affect housing prices. In this context, it is worth mentioning the paper of Bian and Gete (2015), who included easing credit standards for example due to the shadow banking system, in seven drivers influencing housing price dynamics in China. The effect of the aforementioned institutional determinants should be seen in the number and the value of the mortgage loans granted. Bäurle and Scheufele (2019, p. 1962) in the summary of the study on the impact of credit market conditions and housing prices on real economic activity in Switzerland, concluded that "credit supply shocks tend to be more important for housing prices than our identified housing demand shocks, i.e., housing preference shocks and population shocks". Reichenbachas (2017) proven that credit spread shocks had a considerable impact on housing prices in Lithuania, also during the boom phase of the previous business cycle, followed by a downturn during the global financial crisis (the GFC). In turn, during the GFC the residential market had a great impact not only on the other real estate sectors (Yunus, 2017) but on the entire economy. Mallick and Mahalik (2012) indicated the bidirectional causality between real house price growth and bank lending rate as well as domestic credit growth rate in China.

Many articles that present linkages between the mortgage market and the residential market base on the use of the vector auto-regression models (like Plakandaras et al., 2020). As it allows to investigate the two-way direction of the dependencies. Other approaches, nonetheless, also can be pointed. Eliasson and Petursson (2009) built a demand-supply model to look for the impact of among others changes in the real interest rate on housing prices in Iceland. Some studies look for nonlinear relations e.g. Liu and Chen (2016) investigated relationships between house prices, interest rates, and stock prices in Taiwan, using the STVEC-GARCH model.

The purpose of this study is to find out the dependency between the residential market, and the mortgage market as well as its direction in Poland, rather, than to build a comprehensive model of the residential market in Poland. We use the basic regression approach to track the ongoing, quarter to quarter, relationships between the markets. Moreover, we use the vector auto-regression approach (VAR) and the Granger causality test to look for the

[1] Komisja Nadzoru Finansowego.

relationships that take into account mutual lags. We employed data that reflect the dynamics of secondary housing prices and the number and the value of new mortgages granted.

RESEARCH METHODOLOGY

Table 1 presents the quarterly time series used in the study, for the time range first quarter of 2007 – the second quarter of 2020.

Table 1. The time series used in the study

Name of the variable	Time series	Name of the variable	Time series
HI7	Hedonic price index of the secondary housing in seven primary residential markets (Gdańsk, Gdynia, Łódź, Kraków, Poznań, Warszawa, Wrocław), weighted with the market stock of housing, quarter on quarter change	NL	Number of newly granted mortgage loans
HI10	Hedonic price index of the secondary housing in ten secondary residential markets (Białystok, Bydgoszcz, Katowice, Kielce, Lublin, Olsztyn, Opole, Rzeszów, Szczecin, Zielona Góra), weighted with the market stock of housing, quarter on quarter change	VL	Value of newly granted mortgage loans

Source: own study.

Variables HI7 and HI10 represent quarter on quarter hedonic house price indexes of the secondary market in seven and in ten voivodeship cities in Poland, weighted with the market stock of housing. The first time series can be stated as based on the main residential markets in the seven biggest cities. In turn, the second time series can be treated as based on the second-tier residential markets in Poland. The data are published by the National Bank of Poland (NBP,2020). Quarterly data of the number and value of newly granted mortgage loans come from AMRON-SARFiN reports published by the Association of Polish Banks (ZBP, 2020). Figure 1 plots the data employed in the study.

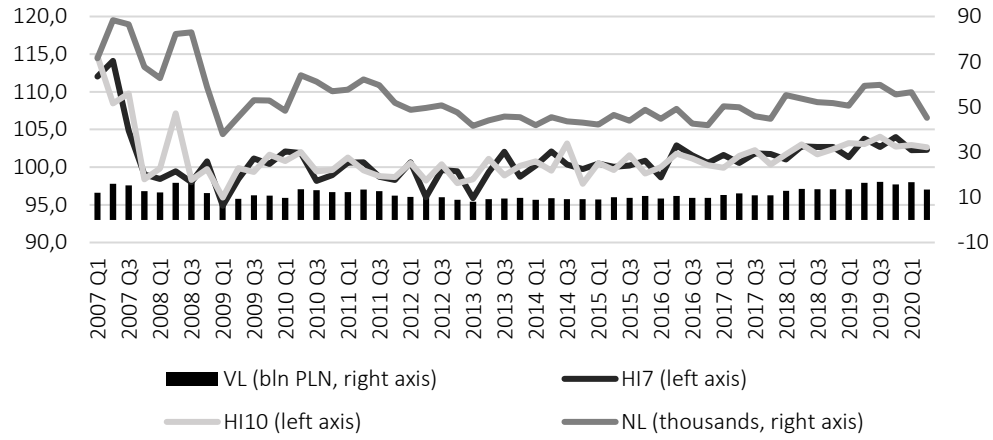

Figure 1. Hedonic price indexes of secondary housing in seven and ten residential markets, number and value of newly granted mortgage loans, Q1 2007 – Q2 2020.

Source: own study.

For the study, the time series were transformed into a natural logarithm form. As some time series was not stationary at first, all-time series were transformed into first differences of natural logarithms in which the stationarity was obtained[2].

To verify the direct interdependence between dynamics of secondary housing prices and both the number and the value of newly granted mortgage loans, econometric models were formulated. However, the use of the basic regression modelling, in the case of the above time series, may cause the endogeneity problem of the overestimation of coefficients. The awareness of such a possibility made us take into account three steps of the study. Therefore, we decided to use also the vector autoregression approach. The basic regression models are used to look for regular quarter to quarter relationships. While the VAR approach allows seeking interdependence with the use of a certain number of lags. Then the third part of the study includes looking for causality in the Granger sense. The VAR approach derives from Sims article (1980). In the VAR model equations with three variables can take the following form:

$$\Delta Y_t = \gamma_Y + \sum_{i=1}^{\eta} \alpha_i \Delta Y_{t-i} + \sum_{j=1}^{\eta} \beta_j \Delta X_{t-j} + \sum_{k=1}^{\eta} \delta_k \Delta Z_{t-k} + \varepsilon_t \quad (1)$$

[2] Results of the ADF test can be provided upon request.

where:

γ_Y – constant,
Y, X, Z- variables representing time series used,
$\alpha_i, \beta_j, \delta_k$ - coefficients of variables X, Y, Z.

In the VAR approach, each variable is explained by its own lags and the lags of other variables used. Thus, in the case of three variables, the model is based on three equations analogous to (1). The VAR model can be determined using the Ordinary Least Squares method (Kośko, Osińska, & Stempińska, 2007, p. 369).

RESULTS & DISCUSSION

The basic regression models

Table 2 presents basic regression models R1 to R4. The models were constructed according to the guideline in which each of the variables employed in the study, is explained by two independent variables i.e. housing price indexes are explained by the number and the value of mortgage loans, the number and the value of mortgage loans are explained by hedonic price indexes. In models R1 and R2, no statistically significant relationships were found. Model R3 indicates the statistically significant impact of the hedonic house price index of seven main residential markets, on the number of newly granted mortgage loans. Also, model R4 points out the statistically significant influence of the variable HI7, this time, on the value of newly granted mortgage loans. In both cases, the relationship is positive i.e. increase in the hedonic house price index cause growth in the mortgage loan market. R^2 in the models ranges from 6.8% to 16.3%. Such results can be considered as low. However, one should bear in mind, that the purpose of the article is not to build a complex model that explains fluctuations in housing prices in Poland. The aim is to seek confirmation of the relationship between the residential market and the mortgage loan market. The models R1 to R4 were subject to a diagnostic check with the use of the selected econometric tests: the Shapiro-Wilk normality test for residuals, the Breusch-Pagan test for heteroskedasticity, and the Durbin's alternative test for autocorrelation. Results of the tests are enclosed in the Appendix, in Table 5, Table 6, and Table 7, respectively. In the case of model R2 hypothesis of normality of residuals cannot be confirmed. In model R2 serial correlation is also indicated. Similar problems did not apply for the models R1, R3, and R4. Residuals in the case of all four models are homoskedastic.

Table 2. The basic regression models R1 to R4

Variables	Model R1			Model R2		
	Coefficient	Std. Err	t	Coefficient	Std. Err	t
Dependent variable	HI7			HI10		
HI7	-	-	-	-	-	-
HI10	-	-	-	-	-	-
NL	0.023	0.111	0.21	0.099	0.133	0.75
VL	0.049	0.107	0.46	-0.043	0.128	-0.34
Constant	-0.002	0.004	-0.46	-0.001	0.004	-0.27
R^2	0.147			0.068		
Prob > F	0.0188			0.1703		
Variables	Model R3			Model R4		
	Coefficient	Std. Err	t	Coefficient	Std. Err	t
Dependent variable	NL			VL		
HI7	1.734	0.723	2.40**	1.861	0.753	2.47**
HI10	0.672	0.631	1.06	0.601	0.657	0.91
NL	-	-	-	-	-	-
VL	-	-	-	-	-	-
Constant	-0.004	0.017	-0.25	0.007	0.018	0.37
R^2	0.163			0.160		
Prob > F	0.0119			0.0127		

Note: * p <0.01; ** p <0.05; *** p < 0.1.
Source: own study.

The vector auto-regression models

The VAR models were formulated with the same variables as basic regression models, i.e. composition of the model VAR1 corresponds to the model R1, the model VAR2 to the model R2, and so on. The number of lags in each model was determined with the use of the lag order selection criteria (Akaike, Hannan-Quinn, Schwarz). The study is based on the quarterly data thus the number of lags was limited to four. As the final form of each of the VAR models (with the final number of lags of these indicated by the selection criteria) was selected the one with the highest number of statistically significant independent variables[3]. Table 3 presents results that relate to the interdependency between the residential market and the mortgage market. In the case of models VAR1 and VAR2 no statistically significant variables of the relationships were obtained, therefore, in Table 3 only models VAR3 and VAR4 are included[4].

[3] Results of the selection-order criteria can be provided upon request.
[4] Results of models VAR1 and VAR2 can be provided upon request.

The model VAR3 indicates that changes in the hedonic price indexes of secondary housing in both seven and ten cities affect the number of mortgage loans. In both cases, variables that lagged one period are statistically significant. However, in the first case, the impact is negative, while in the second case it is positive. Such results cannot be found when it comes to the influence of the housing price indexes, on the value of mortgage loans (model VAR4). Changes in the number and the value of mortgage loans lagged four periods, statistically significantly explain variations of the hedonic price index for seven main residential markets. The impact is negative. Changes in the number and the value of mortgage loans also influence the price index for ten housing markets. Impact of the lag one of the variables NL and VL is positive, whereas the impact of the lag four of the variable VL is negative. In models VAR3 and VAR4 there is clear evidence of auto-regression in particular equations. It is the strongest for the HI10 variable, which is explained by all four own statistically significant lags, in both models. R^2 in particular equations of the VAR models stays between 40.65% and 66.74%. Table 8 and Table 9 in the Appendix provide results of the Lagrange-multiplier autocorrelation test and the Jarque-Bera test for normal distribution, respectively. The tests confirm a lack of autocorrelation and the normal distribution of residuals, however, at a different level of the p-value. The models VAR3 and VAR4 satisfy the stability condition, all the eigenvalues lie inside the unit circle[5].

Table 3. The interdependency between the hedonic house price indexes and the number and the value of mortgage loans, indicated by the models VAR3 and VAR4

		Model VAR3			Model VAR4		
Dependent variable (Equation 1)		Coefficient	Std. Err	z	Coefficient	Std. Err	z
		NL			VL		
HI7	Lag1	-2.914	1.330	-2.19**	-2.048	1.413	-1.45
	Lag2	-2.466	1.709	-1.44	-1.049	1.792	-0.59
	Lag3	-0.999	1.564	-0.64	0.181	1.665	0.11
	Lag4	1.088	0.961	1.13	1.522	1.061	1.43
HI10	Lag1	3.013	1.283	2.35**	2.178	1.372	1.59
	Lag2	3.378	2.085	1.62	1.424	2.184	0.65
	Lag3	1.637	2.144	0.76	-0.488	2.222	-0.22
	Lag4	0.082	1.223	0.07	-0.856	1.270	-0.67
NL	Lag1	-0.180	0.164	-1.10	-	-	-
	Lag2	-0.387	0.178	-2.17**	-	-	-
	Lag3	-0.183	0.156	-1.17	-	-	-
	Lag4	0.170	0.149	1.14	-	-	-

[5] Obtained eigenvalues can be provided upon request.

VL	Lag1	-	-	-	-0.065	0.162	-0.41
	Lag2	-	-	-	-0.210	0.175	-1.20
	Lag3	-	-	-	-0.091	0.155	-0.59
	Lag4	-	-	-	0.261	0.149	1.75***
R^2		0.4281			0.4065		
Dependent variable (Equation 2)		HI7			HI7		
NL	Lag1	-0.030	0.021	-1.43	-	-	-
	Lag2	-0.017	0.023	-0.74	-	-	-
	Lag3	-0.028	0.020	-1.39	-	-	-
	Lag4	-0.041	0.019	-2.11**	-	-	-
VL	Lag1	-	-	-	-0.024	0.020	-1.21
	Lag2	-	-	-	-0.002	0.022	-0.10
	Lag3	-	-	-	-0.018	0.019	-0.93
	Lag4	-	-	-	-0.030	0.018	-1.65***
HI7	Lag1	-1.009	0.172	-5.86*	-0.959	0.175	-5.48*
	Lag2	-0.620	0.221	-2.80*	-0.543	0.222	-2.44**
	Lag3	0.074	0.202	0.37	0.158	0.206	0.77
	Lag4	0.266	0.124	2.14**	0.293	0.132	2.23**
HI10	Lag1	0.407	0.166	2.45**	0.370	0.170	2.17**
	Lag2	0.443	0.270	1.64	0.328	0.271	1.21
	Lag3	0.010	0.278	0.04	-0.133	0.275	-0.48
	Lag4	-0.200	0.158	-1.26	-0.284	0.157	-1.81***
R^2		0.6579			0.6473		
Dependent variable (Equation 3)		HI10			HI10		
NL	Lag1	0.041	0.024	1.72***	-	-	-
	Lag2	-0.012	0.026	-0.47	-	-	-
	Lag3	0.012	0.023	0.51	-	-	-
	Lag4	-0.031	0.022	-1.42	-	-	-
VL	Lag1	-	-	-	0.038	0.022	1.72***
	Lag2	-	-	-	-0.019	0.024	-0.81
	Lag3	-	-	-	0.015	0.021	0.71
	Lag4	-	-	-	-0.036	0.020	-1.77***
HI7	Lag1	-0.123	0.192	-0.64	-0.161	0.191	-0.85
	Lag2	0.305	0.247	1.24	0.273	0.242	1.13
	Lag3	0.263	0.226	1.16	0.218	0.225	0.97
	Lag4	0.466	0.139	3.36*	0.475	0.143	3.32*
HI10	Lag1	-0.931	0.185	-5.03*	-0.913	0.185	-4.93*
	Lag2	-0.814	0.301	-2.71*	-0.771	0.295	-2.61*
	Lag3	-0.598	0.309	-1.93***	-0.560	0.300	-1.87***
	Lag4	-0.339	0.176	-1.92***	-0.324	0.172	-1.89***
R^2		0.6626			0.6674		

Note: * p <0.01; ** p <0.05; *** p < 0.1.

Source: own study.

The Granger causality

Table 4 presents the results of the Granger causality test for groups of three variables being included in the particular (basic regression and VAR) models. As far as the two first sets of variables are concerned the causality in the Granger sense is not found. In the case of sets of the variables which were used to formulate models R3, VAR3, and R4, VAR4 there is an evident causality between variables HI7 and HI10. Whereas the dependency between the housing market and the mortgage market is not so clear. The only statistically significant result applies to the variable representing hedonic price index of housing in seven cities regarded as main residential markets in Poland, which do Granger cause the number of mortgage loans, at the p-value 0.1.

Table 4. Results of the Granger causality Wald test of variables used in the particular models

Dependent variable	Independent variables	Models R1 and VAR1		Independent variables	Models R2 and VAR2	
		chi2	Prob > chi2		chi2	Prob > chi2
HI7	NL	0.63132	0.729	-	-	-
	VL	1.0347	0.596	-	-	-
HI10	-	-	-	NL	0.64427	0.725
	-	-	-	VL	1.8771	0.391
NL	HI7	0.02119	0.989	HI10	3.2181	0.200
	VL	0.4144	0.813	VL	0.53596	0.765
VL	HI7	0.23156	0.891	HI10	2.4087	0.300
	NL	1.532	0.465	NL	2.1559	0.340
Dependent variable	Independent variables	Models R3 and VAR3		Independent variables	Models R4 and VAR4	
		chi2	Prob > chi2		chi2	Prob > chi2
HI7	NL	6.8095	0.146	VL	5.1343	0.274
	HI10	17.464	0.002*	HI10	16.49	0.002*
HI10	NL	6.2327	0.182	VL	7.0268	0.134
	HI7	12.608	0.013**	HI7	12.709	0.013**
NL	HI7	8.0766	0.089***	-	-	-
	HI10	7.2963	0.121	-	-	-
VL	-	-	-	HI7	5.4279	0.246
	-	-	-	HI10	5.3177	0.256

Note: * p <0.01; ** p <0.05; *** p < 0.1.
Source: own study.

Discussion

According to the basic rule of thumb, one may expect that impact of the number and the value of new mortgage loans on housing prices should be

positive. By contrast, the opposite influence should be negative, as increasing prices should deteriorate demand for housing and, therefore, also for mortgages. Obtained results point out that it does not always have to be the truth. The results of the Granger causality test indicate that changes in the hedonic house price index of seven cities do positively cause changes in the number of newly granted mortgage loans. This stays as a confirmation of results obtained in model R3 in which variable HI7 has a positive effect on variable NL. Moreover, in model R4, HI7 positively impacts VL. The interdependence between the residential market and the mortgage market – in both directions - is indicated by the results of the models VAR3 and VAR4. The linkages are not unambiguous, though (positive and negative coefficients).

The positive impact of the rise in residential prices, on the value of granted mortgage loans, can be caused by the rigid price elasticity of demand. In that case, assuming a roughly stable level of demand, an increase in prices can entail an increase in the total value of newly granted mortgages, as the mean value of single mortgage rises. The positive influence of housing prices on the number of granted mortgage loans can be attributed to the influence of factors connected with the economic situation i.e. dynamics of households income, unemployment rate, etc. Nonetheless, such a dependence should take place primarily during the extreme cycle phases, rather than throughout the entire residential market cycle. In the peak phase of the cycle, the most intensive housing price growth is accompanied by an increase in the number of buy/sell transactions and a number of new mortgages granted. The opposite – decreasing housing prices, decreasing number of buy/sell transactions, and a number of mortgages - can be seen at the downward phase of the cycle. Furthermore, one may assume that mutually reinforcing increases/decreases in housing prices, a number of buy/sell transactions, and a number/value of granted mortgage loans, primarily concerns housing that is treated as capital investment, rather than residential space that is bought to be used for a living. Since speculative demand shall be more prone to the cyclical fluctuations on the residential market.

CONCLUSION

During the study period, the dependencies between dynamics of prices of secondary housing in voivodeship cities and both the number and the value of newly granted mortgage loans were indicated by the models based on the basic regression, the VAR approach as well as in the Granger causality test. When it comes to the models R1-R4 and the Granger causality test, only one direction of relations was found i.e. housing price dynamics impacting the

mortgage market. This indicates confirmation of the first hypothesis in all three stages of the study, while the second hypothesis was confirmed only in the part of the study which concerns the VAR models. This fact and some unexpected results when it comes to the character of the relationships (negative or positive) between used time series may be to a certain extent ascribed to the time range of the employed data. The data comes from the period starting in the first quarter of 2007 and ending in the second quarter of 2020. This period includes two peaks of the residential market (2007-2008 and 2018-2019), one downturn phase (started in 2009), and one phase of the gradual growth of the residential market cycle. Perhaps that is why some of the results indicate the specificity of the relationship between the residential market and the mortgage market, typical for the peak and the downturn phases of the cycle. The use of a longer time series (e.g. containing two full cycles) would allow verifying these dependencies. However, this is the availability of the data that defined the time range. This limitation, nonetheless, may be overpassed in the future, with time passing by.

The general indication for practice is that the relationship between the residential market and the mortgage market in Poland is a two-way street. The residential market may be impacted by the condition of the mortgage market but also the residential market may have a significant impact on the condition of the mortgage market and as a result on the banking sector in Poland. We strongly believe that obtained results may serve as a basis for future modelling of the residential market in Poland e.g. with the use of the regime-switching models.

REFERENCES

Bäurle, G., Scheufele, R. (2019). Credit cycles and real activity: the Swiss case. *Empirical Economics*, 56, 1939-1966. https://doi.org/10.1007/s00181-018-1449-0.

Bian, T. Y., Gete, P. (2015). What drives housing dynamics in China? A sign restrictions VAR approach. *Journal of Macroeconomics*, 46(C), 96-112. https://doi.org/10.1016/j.jmacro.2015.08.004.

Calza, A., Monacelli, T., & Stracca, L. (2013). Housing Finance and Monetary Policy. *Journal of the European Economic Association*, 11(1),101-122. https://doi.org/10.1111/j.1542-4774.2012.01095.x.

Cellmer, R., Bełej, M., & Cichulska, A. (2019). Identification of Cause-and-Effect Relationships in the Real Estate Market Using the VAR Model and the Granger Test, *Real Estate Management and Valuation*, 27(4), 85-95. https://doi.org/10.2478/remav-2019-0038.

Chancellor, W., Abbott, M., & Carson, C. (2016). A Study of the Factors Influencing Residential House Prices in Auckland and New Zealand. *New Zealand Journal of Applied Business Research*, 14(1), 55-70.

Chaney, A., Hoesli, M. (2015). Multifamily residential asset and space markets and linkages with the economy. *Journal of Property Research*, 32(1), 50-76. https://doi.org/10.1080/09599916.2014.913656

Chow, H. K., Xie, T. (2016). Are House Prices Driven by Capital Flows? Evidence from Singapore. *Journal of International Commerce*, Economics and Policy, 7(1), 1-21. https://doi.org/10.1142/S179399331650006X.

Eliasson, L., Petursson, T.G. (2009). The residential housing market in Iceland: Analysing the effects of mortgage market restructuring. *Housing Studies*, 24 (1), 25-45. https://doi.org/10.1080/02673030801981696.

Głuszak, M. (2008). Zróżnicowanie preferencji nabywców a popyt mieszkaniowy. *Świat Nieruchomości*, 63, 27-31.

Leszczyński, R., Olszewski, K. (2017). An Analysis of the Primary and Secondary Housing Market in Poland: Evidence from the 17 Largest Cities. *Baltic Journal of Economics*, 17(2), 136-151. https://doi.org/10.1080/1406099X.2017.1344482.

Liu, H. H., Chen, S. H. (2016). Nonlinear relationships and volatility spillovers among house prices, interest rates and stock market prices. *International Journal of Strategic Property Management*, 20(4), 371-383. https://doi.org/10.3846/1648715X.2016.1191557.

Łaszek, J. (2006). Rynek nieruchomości mieszkaniowych i jego specyfika jako czynniki determinujące ryzyko kredytowania hipotecznego. *Materiały i Studia*, *Narodowy Bank Polski,* 203, 1-31.

Mallick, H., Mahalik, M. K. (2012). Fundamental or speculative factors in the housing markets of emerging economies? Some lessons from China. *Journal of Economic Policy Reform*, 15(1), 57-67. https://doi.org/10.1080/17487870.2011.642580.

NBP. (2020). Ceny transakcyjne mieszkań z rynku pierwotnego. Retrieved from: https://www.nbp.pl/.

Osińska, M., Stępińska, J., & Kośko, M. (2007). *Ekonometria współczesna*. Toruń: Wydawnictwo Dom Organizatora.

Plakandaras, V., Gupta, R., Katrakilidis, C. & Wohar, M. E. (2020). Time-varying role of macroeconomic shocks on house prices in the US and UK: evidence from over 150 years of data. *Empircal Economics*, 58(5), 2249–2285. https://doi.org/10.1007/s00181-018-1581-x.

Reichenbachas, T. (2017). Credit-Related Shocks in VAR Models: The Case of Lithuania, *Ekonomika*, 96(3), 7-19. https://doi.org/10.15388/Ekon.2017.3.11547.

Sims, C. A. (1980). Macroeconomics and Reality. *Econometrica*, 48(1), 1-48.
Tomal, M. (2019). The Impact of Macro Factors on Apartment Prices in Polish Counties: A Two-Stage Quantile Spatial Regression Approach, *Real Estate Management and Valuation*, 27(4), 1-14. https://doi.org/10.2478/remav-2019-0031.
Yunus, N. (2017). Dynamic Linkages Among U.S. Real Estate Sectors Before and After the Housing Crisis, *The Journal of Finance and Economics*, 58, 264-289. https://doi.org/10.1007/s11146-017-9639-7.
ZBP. (2020). Raporty AMRON-SARFiN, II kwartał 2007 – II kwartał 2020, Retrieved from: https://www.amron.pl/.

APPENDIX

Table 5. Results of the Shapiro-Wilk normality test for residuals

Model	z	Prob>z
Model R1	0.653	0.25694***
Model R2	3.134	0.00086
Model R3	1.491	0.06799**
Model R4	1.260	0.10386***

Note: * p >0.01; ** p >0.05; *** p >0.1.
Source: own study.

Table 6. Results of the Breusch-Pagan test for heteroskedasticity

Model	chi2(1)	Prob > chi2
Model R1	4.14	0.0419*
Model R2	0.59	0.4432***
Model R3	0.04	0.8425***
Model R4	0.33	0.5684***

Note: * p >0.01; ** p >0.05; *** p >0.1.
Source: own study.

Table 7. Results of the Durbin's alternative test for autocorrelation

Model	Lags(p)	chi2	df	Prob > chi2
Model R1	1	2.453	1	0.1173***
Model R2	1	18.025	1	0.0000
Model R3	1	0.000	1	0.9910***
Model R4	1	0.042	1	0.8377***

Note: * p >0.01; ** p >0.05; *** p >0.1.
Source: own study.

Table 8. Results of the Lagrange-multiplier autocorrelation test

Lag	Model VAR3			Model VAR4		
	chi2	df	Prob > chi2	chi2	df	Prob > chi2
1	11.3606	9	0.25180***	19.1003	9	0.02435*
2	10.7400	9	0.29395***	10.7323	9	0.29451***
3	12.1855	9	0.20305***	9.6048	9	0.38342***
4	5.3217	9	0.80541***	5.9075	9	0.74914***

Note: no autocorrelation at lag order at *p>0.01; **p>0.05; ***p>0.1.
Source: own study.

Table 9. Results of the Jarque-Bera test for normal distribution

Model	Model VAR3			Model	Model VAR4		
Equation (dependent variable)	chi2	df	Prob > chi2	Equation (dependen t variable)	chi2	df	Prob > chi2
HI7	1.322	2	0.51645***	HI7	6.688	2	0.03530*
HI10	2.620	2	0.26979***	HI10	0.820	2	0.66377***
NL	3.204	2	0.20153***	VL	1.843	2	0.39796***
All	7.145	6	0.30760***	All	9.350	6	0.15481***

Note: normal distribution at *p>0.01; **p>0.05; ***p>0.1.
Source: own study.