THE ANALYSIS OF THE DETERMINANTS OF HOUSING PRICES

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ABSTRACT

Fundamental determinants of housing prices which affect housing demand and supply are the most common in developed countries. These are economic and financial determinants as well as demographic indicators. However, housing price analysis in less developed countries submit controversial and not sufficient results about the impact of interest rate, inflation and unemployment. Moreover, it does not investigate the influence of demographic variables and the means of economic policy. In this article the effect of GDP, unemployment, inflation, interest rate, emigration and the means of macroprudential policy on housing prices in Lithuania was evaluated. The results showed that inflation, interest rate and emigration are not causal determinants of housing prices, which mostly depend on GDP, unemployment, the means of macroprudential policy and the average housing prices in the previous period.

Keywords: housing price determinants, housing market, macroprudential policy, emigration, transition economy.

1. INTRODUCTION

The analysis of the determinants of housing prices is important because of the housing impact on economic and social factors. Firstly, homeownership has a positive effect on residential mobility, residents' health and other social consequences (DIETZ *et al.*, 2003).

Secondly, housing is a good, which is closely connected with other markets and the whole economic status of the country. As houses can be purchased by the mortgages as well as the own funds of the residents; the housing market is especially related to financial sector (JUREVIČIENĖ; OKUNEVIČIŪTĖ; NEVERAUSKIENĖ, 2008).

Finally, the changes in housing prices influence the construction market and other economic variables such as unemployment and inflation (AZBAINIS, 2014).

Because of this, a lot of analysis have been done in developed countries. It mostly specified economic and financial determinants of housing prices, such as GDP, unemployment, interest rate and credit conditions (ADAMS; FÜSS, 2010; AGNELLO; SCHUKNECHT 2011; JACOBSEN; NAUG, 2005; CROWE *et al.*, 2011), and more rarely – demographic determinants such as population, ageing and migration (TAKÁTS, 2012; CHEN *et al.*, 2012).

However, the determinants of housing prices in Lithuania do not always coincide with those in developed countries, mostly because of existing historic variable of a planned economy and transition processes to a developing economy. For this reason, the housing market in Lithuania is more similar to transition economies.

Still, researches for the housing market in Lithuania do not submit sufficient results. Firstly, different analysis showed controversial results about the impact of interest rate and inflation (IVANAUSKAS et al., 2008; KANAPECKIENĖ, 2009; LEIKA; VALENTINAITĖ, 2007).

Secondly, the effect of unemployment on housing prices in Lithuania has been investigated only twice (LEIKA; VALENTINAITĖ, 2007; TUPĖNAITĖ; KANAPECKIENĖ, 2009). Furthermore, the impact of demographical variables and the means of economic policy on housing prices has not been evaluated, as there is a problem of short time series in Lithuania, which is especially important for demographic determinants.

This study was performed by adapting several approaches. Firstly, literature analysis, synthesis and generalization were accomplished to investigate the theoretical background of the determinants of housing prices. Secondly, the Granger causality test was applied to reduce the causal determinants of housing prices in Lithuania. Finally, regression analysis was performed to evaluate the influence of the educed causal determinants.

The analysis investigated the impact of GDP, unemployment, inflation, interest rate, emigration; and the means of macroprudential policy on housing prices in Lithuania in the period from 2001 to 2014.

2. THE FUNDAMENTAL DETERMINANTS OF HOUSING PRICES

Housing prices can be explained mostly by fundamental determinants, which affect housing demand and supply. The demand side depends on the households ability to pay for a house or for a mortgage. Furthermore, the higher construction costs lead to decrease in construction and thus to a lower level of housing stock (ADAMS; FÜSS, 2010).

The most common determinants of house prices are macroeconomic determinants such as GDP, disposable income, and unemployment. An increase in economic activity increases the demand for space and since the housing stock cannot change in the short run, rents increase which leads to higher housing prices (ADAMS; FÜSS, 2010).

Moreover, the persistence of growth in per-capita real GDP may lead to the perception of higher life-time income growth and the willingness of agents to spend a larger share of income on housing and related debt service. Because of this, we may see higher growth of personal income being positively associated with a higher probability of a housing boom and reversely lower growth with a higher probability of a bust (AGNELLO; SCHUKNECHT, 2011).

The decrease of unemployment also has a positive effect on disposable income and causes agents to move to more economical but also more expensive housing (LEIKA; VALENTINAITĖ, 2007). However, increased unemployment results in expectations of lower wage growth and increased uncertainty concerning future income and ability to repay debt. This reduces the willingness to pay for owner-occupied dwellings (JACOBSEN; NAUG, 2005).

While macroeconomic determinants mostly affect the ability to pay for a house, financial determinants such as interest rate and credit conditions influence mortgage accessibility. A higher long-term interest rate increases the return of other fixed-income assets such as bonds relative to the return of real estate, thus shifting the demand from real estate into other assets. A higher long-term interest rate is furthermore reflected in higher mortgage rates, which reduce demand and further decrease housing prices (ADAMS; FÜSS, 2010).

The other important financial determinant is credit conditions such as: down payment requirements, loan-to value (LTV) ratio and debt-to-income (DTI) ratio. Chu (2014) finds that housing prices are sensitive to the changes of the down payment requirements if owner-occupied and rental houses are inelasticity supplied. Besides, Crowe et al. (2011) points out that the LTV ratio reduces the pool of borrowers that can obtain funding and thus reduces demand pressures and contains the boom. Similar to the LTV ration, the DTI ratio limits rein in the purchasing power of individuals, which reduces the pressure on real estate prices. Hence, macroprudential measures may limit mortgage credit and tackle the risks of housing prices booms.

Finally, demographic determinants such as population, ageing and migration also determine housing prices. Takáts (2012) states that a larger population is associated with higher real housing prices. Moreover, house prices might come under pressure, if the relative size of the older population compared to working population increases. Still, Chen et al. (2012) finds that population ageing is not likely the main determinant of housing prices.

To sum up, the most important determinants of housing prices are economic and financial indicators, however, we can see there is a smaller but significant influence of demographic determinant in a long run.

3. THE DETERMINANTS OF HOUSING PRICES IN LITHUANIA

Because of different markets, the determinants of housing prices, which are significant in developed countries, do not perfectly fit for housing markets in countries with transition economy. Although Lithuanian housing market has achieved vast developments and shifts towards the perception of more developed market, the history of a planned economy has its impact on the country's housing market, and thus

embodies principles of transition economies. However, different researches show rather different results, depending on data period and the method of the analysis.

The most important economic determinant in Lithuania is GDP, as showed Leika and Valentinaitė (2007), Simanavičienė and Keizerienė (2011), Tupėnaitė and Kanapeckienė (2009). Still, Ivanauskas et al. (2008) argued that neither GDP nor disposable income were causal determinants of housing prices in the period from 1998 to 2014. They explained that the negative results on the possible causality of housing costs and GDP might indicate a housing costs bubble.

Moreover, there have been only two studies of the impact of unemployment in Lithuania (LEIKA; VALENTINAITĖ, 2007; TUPĖNAITĖ; KANAPECKIENĖ, 2009), which showed that there was no effect of unemployment on house prices. Such results could be explained by the steady decline of unemployment in the period of research (TUPĖNAITĖ; KANAPECKIENĖ, 2009). Finally, Tupėnaitė and Kanapeckienė (2009) showed that inflation had negative impact, while Simanavičienė and Keizerienė (2011) showed a positive effect of inflation on housing prices.

The impact of financial determinants on housing prices is also not clear in Lithuania. Although Ivanauskas et al. (2008) did not identify a causal relation between interest rate and housing prices, Leika and Valentinaitė (2007) showed that real interest rate and credit supply were significant determinants of housing prices. Moreover, Tupėnaitė and Kanapeckienė (2009) supported the result that credit supply has a strong influence on housing prices.

Finally, the impact of demographical variables and the means of economic policy on housing prices has not been evaluated. Although fiscal and monetary policy is limited in the area of the regulation of house prices in Lithuania, macroprudential policy has been introduced in 2011 (LIETUVOS..., 2011). As it set the credit conditions such as the LTV ratio (85 percent) and the DTI ratio (40 percent), it is important to evaluate the impact of the introduction of macroprudential policy on housing prices.

To sum up, researches of the housing market in Lithuania showed controversial results about some variables, such as impact of interest rate and inflation. This could happen because most of these researches were based on regression and correlation analysis (LEIKA; VALENTINAITĖ, 2007; SIMANAVIČIENĖ; KEIZERIENĖ, 2011; TUPĖNAITĖ; KANAPECKIENĖ, 2009). Although regression analysis deals with the

dependence of one variable on other variables, it does not necessarily imply the causation (GUJARATI; PORTER, 2009), hence, causal determinants of housing prices are not clear in Lithuania.

4. METHODOLOGY

The analysis investigated the impact of GDP, unemployment, inflation, interest rate, emigration and the introduction of macroprudential policy on housing prices in Lithuania in the period from 2001Q1 to 2014Q4. Data sources: average house prices – the State Enterprise Centre of Registers; GDP, unemployment and emigration – Statistics Lithuania; interest rate (6 month VILIBOR) – Bank of Lithuania. Seasonality from the data was removed using the multiplicative method. As the main means of macroprudential policy has not changed since 2011, the introduction of macroprudential policy was included into the model as a qualitative variable.

As housing prices also have an impact on economic variables (AZBAINIS, 2014), the Granger causality test was applied to reduce the quantitative causal determinants of housing prices. The simple causal model is (GRANGER, 1969):

$$X_t = \sum_{j=1}^{m} a_j X_{t-j} + \sum_{j=1}^{m} b_j Y_{t-j} + \varepsilon_t$$
$$Y_t = \sum_{j=1}^{m} c_j X_{t-j} + \sum_{j=1}^{m} d_j Y_{t-j} + \eta_t \tag{1}$$

where εt and ηt are taken to be two uncorrelated white-noise series, m will be assumed finite and shorter than the given time series.

As it is assumed that all variables are stationary in Granger causality test, the Augmented Dicky-Fuller test was performed to check for stationarity. The ADF test consists of estimating the following regression (GUJARATI; PORTER, 2009):

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \sum_{i=1}^{m} \propto_i \Delta Y_{t-1} + \varepsilon_t \tag{2}$$

where εt is a pure white noise error term and where $\Delta Y_{t-1} = (Y_{t-1} - Y_{t-2})$. If the hypothesis that $\delta = 0$ is rejected, the time series is stationary. Sometimes taking the first differences of the variables makes them stationary, if they are not already stationary in the level form.

The number of lagged terms was introduced in the causality test based on Akaike information criterion (AIC), as AIC is a better choice for a smaller than 120 observations sample (LIEW, 2004). AIC is defined as (GUJARATI; PORTER, 2009):

$$AIC = e^{2k/n} \frac{RSS}{n} \tag{3}$$

where k is the number of regressors and n is the number of observations.

To evaluate the influence of the educed causal determinants, regression analysis was performed. The basic form of the model is:

$$Y = \beta_0 + \sum \beta_j x_j + u \tag{4}$$

where Y is an average housing price; x_j – the determinants of housing prices; u – residual.

To measure the goodness of fit of the multiple regression model, the adjusted coefficient of determination (R_a^2) was used. R_a^2 gives the proportion of the variation in Y explained by the variables X_j and can be specified as:

$$R_a^2 = 1 - (1 - R^2)\frac{n-1}{n-k} \tag{5}$$

where R^2 – multiple coefficient of determination; k – the number of parameters in the model including the intercept term; n – the number of observations.

Because the model (4) is the multiple regression, it must fit these assumptions:

- There is no multicollinearity among the regressors included in the regression model. Multicollinearity can be seen with the variance-inflating factor (VIF), which is defined as:

$$VIF_j = \frac{1}{1 - R_j^2} \tag{6}$$

When R_j^2, the coefficient of determination in the regression of regressor X_j on the remaining regressors in the model, increases, the VIF also increases. As a rule of thumb, if the VIF of a variable exceeds 10, that variable is said to be highly collinear.

- The disturbances appearing in the population regression function are homoscedastic. To detect heteroscedasticity White's test was used: the squared residuals from original regression are regressed on the original X variables or regressors, their squared values, and cross products of the regressors:

$$u_i^2 = \alpha_1 + \alpha_2 X_{2i} + \alpha_3 X_{3i} + \alpha_4 X_{2i}^2 + \alpha_5 X_{3i}^2 + \alpha_6 X_{2i} X_{3i} + v_i \tag{7}$$

Under the null hypothesis that there is no heteroscedasticity, it can be shown that nR^2 from the (7) regression asymptotically follows the chi-square distribution χ_{df}^2 with df equal to the number of regressors (excluding the constant term). If χ_{df}^2 exceeds the critical chi-square value, there is heteroscedasticity.

- There is no autocorrelation in the error terms, which was detected using the Breusch-Godfrey (BG) test. In the BG test, the following regression is estimated:

$$u_t = \alpha_0 + \alpha_1 X_{1t} + \alpha_2 X_{2t} + \alpha_3 X_{3t} + p_1 u_{t-1} + p_2 u_{t-2} \cdots + p_p u_{t-p} + \varepsilon_t \qquad (8)$$

where the term u_t follows p^{th} – order autoregressive scheme. If the sample size is large, $(n–p)$ R^2 obtained from (8) asymptotically follows the chi-square distribution χ_p^2. If $(n-p)$ R^2 exceeds the critical chi-square value, we reject the null hypothesis that there is no serial correlation of any order.

- The residuals from (4) model are normally distributed. Jargue-Bera (JB) Test of Normality was applied, which uses the following test statistic:

$$JB = (n-k)\left(\frac{S^2}{6} + \frac{(K-3)^2}{24}\right) \qquad (9)$$

where n – sample size; k – the number of parameters in the model; S – skewness coefficient and K – kurtosis coefficient. Under the null hypothesis that the residuals are normally distributed, asymptotically the JB statistics follows the chi-squared distribution with 2 df.

According to these testing procedures, the model, which satisfies all these assumptions, was constructed. Based on this model, the impact of the determinants of housing prices were evaluated.

5. THE RESULTS AND THEIR INTERPRETATION

The Granger causality test was performed to educe causal quantitative determinants of housing prices in Lithuania in the period from 2001Q1 to 2014Q2. ADF test showed that the p value of t statistic is higher than 0,05 for each variable, thus all variables are nonstationary. Still, the p value of t statistic for the first differences of each variable, is lower than 0,05. For this reason, the first differences were used for the Granger causality test. Moreover, different numbers of lagged terms were introduced in each causal model, according to AIC: 14 lags for the model of house prices and GDP, 12 – for unemployment (u), 3 – for inflation (π), 12 – for interest rate (i), and 1 – for emigration (e).

The Granger causality test showed that both GDP and unemployment are causal determinants of housing prices (Table 1 and Table 2). As GDP and

unemployment also have influence on disposable income, we can see that residents' ability to obtain a housing on their own funds is very important in Lithuania.

Table 1: The results of Granger causality test for housing prices and GDP

Lags: 14			
Null Hypothesis:	Obs	F-Statistic	Prob.
GDP does not Granger Cause Y	41	2,6932	0,0466
Y does not Granger Cause GDP		2,1643	0,0937

Table 2: The results of Granger causality test for housing prices and unemployment

Lags: 12			
Null Hypothesis:	Obs	F-Statistic	Prob.
u does not Granger Cause Y	43	2,4313	0,0431
Y does not Granger Cause u		1,1252	0,3988

There is also a causal relation between housing prices and inflation, however, causation is from housing prices to inflation, not vice versa (Table 3). This means that Tupėnaitė, Kanapeckienė (2009) and Simanavičienė, Keizerienė (2011), who had adapted only correlation and regression analysis, could show the incorrect result that inflation affect housing prices.

Table 3: The results of Granger causality test for housing prices and inflation

Lags: 3			
Null Hypothesis:	Obs	F-Statistic	Prob.
π does not Granger Cause Y	52	0,8749	0,4612
Y does not Granger Cause π		5,2987	0,0033

Interest rate is not a causal determinant of housing prices (Table 4). This is because only a small fraction of housing is purchased by housing mortgages in Lithuania. For example, in the first quarter of 2015 only one-fourth of housing transactions were made using mortgages (LIETUVOS BANKAS, 2015).

Moreover, although the Granger causality test showed that house prices cause interest rate, this does not prove causality in this case, as the Granger causality test firstly requires a logical foundation. Because a currency board existed in Lithuania till 2015, the Bank of Lithuania could not influence interest rate independently (KOPCKE, 2000), thus it is not likely that housing prices could determine interest rate in Lithuania.

Table 4: The results of Granger causality test for housing prices and interest rate

Lags: 12			
Null Hypothesis:	Obs	F-Statistic	Prob.
i does not Granger Cause Y	43	1,4093	0,2478
Y does not Granger Cause i		4,7074	0,0017

Finally, there is no causal relation between housing prices and emigration (Table 5). However, this result could be explained by several reasons. Firstly, the analysis was made only for the period of 14 years, while literature analysis showed that demographic determinants influence housing prices only in a long term (TAKÁTS, 2012; CHEN et al., 2012).

Furthermore, the effect of emigration on housing prices could be dual: on one hand, emigration has a negative impact on population and reduces housing demand and housing prices. On the other hand, emigration increases the transactions for the residents in Lithuania and this leads to higher housing prices (LEIKA; VALENTINAITĖ, 2007). Because of this, different sides of emigration could offset each other.

Table 5: The results of Granger causality test for housing prices and emigration

Lags: 1			
Null Hypothesis:	Obs	F-Statistic	Prob.
e does not Granger Cause Y	54	3,4390	0,0695
Y does not Granger Cause e		0,0708	0,7913

According to the Granger causality test, inflation, interest rate, and emigration were not included into the multiple regression model. As a result, Table 6 describes the model, where house prices depend on GDP, unemployment and the introduction of the means of macroprudential policy (D). Although all the variables in this model are statistically significant (p value of t statistic is less than 0,05 for each variable) and the value of R_a^2 is high, there are two problems in this model. Firstly, BG test showed that p value of $\chi^2(2)$ is 0,00 < 0,05, hence there is autocorrelation in the error terms. Secondly, WT test showed that p value of $\chi^2(8)$ is 0,01 < 0,05, thus the model is heteroscedastic.

Table 6: The results of the primary regression model of house prices

Included observations: 56			
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-519,3441	324,5538	-16,0018	0,0000
ln(GDP)	679,2101	36,4468	18,6357	0,0000
u	-14,0863	2,2373	-6,2962	0,0000
D	-213,5580	26,4953	-8,0602	0,0000
R-squared	0,9160			
Adjusted R-squared	0,9112			
F-statistic	189,0302			
Prob. (F-statistic)	0,0000			

In order to remove heteroscedasticity from the model, the new model was specified, where all quantitative variables (house prices, GDP and unemployment)

were introduced in logarithmic form. Moreover, autocorrelation in the error terms means that housing prices depend not only on defined independent variables, but also on lagged housing prices. Because of this, the lagged housing price (Y_{t-1}) was introduced into the model as an independent variable.

The description of this revised model is shown in Table 7. It can be seen that all the variables are statistically significant and that 98,76 percent of the variation in house prices can be explained by this model. Finally, the further analysis showed that the problems from the previous model were successfully removed.

Table 7: The results of the revised regression model of housing prices

Included observations: 55 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1,5679	0,6172	-2,5405	0,0142
ln(GDP)	0,4605	0,1163	3,9587	0,0002
ln(u)	-0,1367	0,0215	-6,3579	0,0000
D	-0,1008	0,0360	-2,8005	0,0072
$\ln(Y_{t-1})$	0,6603	0,0652	10,1201	0,0000
R-squared		0,9885		
Adjusted R-squared		0,9876		
F-statistic		1.074,8218		
Prob. (F-statistic)		0,0000		

First of all, there is no multicollinearity among the regressors included into the model, as the values of the estimated VIF are less than 10 for all independent variables (Table 8). Moreover, the BG test showed that p value of $\chi^2(2)$ is 0,85 > 0,05, hence there is no serial correlation of any order. Furthermore, the WT test showed that p value of $\chi^2(13)$ is 0,20 > 0,05, thus the model is homoscedastic. Finally, the residuals from the model are normally distributed (Fig. 1), as *p* value of the JB statistic is 0,76 > 0,05.

Table 8: The coefficients of determination for the regression analysis of independent variables and the values of the VIF

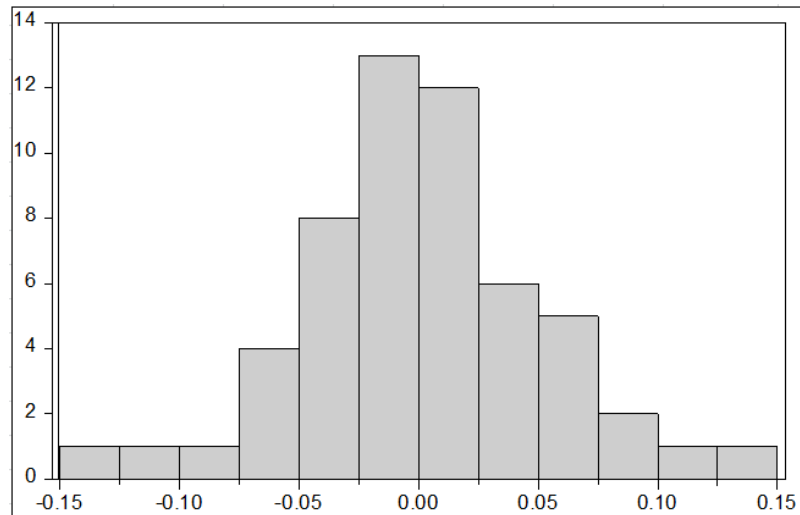|	R-squared	VIF
ln(GDP)	0,1878	1,2313
ln(u)	0,3808	1,6149
D	0,0282	1,0290
$\ln(Y_{t-1})$	0,7757	4,4582

Figure 1: The distribution of the residuals from the revised model

As the model, described in the Table 7 meets all the requirements for the multiple regression model, it can be written as:

$$\ln Y_t = -1{,}5679 + 0{,}4605 * \ln GDP_t - 0{,}1367 * \ln u_t - 0{,}1008 * D_t + 0{,}6603 * \ln Y_{t-1} + u \quad (10)$$

where Y – an average house price (EUR/m^2); t – period; GDP – gross domestic product (M EUR); u – unemployment (%); D – the introduction of the means of macroprudential policy; u – residual.

The (11) model shows that average housing prices in Lithuania mostly depend on GDP, unemployment, the means of macroprudential policy and the average housing prices in the previous period. GDP and the average housing prices in the previous period have the strongest impact: when each of these variables rises by 1 percent, housing prices rise by 0,46 and 0,66 percent respectively, while other variables are unchanged.

Unemployment has smaller but significant effect on housing prices: when unemployment rises by 1 percent, house prices fall by 0,14 percent, while other variables are unchanged. Finally, the introduction of the means of macroprudential policy had a negative impact on housing prices: after introduction of the means of macroprudential policy, housing prices fell on average by 0,10 percent. Because macroprudential policy is the only source of economic policy, which has an effect on housing prices in Lithuania, it is important to investigate not only the impact of introduction of macroprudential policy, but also the impact of separate means of macroprudential policy, such as the LTV and DTI ratios in further researches.

6. CONCLUSION

The analysis evaluated the influence of GDP, unemployment, inflation, interest rate, emigration and the introduction of the means of macroprudential policy on housing prices in Lithuania in the period from 2001 to 2014.

The Granger causality test showed that inflation, interest rate and emigration are not causal determinants of average housing prices. Although, there is a statistical relation between inflation and housing prices, inflation is a dependent variable. This means that researches of other authors, who had adapted only correlation and regression analysis, could show the incorrect result that inflation affects housing prices. Because of this, it is recommended to test causal relations of the variables before including them into the regression model.

The multiple regression model showed that housing prices can be determined by GDP, unemployment, the introduction of the means of macroprudential policy and the average housing prices in the previous period. By these variables 98,76 percent of the variation in housing prices can be explained.

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