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Housing loans and domestic credit in the Baltic States and Poland: Structural breaks and macroeconomic determinants

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Abstract

Aim/purpose – This study examines the time-series properties of home loans and domestic credit in Poland and the three Baltic countries, first in the univariate sense by identifying structural breaks in the series, and then using a multivariate model to identify the key drivers of loan growth.
Design/methodology/approach – Structural break tests are conducted using the method of Bai & Perron (1998), while orthgonalised VARs are used for the macroeconomic model.
Findings – The Estonian and Lithuanian home lending growth series have structural breaks in 2007, preceding the onset of the 2008 Global Financial Crisis. Estonian home lending has two additional structural breaks in 2009 and 2013. Neither of the two Polish lending series has any break after the sample begins in 2009, indicating more stability in the country's markets. In the macroeconomic model, consumer price inflation and real effective exchange-rate appreciations have the largest influence on lending and credit growth, and Poland more affected than the Baltic countries.
Research implications/limitations – This study opens the door to future research behind the specific causes of structural breaks in these series. While there is some evidence of an 'early warning' before the 2008 crisis, longer data series are needed for Poland and especially in the case of Latvia.
Originality/value/contribution – This study offers insight into the lending markets in an area of the world that was significantly impacted by the 2008 crisis. Understanding the behaviour and causes of lending growth will help avoid future problems.

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JEL Classification: E51, C22.

1. Introduction

As their economies have grown and converged to those of the rest of the European Union, Central and Eastern Europe's housing markets have matured and become more complex. At the same time, lending channels – including both domestic credit and home loans – have also become more advanced. As noted below, studies such as those by Ivanauskas, Eidukevičius, Marčinskas, & Galiniene (2008), Poskart (2012), and Henilane (2016) detail developments in the region.

This growth can lead to house-price increases, which could represent both increases in real incomes as well as a 'bubble,' in addition to strong connections between the credit channel and the overall macroeconomy. These linkages can be multidirectional, whereby credit can influence macroeconomic variables such as growth, inflation, and interest rates – or vice versa. In the latter case, the main drivers of housing credit can be explained using macroeconomic models. Reichenbachas (2017), for example, examines the effect of credit shocks on Lithuania's economy; other analyses are mentioned in the next section.

Knowing these linkages is important because on the one hand, it can help design policies to achieve the optimum growth rate for domestic and housing credit; on the other, it will allow central bankers and other policymakers to look for 'warning signals' that might precede a credit contraction that might destabilise the entire economy. The 2008 Global Financial Crisis, in fact, was preceded by a vast expansion in domestic credit in Central and Eastern Europe; both this expansion and the subsequent crash were highly destabilising for the small open Baltic economies in particular. These three countries' currencies were pegged to the euro as a prerequisite to eventually joining the common currency, which deprived them of an important stabilisation tool. Poland, on the other hand, with its floating currency and much larger economy, was the only EU country to avoid a recession during this time.

So far, however, a credit 'bubble' similar to the mid-2000s, when membership in the European Union helped attract large amounts of foreign capital, has not yet re-appeared. Hegerty (2020) examines 11 Central and Eastern European (CEE) countries and notes that domestic credit as a share of GDP has remained low in recent years in the Baltics, while Poland's share has been rising.

This study examines domestic credit and housing loans in four CEE countries – the Baltic States and Poland – to understand the time-series properties of these variables, as well as their macroeconomic determinants. Monthly time-series data from central banks are used to investigate the growth of home loans and of domestic credit, as well as the ratio of the two variables in levels, for Estonia, Latvia, Lithuania, and Poland. Structural break tests (using the method of Bai & Perron, 1998) are applied to examine periods of change in the series. Then, Vector Autoregressive (VAR) methods are used to capture the responses of these lending variables to a number of macroeconomic shocks. Overall, Estonia's lending variables experience the most structural breaks, while inflation and real appreciations appear to drive lending growth.

This paper proceeds as follows: Section 2 provides a literature review. Section 3 outlines the methodology, and Section 4 discusses the results. Section 5 concludes.

2. Literature review

While a number of earlier studies examine credit growth and housing in the CEE region, many of these focus either on the macroeconomic aspects of (aggregate) domestic credit, or on the determinants of house prices or home loans. Relatively little research, however, focuses specifically on home lending as a macroeconomic variable. In addition, a great deal of earlier work on domestic credit in the macroeconomy tends to focus on the immediate run-up to the crisis.

Hoffmann (2010), for example, examines credit cycles in Poland, Estonia, and Romania, and finds loose monetary policies of the European Central Bank to be responsible for overinvestment in the region. Lane & Milesi-Ferretti (2011) find that current account deficits, as well as the ratio of private credit to GDP, help explain the intensity of the crisis. Apostoaie, Percic, Cocriş, & Chirleşan, (2014) find linkages between credit and economic growth in Poland. Overall, domestic credit is examined as a cause of economic growth – and vice versa. Škare, Sinković, & Porada-Rochoń (2019) conduct Granger causality tests and find bidirectional causation between household loans and growth in Croatia.

In the second strand of the literature, many earlier studies focus on prices and costs rather than the volume or value of loans; of these studies, economic growth has emerged as a key driver. Ivanauskas, Eidukevičius, Marčinskas, & Galiniene (2008) show this to be the case for the cost of housing in Lithuania; Poskart (2012) finds growth to be behind that the number of housing loans in Poland, which peaked in 2007.

Using time-series methods that are relevant to the current study, Henilane (2016) describes mortgage lending in Latvia. Posedel & Vizek (2009) use VAR methods to examine housing prices in six EU countries (including Poland and Estonia), finding that interest rates, income, and housing loans explain much of the variance in house prices. Krušinskas (2012) calculates the ratios of house prices to income to examine 'bubbles' in the capital cites of the region; these are shown to be relatively large in Tallinn (vis-à-vis the rest of the Baltics) and Warsaw (compared to the rest of Central Europe). Aus, Kolbre, & Kahre (2015) examine housing market cycles in Estonia, focusing mostly on prices and volume. Kulikauskas (2016) examines 'overheating' in the Baltic property markets by estimating long-run fundamental housing prices and misalignments from these long-run values. Most recently, Reichenbachas (2017) uses VAR methods to assess the macroeconomic effects of credit shocks on Lithuania's macroeconomy, and Korzeniowska (2019) examines Polish household credit on a smaller scale.

Thus far, few studies have examined housing loans and their time-series properties in this region of the world. There exists a substantial gap in the literature for a statistical examination of housing credit, rather than simply of housing prices. This study fills this gap, using monthly data for the three Baltic countries and Poland, testing for structural breaks and isolating the macroeconomic determinants of credit growth. These findings are key, since the presence of structural breaks helps show which series have undergone the most change over time, and uncovering the determinants of lending growth will help policymakers target the appropriate variables to help maintain macroeconomic stability.

3. Research methodology

Monthly data for measures of housing loans and domestic credit are taken from each country's central bank website. Specific variables and their construction are provided in the Appendix. The timespan varies from country to country; it is shortest for Latvia and Poland (and omits the 2008 Global Financial Crisis), but all series end in 2019. These series are converted into real form by deflating them with the Consumer Price Index, and are deseasonalised using the Census--X13 procedure available through R's *seasonal* package. The ratio of the two nominal series (housing loans to domestic credit) is also calculated. Log changes in each variable are then calculated; these growth rates are shown to be stationary in the author's preliminary calculations.

The first empirical exercise is to estimate possible structural breaks in each series' growth rates. This is done using the Bai–Perron test (Bai & Perron, 1998), available through the *strucchange* package in R (Zeileis, Kleiber, & Hornik, 2003; Zeileis, Leisch, Hornik, & Kleiber, 2002). While it is often used in the case of a multivariate model (such as a linear regression), here this particular test is conducted on the series themselves, which is similar to a regression on a constant. With this test, the model parameters are allowed to break at *m* possible break points, as shown in Equation (1):

$$y_t = \beta_0 = z_t' \delta_j + u_t \quad (1a)$$
$$t = T_{j-1} + 1, \dots, T_j \quad (1b)$$
$$j = 1, \dots, m + 1 \quad (1c)$$

Of the 12 time series analysed here (three for each of the four countries), those with multiple breaks are noted. This can show events that signify changes to the mortgage market that are important for policymakers and lenders. Series with few or no structural changes might exhibit more stability.

The second empirical estimation is of a macroeconomic model of the determinants of each series. This is performed with a VAR model. VAR models allow for mutual interactions among each variable, and therefore do not make any strict endogeneity assumptions. Each variable is modelled as a function of the others, including the variables' lagged values. While it is possible to report the coefficients form the VAR's Ordinary Least Squares estimation, these do not offer any economic insight. Instead, the impact of shocks to the VAR errors is key, showing the short-run effects to shocks in a number of variables.

The variable of interest is depicted in Equation (2) as *LEND*; this is either (log changes in) real housing loans, (log changes in) real domestic credit, or the ratio of the two nominal level series. Macroeconomic drivers include (log changes in) the real effective exchange rate (*REER*) as a measure of international competitiveness and market conditions; economic growth (proxied by log changes in the index of industrial production); the domestic interest rate; and the inflation rate. All variables are stationary; Phillips–Perron test (Phillips & Perron, 1988) results are available upon request. Each variable is in log differences except interest rates; their occasional negative values preclude the use of natural logarithms.

$$\begin{bmatrix} \Delta\ln(REER)_t \\ GROWTH_t \\ \Delta r_t \\ INF_t \\ LEND_t \end{bmatrix} = \begin{bmatrix} \alpha_{01} & \cdots & \alpha_{51} \\ \vdots & \ddots & \vdots \\ \alpha_{05} & \cdots & \alpha_{55} \end{bmatrix} \begin{bmatrix} CONSTANT \\ \Delta\ln(REER)_{t-1} \\ GROWTH_{t-1} \\ \Delta r_{t-1} \\ INF_{t-1} \\ LEND_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \\ \varepsilon_{5t} \end{bmatrix} \quad (2)$$

In these orthogonalised VARs (using the classic method of Sims, 1980), the variables are ordered from most to least endogenous (from left to right, with a lower triangular matrix), so that the Cholesky decomposition might be applied. The international variable is expected to influence domestic growth, which drives interest rates and inflation. Equation (1) shows a VAR with one lag; in reality, the optimal lag length is chosen (out of a maximum of 12) by minimising the Schwarz Bayesian Criterion. In all, 12 VARs are estimated, for three variations in *LEND* for four countries.

For each VAR, Impulse-Response Functions (IRFs) are generated for a one--standard deviation shock in each of the four macroeconomic variables. This will show whether there are any significant effects on the lending market over a 12-month horizon. Home loans might behave differently from overall domestic credit, or the ratio of the two might be unaffected. Significant responses might be positive or negative, and might be largest at different horizons.

This study also estimates Forecast Error Variance Decompositions (FEVDs), which show the contributions of each macroeconomic variable to each lending variable's forecast errors. Just like is the case with the IRFs, the key drivers of lending in these countries can be isolated. The results are presented below.

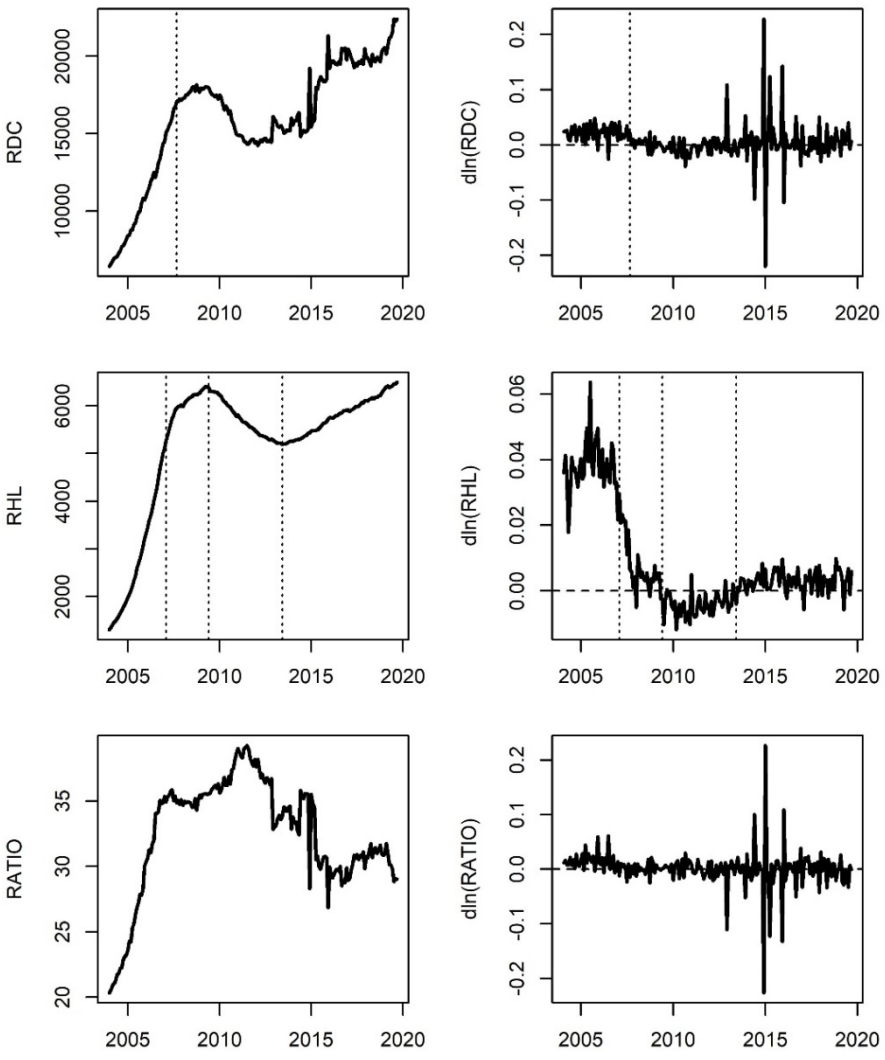
4. Research findings and discussion

Figure 1 shows each of the four countries' time series for housing loans and domestic credit, as well as the ratio of the two. These are presented both in levels and in log changes. Latvia's short series is declining throughout its truncated sample; this country is only included here to ensure a comprehensive look at all three Baltic countries. This country exhibits no structural changes, but the sample is not long enough to include the most likely periods for one to occur. Estonia's real home lending showed more of a pre-crisis 'bubble' than does real domestic credit; both recovered from their declines, but the ratio of the two has fallen since domestic credit increased more over time. Lithuania, which together

with Estonia has the longest time span of home-loan data, behaves similarly, with the exception that its ratio is more stable over the sample period. While Poland's time series begins in 2009, its series steadily increase afterward. There is a drop in the ratio late in the sample, likely due to a brief dip in home lending after 2015.

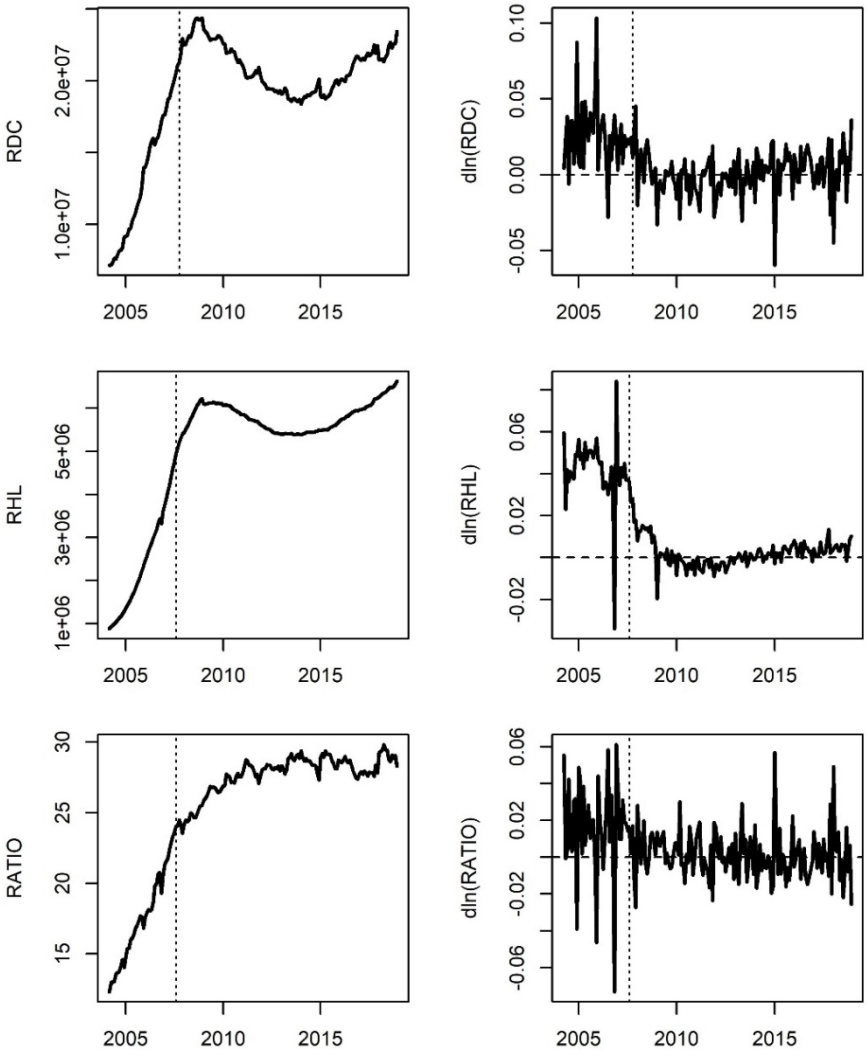
Figure 1. Loans and credit: Levels and log changes

Estonia

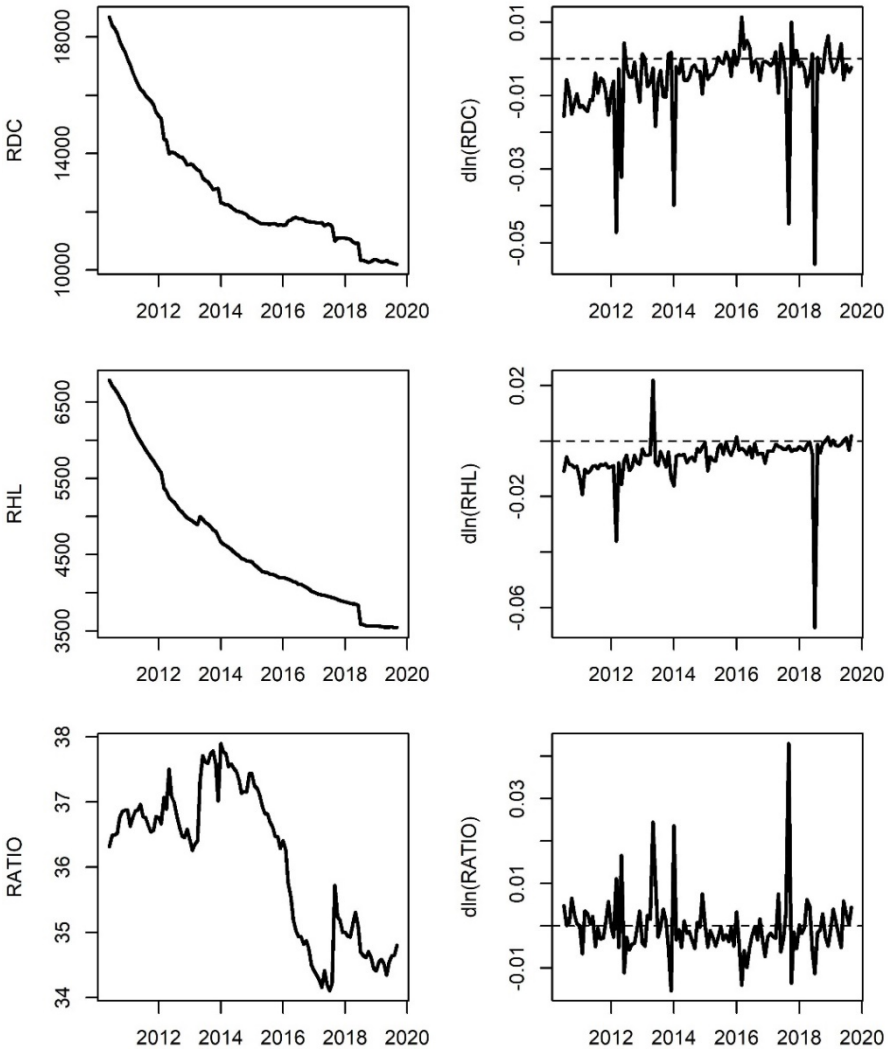


RHL = Real Home Loans; RDC = Real Domestic Credit; Ratio = Loans/Credit.

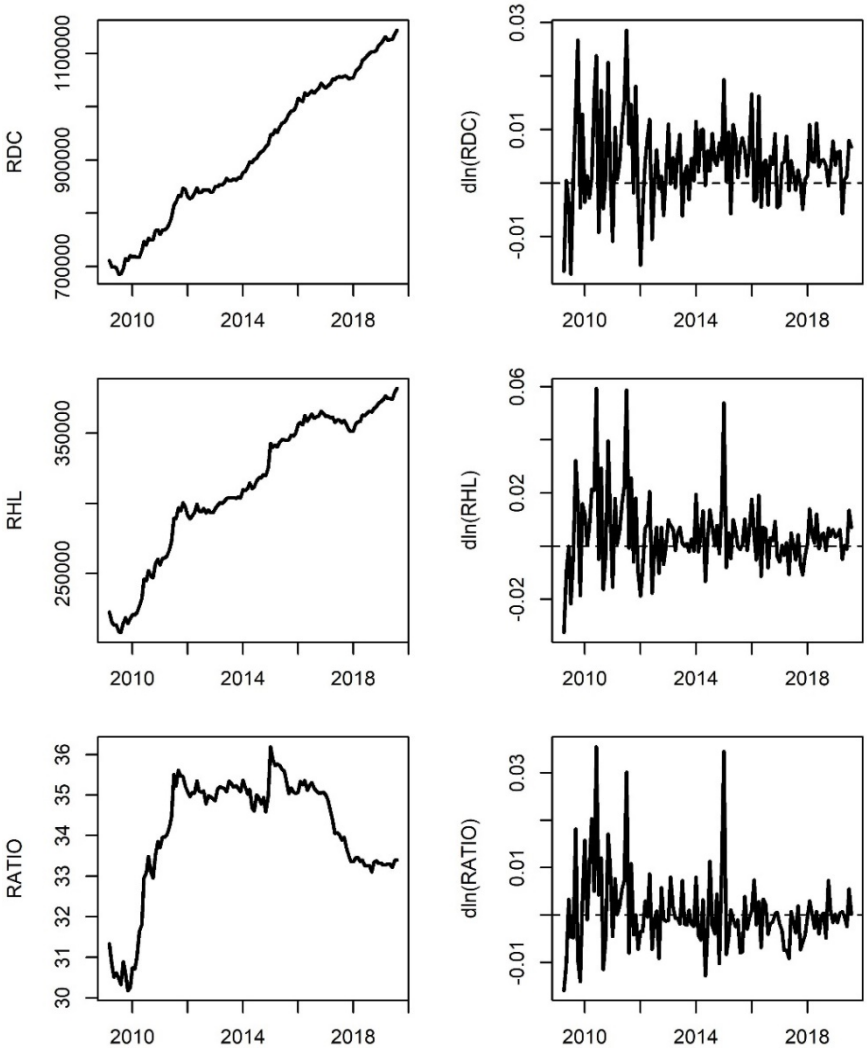
Lithuania


RDC
1.0e+07
2.0e+07
2005
2010
2015
dln(RDC)
-0.05
0.00
0.05
0.10
RHL
1e+06
3e+06
5e+06
dln(RHL)
-0.02
0.02
0.06
RATIO
15
20
25
30
dln(RATIO)
-0.06
-0.02
0.02
0.06

Latvia


RDC
10000
14000
18000
2012
2014
2016
2018
2020
dln(RDC)
-0.05
-0.03
-0.01
0.01
RHL
3500
4500
5500
6500
dln(RHL)
-0.06
-0.02
0.02
RATIO
34
35
36
37
38
dln(RATIO)
-0.01
0.01
0.03

Poland



Note: Vertical lines = Bai–Perron structural breaks; generated in log change series.

Source: All data sources are listed in the Appendix.

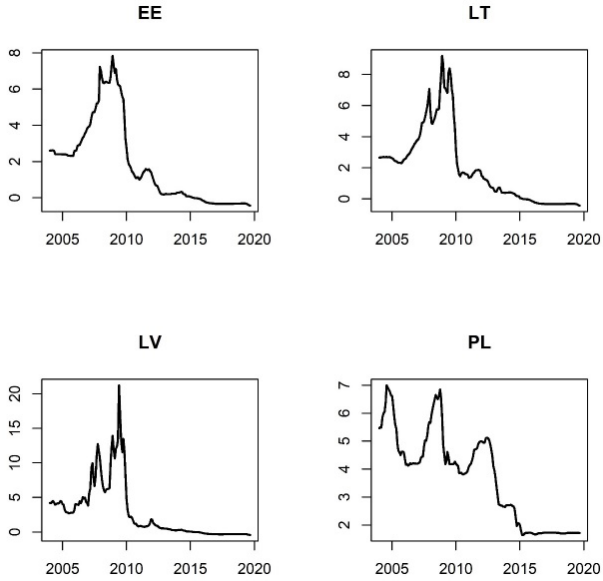
One interesting finding is that for Estonia and Lithuania, real domestic credit has one structural break that precedes the 2008 Global Financial Crisis (in 2007m9 and 2007m12, respectively). Lithuania's real home lending also shows a structural break in 2007m10. This suggests that there may have been a 'warning sign' in advance of the onset of the crisis. In fact, many U.S. forecasters were debating the probability of an upcoming crisis at this time. Here, CEE lending markets may have anticipated it.

Estonia's real home lending exhibits the most structural breaks, with three occurring in 2007m2, 2009m6, and 2013m6. This series is therefore worthy of additional investigation. In particular, the drivers behind these breaks, and specific events that might be connected to them, could be assessed in detail. Perhaps some real economic or political event, or a legal change, might be responsible.

While its time series begin after the 2008, none of Poland's lending growth rates has a structural break; this stands in contrast to the Baltic countries, particularly Estonia, since there are no changes even later in the sample. Perhaps, not having had to transition from a pure Soviet-style economy, the resulting changes in lending markets have been less severe. In addition, the ratios of home loans to domestic credit have no structural break for any country except Lithuania in 2007m10. Most likely, there have been no major shocks to the lending market that have led to instability in wider credit markets.

Having investigated the time-series properties of each lending time series in isolation, the next step of this analysis is to examine the macroeconomic determinants of these series and their ratios using VAR methods. One of the most important drivers of lending is the interest rate; Figure 2 depicts the 3-month/90-day rates for each country. In the Baltics, rates rose before the crisis before falling and remaining flat afterward. Again, Poland behaves differently, with lower rates only after 2015. Most likely, its mortgage and credit markets will exhibit their own unique behaviours.

Figure 2. Interest rates (90-day)

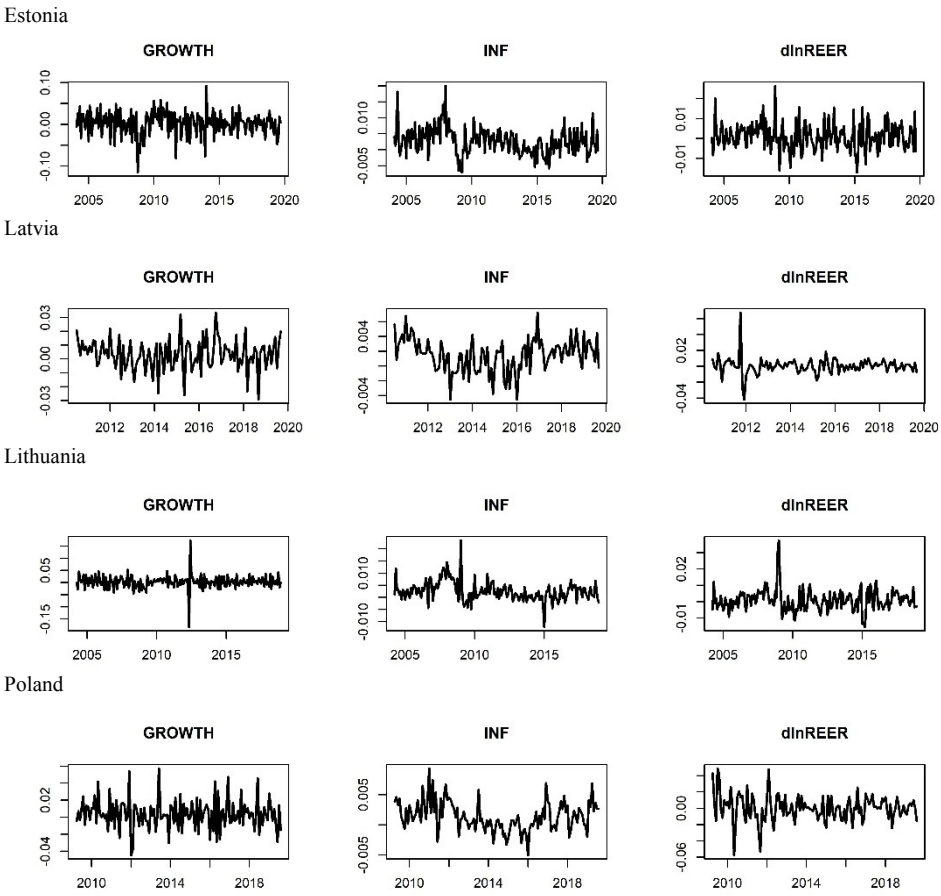


Note: EE – Estonia, LT – Lithuania, LV – Latvia, PL – Poland.

Source: All data sources are listed in the Appendix.

Figure 3 presents the other main macroeconomic variables that are expected to drive lending in these countries. Inflation, for example, rose in the Baltics before 2008, as capital flowed into the region, and currency pegs forced the economies to adjust through the price level rather than through nominal appreciation. These countries' real effective exchange rates, however, showed this adjustment, even though the nominal rates were fixed.

Figure 3. Macroeconomic variables

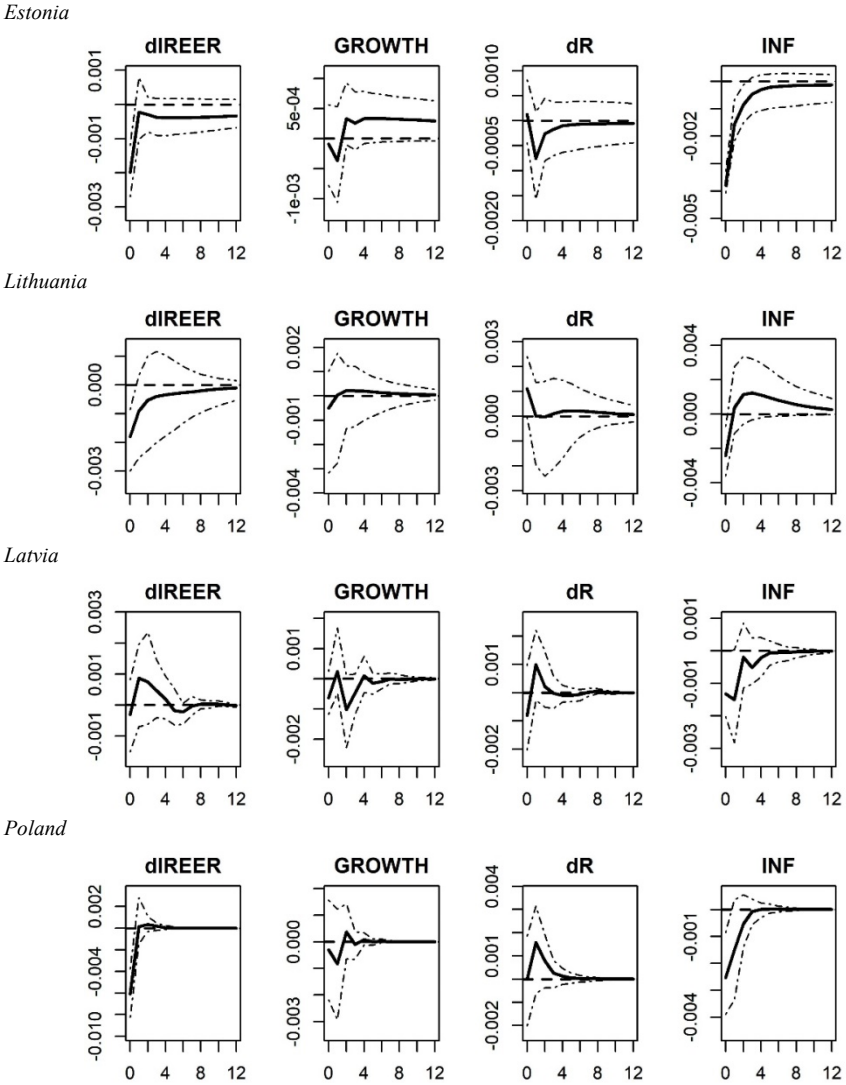


Source: All data sources are listed in the Appendix.

The Impulse Response Functions of log changes in real home lending to a one standard deviation shock to each macroeconomic variable are presented in Figure 4. Inflation and appreciations in the REER have the strongest effects overall. Inflation has a negative effect, reducing lending in Estonia, Latvia, and Poland at short time horizons; REER appreciations have some negative impact

on Estonia, Lithuania, and Poland. As is the case with the other lending variables, income has little effect. Interest rates, contrary to what might be expected, do not generate significant responses either. Perhaps this is due to the globalisation of finance, particularly in the small open economies of the Baltic States. Domestic interest rates might be less binding if capital is available elsewhere – particularly in the Scandinavian and Nordic banks that dominate the region.

Figure 4. Impulse-Response Functions: Real home loan growth (with ±2 s.e. bands)

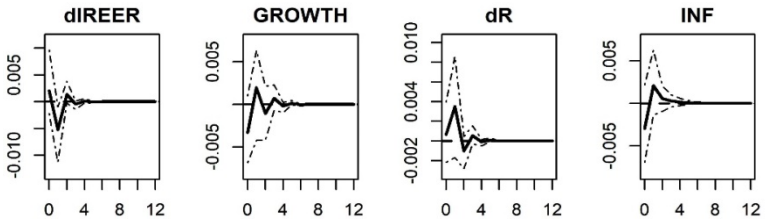


Note: dR = first difference of interest-rate series, dlREER = log difference in REER.

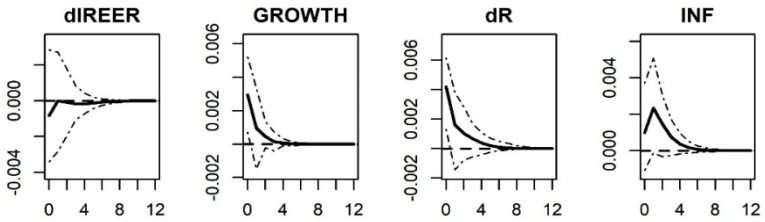
Figure 5 plots the IRFs for domestic credit; these results are not expected to be the same as those of Hegerty (2020) because that study examined quarterly series that were deflated by GDP rather than by price levels. Here, interest-rate increases have a limited yet positive effect on Latvian and Lithuanian credit; otherwise Poland's real credit growth is reduced by positive shocks to inflation and the real effective exchange rate. Poland's home-loan-to-domestic-credit ratio is the most likely of the four to respond significantly to a macroeconomic shock. While a positive growth shock reduces this ratio in Lithuania, Figure 6 shows that shocks to inflation, and particularly to the country's REER, significantly reduce it in Poland.

Figure 5. Impulse-Response Functions: Real domestic credit growth (with ±2 s.e. bands)

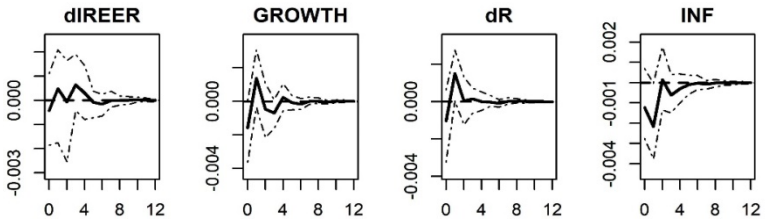
Estonia



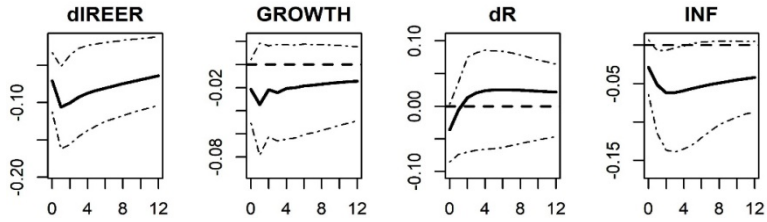
Lithuania



Latvia



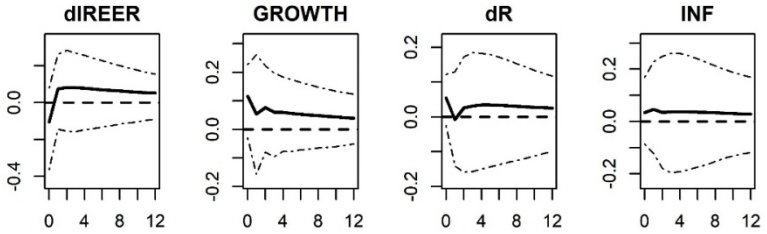
Poland



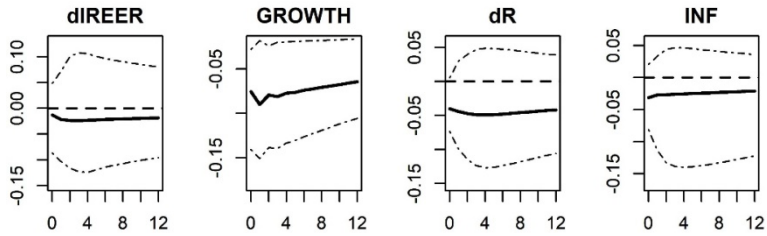
Note: See Figure 3 for variable definitions.

Figure 6. Impulse-Response Functions: Ratio of Home Loans to Domestic Credit (with ±2 s.e. bands)

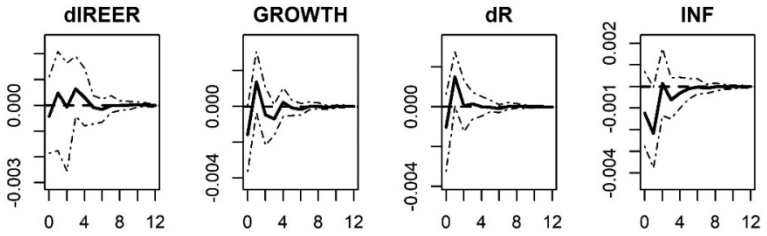
Estonia



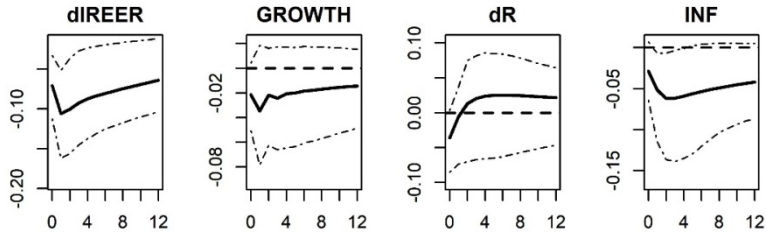
Lithuania



Latvia



Poland



Note: See Figure 3 for variable definitions.

Table 1 presents the Forecast Error Variance Decompositions for each country and lending variable. Some of the highest values can be found for Poland; in particular, the REER's contribution to the forecast error variance in housing loans and domestic credit can be as high as 20 or 30 per cent, respec-

tively. Inflation also contributes 8.5 per cent of the forecast error variance of domestic credit at four and eight month horizons. Elsewhere, inflation contributes 33.2 per cent of the forecast error on Estonian real home loans at a 4-month horizon, and the real effective exchange rate's contribution is eight per cent. Most of the remaining values are small.

Table 1. Forecast Error Variance Decompositions

Estonia: Real home loans					
Horizon	dlnREER	GROWTH	dR	INF	dlnRHL
1	0.146	0.000	0.001	0.527	0.326
4	0.079	0.006	**0.013**	0.332	0.570
8	0.062	0.010	**0.009**	0.231	0.688
Estonia: Real domestic credit					
Horizon	dlnREER	GROWTH	dR	INF	dlnRDC
1	0.004	0.010	0.000	0.008	0.978
4	0.027	0.013	0.011	0.011	0.938
8	0.027	0.013	0.011	0.011	0.938
Estonia: Home loan/domestic credit ratio					
Horizon	dlnREER	GROWTH	dR	INF	RATIO
1	0.010	0.012	0.003	0.001	0.975
4	0.008	0.007	0.001	0.002	0.983
8	0.008	0.006	0.001	0.002	0.983
Lithuania: Real home loans					
Horizon	dlnREER	GROWTH	dR	INF	dlnRHL
1	0.025	0.002	0.010	0.045	0.918
4	0.016	0.001	0.004	0.031	0.947
8	0.014	0.001	0.004	0.036	0.944
Lithuania: Real domestic credit					
Horizon	dlnREER	GROWTH	dR	INF	dlnRDC
1	0.002	0.023	0.047	0.003	0.926
4	0.002	0.024	0.052	0.022	0.900
8	0.002	0.024	0.053	0.023	0.899
Lithuania: Home loan/domestic credit ratio					
Horizon	dlnREER	GROWTH	dR	INF	RATIO
1	0.001	0.037	0.011	0.006	0.945
4	0.003	0.046	0.014	0.005	0.932
8	0.004	0.046	0.016	0.005	0.929
Latvia: Real Home Loans					
Horizon	dlnREER	GROWTH	dR	INF	dlnRHL
1	0.001	0.006	0.010	0.027	0.956
4	0.022	0.024	0.023	0.059	0.871
8	0.024	0.024	0.023	0.060	0.869

Table 1. cont.

Latvia: Real domestic credit					
Horizon	dlnREER	GROWTH	dR	INF	dlnRDC
1	0.002	0.026	0.011	0.015	0.947
4	0.007	0.046	0.030	0.059	0.858
8	0.009	0.046	0.030	0.06	0.856
Latvia: Home loan/domestic credit ratio					
Horizon	dlnREER	GROWTH	dR	INF	RATIO
1	0.001	0.009	0.000	0.000	0.990
4	0.014	0.013	0.005	0.001	0.968
8	0.012	0.015	0.006	0.001	0.966
Poland: Real Home Loans					
Horizon	dlnREER	GROWTH	dR	INF	dlnRHL
1	0.206	0.001	0.000	0.036	0.758
4	0.199	0.005	0.017	0.048	0.731
8	0.199	0.005	0.017	0.048	0.731
Poland: Real domestic credit					
Horizon	dlnREER	GROWTH	dR	INF	dlnRDC
1	0.308	0.000	0.029	0.065	0.598
4	0.304	0.009	0.034	0.085	0.568
8	0.304	0.009	0.034	0.085	0.568
Poland: Home loan/domestic credit ratio					
Horizon	dlnREER	GROWTH	dR	INF	RATIO
1	0.072	0.007	0.018	0.012	0.892
4	0.128	0.010	0.007	0.041	0.813
8	0.130	0.009	0.009	0.049	0.803

Note: dR = first difference of interest-rate series, dlnREER = log difference in REER, dlnRHL = log difference in real home loans, dlnRDC = log difference in real domestic credit, ratio = home loans / domestic credit.

Source: Author's calculations.

Overall, while Estonia's home-lending market shows the most structural change over this period, most of the time series examined here have similar determinants: the inflation rate and appreciations in the real effective exchange rate. Growth in industrial production, and especially changes in interest rates, have less of an effect than might be expected. This is likely due to the dominance of Swedish and other Scandinavian banks (such as Swedbank, SEB, and Danske Bank), and the availability of capital through global markets. Further research could expand these models to uncover long-run effects and additional drivers of these processes.

5. Conclusions

After they joined the European Union in 2004, CEE countries attracted large amounts of foreign investment that helped fuel credit bubbles. These 'popped' in the wake of the 2008 Global Financial Crisis, and so far, there is shown to be little evidence of their return. But since a resurgence could be destabilising these countries' economies, understanding credit dynamics is essential. This study examines the levels and growth rates of housing loans and domestic credit in Poland and the Baltic countries, using monthly data up to 2019. After plotting each time series, structural break tests are conducted. Then, using a VAR model, the impact of macroeconomic variables on these lending growth rates are assessed.

Estonia and Lithuania, which have the longest time series that begin in 2004, show evidence of structural breaks in late 2007 – before the financial crisis officially hit. This suggests that these lending markets registered some type of an 'early warning' that anticipated the credit collapse that would follow. The time series for Poland and Latvia begin later and therefore do not register any early structural breaks, but these series also do not have any structural changes later in the sample. Estonian home lending has the most structural breaks, suggesting that the evolution of this country's mortgage market be examined in more detail in a future study.

Impulse-Response Functions and Forecast Error Variance Decompositions, generated using VAR methods, show that of the main macroeconomic determinants, inflation and real exchange-rate appreciations often have the most significant effects. This is particularly true for growth in mortgage loans; changes in interest rates have more of an effect on growth in domestic credit. Of the four countries examined here, only Poland's ratio of home loans to domestic credit responds (negatively) to inflation and real appreciations, while economic growth seems to lower the ratio for Lithuania.

These results highlight the role of domestic and international prices as the drivers of lending in this set of countries. Real factors, proxied by growth, have less of an impact, as does the interest rate. Policymakers should be aware of the importance of maintaining competitiveness, which not only is key from a trade standpoint, but also for the lending markets examined here.

Further research could not only seek to analyse longer time series (ideally beginning at least in 2004 for all countries), but to examine in more detail the underlying mechanisms behind these findings. In particular, the trade and finan-

cial channels that might link competitiveness to home loans and domestic credit could be empirically investigated. Such data, however, are usually unavailable at monthly frequencies, so a different research design would need to be proposed. Nonetheless, the current study highlights differences among these countries and between the two categories of lending, showing specific results for Estonia and for the role of domestic and international prices.

Appendix: Data Definitions and Sources

All data are monthly and begin in 2004m1 for Estonia and Lithuania, 2010m6 for Latvia, and 2009m3 for Poland. All series, with one exception, end in 2019m9. They are deseasonalised if necessary using the Census-X13 method available through R's seasonal package.

Data for home loans and domestic credit are taken from the respective countries' central banks, and compared with IFS data (which do not cover the entire time period) to ensure that they match.

Latvia (Bank of Latvia Statistical Database, www.bank.lv)

HL Loans to households for house purchase (residents)

DC Sum of: Local government (residents), other financial intermediaries and financial auxiliaries (residents), Insurance corporations and pension funds (residents), Public non-financial corporations (residents), Private non--financial corporations (residents), Loans to households for house purchase (residents), Consumer credit to households (residents), Other loans to households (residents)

Estonia (Eesti Pank Statistics, www.eestipank.ee)

HL Lending for house purchase

DC Lending to residents

Poland (NBP, www.nbp.pl)

HL Banking Sector Loans and Advances – Gross Carrying Amount (Portfolio B) Housing loans

DC Loans and other claims on domestic residents

Lithuania (Bank of Lithuania Statistical Database, www.lb.lt)

HL Loans for house purchase held by other monetary financial institutions vis-a-vis resident households and NPIs serving households (outstanding amounts)

DC Loans held by other monetary financial institutions (outstanding amounts)

Two macroeconomic variables are taken from the International Financial Statistics of the International Monetary fund. (*data.imf.org*)

GROWTH Monthly log change in each country's index of industrial production. This series ends in 2018m12 for Lithuania and 2019m8 for Poland.

INF Monthly log change in each country's Consumer Price Index.
Interest rates are the 3-Month or 90-day Rates and Yields: Interbank Rates taken from the OECD database (through the FRED website)

Nominal and Real effective exchange rates (*NEER and REER*) are the 'broad' indices from the Bank for International Settlements database (through the FRED website, *fred.stlouisfed.org)*

References

Apostoaie, C.-M., Percic, S., Cocriş, S., & Chirleşan, D. (2014). Research on the credit cycle and business cycle with a focus on ten states from Central, Eastern, and Southeastern Europe. *Emerging Markets Finance & Trade, 50*(4), 63-77. https://doi.org/10.2753/REE1540-496X5004S404

Aus, V., Kolbre, E., & Kahre, K. (2015). Drivers of Estonian housing market cycles. *Research in Economics and Business: Central and Eastern Europe, 7*(2). Retrieved from http://rebcee.eu/index.php/REB/article/view/79

Bai, J. & Perron, P. (1998). Estimating and testing linear models with multiple structural changes. *Econometrica, 66*(1), 47-78. https://doi.org/10.2307/2998540

Bank for International Settlements. (n.d.). Real and Nominal Broad Effective Exchange Rates, retrieved from FRED, Federal Reserve Bank of St. Louis. Retrieved from fred.stlouisfed.org

Bank of Latvia Statistical Database. (n.d.). Retrieved from https://statdb.bank.lv/lb/

Bank of Lithuania Statistical Database. (n.d.). Retrieved from https://www.lb.lt/lt/statistikos-duomenu-baze-2

Eesti Pank Statistics. (n.d.). Retrieved from https://www.eestipank.ee/en/statistics

Hegerty, S. W. (2020). Do capital flows drive credit growth and consumption in Central and Eastern Europe? *Post-Communist Economies, 31*(1), 36-51. https://doi.org/10.1080/14631377.2018.1461516

Henilane, I. (2016). Review of housing mortgage lending policy practices in Latvia. *Journal of Business Management, 10*, 59-69.

Hoffmann, A. (2010). An overinvestment cycle in Central and Eastern Europe. *Metroeconomica, 61*(4), 711-734. https://doi.org/10.1111/j.1467-999X.2010.04103.x

International Financial Statistics [IFS]. (n.d.). Country Tables [Data File]. Washington, D.C.: International Monetary Fund. Retrieved from data.imf.org

Ivanauskas, F., Eidukevičius, R., Marčinskas, A. & Galiniene, B. (2008). Analysis of the housing market in Lithuania. *International Journal of Strategic Property Management, 12*(4), 271-280. https://10.3846/1648-715X.2008.12.271-280

Korzeniowska, A. M. (2019). Sources of financing of household debt in Poland. *Folia Oeconomica Stetinensia, 19*(2), 56-67. https://doi.org/10.2478/foli-2019-0013

Krušinskas, R. (2012). Research on housing bubbles in the capitals of the Baltic and Central Europe. *Economics and Management, 17*(2), 480-485. https://doi.org/10.5755/j01.em.17.2.2169

Kulikauskas, D. (2016). Fundamental housing prices in the Baltic States: Empirical approach. *Baltic Journal of Economics, 16*(2), 53-80. https://doi.org/10.1080/1406099X.2016.1173446

Lane, P. R., & Milesi-Ferretti, G. M. (2011). The cross-country incidence of the global crisis. *IMF Economic Review, 59*, 77-110. https://doi.org/10.1057/imfer.2010.12

National Bank of Poland [NBP]. (n.d.). *Statistics and indicators*. Retrieved from https://www.nbp.pl/home.aspx?f=/statystyka/statystyka.html

Phillips, P. C. B., & Perron, P. (1988). Testing for a unit root in time series regression. *Biometrika,* 75(2), 335-346. https://doi.org/10.2307/2336182

Posedel, P. & Vizek, M. (2009). House price determinants in transition and EU-15 countries. *Post-Communist Economies, 21*(3), 327-343. https://doi.org/10.1080/14631370903090640

Poskart, R. (2012). Changes in Poland's housing loan market in 2004-2010. *Nauki o Finansach. Financial Sciences, 1*(10), 97-115.

Reichenbachas, T. (2017). Credit-related shocks in VAR models: The case of Lithuania. *Ekonomika/Economics, 96*(3), 7-19.

Sax, C., & Eddelbuettel, D. (2018). Seasonal adjustment by X-13ARIMA-SEATS in R. *Journal of Statistical Software, 87*(11), 1-17. https://doi.org/10.18637/jss.v087.i11

Sims, C. A. (1980). Macroeconomics and reality. *Econometrica, 48*, 1-48. https://doi.org/10.2307/1912017

Škare, M., Sinković, D., & Porada-Rochoń, M. (2019). Measuring credit structure impact on economic growth in Croatia Using (VECM) 1990-2018. *Journal of Business Economics and Management, 20*(2), 294-310. https://doi.org/10.3846/JBEM.2019.8344

Zeileis, A., Leisch, F., Hornik, K., & Kleiber, C. (2002). *strucchange*: An R package for testing for structural change in linear regression models. *Journal of Statistical Software, 7*(2), 1-38. https://doi.org/10.18637/jss.v007.i02

Zeileis, C., Kleiber, W. & Hornik, K. (2003). Testing and dating of structural changes in practice. *Computational Statistics & Data Analysis, 44*, 109-123. https://doi.org/10.1016/S0167-9473(03)00030-6