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## Article

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## Impact of Macroeconomic Indicators on Mortgage Loans in the V4<sup>1</sup>

Radmila KRKOŠKOVÁ\* – Zuzana SZKORUPOVÁ\*\*

### Abstract

*The aim of this article is to analyse the impact of selected macroeconomic indicators on mortgage loans in the V4. This group of countries was chosen because they are close, both geographically and economically. This paper tries to find reasons for possible differences or similarities between the Czech Republic, Slovakia, Poland and Hungary. The article analyses which of the macroeconomic variables (GDP, inflation, the unemployment rate, and mortgage interest rate) affect the volume of mortgage loans. The article uses the tools of time series econometrics, especially the ADF test, Autoregressive Distributed Lag (ARDL) model, Error Correction Model (ECM), and the Granger causality test. It was found that there is a short-term relationship between the volume of mortgage loans and GDP for all countries, except Poland. Over a longer time series, however, a long-term relationship exists for all of countries between the volume of mortgage loans and GDP, the mortgage interest rate, and the unemployment rate. The data used is based on a quarterly time series running from 2005Q1 to 2019Q4.*

**Keywords:** ADF test, ARDL model, ECM, Granger causality test, mortgage loans, V4

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## Introduction

Mortgage loans play an important part in most countries around the world. Their role is to secure the financing of real estate and other investments related to housing. From the perspective of the national economy, mortgage loans are a sign of a functioning economy. The mortgage market is the market for financing real estate assets. The provision of housing can be successful if the nation has a well-developed mortgage market. The institutions involved in the provision of mortgages include commercial banks and specialized mortgage firms.

Compared to other countries of the Visegrád Group, mortgages in the Czech Republic in 2019 were markedly cheaper than mortgages in Poland or Hungary. According to the European Mortgage Federation, the average mortgage rate in the Czech Republic in the 1<sup>st</sup> quarter of 2019 amounted to 2.97%. In Poland, the average mortgage rate was six percent; in Hungary, 5.17%. In Slovakia, however, mortgages were even cheaper than in the Czech Republic – the average rate was below two percent in the first quarter. This may be mostly due to the different monetary policy of the respective central banks. Slovakia is the only V4 country which is also a member of the Eurozone, and her monetary policy is thus affected by that of the ECB, which has long been setting lower rates than the Czech National Bank or the central national banks of Poland and Hungary. For similar reasons, mortgage loans are also cheaper in Germany or Austria. Moreover, the higher mortgage rates in Poland and Hungary can be caused by differences in the amount of non-performing loans, which is higher in these countries. Another factor which affects the mortgage rate is the insolvency law, or rather the ability of local banks to settle a debt resulting from an outstanding mortgage loan by selling the mortgaged real estate.

The average mortgage loan interest rate decreased, and in the first quarter of 2020 it had dropped to 2.53 percent in the Czech Republic. In the case of Hungary, the mortgage interest rate decreased to a value of 4.17 percent, in the case of Poland it reached 3.7 percent, and in Slovakia it was 1.22 percent. This was part of an overall trend of falling mortgage interest rates in Europe.

The aim of this article is to analyse the impact of selected macroeconomic indicators on mortgage loans in the V4. There are many factors which affect mortgage loans. These include GDP, inflation, unemployment, the mortgage interest rate, real estate prices, tax rates, state support, financial literacy, and competition in banking sector. The article analyses which of the selected macroeconomic variables (GDP, inflation, the unemployment rate, and the mortgage interest rate) affect the volume of mortgage loans. One of the important factors which impacts mortgage loans is economic growth. This fact is confirmed by Shahini (2014, p. 124). They argue that the demand for housing loans has a strong positive relation

to economic growth and that an increase in economic growth makes people more confident about their investments. In general, a stable macroeconomic environment with low inflation is important for a successful mortgage market. This is confirmed by studies such as those by Warnoc and Warnoc (2008, p. 241) and Boamah (2009, p. 21). Next on the list of important factors which have an impact on mortgage loans is unemployment. There is an assumption that as unemployment grows, the volume of provided loans decreases. There are also a number of empirical studies in this area (Demir, Kurt and Cagdas, 2003, p. 4; Střelcová and Střelec, 2009, p. 162). Interest rates also generally affect the volume of mortgage loans. An increase in interest rates leads to a reduction in the volume of mortgage loans and vice versa. The relationship between interest rates and mortgages is addressed by a number of empirical studies. We can mention, for example, those by Owuor, Githii and Mwangi (2018, p. 68).

This article is structured as follows: 1. Literature review, 2. Macroeconomic variables, 3. Methodological part and data, 4. Empirical results, 5. a Discussion, and finally the Conclusion on our findings.

## 1. Literature Review

Since analysing mortgage markets and the factors which affect them is such a hot topic, there are currently many relevant studies. This article presents the conclusions of select scientific papers which aim to analyse precisely those macroeconomic factors in relation to the mortgage markets we are monitoring. In their article, Kapounek, Kučerová and Fidrmuc (2017, p. 291) focus on the role of demand and supply in relation to loans. They analyse connections between macroeconomic shocks, the institutional environment, and the responses of the banking sector to the financial crisis in EU member states. To this end, the authors use data on the 27 EU states for 2000 – 2013. They employ OLS and 2SLS fixed effects models. Their results show that macroeconomic shocks ( $\Delta\text{GDP}$ ,  $\Delta\text{HICP}$  – harmonised index of consumer prices, consumption, and un-employment rate) which mainly affect demand factors, also have a significant impact on bank lending activities in the EU countries within the analysed time period. Their results show that inflation tends to accelerate lending activities possibly through higher loan demand. The positive impact of GDP, as well as negative impact of unemployment, confirms the cyclical pattern of loans.

The empirical presence of a relationship between economic growth and loans is shown by Hofmann (2001, p. 26), who uses research conducted in 16 industrially developed countries to confirm that the annual rate of change in real credit is closely related to that of real GDP. The relationship between loans, GDP, and

interest rates in the Eurozone was also studied by Calza (2001, p. 12). Using the Johansen methodology, the latter study identifies one cointegrating relationship linking real loans, GDP and interest rates. This relationship implies that in the long-run, real loans are positively related to real GDP, and negatively to real short term and long-term interest rates. Shahini (2014, p. 124) analysed the housing loan demand in Albania. Three factors were analysed: new mortgage disbursements as the dependent variable, and economic growth and the money aggregate M1 as the independent variables. To treat the problem empirically it was used the log-level regression model. For the period taken into consideration (2008 – 2013), which coincided with the financial crises, they concluded that the demand for housing loans had a strong positive relation with economic growth and a negative relation with M1. The money supply is a broad measure of how much money there is in an economy. An increase in money supply gives rise to greater inflation uncertainty and this has an adverse impact on the real estate market. Excessive growth in the money supply may lead to an inflationary environment and might affect investment because of the higher discount rate, which therefore affects mortgage uptake (Liow, Ibrahim and Huang, 2006, p. 302). In their research of 61 countries, Warnoc and Warnoc (2008, p. 241) confirm that a deeper mortgage market is associated with a stable macroeconomic climate of low and stable inflation. Boamah (2009, p. 21) claims that a stable macroeconomic environment with low inflation is key for a successful mortgage market, as it leads to low and stable interest rates. On the other hand, high inflation results in high interest rates. Using regressive analysis, Badev et al. (2014, p. 11) concludes that inflation is negatively and significantly associated with the development of the mortgage market.

High interest rates lead to high prices in the property market and could scare away buyers, hence low demand for funding. Such rates also make renting relatively more attractive to buying. This is made even worse if there are other competitors providing these services in the region or country (Kariuki, 2015, p. 6). Owuor, Githii and Mwangi (2018, p. 68) studied the relationship between interest rates, exchange rates, economic growth, inflation, and mortgage market growth in Kenya. The research establishes that there is a positive and significant relationship between interest rates, inflation, and growth in the mortgage market. The research also finds that the relationship between exchange rates, gross domestic product, and mortgage market growth is insignificant.

Among other things, mortgage loan providers evaluate a debtor's ability to repay the loan. In this respect, the development of unemployment in an economy is also important. There is an assumption that as unemployment grows, the volume of provided loans decreases. The connection between employment or

unemployment and the development of the volume of loans granted in an economy is examined by a number of empirical studies. In their paper, Demir, Kurt and Cagdas (2003, p. 4) confirm that employment is a factor which influences the demand for loans and housing. If people's income is unstable due to a high unemployment rate, then this condition negatively affects the financing of housing by means of loans. Using empirical studies, Střelcová and Střelec (2009, p. 162) evaluate the relationship between the volume of mortgage loans and selected macroeconomic quantities in 2000 – 2007 in the Czech Republic. Their analysis confirms the negative correlation between the mortgage loan interest rate and the unemployment rate, as well as the positive influence of changes to the prices of real estate. This means that if the mortgage loan interest rate increases, the volume of provided mortgage loans decreases; if the unemployment rate rises, people's interest in getting mortgage loans falls.

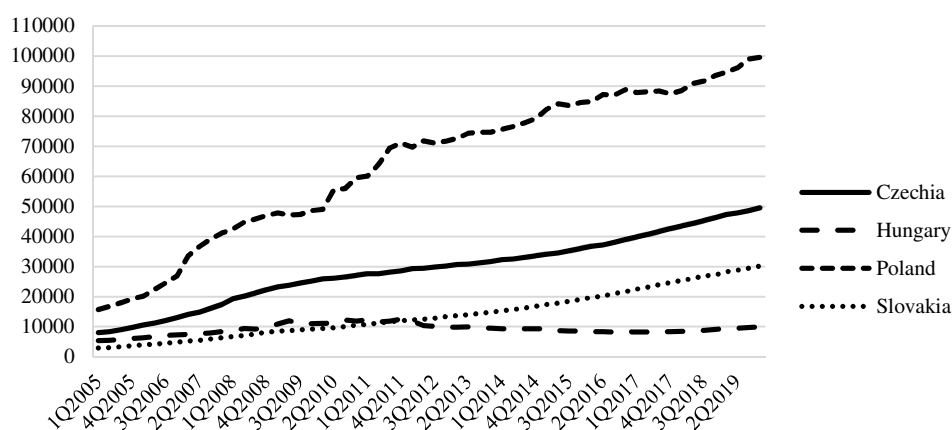
## 2. Macroeconomic Variables

### 2.1. Volume of Mortgage Loans

A mortgage loan is a long-term loan taken to finance the purchase of real estate. It is one of the oldest types of bank loans, where repayment is secured by a mortgage bond being its chief characteristic.

Figure 1

**Development of the Volume of Mortgage Loans in V4 Countries (in million Euro)**



Source: The Global Economy (2020).

A mortgage loan is provided 1. to finance the purchase or building of real estate, its repair, modernization, or reconstruction; 2. to purchase a part of real

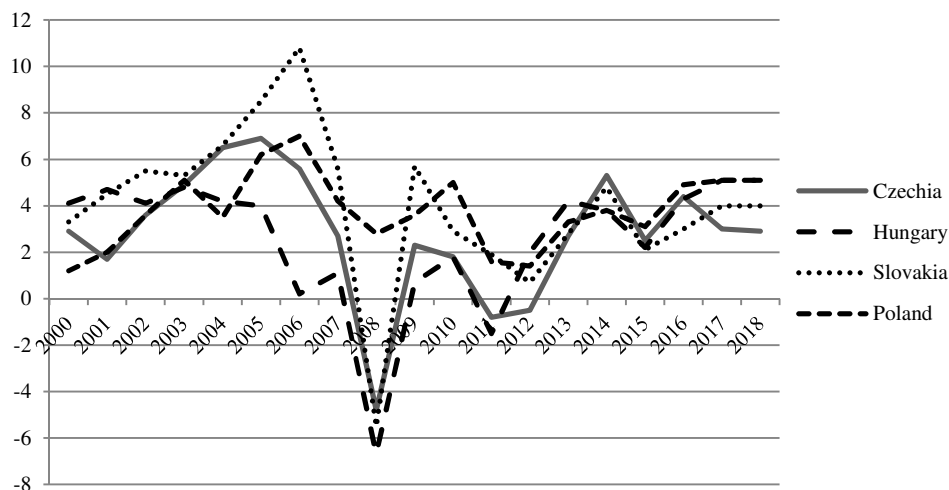
estate to settle inheritance and co-ownership; or 3. to repay previously provided short- and medium-term loans which were used to invest into real-estate. This qualifies it as a multipurpose loan. Figure 1 shows the development of the volume of mortgage loans in V4 countries.

## 2.2. Economic Growth

The development of real gross domestic product is an important macroeconomic variable that compares the performance of economies. But what is the relationship between GDP development and mortgages, or more generally housing loans? Simply put – disregarding cases where economic growth is “doped” by increasing government debt – growing GDP is a sign of a stronger-performing the national economy, or rather of inhabitants’ improving incomes and living conditions. As incomes grow, so does a demand for new or better housing, and paradoxically also a tendency on the part of people to incur debts. That is because their expectations of the positive development of future incomes strengthens their economic confidence, making them more willing to apply for loans despite their growing income. Naturally, this also applies in reverse. Among other effects, an economic slump results in lower interest in loans, including mortgages, and an increased wariness on the part of banks when it comes to granting them.

Figure 2

Development of Real GDP Growth in V4 Countries (in %)



Source: Eurostat (2020).

Figure 2 shows the development of real GDP in the V4 countries between 2005 and 2019. After the countries had become the members of the EU they

became more open to influences from abroad, more transparent, and they benefited from EU funds. Slovakia achieved the highest real GDP growth. On the other hand, there has been a deep decline in Hungary since 2006, mainly due to the high state budget deficit. These problems were fully manifested during the economic crisis, when there was a problem of debt repayment and the entire Hungarian economy was in a deep recession. All V4 countries experienced a noticeable slump, with the exception of Poland, which was not so dependent on exports. After the recession, the V4 countries began to recover from the crisis, as Figure 2 shows.

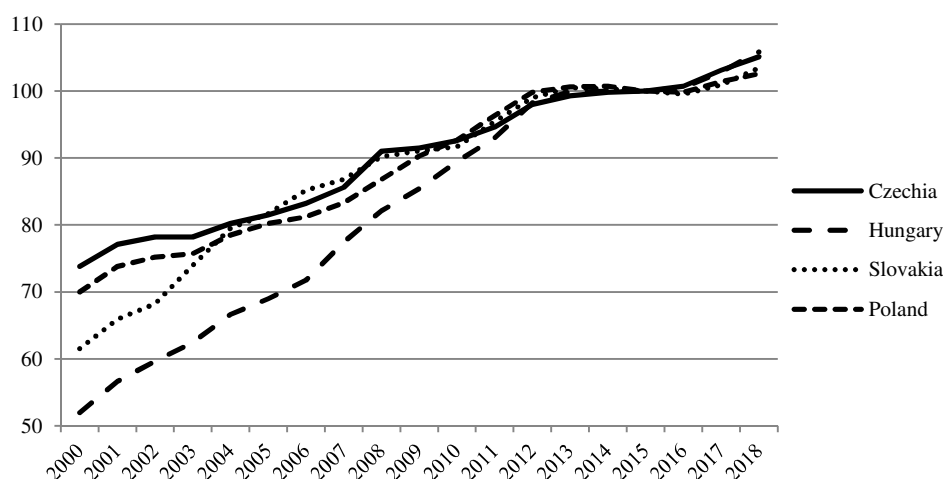
### 2.3. Inflation

Although it harms savings, growing inflation can be beneficial to long-term loans, such as mortgages. This is caused by the falling real value of money. While mortgage repayments are usually fixed, their real value decreases over time due to inflation. Nonetheless, the effect of inflation on the volume of mortgage loans is not clear.

Another important macroeconomic indicator is information on the rate of inflation, or the increase in the general price level of goods and services in individual V4 economies over a given period of time. The turning point for the V4 countries occurred during the financial crisis. Shortly before its outbreak, all of the countries recorded an increase in inflation (2007 – 2008). Thereafter, however, inflation fell again in 2008 – 2009, with a subsequent rise in price levels (2009 – 2010).

Figure 3

**Harmonised Index of Consumer Prices in V4 Countries** (annual average index)



Source: Eurostat (2020).



As shown in Figure 3, price levels were not stable in any V4 country. This was often affected by various reform packages and changes to kickstart the economy and restore growth. Governments were search for ways to raise revenues in this period. As a result, some taxes increased, such as happened in the Czech Republic.

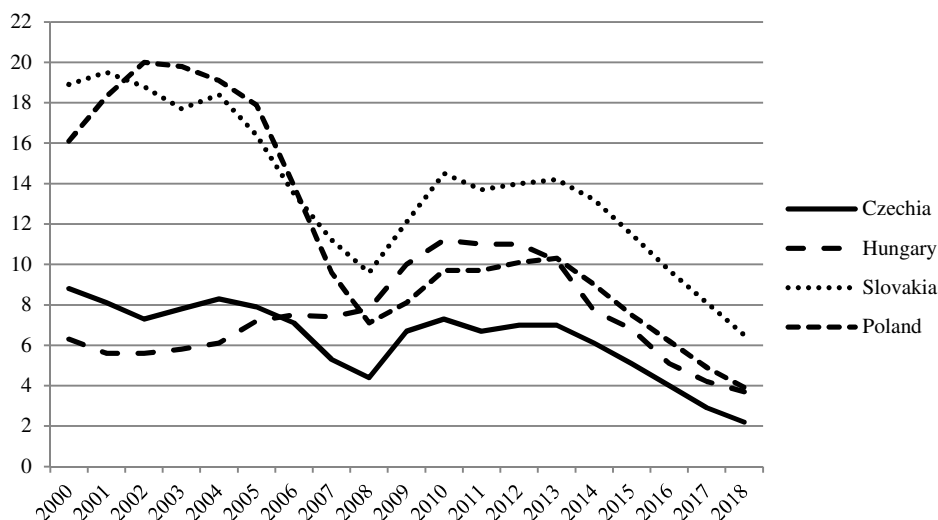
## 2.4. Unemployment Rate

Another macroeconomic indicator is the unemployment rate, which evaluates the economic activity of the population. A growing unemployment rate leads to a lower volume of mortgage loans. It influences both the demand for loans, as people are afraid to incur debt, and their supply, as banks tighten their requirements in regard to assessing borrowers' creditworthiness.

The year of accession to the EU – 2004 – was crucial. Unemployment in the Czech Republic, Poland and Slovakia had been successfully reduced and would remain low until the outbreak of the financial crisis. In 2008 the unemployment rate was 4.4% in the Czech Republic, 9.6% in Slovakia, and 7.1% in Poland. Naturally, these values started to rise during the financial and economic crisis, as confirmed by Figure 4. The worst situation was in Slovakia, with a rate of 14%. Percentage-wise, the situation in Poland was somewhat better, but the number of unemployed was much higher due to its larger population. The Czech Republic was in the best position.

Figure 4

### Unemployment Rate of the V4 Countries



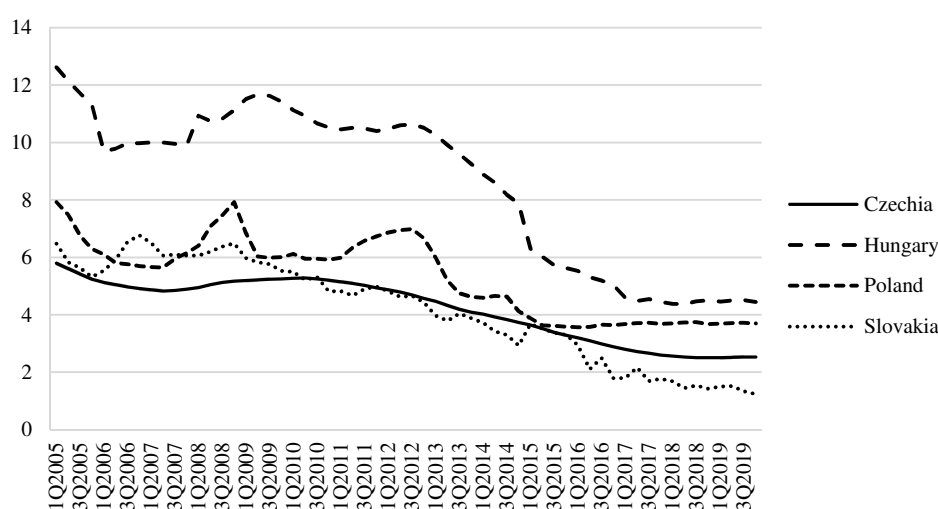
Source: Eurostat (2020).

## 2.5. Mortgage Interest Rate

According to the Fisher equation, the relationship between inflation and interest rates is as follows: nominal interest rate = real interest rate + inflation. Thus, it should follow that at times of high inflation, interest rates grow along with the inflation rate. The effect of interest rates on the mortgage market is indirectly proportional. As the average mortgage interest rate decreases, loans become cheaper and easier to obtain, resulting in a growing volume of mortgages being granted. The mortgage interest rate is based on three factors: 1. the price of the money the bank borrows in order to grant a mortgage loan; 2. a risk surcharge which should cover possible losses in the case of the client defaulting; and 3. the bank's revenue from granting the loan. Figure 5 shows the development of mortgage interest rate in V4 countries.

Figure 5

Development of Mortgage Interest Rate in V4 Countries (in %)



Source: The Global Economy (2020).

## 3. Data and Methodological Part

Quarterly data for the period from 2005/Q1 to 2019/Q4 were used for the calculations. The Eurostat database, the Statistical Offices of V4 countries and the Global Economy database were the primary data source. The description of individual variables is shown in Table 1. All of the time series were seasonally

adjusted. EViews software version 9 was used for the calculations. A similar procedure was followed as that applied in the article by Stoklasová (2018, p. 71).

Table 1

**Description of Variables**

Variable designation	Description of variable
<i>MOL</i>	Volume of mortgage loans (in %, 2010=100).
<i>GDP</i>	Gross domestic product growth (in %, 2010=100). The volume of mortgage loans is expected to be higher with the higher GDP.
<i>CPI</i>	Consumer Price Index (2005=100). It is assumed that the rise in price indices the (inflation growth) will cause a decrease in the volume of mortgage loans.
<i>INR</i>	Mortgage interest rate. As the interest rate on a mortgage loan decreases, the volume of mortgage loans grows.
<i>UNE</i>	The rate of unemployment. Rising unemployment leads to a reduction in the volume of mortgage loans.

Source: The Global Economy (2020).

Most time series in macroeconomics and finance are non-stationary or integrated with order  $I(1)$ , as stated in Engle and Granger (1987, p. 254) and Enders (2014, p. 405).  $I(1)$  denotes a time series the first differences of which are stationary. That is why data stationarity testing or unit root tests are performed. The Augmented Dickey-Fuller test (ADF) is often used in the literature. The ADF test allows you to test the presence of a unit root based on three models.

We also use the ARDL model, which was developed by Pesaran, Shin and Smith (2001, p. 301). The ARDL model is applicable for both non-stationary time series as well as for times series with a mixed order of integration (Tank, Fox and Shojaie, 2019, p. 440). This methodology also enables us to distinguish between short- and long-term effects. Therefore, ARDL is suitable for investigating the impacts of macroeconomic variables on the volume of mortgage loans.

ECM can be derived if the variables are  $I(1)$  and there exists a cointegration relationship. ECM is an extension of the VAR methodology, which allows co-integrated non-stationary variables to be modelled. The methods of cointegration analysis are described in Hendry and Juselius (2000, p. 13; 2001, p. 81).

The procedure for selecting a suitable method is shown below ('Unit root test'). Firstly, it is necessary to determine whether the variable is stationary by using the unit root test. Methods used to analyse stationary time series and non-stationary series are different. If all the variables are stationary, the methodology is simple. In such a case, ordinary least square (OLS) or vector autoregressive (VAR) models can be used. If all the variables are non-stationary, the ARDL model can be used. When the variables used in the analysis are of mixed type, i.e., some are stationary and others are non-stationary, we can use a similar procedure, outlined below (where OLS – ordinary least squares, VAR – vector autoregressive, ARDL – autoregressive distributed lags, ECM – error correction model).

**Unit root test:**

1. All variables stationary  $\Rightarrow$  OLS/VAR models
2. All variables non-stationary: a) Johansen test:
  - a1) No cointegration
  - a2) Cointegration  $\Rightarrow$  ECM, causality test
- b) ARDL models:
  - b1) No cointegration
  - b2) Cointegration  $\Rightarrow$  ECM, causality test
3. Mixed variables  $\Rightarrow$  ARDL models: a) No cointegration
  - b) Cointegration  $\Rightarrow$  ECM, causality test.

**4. Empirical Results****4.1. Stationarity of the Series**

The test results for all variables are provided in Table 2. The Dickey-Fuller test (ADF) was used to test stationarity. The model type of testing the unit root was used model with intercept. The second column contains the calculated T-statistics, and the following column contains the corresponding level of statistical significance. The last column includes the result of testing: N = non-stationary (H0 not rejected), S = stationary (H0 rejected).

Table 2

**ADF Tests**

Variable	T-stat	p-value	Result	Variable	T-stat	p-value	Result
<i>CZ_MOL</i>	-1.231	0.654	N	<i>D(CZ_MOL)</i>	-2.926	0.035**	S
<i>CZ_GDP</i>	-0.899	0.781	N	<i>D(CZ_GDP)</i>	-4.171	0.002***	S
<i>CZ_CPI</i>	-2.837	0.101	N	<i>D(CZ_CPI)</i>	-9.161	0.000***	S
<i>CZ_INR</i>	-0.856	0.795	N	<i>D(CZ_INR)</i>	-2.101	0.041**	S
<i>CZ_UNE</i>	-0.372	0.901	N	<i>D(CZ_UNE)</i>	-3.761	0.006***	S
<i>SK_MOL</i>	-0.203	0.931	N	<i>D(SK_MOL)</i>	-2.584	0.011**	S
<i>SK_GDP</i>	-1.436	0.557	N	<i>D(SK_GDP)</i>	-3.284	0.021**	S
<i>SK_CPI</i>	-1.726	0.411	N	<i>D(SK_CPI)</i>	-4.745	0.000***	S
<i>SK_INR</i>	2.566	0.991	N	<i>D(SK_INR)</i>	-10.56	0.000***	S
<i>SK_UNE</i>	0.497	0.982	N	<i>D(SK_UNE)</i>	-3.139	0.029**	S
<i>PL_MOL</i>	-0.287	0.421	S	<i>D(PL_MOL)</i>	-2.613	0.098*	S
<i>PL_GDP</i>	-1.442	0.555	N	<i>D(PL_GDP)</i>	-4.747	0.001***	S
<i>PL_CPI</i>	-2.856	0.221	N	<i>D(PL_CPI)</i>	-8.864	0.000***	S
<i>PL_INR</i>	-1.443	0.554	N	<i>D(PL_INR)</i>	-4.363	0.001***	S
<i>PL_UNE</i>	-0.535	0.876	N	<i>D(PL_UNE)</i>	-3.868	0.004**	S
<i>HU_MOL</i>	-2.469	0.128	N	<i>D(HU_MOL)</i>	-5.437	0.000***	S
<i>HU_GDP</i>	1.682	0.999	N	<i>D(HU_GDP)</i>	-3.353	0.017**	S
<i>HU_CPI</i>	-0.634	0.852	N	<i>D(HU_CPI)</i>	-4.739	0.000***	S
<i>HU_INR</i>	-0.167	0.936	N	<i>D(HU_INR)</i>	-3.731	0.006***	S
<i>HU_UNE</i>	-0.735	0.829	N	<i>D(HU_UNE)</i>	-5.224	0.000***	S

Note: Statistical significance at the 0.01 level (\*\*\*), at the 0.05 level (\*\*), at the 0.1 level (\*).

Source: Own calculations.

All of variables exhibit the properties of first-order non-stationarity, i.e.  $I(1)$ ; therefore, long-run co-integration relationships may exist between these variables. The methods of the co-integration analysis are described in articles by Hendry and Juselius (2000, p. 13; 2001, p. 81).

#### 4.2. Autoregressive Distributed Lag Model (ARDL)

This part of the article presents the results of ARDL estimates for V4 countries. The ARDL co-integration test was conducted to determine whether there exists a long-run relationship among the chosen variables. The ARDL formulates a single reduced form equation. For the ARDL approach, the conditional error correction model can be written as follows (Turan, Karakas and Ozer, 2020, p. 60):

$$\begin{aligned} \Delta MOL_t = & \beta_0 + \beta_1 MOL_{t-1} + \beta_2 GDP_{t-1} + \beta_3 CPI_{t-1} + \beta_4 INR_{t-1} + \beta_5 UNE_{t-1} + \\ & + \sum_{i=1}^I \beta_i \Delta MOL_{t-i} + \sum_{i=0}^I \beta_i \Delta GDP_{t-i} + \sum_{i=0}^I \beta_i \Delta CPI_{t-i} + \sum_{i=0}^I \beta_i \Delta INR_{t-i} + \\ & + \sum_{i=0}^I \beta_i \Delta UNE_{t-i} + \varepsilon_t \end{aligned} \quad (1)$$

If co-integration is found then the short-run and long-run coefficients are analysed. Especially for a causality analysis, a VEC model is estimated, and this model includes the long-run relationships as the error correction term.

The first part of Table 3 shows the estimates of coefficients and their significance. The second part of Table 3 suggests that there are no serial correlation, heteroscedasticity or parameter instability problems in our estimations. The volume of mortgage loans is an explained variable.

A short-term relationship between the volume of mortgage loans and *GDP* was confirmed for all countries except Poland. In all cases there is a positive relation between the volume of mortgage loans and *GDP*, which is in line with the assumption. A unit increase in *GDP* will cause a 0.18 increase in the volume of mortgage loans in the Czech Republic, a 0.11 increase in Slovakia, and a 0.15 increase in Hungary. A significant relation between the volume of mortgage loans and the consumer price index in the short-run was not confirmed for any country. The study finds that there is a negative and statistically significant relation between the volume of mortgage loans and the mortgage interest rate in the short-run in the case of the Czech Republic and Poland. A unit increase in the mortgage interest rate will cause a 0.21 decrease in the volume of mortgage loans in the Czech Republic, and the same decrease in Poland. In the case of Slovakia, Poland, and Hungary there is also a negative and statistically significant relation between the volume of mortgage loans and unemployment rate.

This means that an increase in the unemployment rate will lead to a decrease in the volume of mortgage loans, which is consistent with the assumption. A unit increase in the unemployment rate will cause a 0.09 decrease in the volume of mortgage loans in Slovakia, a 0.25 decrease in Poland, and a 0.16 decrease in Hungary. The negative relation between the volume of mortgage loans and *UNE* is in line with the assumption.

Table 3

## ARDL Results – Estimates and Diagnostics

Czech Republic		Slovakia		Poland		Hungary	
Short-run	Coef.	Short-run	Coef.	Short-run	Coef.	Short-run	Coef.
<i>Constant</i>	0.006**	<i>Constant</i>	0.034***	<i>Constant</i>	0.021**	<i>Constant</i>	0.013*
<i>D(CZ_MOL)</i>	0.62***	<i>D(SK_MOL)</i>	0.09	<i>D(PL_MOL)</i>	0.41***	<i>D(HU_MOL)</i>	0.27*
<i>D(CZ_GDP)</i>	0.18***	<i>D(SK_GDP)</i>	0.11***	<i>D(PL_GDP)</i>	0.05	<i>D(HU_GDP)</i>	0.15***
<i>D(CZ_CPI)</i>	-0.0001	<i>D(SK_CPI)</i>	-0.001	<i>D(PL_CPI)</i>	-0.002	<i>D(HU_CPI)</i>	-0.02
<i>D(CZ_INR)</i>	-0.21**	<i>D(SK_INR)</i>	-0.02	<i>D(PL_INR)</i>	-0.21**	<i>D(HU_INR)</i>	0.11
<i>D(CZ_UNE)</i>	0.03	<i>D(SK_UNE)</i>	-0.09***	<i>D(PL_UNE)</i>	-0.25**	<i>D(HU_UNE)</i>	-0.16**
Long-run	Coef.	Long-run	Coef.	Long-run	Coef.	Long-run	Coef.
<i>ECT</i>	-0.044***	<i>ECT</i>	-0.044***	<i>ECT</i>	-0.066**	<i>ECT</i>	-0.061*
<i>CZ_GDP</i>	4.51***	<i>SK_GDP</i>	3.51***	<i>PL_GDP</i>	3.11***	<i>HU_GDP</i>	3.02***
<i>CZ_CPI</i>	0.07	<i>SK_CPI</i>	-0.12**	<i>PL_CPI</i>	-0.04	<i>HU_CPI</i>	0.06
<i>CZ_INR</i>	-2.32**	<i>SK_INR</i>	-0.56**	<i>PL_INR</i>	-0.48**	<i>HU_INR</i>	-0.63**
<i>CZ_UNE</i>	-3.08***	<i>SK_UNE</i>	-1.83***	<i>PL_UNE</i>	-0.58**	<i>HU_UNE</i>	-1.06***
Diagnostics							
<i>R<sup>2</sup></i>	0.87		0.86		0.49		0.47
<i>Correlation LM Test</i>	0.69		0.58		0.58		0.31
<i>Heteroskedasticity Test ARCH</i>	0.91		0.26		0.87		0.42
<i>Stabililty CUSUM Test</i>	Stable		Stable		Stable		Stable

Note: Statistical significance at the 0.01 level (\*\*\*), at the 0.05 level (\*\*), at the 0.1 level (\*).

Source: Own calculations.

In all cases the *ECT* coefficients are negative, indicating a return of the variables to long-term equilibrium. The system is getting adjusted towards long-run equilibrium at a speed of 4.4% in the case of the Czech Republic, 4.4% in Slovakia, 6.6% in Poland, 6.1% in Hungary.

For the Czech Republic, this implies that causality is captured by the statistically significant value *ECT* (-0.044), which indicates that this variable will be modified by 4.4% within 1 quarter, in the case of long-term instability in the volume of mortgage loans. In other words, complete elimination of instability would last approximately 22 quarters (1/0.044), i.e. almost 6 years. A similar situation applies for Slovakia. Poland has the shortest time of 15 quarters (1/0.066), with Hungary next on 16 quarters (1/0.061).

The cointegrating equations for each of states are as follows:

$$(CZ\_MOL) = -0.044[CZ\_MOL(-1) + 4.51 \cdot CZ\_GDP(-1) + 0.07 \cdot CZ\_CPI(-1) - 2.32 \cdot CZ\_INR(-1) - 3.08 \cdot CZ\_UNE(-1)] \quad (2)$$

$$D(SK\_MOL) = -0.044[SK\_MOL(-1) + 3.51 \cdot SK\_GDP(-1) - 0.12 \cdot SK\_CPI(-1) - 0.56 \cdot SK\_INR(-1) - 1.83 \cdot SK\_UNE(-1)] \quad (3)$$

$$D(PL\_MOL) = -0.066[PL\_MOL(-1) + 3.11 \cdot PL\_GDP(-1) - 0.46 \cdot PL\_CPI(-1) - 0.48 \cdot PL\_INR(-1) - 0.58 \cdot PL\_UNE(-1)] \quad (4)$$

$$D(HU\_MOL) = -0.061[HU\_MOL(-1) + 3.02 \cdot HU\_GDP(-1) + 0.06 \cdot HU\_CPI(-1) - 0.63 \cdot HU\_INR(-1) - 1.06 \cdot HU\_UNE(-1)] \quad (5)$$

As for long-run relationships, then for all states there is a positively and statistically significant relationship between the volume of mortgage loans and *GDP*, and a negatively statistically significant relationship between the volume of mortgage loans and both the mortgage interest rate and unemployment rate.

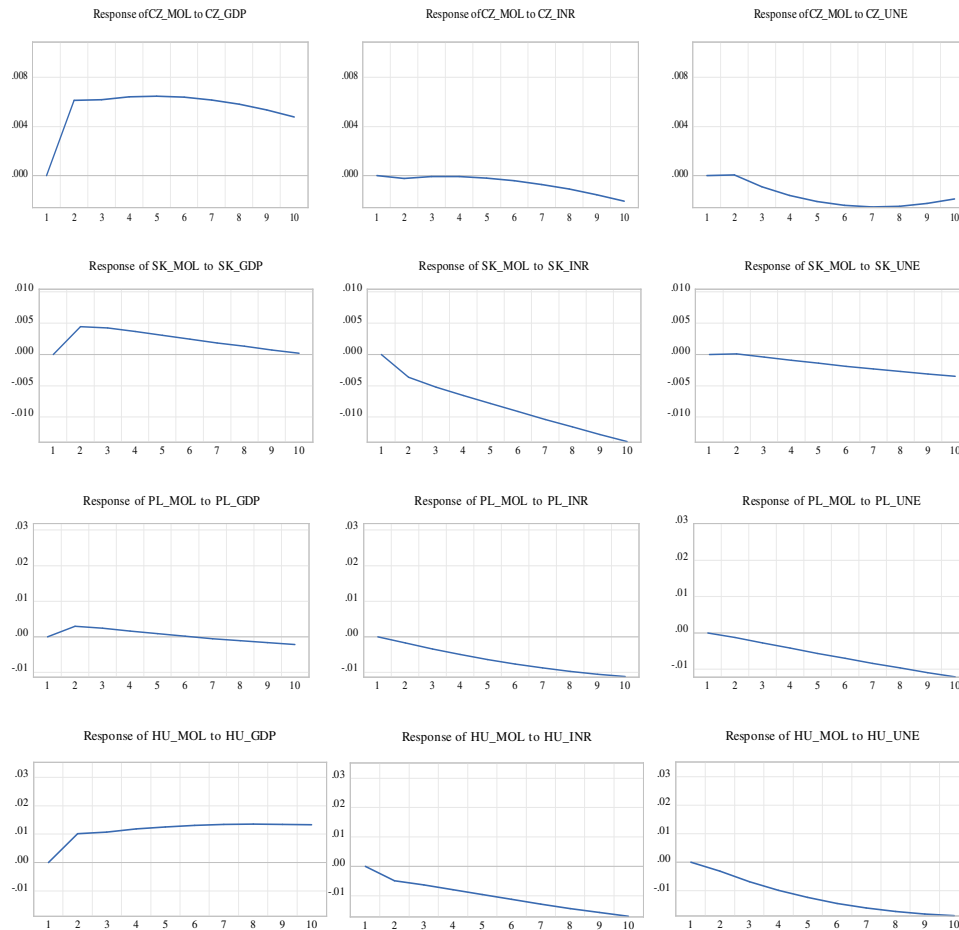
#### 4.3. Impulse Response Function

Impulse-responses trace the effects of structural shocks on endogenous variables. Each response includes the effect of a specific shock on one of the variables of the system at impact  $t$ , then  $t + 1$ , and so on. Figure 6 shows the impulse-response functions for all countries. The response variables are the volume of mortgage loans (*MOL*) on a unit shock of *GDP*, mortgage interest rate (*INR*), or unemployment rate (*UNE*). The significant relation between the volume of mortgage loans and consumer price index in the short-run was not confirmed for any country, therefore this variable is not included in the Figure 6. The responses of the *MOL* variable to individual variables are similar in all countries. The impulse-response function of *MOL* on a unit shock of real *GDP* shows an increase in the *MOL* variable not opposed by any immediate process. The reactions of *MOL* on a unit shock of *INR*, and of *UNE* are negative. The system returns to equilibrium in more than 10 quarters in the event of a unit shock of *UNE* in the case of the Czech Republic and Hungary.

#### 4.4. Granger Causality Test

The Granger causality test is a statistical hypothesis test for determining whether one time series is useful in forecasting another (Granger, 1969, p. 429). Using the term “causality” is a misnomer, as Granger-causality is better described as “precedence” (Leamer, 1985, p. 262), or as Granger later claimed “temporally related” (Granger and Newbold, 1977, p. 112). Rather than testing whether  $Y$  causes  $X$ , Granger causality tests whether  $Y$  forecasts  $X$  (Hamilton, 1994, p. 312). It is necessary to work with the stationary time series.

**Figure 6**  
**Response to Cholesky One S.D. Innovations**



Source: Own calculations.

In the case of the Czech Republic, Table 4 shows these results: *CZ\_GDP* and *CZ\_UNE* have a unidirectional relation with *CZ\_MOL*, *CZ\_MOL* has a unidirectional relation with *CZ\_INR*, whereas there is no relationship between *CZ\_MOL* and *CZ\_CPI*. For Slovakia were rejected two hypotheses, although we can say that *SK\_GDP* and *SK\_UNE* have a unidirectional relation with *SK\_MOL*. In the case of Poland, *PL\_MOL* has a unidirectional relation with *PL\_CPI*, and *PL\_UNE* has a unidirectional relation with *PL\_MOL*. Only in the case of Hungary are both hypotheses rejected while showing that *HU\_MOL* affects *HU\_CPI* and *HU\_CPI* affects *HU\_MOL*. Finally, *HU\_INR* has a unidirectional relation with *HU\_MOL*.



Table 4

## Pairwise Granger Causality Tests

Null Hypothesis:	Statistic	Sign.	Rejection of $H_0$
<b>Czech Republic</b>			
D(CZ_MOL) does not Granger cause D(CZ_GDP)	0.081	0.632	NO
D(CZ_GDP) does not Granger cause D(CZ_MOL)	11.515	<b>0.000***</b>	<b>YES</b>
D(CZ_MOL) does not Granger cause D(CZ_CPI)	0.058	0.729	NO
D(CZ_CPI) does not Granger cause D(CZ_MOL)	0.719	0.512	NO
D(CZ_MOL) does not Granger cause D(CZ_INR)	10.03	<b>0.001***</b>	<b>YES</b>
D(CZ_INR) does not Granger cause D(CZ_MOL)	0.347	0.731	NO
D(CZ_MOL) does not Granger cause D(CZ_UNE)	0.087	0.812	NO
D(CZ_UNE) does not Granger cause D(CZ_MOL)	4.211	<b>0.081*</b>	<b>YES</b>
<b>Slovakia</b>			
D(SK_MOL) does not Granger cause D(SK_GDP)	0.082	0.872	NO
D(SK_GDP) does not Granger cause D(SK_MOL)	8.278	<b>0.003***</b>	<b>YES</b>
D(SK_MOL) does not Granger cause D(SK_CPI)	0.352	0.712	NO
D(SK_CPI) does not Granger cause D(SK_MOL)	1.512	0.421	NO
D(SK_MOL) does not Granger cause D(SK_INR)	1.472	0.352	NO
D(SK_INR) does not Granger cause D(SK_MOL)	0.321	0.712	NO
D(SK_MOL) does not Granger cause D(SK_UNE)	0.014	0.841	NO
D(SK_UNE) does not Granger cause D(SK_MOL)	3.621	<b>0.061*</b>	<b>YES</b>
<b>Poland</b>			
D(PL_MOL) does not Granger cause D(PL_GDP)	0.037	0.921	NO
D(PL_GDP) does not Granger cause D(PL_MOL)	1.621	0.324	NO
D(PL_MOL) does not Granger cause D(PL_CPI)	3.911	<b>0.047**</b>	<b>YES</b>
D(PL_CPI) does not Granger cause D(PL_MOL)	0.002	0.752	NO
D(PL_MOL) does not Granger cause D(PL_INR)	0.678	0.398	NO
D(PL_INR) does not Granger cause D(PL_MOL)	1.814	0.197	NO
D(PL_MOL) does not Granger cause D(PL_UNE)	1.125	0.113	NO
D(PL_UNE) does not Granger cause D(PL_MOL)	3.165	<b>0.081*</b>	<b>YES</b>
<b>Hungary</b>			
D(HU_MOL) does not Granger cause D(HU_GDP)	1.412	0.312	NO
D(HU_GDP) does not Granger cause D(HU_MOL)	0.671	0.516	NO
D(HU_MOL) does not Granger cause D(HU_CPI)	7.618	<b>0.004</b>	<b>YES</b>
D(HU_CPI) does not Granger cause D(HU_MOL)	3.497	<b>0.064*</b>	<b>YES</b>
D(HU_MOL) does not Granger cause D(HU_INR)	0.612	0.512	NO
D(HU_INR) does not Granger cause D(HU_MOL)	3.074	<b>0.083*</b>	<b>YES</b>
D(HU_MOL) does not Granger cause D(HU_UNE)	1.215	0.418	NO
D(HU_UNE) does not Granger cause D(HU_MOL)	0.872	0.287	NO

Note: Statistical significance at the 0.01 level (\*\*\*), at the 0.05 level (\*\*), at the 0.1 level (\*).

Source: Own calculations.

## 5. Discussion

The results of this article show that there is a short-term relationship between the volume of mortgage loans and *GDP* for all countries, except Poland. And as for long-term relationships, there were relations between the volume of mortgage loans and *GDP* (positive relation) and for the mortgage interest rate (negative relation) confirmed for all countries.

As a general indicator of an economy's performance, GDP should have a positive effect on the mortgage market. It can be assumed that as the overall economy grows, so does the construction sector. Along with intensified activity on the part of the construction sector and property development, a substantial amount of real estate appears on the market. Thus, as the housing supply increases, so does the demand for mortgage loans. Thus, a short-term relationship between the volume of mortgage loans and *GDP* has been demonstrated in the Czech Republic, Slovakia and Hungary; indeed, a long-term relationship has been demonstrated in all countries. The same conclusions are confirmed by other studies, e.g. by Hofmann (2001, p. 26) and Calza (2001, p. 12). Shahini (2014, p. 124) confirmed that demand for housing loans has a strong positive relation with the economic growth.

A short-term relationship between the volume of mortgage loans and interest rates has been demonstrated in the Czech Republic and Poland, and a long-term relationship has been demonstrated in all countries. The mortgage interest rate's effect on the mortgage market should be indirectly proportional. As the mortgage interest rate drops, mortgage loans become cheaper and easier to obtain. Conversely, when mortgage interest rates increase, the volume of mortgage loans can be expected to decrease and the number of defaulting clients to rise. This relationship between the interest rate and mortgage loans is also confirmed by empirical studies, such as Kuriuki (2015, p. 6) and Owour et al. (2018, p. 68).

In general, we can say that the effect of inflation on the volume of mortgage loans is inversely proportional. The level of inflation directly affects the nominal interest rate, and thus the mortgage interest rate. Inflation is an important indicator of economic performance. Stable 2% inflation indicates stable economic growth without major macroeconomic shocks. This value of inflation leads to a favorable development of the mortgage market. This fact is also confirmed by empirical studies such as Liow, Ibrahim and Huang (2006, p. 302), Warnoc and Warnoc (2008, p. 241) and Badev et al. (2014, p. 11). Based on our model, we conclude that a short-term relationship between the volume of mortgage loans and CPI has not been demonstrated in any country, and a long-term relationship has been demonstrated only in Poland. These findings could be due to the inclusion of a period of financial crisis. This period is associated with unconventional monetary policy and very low inflation (inflation below the inflation target).

There is an assumption that a growing unemployment rate has a negative effect on the volume of mortgage loans. High unemployment leads to unstable household income and this fact leads to a decline in demand for mortgage loans. Based on our model, we conclude that a short-term relationship between the volume of mortgage loans and unemployment has been demonstrated in Slovakia,

Poland, and Hungary, and a long-term relationship has been demonstrated in all countries. Our conclusions were also confirmed by other empirical studies. Demir, Kurt and Cagdas (2003, p. 4) confirm that employment influences the demand for loans and housing. A high unemployment rate negatively affects the financing of housing by means of loans. Střelcová and Střelec (2009, p. 162) confirm that when the unemployment rate rises, people's interest in mortgage loans falls accordingly.

## Conclusion

The main goal of this article was to find which of the selected macroeconomic indicators impact mortgage loans in the V4. The fourth part of the article sets out the core of the investigation. Here, ARDL models are constructed for all V4 countries to find the short and long-term relationships between the volume of mortgage loans and selected macroeconomic indicators. The results of this article show that there is a short-term relationship between the volume of mortgage loans and *GDP* for all countries, except Poland. As for long-term relationships, relationships were confirmed between the volume of mortgage loans and *GDP* (a positive relation), and for the mortgage interest rate (negative relation) for all of countries. The *ECT* coefficients in all of models are negative, indicating a return of the variables to long-term equilibrium.

A short-term relationship between the volume of mortgage loans and *GDP* has been demonstrated in the Czech Republic, Slovakia and Hungary, while a long-term relationship has been demonstrated in all countries. The hypothesis that *GDP* does not Granger cause *MOL* was rejected for the Czech Republic and Slovakia.

A short-term relationship between the volume of mortgage loans and *CPI* has not been demonstrated in any country. The long-term relationship has been demonstrated, but only in Poland. The hypothesis that *CPI* does not Granger cause *MOL* was rejected for Hungary.

Regarding the unemployment rate, it can be observed to have a negative effect on the volume of mortgage loans. A short-term relationship between the volume of mortgage loans and *UNE* has been demonstrated in Slovakia, Poland, and Hungary, and a long-term relationship has been demonstrated in all countries. The hypothesis that *UNE* does not Granger cause *MOL* was rejected for the Czech Republic, Poland and Slovakia.

The mortgage interest rate's effect on the mortgage market should be indirectly proportional. A short-term relationship between the volume of mortgage loans and *INR* has been demonstrated in the Czech Republic and Poland, its long-term equivalent has been demonstrated in all countries. The hypothesis that *INR* does not Granger cause *MOL* was rejected for Hungary.

The issue of mortgage loans is perennially a hot topic. The coronavirus pandemic affected the mortgage market, and banks report that the number of mortgage applications has dropped by half. Indeed, mortgage rates are stagnating due to uncertainty, even though central banks are lowering base rates. Nevertheless, central banks are extending a helping hand to those seeking mortgages, loosening the restrictions on their granting. Further research could focus on the volume of new mortgage loans granted during the coronavirus crisis.

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