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The Effectiveness of the Macroprudential Policy in a Time of Covid

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Abstract

In this work we assess the effectiveness of macroprudential policy in the light of the Covid crisis. We examine the effects of the policy tools on the growth of the non-performing loans, on the growth of loans and on the house prices. The research is conducted due to an unbalanced panel data set for the period from Q1:2005 to Q4:2021. The countries included in the dataset are European countries chosen according to their activity in the use of the tools. They are as follows: Czech Republic, Denmark, France, Iceland, Ireland, Lithuania, Norway, Slovak Republic and Sweden. We deploy pooled OLS models and Fixed effects models. According to our results the macroprudential policy is effective in enhancing the soundness of the borrowers, in regulating the supply of the credit for the economy and in reducing the house prices growth.

Keywords: macroprudential policy, countercyclical capital buffer, LTV, non-performing loans, credit growth, house prices, Covid, Great Financial Crisis

Abbreviations

BIS	Bank for International Settlements
CCyB	Countercyclical Capital Buffer
DSTI	Debt Service to Income
DTI	Debt to Income
ECB	European Central Bank
ESRB	European Systemic Risk Board
FSB	Financial Stability Board
GDP	Gross Domestic Product
GFC	Great Financial Crisis
GSII	Global Systemically Important Institutions
IMF	International Monetary Fund
LTI	Loan to Income
LTV	Loan to Value
OECD	Organisation for Economic Cooperation and Development
OSII	Other Systemically Important Institutions

Content

1 Introduction

The 21st century is packed with an incredible amount of historical events with lasting consequences for countries all around the globe. First, the Great Financial Crisis (GFC) in 2008 shaped the development of the world for years to come. The worldwide economic slowdown and distrust in the financial system emerged due to this event and it was on the policymakers to support the confidence in the system. As the economy recovered and the developed world experienced a relatively long period of prosperity and historically the longest bull market for the US stock market, another strong hit for the world economy happened (Westbrook and Murdoch 2020). The emergence of the virus Covid-19 at the beginning of 2020, which resulted in the worldwide pandemic situation, halted the period of prosperity and caused a very severe recession married with an unprecedented health crisis. The severity is best described by the fast pace of the rise of the unemployment, which reached its highest levels in years (Falk et al. 2021), as well as one of the fastest equity market falls in the history (Li 2020). On the other hand, policymakers acted very flexibly and due to large monetary and fiscal policy stimulus the threats to the economy were minimized quickly and a fast recovery process emerged (United Nations 2021). However, together with the fast recovery and large policy support, inflation has been on the rise printing the highest readings since the 1980s (Rushe et al. 2022). What is more the aggressive attack on Ukraine by the Russian Federation on the 24th of February 2022 endangered geopolitical stability as well as world prosperity (Zinets and Vasovic 2022). While the Russian Federation is one of the main natural gas exporters, the prices of energy commodities have been increasing significantly since the invasion, which will likely induce an additional rise in inflation (Milne 2022).

Apparently, the 21st century is defined by significant instability, which is a substantial threat to the world economy. As the banking sector is an integral part of the economy supporting the effective allocation of the funds, its operation under these circumstances can be challenging. As was experienced during the Great Financial Crisis, the costs of defaulting of the banking system and eventual distrust are extraordinary. Hence, the banking system's stability even in an unstable environment should be the main aim of the policymakers. This paper will discuss how effective the macroprudential policy is in achieving this goal in the shadow of the Covid-19 pandemic.

The rest of the paper is organized as follows: In section 2 we discuss the related theoretical background of macroprudential policy, section 3 reviews the previous papers and literature, section 4 describes the methodology applied in the empirical analysis, section 5 presents the results and findings, section 6 discusses these findings in a bigger perspective and section 7 offers concluding remarks of this paper.

2 Theoretical background

2.1 Macroprudential policy

The Great Financial Crisis became an extraordinary event in our history. The risk that had been accumulating in the times before the crisis eventually materialized and caused severe consequences. Some institutions such as the infamous investment bank Lehman Brothers went bankrupt while other institutions were bailed out by the government (Fratianni and Marchionne 2010). This event clearly showed that the microprudential approach is insufficient in securing the stability of the financial institutions and spurred the discussion on how to prevent the systematic collapse in the future (Ampudia et al. 2021a). As the result, a new macroprudential approach has been adopted. The macroprudential approach represents an intellectual shift (Borio 2018) when it aims not to evaluate only a particular financial institution in terms of riskiness but its ultimate goal is to secure the stability of the whole financial system (ESRB 2014).

For this goal to be fulfilled a valid risk assessment is necessary. The macroprudential framework distinguishes two dimensions of the risk: the time dimension and the cross-sectional dimension. While the time dimension refers to the build-up of the risk across the time, the cross-sectional dimension considers risk across the institutions at a given time (IMF-FSB-BIS 2016).

The main idea behind the macroprudential policy is leaning against the wind (Kockerols and Kok 2019). This assumes that the period of prosperity and economic growth is the time when economic imbalances and risks are being accumulated while the period of the economic recession is assessed as the time when the risk is materialized (Borio 2018). The implication for macroprudential policy decisions is that it should act pre-emptive and mitigate the risk in the build-up period (Constancio et al. 2019). This means taking tightening measures in the times of prosperity and economic growth while taking releasing measures during the risk materialization periods. This approach should cool down the risk build up and support the economic activity once the risk is materialized (Constancio et al. 2019). The framework for the policy was designed by the Basel Committee for the Banking Supervision under the Basel III Accord (BCBS 2011).

There are plenty of tools this policy can be conducted with. First, the macroprudential policy uses different types of capital buffers that serve different objectives of the policy. Some of them are the buffer for Global systemically important institutions (GSII) and the buffer for Other systemically important institutions (OSII) (ECB 2016). GSII and OSII are usually financial institutions of high importance from the systemic risk perspective whose collapse could endanger the soundness of the whole system (Ampudia et al. 2021a). The difference is that GSII are recognized on the global level while OSII are recognized on the country level (ECB 2016). These buffers serve as additional capital requirements that should support the capital strength of the institutions and prevent any

financial difficulties that could eventually result in a bailout process (ECB 2016). Those buffers aim to address the cross-sectional dimension of the risk arising from the "too big to fail" paradigm (Ampudia et al. 2021a). When the buffers are applied, the institution must comply with the amount and the quality of the capital demanded. In addition, the buffer cannot be deactivated during the stress periods (Drehmann et al. 2020).

Another very important tool is the Countercyclical Capital Buffer (CCyB). This tool aims to reduce the procyclicality of the lending (ECB 2016). During the periods of economic growth the lending activity is relatively lively and the credit accessibility is relatively easy. On the other hand, during the economic downturn banks are usually more cautious about lending. However, this approach contributes to the deepening and prolonging of the recessions (Constancio et al. 2019). To address this issue, CCyB should be tightened during the periods of economic growth to reduce the lending capacity of the banks and to enable them to save the additional capital to be used during the times of risk materialization (Gadanecz and Jayaram 2016). Once the risk materializes, the accumulated capital should be released to cover possible losses from non-performing loans and to support the growth of the lending activity (Ampudia et al. 2021a). This tool is designed to deal with the time dimension of the systemic risk that arises during the economic cycle as it allows a certain degree of flexibility for the policymakers (Borio 2011 and ECB 2016).

Additionally, there are also another two types of capital buffers: Capital Conservation Buffer and Systemic Risk Buffer. While the Capital Conservation Buffer must be applied to all the operating banks to enhance their capital adequacy (Drehmann et al. 2020), the Systemic Risk Buffer, similarly to OSII and GSII buffers, aims to tackle the cross-sectional dimension of the risk and can be applied on all the institutions or only on the chosen institutions (ECB 2016).

But the macroprudential policy is not being conducted only by the use of buffers. There are plenty of different tools and measures that can be deployed. Very widely used measures are Loan-to-Value (LTV), Loan-To-Income (LTI), Debt-to-Income (DTI) or Debt-Service-to-Income (DSTI) ratios caps. These are the borrower based measures and these tools aim to ensure the ability of the debtor to repay his loan thus reducing the riskiness of the credit process (IMF-FSB-BIS 2016). Usually, certain or floating caps of these ratios are set, that must be followed, and the amount of the credit cannot exceed the given cap. For example, if the LTV is set to a maximum of 90% it means the debtor can only receive the credit of the maximum value of 90% of the collateral. A similar applies to the other ratios. These measures are relatively well targeted and can help to deal with the excessive credit growth while they can address the risk arising from the real estate markets as well (Poghosyan 2020).

There are also other tools that help macroprudential policy to mitigate systemic risk such as the tools that control the liquidity of the institutions (i. e. Liquidity Coverage Ratio),

and tools that aim to prevent excessive interconnectedness or excessive exposures to specific markets as well as time mismatch.

2.2 Procyclicality of the financial system

The significant part of the problem and the justification for the existence of the macroprudential policy is that the banks seem to operate very procyclical way. According to Crockett (2002), the issues with bank lending already arose in the calm periods of economic growth. During these periods the banks as well as the borrowers are less prudent and more confident in the investment projects and eventual repayment of the loan (Jiménez and Saurina 2006). However, when the economic situation deteriorates this behaviour can cause the default of a significant number of the loans. In contrast, during the economic downturns the banks can be reluctant to supply the credit to the economy because of the unreasonably low confidence therefore even the potentially effective projects can lack the credit accessibility (Jiménez and Saurina 2006). By this behaviour the banks can amplify the potential shocks to the economy. The unwillingness of the bank to supply the credit to the economy may have its roots in the risk assessing models deployed by the banks (Borio et al. 2001). These models usually estimate the risk for the one-year period, which mostly leads to the conclusion that crediting is too risky during the downturns while it reinforces more aggressive crediting during the boom times (Borio et al. 2001).

Another argument for the procyclicality of the banking system that was raised by Borio et al. (2001) refers to the value of the collateral. As the economic activity is on the rise, so is the value of the collateral, which enables additional credit for the economy and supports the growth. On the other hand, the value of the collateral during the economic downturn tends to decrease which negatively affects the credit potential of the borrowers (Borio et al. 2001).

The literature also offers a few more explanations for this behaviour. One of them is the Disaster Myopia hypothesis established by Guttentag and Herring (1986). This hypothesis is based on the behavioural and psychological aspects of the decision-making process in an uncertain environment. It suggests that subjects tend to underestimate the probability of the high-risk events, which are unlikely to happen. Because of this behaviour the subjects tend to get involved in risky exposures as they underestimate the likelihood of these events, while they are deteriorating their stability (Guttentag and Herring 1986).

Another hypothesis that should be mentioned is the "herd behaviour" hypothesis which was demonstrated by Rajan (1994). According to the theory, the bank management is motivated to behave the same way as the other market participants. The theory assesses that the managers cannot be held accountable individually for the failure when the failure is widely spread across the sector. This incentivizes especially the managers of the institutions that performed poorly in the past to take on excessive risk when it is common

in the market and that eventually transforms into the non-performing loans (Jiménez and Saurina 2006).

Finally, the last hypothesis to be mentioned is called the "institutional memory" hypothesis presented by Berger and Udell (2003). According to them, the behaviour of the institution is influenced by its employees. As time goes by, the older employees leave the institution while the new employees are getting the job. By this, the institution loses the employees that experienced the credit bust and hire the less-skilled employees who are likely to behave less cautiously, as they had never gone through this situation. It is also likely that even though the staff turnover is not that high, the memory of the adverse experience can get less vivid as the time since the bust passes and the employees can abandon the cautiousness once gained (Berger and Udell 2003).

What is more, there is a relatively wide literature discussing the potential procyclicality of the Basel II framework, which has been replaced by the Basel III (Kashyap and Stein 2004, Jokipii and Milne 2008, VanHoose 2008). It was argued that the capital requirements the banks had to comply with were constraining the additional credit to the economy during the bust as the banks had to keep the same amount of the capital as during the boost.

3 Literature Review

As the deployment of macroprudential policy tools is emerging around the globe, the literature considering the effectiveness of the policy is growing. Drehmann and Gambacorta (2012) examined the effect of the countercyclical capital buffer on the cyclicality of the lending in the simulation of the bank behaviour. They found that the use of the CCyB can reduce the procyclicality of lending as the simulation demonstrated that the CCyB tightening can lower the credit growth while the release of the CCyB can induce it (Drehman and Gambacorta 2012). Similar findings were also confirmed by Chen et al. (2019). They analysed the effects of the prudential filter in Slovenia which was adopted in 2006 and released after the Great Financial Crisis hit in 2008. The filter functioned very similarly to the nowadays CCyB. According to Chen et al. (2019) the firms were able to obtain more credit funding by 11 percentage points in the three quarters after the release of the filter from the banks that accumulated the prudential filter higher by one percentage point. What is more, Chen et al. (2019) also concluded that the solid and healthy companies benefited more from the release. Another study conducted by Lewrick et al. (2020) simulated the effect of the release of the different capital buffers that had been accumulated in the previous periods. The aim was to find out how could this freed capital support the economy. According to them the buffer release could induce from 6% to 14% of additional loans if an adverse scenario occurred. However, if a severely adverse scenario occurred, which means a crisis similar to the GFC, the wipeout of the buffer would only result in an 1,3% to 3,1% additional increase of the loans, so the release of the capital buffers alone might not be enough to boost the additional credit (Lewrick et al. 2020). A different conclusion was reached by Borsuk et al. (2020) that used the micro-macro model BEAST to estimate the effect of the capital buffer use in 19 euro area economies on the sample of numerous banks that represented around 70% of the banking sector in these countries. According to them the banks accumulated a reasonable amount of additional funds in their buffers, therefore they were more resilient during the Covid-19 crisis in comparison with GFC. They found that the use of accumulated buffers could boost the credit to the real economy by more than 3% with a positive effect on the GDP growth of 0,5%. In addition, Borsuk et al. (2020) also pointed out positive effects on bank profitability and soundness due to a decrease in the non-performing loans and loss given defaults.

Other researchers focused more on a variety of macroprudential tools instead of only the buffers. Cerruti et al. (2017) composed a wide macroprudential index consisting of 12 different policy instruments such as LTV, DTI, DSTI caps as well as countercyclical capital buffer and taxes examined in 119 countries. The index is based on dummy variables for particular instruments that are given a value of 1 during the time of being in effect. The value of the index is then given by the sum of the dummy values for instruments. They

found that macroprudential policy was more often used in emerging economies and that the borrower based measures such as LTV and DTI caps seem to have a bigger impact on credit growth. The feature of the dummy based index composed this way is that it does not measure potential changes in the policy instruments (Cerutti et al. 2017). Alam et al. (2019) attempted to address this issue by using simple average values of imposed LTV caps across 66 countries. They found that tightening the LTV cap by 1 percentage point induced the decline of the household credit growth by 0,65 percentage points with the delay of the one year. They also quantified that the tightening of any of the macroprudential tools resulted in the reduction of the household credit growth by the 0,8 percentage points on average, while this effect is even stronger for the emerging economies (Alam et al. 2019). Gross and García (2016) examined the effectiveness of the borrower based measures in mitigating the household risk in terms of probability of default and loss given default. They developed the integrated micro-macro model to analyse the effects on seven European union countries. Their simulation suggested that LTV and DSTI caps can reduce the probability of default as well as loss given default. According to them the households with higher LTV loans have often more issues with servicing their debt. They also concluded that the DSTI cap appeared to be more effective than LTV in lowering the household risk while maintaining a higher volume of the loan giving (Gross and García 2016). Ampudia et al. (2021a) examined macroprudential measures across European Union countries. For this analysis they constructed a set of different models (logit, VAR, SVAR, micro-macro model). They concluded that macroprudential measures can contribute to credit regulation while their effects are relatively long-delayed and it can be until 20 quarters to reach a maximum effect. They also found that the deployment of the borrower based measures increases the resilient of the borrower as well as the soundness of the bank due to the decrease of the probability of the default and the loss given default, which positively influences the mortgage portfolio of the bank. According to them, the macroprudential policy is beneficial as it supports financial stability which eventually results in economic growth in the long term (Ampudia et al. 2021a). Another study by Ampudia et al. (2021b) concluded similar results as Ampudia et al. (2021a). In addition, their estimation of the DSGE model suggested that the macroprudential measures can also influence house prices and similarly to before mentioned authors that the effect of the borrower based measures is larger (Ampudia et al. 2021b).

The research conducted by Gambacorta and Murcia (2019) focused on the wider scope of the issues connected with the use of the macroprudential policy. First, they found, similar to above mentioned authors, that tightening in macroprudential policy measures can reduce the annual credit growth by 4,2% after three months and 7,2% after a year since the action was taken. The substantial effect of the decrease is assigned to the capital buffer which is associated with a 3-6% reduction in the credit growth after the one year

since the tightening. They also recognized that the effect is more statistically significant after the year, which suggests that there is a certain delay between the adoption of the measure and its effect on the real economy. In their research, Gambacorta and Murcia (2019) considered the relationship between macroprudential policy and monetary policy and they concluded, that macroprudential policy is more effective in reducing the credit when it is supported by a tight monetary policy stance. Finally, according to them macroprudential policy reduces the risk to the banking sector (Gambacorta and Murcia 2019).

Another piece of literature focuses on the interaction between the macroprudential policy and house prices. Kuttner and Shim (2012) examined the effects of the macroprudential measures on the house prices in the panel regression for 57 countries from different regions (Asia, Pacific, Europe, North America, Latin America, The Middle East and Africa) between 1980 and 2011. They found that macroprudential measures affected house prices while the effect of the LTV is bigger than the effect of the DSTI cap (Kuttner and Shim 2012). Vandenbussche et al. (2015) conducted the research with a similar aim. They used panel regression for 16 European countries. In contrast with the conclusion of Kuttner and Shim (2012), Vandenbussche et al. (2015) discovered that the changes in capital requirements significantly influence the house prices and that the effect of the tightening is the largest after four quarters. The significant effect of the capital requirements was also observed for the credit growth. On the other hand, the effect of the LTV cap was found to be significant only for the house prices but not for the credit growth (Vandenbussche et al. 2015). The study conducted by Akinci and Olmstead-Rumsey (2015) uses a similar approach as Cerutti et al. (2017) which is the construction of the dummy based index to evaluate measures that were adopted. Similarly to Kuttner and Shim (2012) the panel regression based on the data for 57 countries between 2000 and 2013 was deployed (Akinci and Olmstead-Rumsey 2015). According to their findings, the capital requirements have a greater impact on restricting the overall credit growth while the borrower based measures are more effective in reducing the house related credit growth. What is more, Akinci and Olmstead-Rumsey (2015) found that DTI caps influence house prices the most followed by LTV caps. The recent study by Poghosyan (2020) continues in the development of this topic. He examined lending restriction instruments across the period from 1990 to 2018 and he discovered that these measures were effective in decreasing the property prices growth as well as the credit growth. According to him, the effect of these measures is delayed so it reaches its maximum after three years (Poghosyan 2020).

The outbreak of the novel coronavirus, which resulted in the worldwide pandemic also caused severe economic distress and endangered financial stability. On the other hand, it appears as a good opportunity to study how the macroprudential tools work in the

practice. Forbes (2020) approached to evaluate the effects of tighter macroprudential measures adopted in the preceding periods on the resilience of the country, which he proxied using the equity market performance, credit default swap rate, the exchange rate and GDP growth forecast. He conducted the regression on the data for 134 countries and found that countries that had deployed macroprudential tightening before the Covid pandemic experienced a shallower decline of the equity market by the 5,6 percentage points (Forbes 2020). He also discovered a correlation between lower credit default swaps rates and macroprudential measures but the effect was not statistically significant (Forbes 2020). Another research on this topic was conducted by Igan et al. (2022) that examined the data for 981 banks from 52 countries. Similarly to Forbes (2020), they used banks' share prices as the proxy for financial stability. For the evaluation of the effects there was constructed macroprudential index and the OLS estimation method was deployed. According to them, the use of macroprudential measures had a stabilizing effect on the share prices of the banks while the employment of the additional measure was associated with a 2,1% increase in the share price value during the pandemic. On the other hand, they found that additional capital requirements imposed on systemically important institutions had a negative effect on the share value (Igan et al. 2022). The study provided by Gholipour and Arjomandi (2021) focused on the growth of the non-performing loans as a consequence of the pandemic. They compared the effects of the different policies used to support the economy and decrease the pressure on the financial system. They used the data for 47 countries between the years 2019 and 2020. According to the results of the OLS regression prudential measures and borrower assistance managed to reduce the growth of non-performing loans in the countries when they were deployed (Gholipour and Arjomandi 2021). This suggests that the adoption of macroprudential measures helped to address the adverse impact of the pandemic on the economy.

4 Methodology

The aim of our work is to assess the effectiveness of macroprudential policy tools in securing the financial stability and soundness of the financial system and to evaluate its ability to prevent financial shocks in the light of the Covid-19 pandemic. We will focus on the countercyclical capital buffer and LTV cap as the main and most widely used tools. For this purpose we have constructed the panel dataset for 9 European countries, that are: Czech Republic, Denmark, France, Iceland, Ireland, Lithuania, Norway, Slovak Republic and Sweden. The dataset is unbalanced because of a lack of data availability and is based on the quarterly data for the period Q1:2005 until Q4:2021. The composition of the countries has been chosen according to their approach toward the use of the macroprudential tools, especially CCyB. As Figure 1 demonstrates, the countries of our interest use CCyB relatively pro-actively. On the other hand, plenty of countries (for example Germany, Netherlands etc.) were unable to start with the accommodation of the buffer before the Covid-19 pandemic emerged (ESRB 2022).

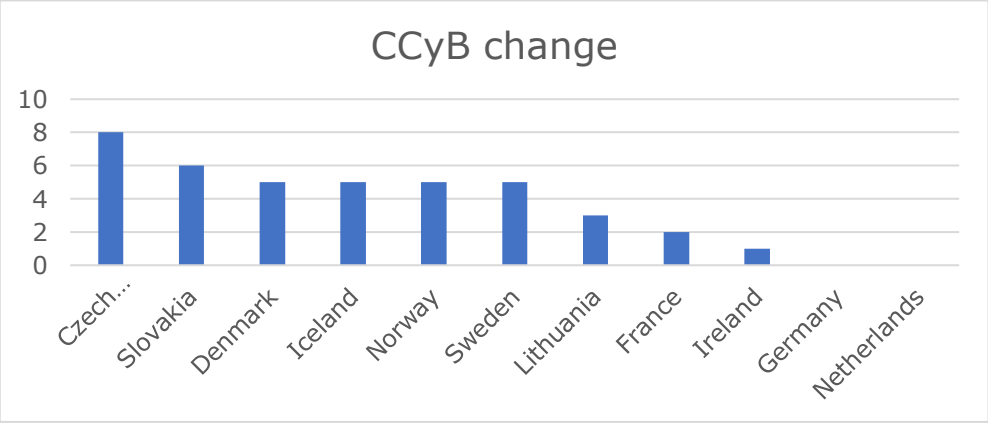

Figure 1 Number of policymakers' decisions towards the countercyclical capital buffer. Source: own processed based on ESRB.

The activity that has been undertaken in the accommodation of the CCyB is demonstrated in Figure 2. We can observe that the first country to start with a build-up of an additional supply of capital was Sweden in 2014 followed by Norway in 2015. Slovak Republic, Czech Republic and Iceland joined in 2016 and 2017 respectively. The last country to begin with the accumulation was Ireland, which started just a few quarters before the Covid-19 pandemic emerged. In the response to this shock all the observed countries deflated the accumulated buffers to support the banking sector and its willingness to supply credit to the economy. Yet, not all of the countries released the buffer to its full extent. Slovak Republic and Czech Republic both released their buffer only partially and kept it on the level of 0,5% and 1% respectively, despite the pandemic.

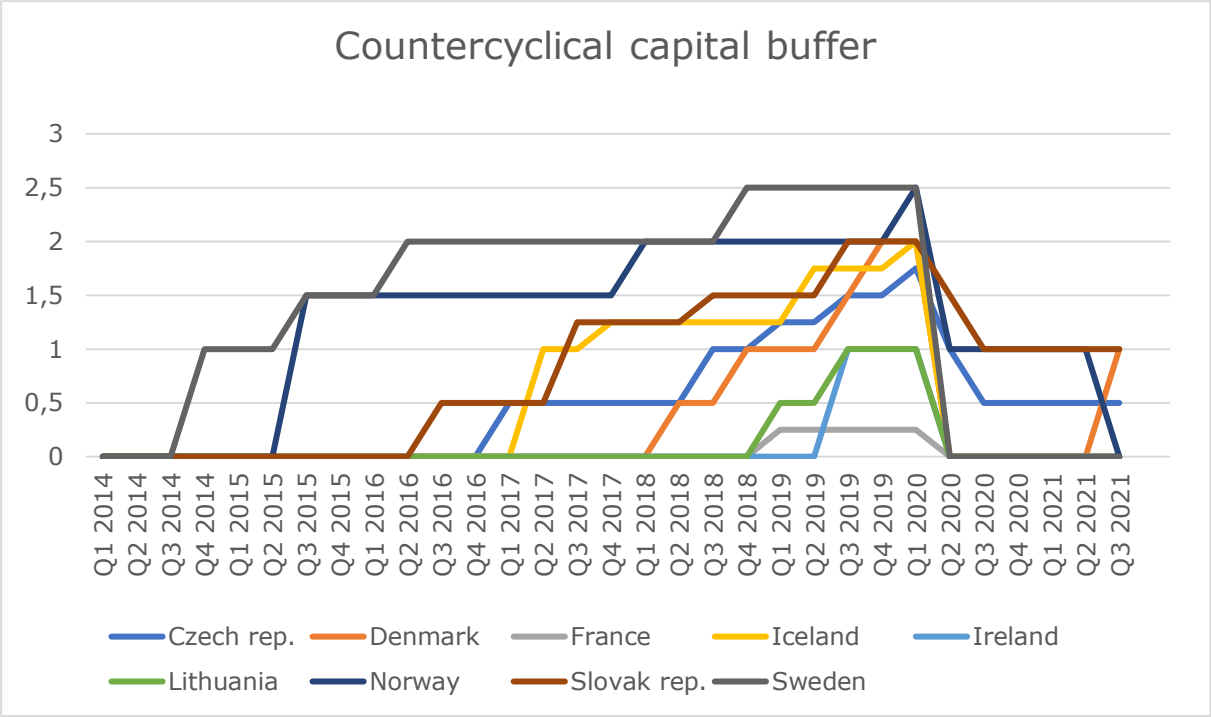

Figure 2 Countercyclical capital buffer accommodation in the observed countries. Source: own processed based on ESRB.

Another reason why we have chosen those countries is their active use of the LTV caps which is a relatively widely used tool of the macroprudential policy. According to European Systemic Risk Board dataset 7 of our countries have adopted this measure except for Denmark and France that adopted different measures focused on borrowers' resiliency (LTV and DSTI). During the observed period LTV limit has only been tightened.

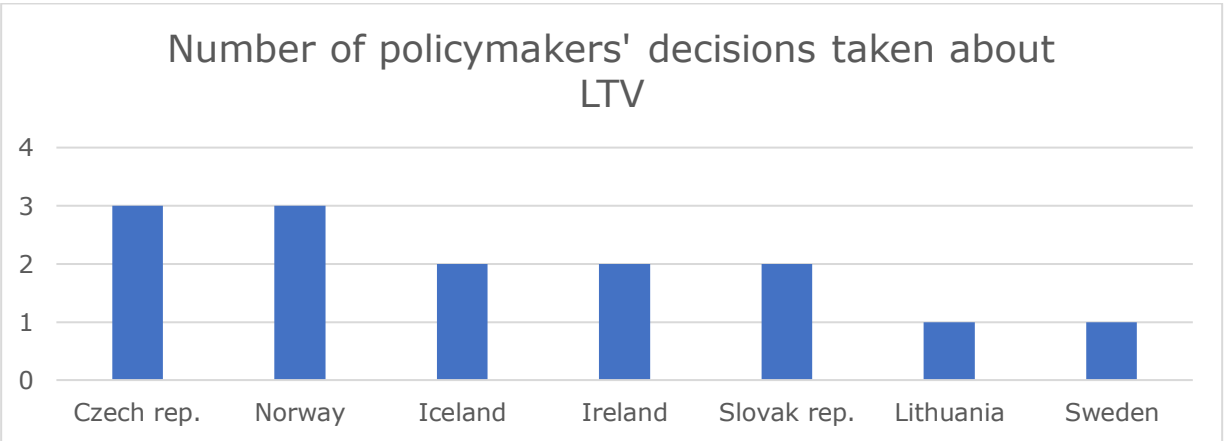

Figure 3 The number of the policymakers' decisions taken about LTV caps. Source: own processed based on ESRB.

Due to the relative activity in the use of macroprudential policy by the chosen countries we should be able to measure and evaluate the discrete effects of policy changes. Some authors focusing on this topic conducted the research by the creation of the macroprudential index (for example Akinci and Olmstead-Rumsey 2015, Cerutti et al.

2017, Igan et al. 2022). This index is usually based on the dummy variables assigned to particular tools that takes value 1 if the tool was activated or its setup was changed and value 0 if the tool was not activated or there was no change in the setup. Then the index is given by the sum of these dummy variables. The disadvantage of this approach is that while it measures the overall effect of the macroprudential policy, it does not evaluate the effect of the single tool or the incremental change. On the other hand, it is true that the measuring the effect of some tools is especially complicated. For example, borrower based measures are very often designed as the floating caps with fluctuation bands or they assign different limits to different types of borrowers. What is more, very often there are different tools activated at the same time that focus on the same source of the risk. Distinguishing between their effects can be a tricky task.

SUMMARY OF THE VARIABLES

VARIABLE	DESCRIPTION	SOURCE
CCYB	Actual value required by the regulatory authority.	European Systemic Risk Board
COVID	Dummy variable, it takes a value of 1 from the 1st quarter of 2020 until the 4th quarter of 2021	Own processed
CRISIS	Dummy variable, it takes a value of 1 since the 1st quarter of 2007 until the 4th quarter of 2009	Own processed
GDP	GDP growth, a percentage change of GDP in current prices	OECD
HOUSE PRICES	Growth of the house prices, a percentage change of the index of house prices	OECD
HOUSEHOLD DEBT	Growth of the household debt, percentage changes of household debt to GDP ratio	IMF, OECD, Central Bank of Iceland, National Bank of Slovakia
LOANS	Growth of gross loans, a percentage change of gross loans, winsorized on 5th and 95th percentile	IMF
LONGTERM INTEREST RATE	An interest rate of the 10 years government bond, the average for the period	OECD
LTV	Dummy variable, it takes a value of 1 when LTV is adopted and keeps the value for the whole time the LTV cap is in effect	Own processed based on European Systemic Risk Board

LTV TIGHTENING1	Dummy variable, it takes value of 1 when additional LTV tightening is adopted and keeps the value for the whole time the additional tightening of the LTV cap is in effect	Own processed based on European Systemic Risk Board
LTV TIGHTENING2	Dummy variable, it takes a value of 1 when additional LTV tightening is adopted and keeps the value for the whole time the additional tightening of the LTV cap is in effect	Own processed based on European Systemic Risk Board
NPL	Growth of the non-performing loans, a percentage change of the non-performing loans to total loans ratio	IMF
REGULATORY CAPITAL	Growth of the regulatory capital, percentage change of the regulatory capital to risk-weighted assets ratio	IMF
UNEMPLOYMENT	Percentage change of the unemployment rate	OECD

Table 1 Summary of the variables. Source: own processed.

To tackle this issue, we focuse on the countries that mostly use the LTV cap. To be able to measure its effect we created a set of dummies. First, the dummy LTV takes value 1 for the whole time the LTV cap is activated and value 0 when it is not. Then we created the dummies LTV tightening1 and LTV tightening2, that take value 1 when there is a tightening in the LTV cap and keep this value for all the time the tighten measure is in place. By this approach we should be able to measure the additional effects of tightening. For the measurement of the effect of the countercyclical capital buffer we use percentage values of its setup. We constructed these variables based on the data from European Systemic Risk Board database. We also deploy another set of dummies that measure the effects of the Great Financial Crisis and the Covid-19 crisis. The dummy variable Crisis controls for the effect of the Great Financial Crisis and it takes value 1 from the first quarter of 2007 until the last quarter of 2009. The dummy variable Covid aims to measure the impact of the Covid-19 pandemic on the economy. It takes value 1 from the first quarter of 2020 until the end of the dataset so the fourth quarter of 2021. For the rest of our dataset we use data obtained from the public databases of the Organization for Economic Cooperation and Development (OECD) and the International Monetary Fund's (IMF) Financial Soundness Indicators database. The description of the variables is also presented in Table 1.

To assess the effectiveness of macroprudential policy we employ a set of different models. We use pooled OLS estimating method as well as the fixed effects OLS model to control for the country specific effects. The variables for both kinds of models are the same so to demonstrate the specification we use fixed effects OLS. The specification goes as follows:

$$NPL_t = \alpha_0 + \beta_1 CCyB_{t-8} + \beta_2 LTV_t + \beta_3 LTV_{tightening1_t} + \beta_4 LTV_{tightening2_t} + \beta_5 Crisis_t + \beta_6 Covid_t + \beta_7 GDP_t + \beta_8 Longterm\ interest\ rate_t + \beta_9 Unemployment_t + \beta_{10} Household\ debt + \beta_{11} House\ prices_t + \delta + \gamma + \omega + \epsilon \quad (1)$$

$$Loans_t = \alpha_0 + \beta_1 CCyB_{t-8} + \beta_2 LTV_t + \beta_3 LTV_{tightening1_t} + \beta_4 LTV_{tightening2_t} + \beta_5 Crisis_t + \beta_6 Covid_t + \beta_7 GDP_t + \beta_8 Longterm\ interest\ rate_t + \beta_9 Unemployment_t + \beta_{10} Regulatory\ capital_t + \beta_{11} House\ prices_t + \delta + \gamma + \omega + \epsilon \quad (2)$$

$$House\ prices_t = \alpha_0 + \beta_1 CCyB_{t-8} + \beta_2 LTV_t + \beta_3 LTV_{tightening1_t} + \beta_4 LTV_{tightening2_t} + \beta_5 Crisis_t + \beta_6 Covid_t + \beta_7 GDP_t + \beta_8 Longterm\ interest\ rate_t + \beta_9 Unemployment_t + \beta_{10} Regulatory\ capital_t + \beta_{11} Household\ debt_t + \delta + \gamma + \omega + \epsilon \quad (3)$$

The variable *NPL* presents the growth of the non-performing loans that are defined as the ratio of the gross loans. The data was acquired from the IMF's Financial Soundness Indicators database. From the same IMF's database we use numbers for *Regulatory capital*, which is presented as the percentage change against the previous period. It is calculated as the ratio of the capital demanded by the regulatory authority to total risk-weighted assets. The last variable from this database is *Loans*, which stands for growth of the gross loans. This variable is winsorized on the 5th and 95th percentile because of substantial volatility of the gross loans changes and numerous outliers. The rest of the variables were obtained from OECD's databases. The variable *GDP* presents growth rates of the GDP at current prices. The variable *Unemployment* indicates the percentage change of the Unemployment rate in comparison with the previous period. Another variable acquired from the OECD's database is the *Longterm interest rate* which presents the market average yield of the long-term maturity bonds. The variable *Household debt* represents the growth rate of the index of household indebtedness. The data for this variable was supplied by different sources (OECD, IMF, National Central Banks) because of the lack of availability of all data in one database. Finally, the variable *House prices* stands for the percentage change of the index which demonstrates property prices acquired from the OECD database.

The first equation represents the model where the dependent variable is non-performing loans (NPL). This can be considered as the proxy for the financial stability and soundness of the banks. The unexpected and steep growth of NPL could cause potential danger for the banking system and reduce its liquidity. We assume that tightening the CCyB as well as LTV should reduce the growth of NPLs. We use CCyB lagged by 8 quarters, which is in line with previous findings discussed in the Literature Review (for example Vandenebussche et al. 2015, Gambacorta and Murcia 2019, Poghosyan 2020, Ampudia et

al. 2021a). We also assume that the growth of the NPLs during the Great Financial Crisis should was much higher than during the Covid crisis because of the macroprudential measures adopted in the preceding periods. The rest of the variables control for the actual economic situation. It is expected that the economic growth reduces growth in the non-performing loans, while the increase in the interest rates and unemployment should have a negative effect on non-performing loans thus causing its increase. It is also expected that the increase in the household debt could potentially boost the growth of the non-performing loans due to more difficulties with servicing the debt. A similar applies to house prices. It is expected that the growth in house prices induces more debt taking which eventually results in a higher probability of the borrowers defaulting on their debt.

The second equation represents another model we aim to estimate. The dependent variable Loans stands for the growth of the gross loans, which is a proxy for the credit cycle. As was found in the previous research the macroprudential policy should be effective in reducing the cyclicality of the credit and it should be able to tame the growth when it is desired (for example Drehmann and Gambacorta 2012, Alam et al. 2019, Borsuk et al. 2020). Therefore, we expect that tightening measures in the countercyclical capital buffer and LTV cap should reduce the growth of the loans. We also measure the effects of the Great Financial Crisis and Covid crisis where we anticipate that there was a decline in the loans during the Great Financial Crisis while there could be a potential increase in the loans during the Covid crisis as all the observed countries reduced their countercyclical capital buffer to boost the credit. The same as the previous model, we also control for the economic conditions with a set of variables. We assume that the growth in the GDP should as well enhance the growth of loans as it signals convenient economic conditions that should support the banks' willingness to provide the credit. On the other hand, an increase in the interest rate and unemployment represents tighter monetary conditions, so the loan supply should decrease. As the higher interest rate represents a higher cost of borrowing, borrowers should be less willing to take the debt. In contrast, an increase in unemployment can make the banks more cautious about their potential borrowers so they are less willing to provide a credit. We also assume that the increase in the house prices should be associated with the growth of the loans, as the borrowers will need more capital to buy a property. Finally, the role of the regulatory capital should be similar to the countercyclical capital buffer so its increase should cause a reduction in credit supply but it is also important to distinguish between these two measures as the regulatory capital is not as flexible as the buffer and the requirements do not change that often.

Finally, the last model which we estimate aims to examine the effects of macroprudential policy on property prices. The expectation is that the tightening of the macroprudential measures should decrease property prices. The reason is that if the policy is effective, it should regulate the credit growth and the decrease in the credit growth

should eventually reflect in the decrease in the demand for the properties which should result in a decrease in their prices. This relationship was studied in the previous research and it was found to be significant and the policy to be effective (Kuttner and Shim 2012, Akinci and Olmstead-Rumsey 2015, Vandenbussche et al. 2015, Poghosyan 2020). In this model we also evaluate the effects of the Great Financial Crisis and Covid crisis. We expect property prices to decline during the Great Financial Crisis while, if the macroprudential policy is effective, the property crisis during the Covid crisis could even increase as the supply of the credit should be stable so the demand for properties should also be. We assume that the effects of the GDP growth, unemployment and the interest rate should be the same as we expect for the second model. A similar applies to the regulatory capital. Finally, we assume that the increase in the household debt should boost the house prices as a consequence of the higher demand.

5 Results and findings

For a better understanding of the results that will be demonstrated in this section we include descriptive statistics that can be found in Table 2.

DESCRIPTIVE STATISTICS

VARIABLES	Mean	Median	Minimum	Maximum
CCYB	0,3371	0,0000	0,0000	2,5000
COVID	0,1261	0,0000	0,0000	1,0000
CRISIS	0,1133	0,0000	0,0000	1,0000
GDP	1,1105	1,0226	-12,0800	26,4350
HOUSE PRICES	1,1720	1,2631	-20,0510	10,9860
HOUSEHOLD DEBT	0,2941	0,7865	-74,7210	21,2950
LOANS (NOT WINSORIZED)	1,1587	1,0209	-40,6460	71,4660
LOANS (WINSORIZED ON 5TH AND 95TH PERCENTILE)	1,0890	1,0209	-4,6541	8,1949
LONGTERM INTEREST RATE	2,2212	1,7583	-0,4927	14,5000
LTV	0,4680	0,0000	0,0000	1,0000
LTV TIGHTENING1	0,1795	0,0000	0,0000	1,0000
LTV TIGHTENING2	0,0513	0,0000	0,0000	1,0000
NPL	-1,5739	-2,5029	-46,4470	85,0700
REGULATORY CAPITAL	1,3746	0,9205	-20,1580	66,7040
UNEMPLOYMENT	-0,2535	-0,9615	-18,6170	44,6970

Table 2 Descriptive statistics of the variables used in the regressions. Source: own processed.

5.1 Macroprudential policy and non-performing loans

The first model we estimate is the one with non-performing loans as the dependent variable. This model aims to examine the effect of the macroprudential measures on the growth of non-performing loans. The equation for the pooled OLS is as follows:

$$NPL_t = \alpha_0 + \beta_1 CCyB_{t-8} + \beta_2 LTV_t + \beta_3 LTV_{tightening1_t} + \beta_4 LTV_{tightening2_t} + \beta_5 Crisis_t + \beta_6 Covid_t + \beta_7 GDP_t + \beta_8 Longterm\ interest\ rate_t + \beta_9 Unemployment_t + \beta_{10} Household\ debt + \beta_{11} House\ prices_t + \epsilon$$

The equation for the fixed effects model is as follows:

$$NPL_t = \alpha_0 + \beta_1 CCyB_{t-8} + \beta_2 LTV_t + \beta_3 LTV_{tightening1_t} + \beta_4 LTV_{tightening2_t} + \beta_5 Crisis_t + \beta_6 Covid_t + \beta_7 GDP_t + \beta_8 Longterm\ interest\ rate_t + \beta_9 Unemployment_t + \beta_{10} Household\ debt + \beta_{11} House\ prices_t + \delta + \gamma + \omega + \epsilon$$

RESULTS OF THE REGRESSIONS FOR THE FIRST SPECIFICATION

DEPENDENT VARIABLE:				NPL
	Pooled OLS		Fixed effects	
INDEPENDENT VARIABLES:	Coefficient	P-value	Coefficient	P-value
CONSTANT	-2,0263	0,1149	*-3,9384	0,0602
CCYB(8)	0,1816	0,8774	-1,1606	0,4584
LTV	**-2,8847	0,0380	-0,6235	0,7900
LTV TIGHTENING1	-0,3231	0,8443	-1,7886	0,3890
LTV TIGHTENING2	2,2025	0,4230	2,9081	0,3751
CRISIS	***13,6451	0,0068	**12,9178	0,0123
COVID	2,3190	0,2192	*3,9156	0,0542
GDP	***-0,5442	0,0080	**-0,5000	0,0162
LONGTERM INTEREST RATE	***1,0638	0,0077	***1,6390	0,0018
UNEMPLOYMENT	**0,1981	0,0340	*0,1835	0,0526
HOUSEHOLD DEBT	0,0346	0,7319	0,0364	0,7240
HOUSE PRICES	-0,1332	0,6646	-0,1034	0,7443
R-SQUARED	0,2479		0,2685	
NO. OF OBSERVATIONS	335		335	

*Table 3 The results of the first regression. Source: own processed. Note: Signs */**/*** denote the statistical significance on the conventional levels 10%/5%/1%.*

The results of the regression are presented in Table 3. According to the regression the constant is negative and this result is even statistically significant in the fixed effects model on the level of significance of 10%. It suggests that there is a downward trend in the growth of non-performing loans, which can be considered positive. The model also suggests that there was a relatively substantial increase in non-performing loans during the Great Financial Crisis. The pooled OLS model quantifies this effect as an increase by 13,65 percentage points on average, which is a relatively big increase, when we consider that the mean and the median of the variable take values -1,57 and -2,50 respectively. A similar effect is concluded by the fixed effects model, which indicates that non-performing loans increased on average by 12,92 percentage points during the Great Financial Crisis in the observed countries. These results are statistically significant in both models while it comes statistically significant at the 1% level in the OLS and at the 5% level in the fixed effects model. On the other hand, models suggest that the increase in the non-performing loans during the Covid crisis was not that substantial in comparison with the Great Financial Crisis. As we can see, the increase in the non-performing loans during the Covid crisis is quantified to be on average 2,32 percentage points according to pooled OLS model, but this result is not statistically significant on any of the conventional levels. A more reliable result could be reached by the fixed effects model, which indicates the increase by 3,92 percentage points and it comes significant at the 10% level and is also close to the

significance at the 5% level. This suggests that the increase in the non-performing loans during the Covid crisis was substantially lower in comparison with the increase during the Great Financial Crisis. The same finding is supported by Figure 4 where we compare the average amount of the non-performing loans during the Great Financial Crisis with this amount during the Covid crisis. According to Figure 4 a larger amount of defaults during the Great Financial Crisis is quite obvious.

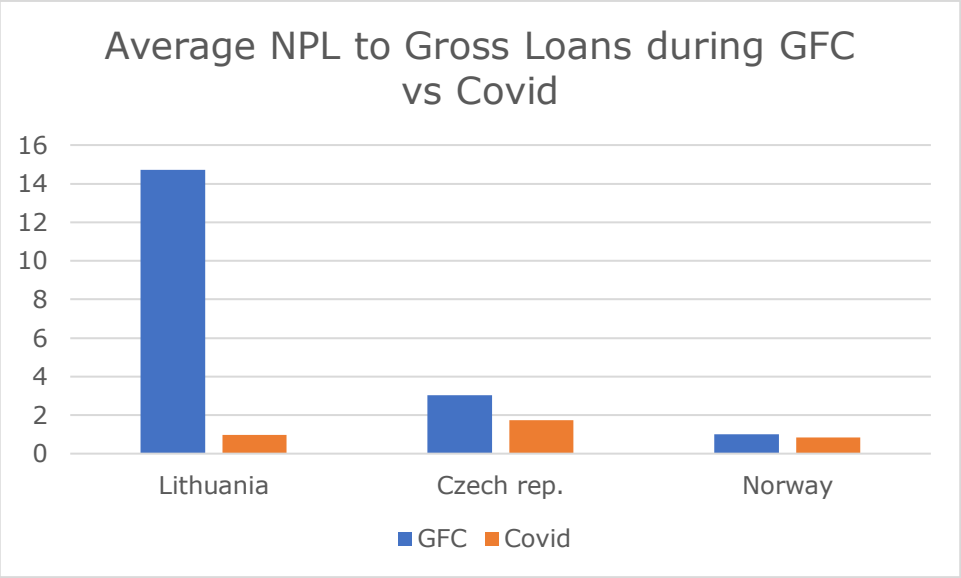

Figure 4 Comparison of the amount of the non-performing loans during the Great Financial Crisis vs during the Covid crisis. Source: own processed based on data from IMF.

The results for the macroprudential tools are fairly interesting. According to models, countercyclical capital buffer does not seem to be an effective tool to deal with non-performing loans. For both of the regressions the effect of the buffer is not statistically significant on any of the levels. On the other hand, according to the pooled OLS model the effect of the LTV cap is quite substantial as the model suggests that there is a decrease in the growth of non-performing loans by 2,88 percentage points on average when the measure is adopted and in action. This effect is statistically significant in the pooled OLS model and is also in line with previous findings of other authors (Gross and García 2016, Ampudia et al 2021a, Gholipour and Arjomandi 2021). In contrast, this result is not proved by the fixed effects model where the effect is not found to be significant even though the coefficient also suggests a negative impact on the non-performing loans growth. What is more, the effect of the additional tightening of the LTV cap seems to be negligible according to the results of the regression, as in both cases the coefficients are not statistically significant.

The effects of the GDP growth, unemployment growth and the long term interest rate are in line with our expectations and all of them are significant on the conventional levels. According to the results of the regression the change in the GDP growth by 1 percentage point is associated with the decrease in the growth of the non-performing loans

by 0,54 and 0,50 percentage points depending on the model deployed while those coefficients are significant at the 1% level and 5% level respectively. This suggests that the trend of the non-performing loans is relatively dependent on the changes in the GDP growth, which implies that recessions are strongly connected with the increase in the amount of the non-performing loans. The same is suggested by our findings regarding the Great Financial Crisis and the Covid crisis where we can observe the increase of the non-performing loans in both cases even though the intensity of the increase is substantially different. The effect of the change in the long term interest rate is also relatively substantial. According to the models the 1 percentage point increase in the long term interest rate is associated with the increase of the growth of non-performing loans by 1,06 and 1,64 percentage points respectively, depending on the model deployed. The results are significant with a 1% confidence level in both cases. These results demonstrate the sensitivity of the borrowers to the changes in the interest rates. Apparently, the fast increase in the interest rate can result in a strong increase in defaults. That is why it is important to support the soundness of the borrowers through the different measures as is also the LTV cap, which proved to have a certain ability to reduce the growth of the non-performing loans according to the pooled OLS model. Speaking of the soundness of the borrowers, the rise in unemployment also substantially affects the growth of non-performing loans. The models imply that the growth of the unemployment by 1 percentage point is associated with the increase of the growth of the non-performing loans by 0,20 and 0,18 percentage points respectively while both of the coefficients are significant on the 5% level and 10% level. Even though it can seem like a relatively small effect, it is important to understand that we use unemployment expressed as percentage changes, so the increase in the unemployment rate from 3% to 6% would mean an increase by 100%, which implies the growth of the non-performing loans by 20 or 18 percentage points respectively and that is very substantial.

Finally, according to the results of the regressions the changes in the household debt and house prices do not prove to affect the non-performing loans as their effect do not come to be statistically significant on any of the conventional levels.

5.2 Macroprudential policy and loans growth

In this section we present the results of the regression examining the relationship between the macroprudential policy tools and the growth of the gross loans in the observed countries. The aim of the models is to consider the effects of macroprudential policy on the credit cycle. The specification of the OLS model is as follows:

$$Loans_t = \alpha_0 + \beta_1 CCyB_{t-8} + \beta_2 LTV_t + \beta_3 LTV_{tightening1_t} + \beta_4 LTV_{tightening2_t} + \beta_5 Crisis_t + \beta_6 Covid_t + \beta_7 GDP_t + \beta_8 Longterm\ interest\ rate_t + \beta_9 Unemployment_t + \beta_{10} Regulatory\ capital_t + \beta_{11} House\ prices_t + \epsilon$$

The specification of the fixed effects model is as follows:

$$Loans_t = \alpha_0 + \beta_1 CCyB_{t-8} + \beta_2 LTV_t + \beta_3 LTV_{tightening1_t} + \beta_4 LTV_{tightening2_t} + \beta_5 Crisis_t + \beta_6 Covid_t + \beta_7 GDP_t + \beta_8 Longterm\ interest\ rate_t + \beta_9 Unemployment_t + \beta_{10} Regulatory\ capital_t + \beta_{11} House\ prices_t + \delta + \gamma + \omega + \epsilon$$

The dependent variable is calculated as the percentage change of the gross loans in selected countries. It is winsorized on the 5th and 95th percentile because of the relatively high variability of the variable. The winsorized and non-winsorized variables for the growth of the loans are presented in the Table 2. While not winsorized variable's maximum and minimum values strongly deviates from the mean (min=-40,65 and max=71,47 vs mean=1,16), this does not apply to the winsorized variable (min=-4,65 and max=8,19 vs mean=1,09), which makes it more suitable for the regression. The results of regressions are presented in Table 4.

RESULTS OF THE REGRESSIONS FOR THE SECOND SPECIFICATION

DEPENDENT VARIABLE:				**Loans**
	Pooled OLS		**Fixed effects**	
INDEPENDENT VARIABLES:	**Coefficient**	**P-value**	**Coefficient**	**P-value**
CONSTANT	***1,3905	0,0008	***1,9603	0,0047
CCYB(8)	*-0,5965	0,0673	**-1,0358	0,0335
LTV	**0,9968	0,0182	0,0365	0,9595
LTV TIGHTENING1	0,0002	0,9996	0,8949	0,1336
LTV TIGHTENING2	0,1078	0,8885	-0,2497	0,7861
CRISIS	1,5995	0,3096	1,2880	0,4146
COVID	0,6916	0,1965	*0,9757	0,0863
GDP	0,0637	0,2593	*0,1079	0,0572
LONGTERM INTEREST RATE	***-0,4128	0,0061	**-0,4625	0,0270
UNEMPLOYMENT	*-0,0437	0,0977	*-0,0471	0,0730
REGULATORY CAPITAL	**-0,0853	0,0394	**-0,0892	0,0297
HOUSE PRICES	*-0,1870	0,0616	**-0,2131	0,0341
R-SQUARED	0,0916		0,1519	
NO. OF OBSERVATIONS	294		294	

*Table 4 The results of the second regression. Source: own processed. Note: Signs */**/*** denote the statistical significance on the conventional levels 10%/5%/1%.*

According to the results of the regressions the constant is positive and significant at a 1% level of significance in both models which suggests that the overall trend of the gross loans is positive, so the amount of the gross loans is on average increasing in time. The same can be concluded according to Figure 5 which depicts the amount of the gross

loans. In this case we use indexed variables (100 = 1st quarter of 2016) to be able to compare the countries.

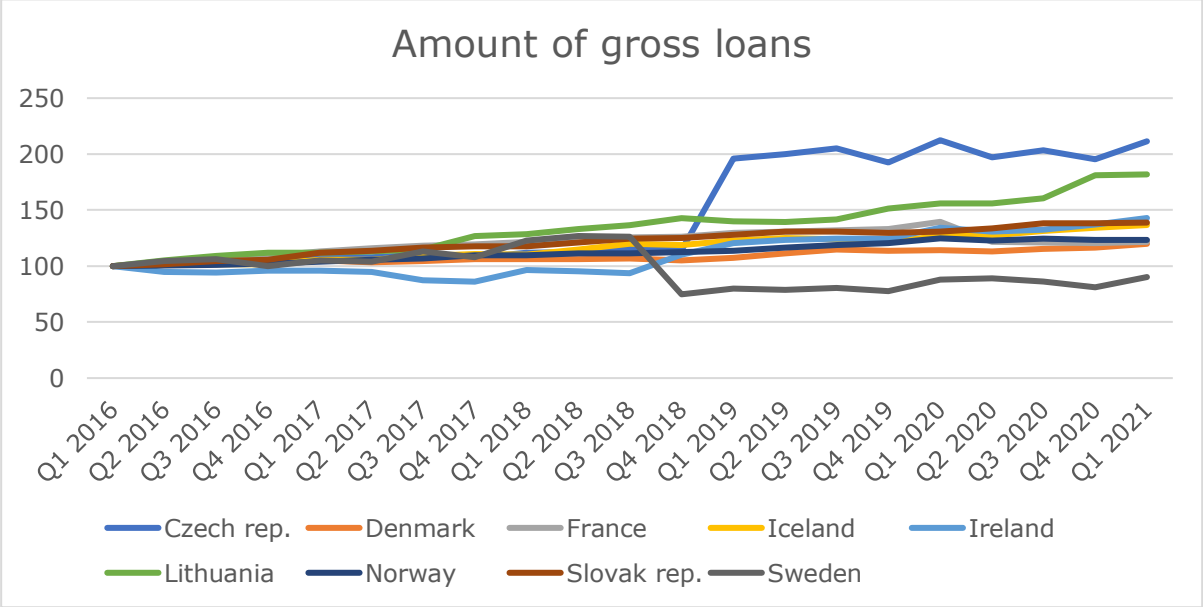

Figure 5 Amount of the gross loans in the observed countries during the period Q1:2016-Q1:2021. The variable is indexed with the base of the Q1:2016. Source: own processed based on the IMF's data.

The reason for this can be that there is a relatively strong relationship, which is demonstrated in the results of the regressions, between the growth of the loans and the long term interest rate. According to the results, the increase in the long term interest rate is associated with the decrease in the loans' growth by 0,41 and 0,46 percentage points respectively. As the mean of the variable equals 1,09 this effect can be considered substantial. What is more, the effect was found to be significant on the 1% level and 5% level of significance according to pooled OLS model and Fixed effects model respectively. As we can see in Figure 6 the long term interest rates were gradually decreasing during the observation period, which could boost the growth of the loans according to our findings.

As was stated by the other authors in previous studies (Borio 2001, Crockett 2002, Borio 2011, Gadanecz and Jayaram 2015), excessive credit growth can be very dangerous for the real economy and that is why policymakers need an effective tool to deal with this risk. According to our findings it seems that a countercyclical capital buffer could be that tool. The results of regressions suggest that an increase of the buffer by one percentage point is associated with the decrease in the growth of the gross loans by roughly 0,60 and 1,04 percentage points after 8 quarters (the variable for the countercyclical capital buffer is lagged by 8 periods). What is more, both coefficients are statistically significant, one on the 10% level and another on the 5% level. When we consider that the loans grow on average by 1,09%, the effect of the buffer is quite material. On the other hand, it takes a relatively long time for the effect to pronounce to its full extent.

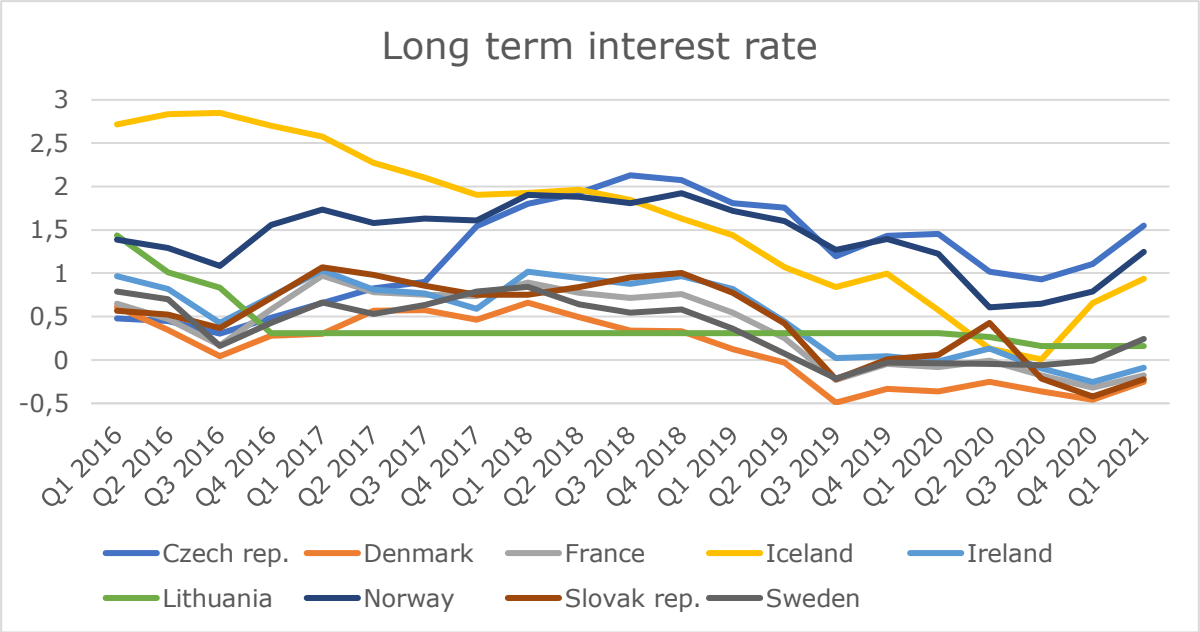

Figure 6 Long term interest rate in the observed countries for the periods Q1:2016-Q1:2021. Source: own processed based on the OECD's data.

Relatively interesting is the effect of the LTV cap on the growth of the loans. The result from Pooled OLS model suggests that the adoption of the LTV cap motivates higher loans' growth, which increases by roughly 1 percentage point. This result comes significant on the 5% level but only according to pooled OLS model. It might seem unintuitive at the first sight, but on the other hand there can be logical reasons. As we proved in the previous regressions and as was proven by other authors (Gross and García 2016, Ampudia et al 2021a, Gholipour and Arjomandi 2021) the LTV cap improves the resilience of the borrowers. Thanks to their less risky profile the banks can be more willing to provide them with credit. As result, the adoption of the LTV cap may then motivate more lending rather than slowing it down. The models also suggest that there is no significant effect of additional tightening of the LTV caps, which corresponds with the results of previous regressions.

Another interesting finding is the positive effect of the Covid pandemic. According to the fixed effects model the growth of the gross loans increased during the Covid crisis on average by 0,98 percentage points which is quite substantial considering the mean value of the gross loans' growth. The effect is also statistically significant at the 10% level, but this is true only for the fixed effects model. Nevertheless, this result suggests the effectiveness of the macroprudential policy, especially of the countercyclical capital buffer. As we demonstrated in the Methodology section, all of the countries deflated the buffer to some extent. At the same time, the result of the regression suggests that the buffer can influence the growth of the gross loans as well as that there was an increase in this variable during the Covid pandemic. This all together indicates that the deflation of the buffer could boost the lending and thus reduce the traditional procyclicality of the lending.

The fixed effects model also suggests there is a positive effect of the GDP growth on the growth of the gross loans. According to a model the rise of the GDP by one percentage point is associated with the rise of the gross loans by 0,11 percentage points. This effect is statistically significant at the 10% level only according to the fixed effects model. The coefficient is not that substantial considering the mean value of the gross loans variable which also supports our finding regarding the reduction of the procyclicality.

Following the results we can conclude a relatively substantial negative effect of the unemployment growth on the growth of the loans. When we consider a change in the unemployment rate from 3% to 6% we are talking about an increase in unemployment by 100% which is associated with the decrease of the gross loans growth by 4,37 and 4,71 percentage points respectively. The effect is found to be statistically significant at the 10% level according to both models.

Both models also indicate the negative effect of the rise of the regulatory capital on the gross loans' growth. According to them the increase in the regulatory capital by one percentage point is associated with the decrease in the loan growth by roughly 0,08 and 0,09 percentage points, which is not a very substantial decrease. The results are also statistically significant at a 5% level of significance according to both models.

Finally, the last variable to discuss is the variable for the percentage change of the house prices. The models suggest that the increase in the house prices by the one percentage point is associated with the decrease in the gross loans' growth by 0,19 and 0,21 percentage points respectively. The coefficient is statistically significant at the 10% level and 5% level respectively in pooled OLS model and fixed effects model. The reason for this unintuitive result can be that banks are becoming more cautious during the time of asset price booms. It can also be influenced by the accommodation of the countercyclical capital buffer, which we proved to be efficient in reducing the loans growth. As the countercyclical capital buffer is being accumulated during the boom of the cycle when the house prices usually tend to grow, the accumulation can cause the reduction of the loans' growth even though the house prices are growing.

5.3 Macroprudential policy and house prices' growth

The aim of the last model we estimate is to examine the effects of the macroprudential tools on the growth of house prices. As the macroprudential policy seems to be effective in influencing the loans' growth it could also possibly affect the development of the house prices through the credit regulation which could potentially influence the demand for the housing and eventually its price. The pooled OLS model specification goes as follows:

$$House\ prices_t = \alpha_0 + \beta_1 CCyB_{t-8} + \beta_2 LTV_t + \beta_3 LTV_{tightening1_t} + \beta_4 LTV_{tightening2_t} + \beta_5 Crisis_t + \beta_6 Covid_t + \beta_7 GDP_t + \beta_8 Longterm\ interest\ rate_t + \beta_9 Unemployment_t + \beta_{10} Regulatory\ capital_t + \beta_{11} Household\ debt_t + \epsilon$$

The specification for the fixed effects model goes as follows:

$$House\ prices_t = \alpha_0 + \beta_1 CCyB_{t-8} + \beta_2 LTV_t + \beta_3 LTV_{tightening1_t} + \beta_4 LTV_{tightening2_t} + \beta_5 Crisis_t + \beta_6 Covid_t + \beta_7 GDP_t + \beta_8 Longterm\ interest\ rate_t + \beta_9 Unemployment_t + \beta_{10} Regulatory\ capital_t + \beta_{11} Household\ debt_t + \delta + \gamma + \omega + \epsilon$$

The results of the regressions are presented in Table 5.

RESULTS OF THE REGRESSIONS FOR THE THIRD SPECIFICATION

DEPENDENT VARIABLE:				**House prices**
	Pooled OLS		**Fixed effects**	
INDEPENDENT VARIABLES:	**Coefficient**	**P-value**	**Coefficient**	**P-value**
CONSTANT	***1,2157	0,0000	***2,0034	0,0000
CCYB(8)	-0,3275	0,1236	**-0,6522	0,0162
LTV	**0,5840	0,0191	-0,3240	0,4352
LTV TIGHTENING1	-0,1667	0,5744	0,0737	0,8412
LTV TIGHTENING2	0,6513	0,1894	0,9031	0,1176
CRISIS	**-2,2270	0,0137	*-1,78034	0,0501
COVID	***1,1765	0,0005	***1,2741	0,0003
GDP	**0,0925	0,0121	***0,0851	0,0207
LONGTERM INTEREST RATE	***-0,2959	0,0000	***-0,4373	0,0000
UNEMPLOYMENT	***-0,0710	0,0000	***-0,0748	0,0000
REGULATORY CAPITAL	0,0050	0,7873	0,0079	0,6678
HOUSEHOLD DEBT	-0,0057	0,7545	-0,0039	0,8297
R-SQUARED	0,3553		0,3968	
NO. OF OBSERVATIONS	337		337	

*Table 5 The results of the third regression. Source: own processed. Note: Signs */**/*** denote the statistical significance on the conventional levels 10%/5%/1%.*

The positive and significant coefficient of the constant in both models implies that the percentage change of the house prices is on average positive, which means there is an ascending trend in the development of the house prices. The same conclusion can be made after looking at Figure 7 where we can see the clean ascending trend of the house prices in the observed countries. The prolonged period of the house prices growth can be beneficial for the homeowners as their assets are increasing in value but can be also a serious threat to the stability of the economy. It was during the Great Financial Crisis when the bust of the property prices caused serious financial panic all over the world, even though it was not only the property market where the imbalances were built. For this

reason, there is a need for a tool for policymakers that could prevent the building of such imbalances and mitigate the risk arising from the property market.

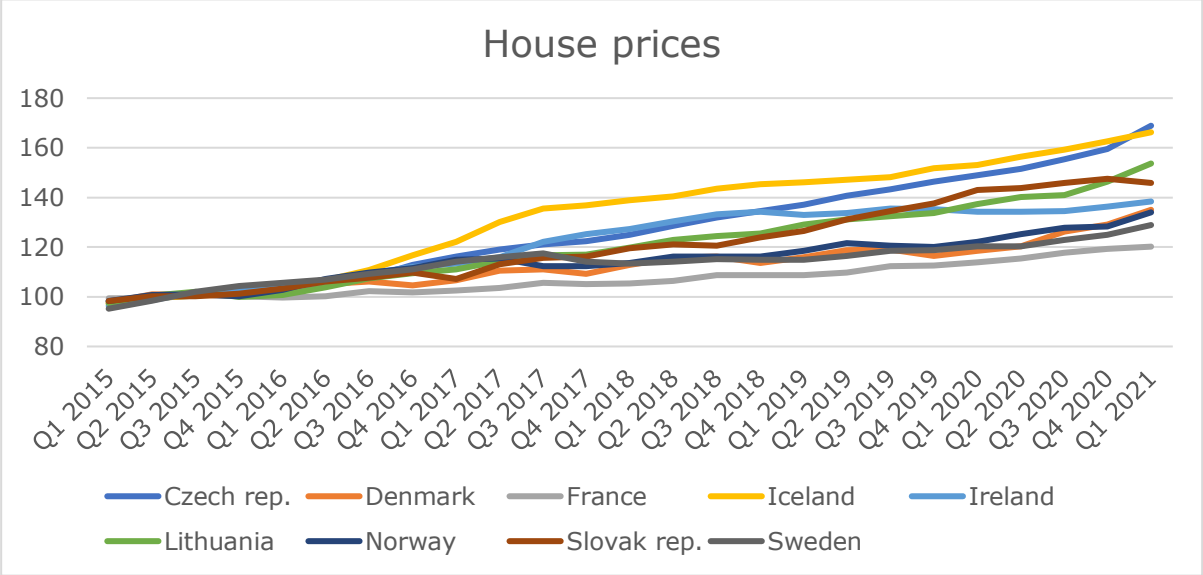

Figure 7 House prices development index in observed countries during the period Q1:2015 - Q1:2021. Source: own processed based on OECD's data.

The countercyclical capital buffer could be such a tool. Following the regressions' results, the fixed effects model suggests that the increase in the countercyclical capital buffer by one percentage point is associated with the decrease in the house prices growth by 0,65 percentage points while this result is statistically significant on the 5% level of the significance. Considering the mean for the house price growth variable, which takes a value of 1,17 we can find the effect of the buffer to be substantial as its accumulation can slow down the prices' growth by more than a half. On the other hand, for the effect to reach this extent it takes 8 quarters.

Interesting is the effect of the LTV cap. The pooled OLS model suggests that the adoption of the LTV cap results in the increase of the house prices by roughly 0,60 percentage points which is a relatively substantial effect. The explanation for this may be found in the results of previous models. We have found that the adoption of LTV positively influences the loans' growth, likely due to better prospects for borrowers to repay the debt. The consequence of the higher loans' growth can be the higher house prices' growth, which the model suggested. As well as according to the previous regressions, additional tightening of the LTV cap does not seem to affect the house prices as the coefficients do not come statistically significant on any of the conventional levels.

The effects of the crisis are completely different according to the results. While during the Great Financial Crisis the house prices declined on average by 2,23 or 1,78 percentage points depending on the model deployed (both coefficients statistically significant at 5% level and 10% level), during the Covid crisis the house prices increased on average by 1,18 and 1,27 percentage points respectively (coefficients are significant on

the 1% level). The reason for this can be found also in the previous regressions. The previous results suggested that the macroprudential tools are effective in controlling the credit growth and supporting the lending even during the economic downturn. The deflation of the countercyclical capital buffer to support the lending could then result in an increase in the house prices as the demand for the houses during the covid did not decrease.

Following the results of the regressions we can also see the positive effect of the GDP growth on house prices, which is in line with our expectations, as the asset prices usually increase during the periods of economic growth. According to the models the growth of the GDP by one percentage point is associated with the increase of the house prices by roughly 0,09 percentage points and this result is statistically significant according to both models at 5% and 1% levels respectively. In the terms of the coefficient size the effect seems to be not very substantial.

On the other hand, the effects of the long term interest rate as well as the unemployment rate are both negative as expected. According to the regressions the increase by the one percentage point of the long term interest rate is associated with the decrease of the house prices by around 0,4 percentage points. The result is logical as many homeowners need to take a mortgage before buying the property, so the changes in the interest rates can influence the demand for the properties as well as their prices. Its effect is relatively substantial but the effect of the unemployment increase is bigger. As we mentioned before, it is reasonable to think about the change of 100% due to variable transformation to assess the size of the effect. Following this the increase in unemployment would result in the decrease of the house prices growth by around 7 to 7,5 percentage points which is really substantial considering the mean value of the house prices growth that is 1,17. In both cases, coefficients for long term interest rate and unemployment rate are significant at a 1% level.

Finally, changes in the household debt as well as the changes in the regulatory capital are not found to be statistically significant by any of the models deployed on any of the conventional levels.

5.4 Robustness test

To check the credibility of the results of the regressions we conduct the robustness test. To perform the test we split the sample randomly by the countries in the ratio of 5:4 as the number of the observed countries is 9. In the first subsample group there are included the following countries: Czech Republic, Denmark, Iceland, Norway and Slovak Republic. In the second subsample there are included the following countries: France, Ireland, Lithuania and Sweden. The test aims to consider the stability of the coefficient over the different samples.

TEST REGRESSIONS RESULTS

FIRST SPECIFICATION						
Dependent variable:						**NPL**
	Pooled OLS			**Fixed effects**		
	Baseline	**1. sub-sample**	**2. sub-sample**	**Baseline**	**1. sub-sample**	**2. sub-sample**
LTV	-2,8847	-0,3337	-4,5077	-0,6235	-1,1711	-3,6940
Crisis	13,6451	11,1006	25,7264	12,9178	10,9779	25,6089
Covid	2,3190	2,0101	2,7558	3,9156	2,0819	4,3664
GDP	-0,5442	-0,7027	-0,3953	-0,5000	-0,6840	-0,3895
Longterm interest rate	1,0638	0,0136	0,6830	1,6390	-0,3438	0,8333
Unemployment	0,1981	0,1167	0,2401	0,1835	0,1322	0,2250
SECOND SPECIFICATION						
Dependent variable:						**Loans**
	Pooled OLS			**Fixed effects**		
	Baseline	**1. sub-sample**	**2. sub-sample**	**Baseline**	**1. sub-sample**	**2. sub-sample**
CCyB(8)	-0,5965	-0,2148	-0,8548	-1,0358	-0,3910	-1,2463
LTV	0,9968	0,6921	1,4707	0,0365	0,3573	-0,1328
Covid	0,6916	0,9238	0,4084	0,9757	1,0537	0,4760
GDP	0,0637	0,0691	0,0396	0,1079	0,0720	0,1136
Longterm interest rate	-0,4128	0,0572	-0,8618	-0,4625	-0,0334	-0,5503
Unemployment	-0,0437	-0,0529	-0,0255	-0,0471	-0,0547	-0,0454
Regulatory capital	-0,0853	-0,1921	-0,0187	-0,0892	-0,1893	-0,0184
House prices	-0,1870	-0,2034	-0,3313	-0,2131	-0,2030	-0,2460
THIRD SPECIFICATION						
Dependent variable:						**House prices**
	Pooled OLS			**Fixed effects**		
	Baseline	**1. sub-sample**	**2. sub-sample**	**Baseline**	**1. sub-sample**	**2. sub-sample**
CCyB(8)	-0,3275	-0,6057	-0,2887	-0,6522	-0,8844	-0,7725
LTV	0,5840	0,9595	0,3530	-0,3240	0,5389	-2,0497
Crisis	-2,2270	-1,0110	-4,0705	-1,7803	-0,8104	-1,5880
Covid	1,1765	1,9738	0,8258	1,2741	1,9762	0,8430
GDP	0,0925	0,0744	0,1012	0,0851	0,0649	0,0922
Longterm interest rate	-0,2959	-0,0845	-0,2585	-0,4373	-0,1855	-0,6472
Unemployment	-0,0710	-0,0387	-0,0942	-0,0748	-0,0422	-0,0967

Table 6 Results of the test regressions. Source: own processed.

The results of the partial regressions are presented in Table 6. To make the table easier to read we included only the variables that come significant on any value of significance in the baseline regressions. As we can see in Table 6, the coefficients are mostly stable speaking of their signs or direction of the effect respectively. From this point of view we can conclude that the results are mostly credible and resilient to the change of the subsample. The most pronounced exception from this is the effect of the LTV cap that appears to be inconsistent when the second and the third specification of the model is deployed. The reason for this can be the different use of the LTV by the different countries while our models only recognize the adoption of the LTV. While one country can adopt the LTV on a relatively tight level, another can adopt it on a looser level so the effect can be less pronounced. That is why there can arise certain discrepancies in the coefficient depending on the subsample or countries included in the regression. For this reason, it requires a certain caution in interpreting its effects.

We can also observe a certain degree of variability in the size of the coefficients in Table 6. The dummy variable for crisis is relatively varying in its size where the coefficient takes value from 10,98 to 25,73 for the first specification and from -0,81 to -4,07 for the second specification. This suggests the effect of the crisis on different dependent variables varies from country to country. A similar can be observed also for the Covid crisis, while in this case the differences are not that pronounced. We can also notice the relatively variable effect of the countercyclical capital buffer. The size of the coefficient fluctuates from -0,21 to -1,25 for the second specification and from -0,29 to -0,88 for the third specification. This suggests the effect of the countercyclical capital buffer differs from country to country especially in constraining the credit growth, where the coefficient changes relatively a lot.

To avoid the problem of the excessive correlation we mostly use percentage changes of the variables where possible to ensure the stability of the coefficients and the credibility of the model. According to Table 6 this approach seems to be working. We also constructed the Correlation matrix, which is presented in Table 7. Following the matrix we can see that most of the variables used in regressions are not heavily correlated with each other where in many cases the correlation coefficient takes the value which is equal to or less than 0,10 in absolute numbers. There are only a few coefficients taking higher values while the highest coefficient of correlation takes the value of 0,50, which is still acceptable.

CORRELATION MATRIX

CCYB	Covid	Crisis	GDP	House prices	Household debt	Loans	Longterm interest rate	LTV	LTV tightening1	LTV tightening2	NPL	Regulatory capital	Unemployment	
1,00	0,11	-0,17	-0,04	0,06	-0,04	0,10	-0,33	0,47	0,46	0,37	-0,07	-0,07	0,03	**CCYB**
	1,00	-0,13	0,00	0,18	0,01	0,08	-0,34	0,23	0,29	0,26	0,00	-0,05	0,16	**Covid**
		1,00	-0,12	-0,25	0,07	-0,09	0,47	-0,31	-0,16	-0,08	0,40	0,11	0,32	**Crisis**
			1,00	0,28	-0,13	0,06	-0,13	0,09	0,04	0,01	-0,26	0,03	-0,22	**GDP**
				1,00	-0,01	0,05	-0,43	0,22	0,14	0,07	-0,26	-0,07	-0,34	**House prices**
					1,00	0,01	0,05	-0,06	-0,03	0,00	0,04	-0,05	0,04	**Household debt**
						1,00	-0,25	0,18	0,10	-0,01	-0,35	-0,10	-0,08	**Loans**
							1,00	-0,43	-0,28	-0,08	0,37	0,14	0,20	**Longterm interest rate**
								1,00	0,50	0,25	-0,24	-0,02	-0,05	**LTV**
									1,00	0,50	-0,11	-0,05	-0,04	**LTV tightening1**
										1,00	0,02	-0,03	0,09	**LTV tightening2**
											1,00	0,08	0,29	**NPL**
												1,00	0,07	**Regulatory capital**
													1,00	**Unemployment**

Table 7 Correlation matrix. Source: own processed. Note that variable Loans are winsorized on the 5th and 95th percentile.

6 Discussion

To reach a reasonable conclusion, our findings presented in the part Results and findings should not be considered as stand-alone but it is more appropriate to assess them in accordance with our other findings and the findings of the other authors.

We found that on average the increase in the non-performing loans during the Covid crisis was tamer than during the Great Financial Crisis. Even though the size of the coefficients varies depending on the countries included in the regression, the difference is still substantial with the same result, which is also supported by Figure 4. What is more, we discovered a negative and statistically significant effect of the adoption of the LTV cap on the growth of non-performing loans. Although it was mentioned in the previous section that the coefficient is not very stable and should be interpreted cautiously, it does not apply to this specification of the regression where the coefficient is fairly stable in the case of the direction (see Table 6). As most of the countries applied LTV before the crisis hit and as the regressions suggest that the LTV cap is effective in reducing the growth of non-performing loans, it seems that a lower increase of the non-performing loans during the Covid crisis in comparison with the Great Financial Crisis can be associated with the adoption of the LTV cap in previous periods. This conclusion is logical since we found that adoption of the LTV cap increases the resilience of the borrowers, which is also supported by the findings of the other authors (Gross and García 2016, Ampudia et al. 2021a, Gholipour and Arjomandi 2021). This suggests that macroprudential policy is effective in preventing financial distress and in smoothening the cycle.

The argument for the smoothening of the cycle is also supported by the results of the regressions that were run using the second specification. We found that the effect of the countercyclical capital buffer on loans growth is substantial and statistically significant in both models deployed. According to Table 4 the increase in the countercyclical capital buffer can constrain the growth of the loans with a delay of 8 quarters. The coefficient is stable regarding the direction of the effect as was proved by the partial regressions. On the other hand, the intensity of the effect can differ from country to country. We also discovered that on average the amount of the loans grew during the Covid crisis, while this period also coincides with the full or partial release of the buffers accommodated before the crisis, which is supported by Figure 2. These findings indicate that a countercyclical capital buffer is an effective tool in regulating the credit cycle, which is also supported by the other authors (Drehmann and Gambacorta 2012, Akinci and Olmstead-Rumsey 2015, Vandenbussche et al. 2015, Gambacorta and Murcia 2019, Alam et al. 2019, Borsuk et al. 2020, Ampudia et al 2021a). What is more, as we use linear model specification, it is reasonable to expect the same effect as the model ascribed to tightening but in the opposite direction when the buffer is released or deflated to a certain level. It suggests that the release of the buffer likely supported the increase of the loans, which proves this

tool to be effective. This result is backed by previous studies as well (Chen et al. 2019, Borsuk et al. 2020, Lewrick et al. 2020)

Using this model specification we found a positive effect of the adoption of the LTV cap on loans growth. This effect came statistically significant in one of the models. However, as we used partial regressions to examine the stability of the coefficients we concluded that the coefficient changes its direction depending on the subsample and also the value of the coefficient varies greatly. Following the results this finding seems to be inappropriate.

Thanks to the third model specification we observed that the increase in the countercyclical capital buffer is able to lower the house prices with a delay of 8 quarters. The coefficient is stable speaking of its direction and relatively stable considering its value. This finding is also supported by the other authors, that found the macroprudential policy to be effective in reducing the house prices growth (Kuttner and Shim 2012, Akinci and Olmstead-Rumsey 2015, Vandenbussche et al. 2015, Poghosyan 2020). On the other hand, using this specification we found an LTV cap to effectively support the rise in the prices. We argued in the results section of the second model, which suggested that LTV cap adoption boosts the lending, so it can also boost the house prices via this channel. However, there is a lack of evidence in the partial regressions for this conclusion. The coefficient is not stable regarding its direction and the value differs greatly so it is reasonable to consider this finding to be inadequate as well.

We also discovered that the house prices increased on average during the Covid crisis while they substantially decreased during the Great Financial Crisis. The coefficients are stable in direction while there are certain differences in their value depending on the subsample. When we consider the previous finding that the regulation of the countercyclical capital buffer appears to be effective in smoothening the credit cycle and that there was an increase in the loans' growth during the Covid crisis, the increase in house prices appears as a logical consequence of that. This conclusion then supports the previous finding that the release of the countercyclical capital buffer can boost additional lending. That enhances the demand and eventually the house prices.

Considering the above-mentioned regressions, they provide us with the evidence that the macroprudential policy is effective in fulfilling its goals. What is more, it seems that macroprudential policy withstood the real-life stress test of the Covid crisis and was able to bring support to the economy by additional lending and enhancing the resilience of the borrowers. Thanks to that the consequences of the Covid crisis appears to be materially less severe in comparison with the Great Financial Crisis. These findings are also supported by some authors (Borsuk et al. 2020, Lewrick et al. 2020, Gholipour and Arjomandi 2021).

On the other hand, there can also be some imperfections in our approach that possibly shaped the results and that should be addressed in future works. According to

previous works (McDonald 2015, Kuttner and Shim 2016, Cerutti et al. 2017, Poghosyan 2020), it seems that the effects of the macroprudential policy are unequal, so the non-linear model specification would have been a better choice to explain the effects of macroprudential policy. That also may be the reason why some models that we used suffered from relatively low R-squared (see the second specification results in Table 4). Another problem we faced was the lack and inconsistency of the data so even though we constructed a relatively robust panel across a long time period, the effective number of the observations used in regressions was somewhat lower than desired. In addition, the effect of the Covid crisis may have not been pronounced to its full extent yet as the pandemic still has not come to its end. Finally, there could have also been a better methods of quantifying effects deployed. As we mentioned, it is relatively complicated to evaluate incremental changes in the LTV cap. The same applies to the other macroprudential instruments that could be applied in different countries and played a role in taming the consequences of the crisis as well.

7 Conclusion

In this work we examined the effectiveness of the macroprudential policy and its implications for handling the crisis caused by the spread of Covid-19 in comparison to the Great Financial Crisis. We found that macroprudential tools are effective and that different policy tools affect different issues. We proved that LTV cap is useful in enhancing the soundness of the borrowers and as the consequence we could observe substantially less severe growth of non-performing loans during the Covid crisis in comparison with the Great Financial Crisis. We also found that the countercyclical capital buffer is an effective tool for regulating the supply of the credit for the economy and reducing the cyclicality of the financial sector if used correctly. Finally, our results confirmed that tightening of the countercyclical capital buffer can reduce the growth of the house prices.

All these results indicate that macroprudential policy is effective and that it played its part during the Covid crisis and helped to prevent more serious economic consequences. On the other hand, the results are still relatively preliminary. As there is a certain data unavailability the further research is needed to examine the effects as soon as more data is available. What is more, the pandemic still has not come to its end and a new geopolitical tensions have emerged recently. This puts additional pressure on the policymakers and it is questionable how the macroprudential policy will stand the test of prolonged uncertainty. In addition, our research focused on selected European countries that are relatively experienced in use of the macroprudential policy. Even in this quite a homogenous sample we could observe substantial differences of the policy effects. That raises the question of how effective the macroprudential policy is according to a broader based sample. In this context further research is needed to deliver more sound arguments.

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