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The Impact of Macroprudential Policy on Credit Growth in Nine Euro Area Economies*

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Abstract

In this paper, we investigate the impact of macroprudential policy measures (bundled together into a macroprudential policy index, MPI) on the non-financial corporate sector credit and household credit growth using a one-step system GMM empirical research method. The goal of our paper is to test whether contractionary macroprudential policy stymies credit growth rate and whether expansionary macroprudential policy spurs credit growth rate in selected Euro Area economies (Austria, Belgium, Finland, Germany, Ireland, Italy, Netherlands, Slovenia, and Spain) over the period 2008Q4–2018Q4. We test two hypotheses: H1: The tightening of macroprudential policy measures reduces the non-financial corporate sector credit growth rate, and H2: The tightening of macroprudential policy measures reduces the growth rate of household credit. Based on our empirical results, we can confirm the first hypothesis. In contrast, the second hypothesis can be neither confirmed nor rejected since the explanatory variable of interest (MPI) is statistically insignificant in the second model.

Introduction

Banks' significant losses during the 2007–2008 subprime crisis called into question banks' risk-taking behavior. Lehman Brothers' default pointed out that financial stability has a macroprudential or systemic dimension (Matysek-Jędrych, 2018). If the financial system is treated simply as the sum of its parts, its historical tendency to transition between booms and busts can be overlooked (Beck & Gambacorta, 2020). Before the emergence of the crisis, banks were involved in exuberant risk-taking activities (Luu & Vo, 2021) and excessive lending to borrowers with dubious creditworthiness, which led to credit and asset price booms, a banking crisis, and a surge in non-performing loans (Festić & Romih, 2008). In the fallout of the crisis, policymakers and academics recognized that more effective macroprudential policies and regulatory actions are required to reduce excessive optimism of economic agents, stem moral hazard behavior, and prevent banks from unrestrained risk-taking (Luu & Vo, 2021). The "Greenspan doctrine" (Greenspan, 2002,

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2011), advocating the view that it was preferable to inject liquidity into the financial system after a final crisis had occurred, has ended. The ex-ante policy interventions are no longer seen as too costly, blunt, or unpredictable in their effects (Jeanne & Korinek, 2020). In this paper, we investigate the impact of macroprudential policy measures (bundled together into a macroprudential policy index, MPI) on the growth rate of loans extended by banks to non-financial institutions and households respectively. The objective of our paper is to establish whether contractionary macroprudential policy stymies credit growth rate and whether expansionary macroprudential policy spurs credit growth rate in selected Euro Area economies (Austria, Belgium, Finland, Germany, Ireland, Italy, Netherlands, Slovenia, and Spain) over the period 2008Q4 to 2018Q4.

The first time the term "macroprudential" was used in an official report was in 1986 when the Cross Report was published (BIS, 1986; Bini Smaghi, 2009; Maes, 2010). In the Cross Report, the goal of the macro-prudential policy was defined as "the safety and soundness of broad financial system and payments mechanism". The seminal papers by BIS economists which defined the concept of macroprudential policy are Borio (2003), Borio and White (2004), and White (2006). That said, while macroprudential tools may not have been actively used since the early 1990s, they were frequently used and were an integral part of the policy toolkit of the Federal Reserve and of the other authorities in the United States between the First World War and the early 1990s (Elliott, Feldberg & Lehnert, 2013; Borio, 2011; ECB, 2020, Galati & Moessner, 2011). They were only not named "macroprudential". Examples of such macroprudential tools used in the US are underwriting standards, stock margin requirements, selective credit controls on portfolios, reserve requirements, interest rate ceilings, capital requirements, supervisory guidance, and "direct pressure" etc. (Elliott, Feldberg & Lehnert, 2013). Nowadays, macroprudential policy is defined as "the use of primarily prudential tools to limit systemic risk – the risk of disruptions to the provision of financial services that is caused by an impairment of all or parts of the financial system, and can cause serious negative consequences for the real economy" (IMF, 2013).

Ben Bernanke, a former Federal Reserve Chairman, in 2008 acknowledged the need for macroprudential regulation by asserting: "Going forward, a critical question for regulators and supervisors is what their appropriate "field of vision" should be. Under our current system of safety-and-soundness regulation, supervisors often focus on the financial conditions of individual institutions in isolation. An alternative approach, which has been called systemwide or macroprudential oversight, would broaden the mandate of regulators and supervisors to encompass consideration of potential systemic risks and weaknesses as well" (Bernanke, 2008). Similarly, Andrew Crockett, a former general manager of the BIS, championed the push for macroprudential regulation with the following statement: "Strengthening the macro-prudential orientation of the regulatory and supervisory framework is important because of the costs and nature of financial instability. The main costs take the form of output losses. The nature of the processes generating instability puts a premium on a macro-prudential conception of economic behavior (Crockett, 2012)."

It strives to ensure that the financial system does not magnify a downturn in the real economy – for instance, by financial institutions having to reduce the supply of credit in a stressful situation (Aikman et al., 2019). The ultimate target of macroprudential policy is not to eliminate recessions altogether but rather to prevent the financial system from creating shocks that set off recessions and from magnifying shocks that make recessions worse (Aikman et al., 2019; ECB, 2020; Claessens, 2014). The key is the preventive, ex-ante reaction to the build-up of systemic risk. For instance, Laidroo and Männasoo (2014) demonstrate that regulatory and supervisory authorities should monitor credit lines for timely recognition of periods in which banks overextend credit.

Systemic crises come about as a result of the build-up of financial imbalances (mostly leveraged booms) in the financial sector, which is why the ex-ante prevention of immoderate risk-taking is a key objective of macroprudential policy (Peydró, 2016). The macroprudential policy takes the edge off the credit supply cycles, which positively affects the real economy during a crisis (Peydró, 2016). While financial stability is the first and foremost goal of macroprudential policy, its intermediate target is the correction of externalities (e.g. excessive house price appreciation and credit growth) and the mitigation of market failures and imperfections which generate systemic risk even when microprudential supervision and monetary policy are conducted effectively (Claessens, 2014). First, the causes of systemic risk need to be identified, and, they need to be corrected by specific macroprudential tools and instruments. In our paper, the intermediate target of macroprudential policy measures implemented by individual Euro Area economies (bundled into a macroprudential policy index) is credit growth (the growth rate of loans extended by banks to non-financial institutions and households).

Even in 2014, more than seven years after the crisis, the meaning of the term "macroprudential regulation" was obscure (Barwell, 2013), and its effectiveness was debated (Galati & Moessner, 2014). There has been a spike in empirical and theoretical studies on macroprudential policy and macroprudential regulation in the past few years. Since 2008, the term "macroprudential" in speeches by central bankers has surged along with academic research on this topic (Galati & Moessner, 2011). Nonetheless, there is still insufficient agreement on what constitutes a macroprudential policy framework, which contrasts with a monetary policy framework where there is a clear consensus on the definition of an inflation-targeting regime (Lombardi & Siklos, 2016). Our paper is a contribution to this field.

This paper is structured as follows: The second section provides an overview of the theoretical background of the empirical analysis. The third section lays down data specification, hypotheses, and methodology. The fourth section sets out empirical results and discusses them. The fifth section concludes.

The paper aimed to test whether expansionary macroprudential policy spurs credit growth and vice versa. We selected the sample of countries on the criteria of compatible database and similar timelines of the impulses of macroprudential policy regarding to the economic cycle.

The implications for macroprudential policy conclude that the same approach in different countries has the same impact on credit growth regarding the economic cycle phase. The limitation of the study is the aggregate approach and general conclusion, which could differentiate between small and systemic important banks.

Theoretical Background

Granular credit registry data to study the impact of macroprudential policies has so far been used in very few cases: Dassatti Camors et al. (2019) investigate the impact of changes in reserve requirements in Uruguay; Jimenez et al. (2017) examine dynamic provisioning in Spain; and Gambacorta and Murcia (2020) use confidential bank-loan data to shed light on the effectiveness of macroprudential policy tools and their interaction with monetary policy (more in Claessens, 2014; Akinci and Olmstead-Rumsey, 2018; Poghosyan, 2020).

Even in the euro area, the effectiveness of various monetary policy and macroprudential policy instruments varies and may or may not be in accordance with country-specific conditions, as demonstrated by Cocriş and Nucu (2014). In our paper, we use aggregate country-level data (as opposed to granular credit registry data) in line with the majority of the existing body of research on the effects of macroprudential policy.

The literature examining the impact of macroprudential policy instruments is vast and versatile (Morgan, Regis & Salike, 2019). In general, we can identify three strands of literature: The first strand is the empirical research employing cross-country macro data and assessing the impact of various macroprudential policy instruments on the housing market, the credit cycle, or some other indicator of financial stability (ibid., 2019). The second set is the case studies of countries using micro-level data and investigating the effect of one or more macroprudential policy instruments on financial stability (ibid., 2019). The third group of studies, which is the most recent one, employs both macro- and micro-level data to estimate the impact of country-specific macroprudential policy instruments on financial stability (ibid., 2019). This type of literature draws on the data retrieved from many banks headquartered in different countries, which gives an insight into how changes in macroprudential policy affect other countries and groups of banks (ibid., 2019).

Some studies assess the impact of macroprudential policy instruments on financial variables such as asset prices, credit, and economic imbalances in the economy (e.g., Akinci & Olmstead-Rumsey, 2018; Cerutti, Dagher & Dell'Ariccia, 2015; Lim et al., 2011), whereas others focus on the impact of macroprudential policy instruments on macroeconomic variables traditionally targeted by monetary policy – inflation and output (e.g., Richter et al., 2019; Kim & Mehrotra, 2017). Most studies construct dummy indices that are based on the dates of policy actions (Lim et al., 2011; Shim et al., 2013; Cerutti, Claessens & Laeven 2017; Cerutti, Correa, Fiorentino & Segalla, 2017; Akinci & Olmstead-Rumsey, 2018). The dummy indices signal a tightening or a loosening of the macroprudential policy stance but do not reflect the intensity of changes in macroprudential policy instruments (Kim & Oh, 2020). Some relatively recent studies incorporate the power of macroprudential policy actions. For example, Alam et al. (2019) and Richter et al. (2019) created a loan-to-value (LTV) index reflecting the intensity of changes in the LTV cap. Vandenbussche et al. (2015) designed dummy indices of policy measures that incorporate the changes' intensity.

Recent empirical results indicate that debt-to-income and loan-to-value caps are more effective than capital requirements for limiting credit growth (Claessens et al., 2013; Basten & Koch, 2015; Drehmann & Gambacorta, 2012). Another strand of literature (e.g. Jakubik & Hermanek, 2008) investigates the impact of macroprudential policy

instruments on financial stability by constructing stress scenarios and presenting stress test results (more in Altunbas, Binici & Gambacorta, 2017).

Macroprudential policy instruments seem to be effective in mitigating the sensitivity of leverage and credit to the business cycle – i.e. the procyclicality of leverage and credit growth (Lim et al., 2011; Galati & Moessner, 2014; Claessens, 2013). Macroprudential tools appear to be effective also in restraining asset growth, leverage, and credit growth (Vandenbussche et al., 2015; Alper et al., 2014; Cerutti, Claessens & Laeven, 2017; Claessens, Ghosh & Mihet, 2013; Olszak, Roszkowska & Kowalska, 2018).

The empirical evaluation of the effectiveness of macroprudential policies is complicated for several reasons (Poghosyan, 2020): Insufficient number of macroprudential policy measures; intensity of measures; and endogeneity. These possible problems could potentially make our empirical assessment more complex and intricate.

Insufficient number of macroprudential policy measures: Certain macroprudential policy measures (such as liquidity coverage ratio, net stable funding ratio, and leverage ratio) have been enacted only 3-5 years ago (or even more recently or are obligatory only since end-June 2021 onwards) and in a limited number of countries, which may make the number of observations for the empirical assessment insufficient. Furthermore, it is difficult to estimate the dynamic effects of measures which came into force only recently because the number of observations on the target variable after the implementation of the measures is not yet sufficient (Poghosyan, 2020).

Intensity of measures: It is difficult to quantify the intensity of macroprudential policy measures. For example, an increase in the annual amortization requirement by 1% and a decrease in the loan-to-value (LTV) ratio by 5% indicate macroprudential tightening; however, it is difficult to say which of the two instruments is more stringent. Many researchers thus rely on categorical variables to differentiate between tightening and loosening calibration of macroprudential policy instruments (ibid., 2020). Carreras, Davis, and Piggott (2018) findings suggest that macroprudential policy instruments positively impact stalling household credit growth and house prices in both the short and long run.

Endogeneity: The problem of reverse causality exists between macroprudential policy instruments and the target variables since the former are usually calibrated in response to a change in the latter. For example, in periods of rising house prices macroprudential policy will usually be tightened, leading to a positive correlation between the macroprudential policy variables and the residual (Vandenbussche et el., 2015). This can cause the coefficient of the macroprudential variable to be biased upwards. Hence, the estimated coefficients of macroprudential variables are usually given as lower bounds. If the regression coefficient of the macroprudential variable is insignificant and/or does not have the right sign, this can be a result of the upward bias. As a consequence, the estimation can be uncertain. Conversely, if the regression coefficient of the macroprudential variable has the right sign and is significant, the lower bound of the estimate is substantial, hence macroprudential policy can be characterized as effective. Many researchers resort to using the generalized method of movement (GMM) as the econometric method of choice for estimating parameters in statistical models (Poghosyan, 2020). In our paper, we employ the one-step GMM (dynamic panel-data estimation) empirical research method to avoid the problem of endogeneity.

Similarly, Olszak, Roszkowska and Kowalska (2019) investigate if macroprudential policies dampen the procyclical impact of capital ratios on bank lending in a sample of sixty-five countries. Of the investigated macroprudential instruments, only borrower-based measures such as LTV and DTI caps seem to countercyclically by weakening the positive impact of capital ratio on bank lending, particularly in crisis periods.

Along the same lines, Arregui et al. (2013) develop an analytical framework for estimating macroprudential policies' costs, benefits, and unintended consequences. They propose a measure of net benefits of implementing macroprudential policy, composed of the probability of a crisis, the loss of output in a crisis, the ability of policy to reduce the likelihood and damage during a crisis, and the output costs of a certain policy decision. They also describe the unintended consequences of certain policies and identify instruments that could minimize such leakages. The macroprudential policy measures which authors identify as the most effective for stemming house price appreciation and credit growth are reserve requirements, higher risk weights on capital, and LTV limits. Loan loss provisioning policies do not seem to substantially affect house prices and credit.

Comparably, Ma (2020) analyzes the trade-off between growth and financial stability as a consequence of macroprudential policy implementation. This is done by examining the effect of optimal macroprudential policy in a small open economy on growth and welfare (annual consumption). Macroprudential policy substantially strengthens financial stability (it reduces the frequency and probability of crises) at the cost of a very small negative effect on average growth and welfare.

In the same vein, Akinci and Olmstead-Rumsey (2018) examine the effectiveness of macroprudential policies in limiting credit

growth and house price growth by using a dynamic panel data model for 57 economies from 2000 to 2013. To this end, the authors develop new indices for seven macroprudential tools (LTV limits, DSTI limits, other housing measures, time-varying capital requirements, provision requirements, consumer loan limits, and credit growth ceilings). Counterfactual simulations indicate that, if the countries had not used any macroprudential policy measures in 2011–2013, the bank credit growth, housing credit growth, and house price appreciation would have been substantially higher.

Similarly, Meuleman and Vander Vennet (2020) examine the effectiveness of macroprudential policy in mitigating the systemic risk of banks in Europe from 2000–2017. The systemic risk measure is decomposed into individual bank risk and systemic risk. This is crucial for the differentiation between microprudential and macroprudential policy effects. The macroprudential policy instruments seem to reduce individual bank risks and bank systemic risk, as assessed by stock market investors.

Comparably, Altunbas, Binici, and Gambacorta (2017) shed light on the impact of macroprudential policies on bank risk by drawing on data from 61 countries over the time span 1990–2012. Small, weakly capitalized banks and banks having a high share of wholesale funding respond more strongly to changes in macroprudential policy tools. Macroprudential policies are more efficient when employed during a downturn than during a boom.

Along the same lines, Zakaria and Fatine (2017) analyze macroprudential policy instruments and empirically show that these instruments should be deployed only in particular macroeconomic circumstances and with a certain risk profile of financial institutions. The variables to be considered when taking macroprudential policy decisions are the output gap (which depicts economic cycle), the Z-score, liquidity ratios, and changes in bank profitability. The use of macroprudential instruments mitigates the build-up of systemic risk in the financial system and positively affects its resilience. This notwithstanding, the use of financial instruments should be temporary so as not to lead to negative externalities.

Similarly, Cizel, Frost, Houben and Wierts (2019) investigate whether implementing macroprudential policy leads to substituting bank credit with non-bank credit. However, the results vary across methodologies and samples. On the one hand, it could be claimed that the substitution effect leads to the propagation of new systemic risks. On the other hand, it could be asserted that the substitution effect reduces systemic risks since non-bank financial institutions are, by and large, less leveraged and with lower liquidity risks than the banks.

Another comparable study is that of Bambulović and Valdec (2020) who investigate the impact of macroprudential policy measures on foreign and domestic banks' lending in Croatia over a 19-year period split into the period before the 2008 financial crisis and after it. The study concludes that macroprudential policies were relatively successful in containing credit growth and constraining the build-up of risks for banks in foreign ownership. The macroprudential policy measures were more effective during the pre-crisis period than during the crisis period. The direction of the measure implementation (tightening or loosening) does not result in an impact of the same magnitude. This resulted in an increase in lending activity in sectors other than the banking sector. Consequently, the private sector's indebtedness markedly increased. As such, one of the paper's conclusions is that policymakers should consider both the supply and the demand side of the borrowing and lending process. Furthermore, banks anticipated the introduction of macroprudential policy measures and increased their lending activities shortly beforehand, which underscores their procyclical behavior. Tighter macroprudential policy in the home countries of banks under foreign ownership had a negative impact on the lending of those banks in Croatia, which underlines regulatory spillover effects. This finding highlights the relevance of aligning policy stances and reciprocity agreements among the EU member states.

Along the same lines, Gambacorta and Murcia (2020) use confidential granular credit registry (bank-loan) data of five Latin American countries (Argentina, Brazil, Colombia, Mexico, and Peru) to investigate the effectiveness of macroprudential policy tools and their interaction with monetary policy. The panel regressions and meta-analysis technique are employed to compare results across countries. The key takeaways from the study are that macroprudential policies have been effective in stabilizing credit cycles and reining in banking sector risk; the policies aimed at restraining the credit cycle are more effective at curbing credit growth than policies aimed at enhancing financial institutions' resilience; and macroprudential policy tools have a more pronounced impact on credit growth when the monetary policy complements them.

In a similar vein, Ely, Tabak, and Teixeira (2021) use a novel identification approach based on the nearest neighbor matching with propensity scores and a system-GMM model to examine how twelve different macroprudential policy instruments impact the risk-taking behavior of banks by drawing on a sample of 16.255 banks in 45 emerging and developed countries and the time period 2000–2014. Empirical results show that instruments that attempt to mitigate vulnerabilities stemming from interconnectedness and contagion of the financial system (e.g., caps on asset

concentration and interbank exposures) reduce leverage, improve the tradeoff between the risk and return, and facilitate bank stability. Likewise, certain borrower-based instruments (e.g., loan-to-value ratio, debt-to-income ratio, and capital surcharges on systemically important banks) decrease leverage and positively impact bank stability. Concentration limits are more effective for bigger and more leveraged banks, whereas loan-to-value and debt-to-income ratios are more efficient in concentrated markets. All structural and borrower-based policies appear less effective for more stable banks. Capital-based policies (e.g. countercyclical capital requirements, capital surcharges for systemically important banks, leverage ratios and dynamic loan-loss provisions) have mixed effects. Asset-based policies (e.g., caps on domestic and foreign currency loans) lead banks to reduce capital, which negatively affects bank stability. The effects of implementing various instruments are heterogeneous and differ depending on banks' size, leverage, liquidity, risk level, and market concentration. The study results support the usage of macroprudential policy instruments in countries with very different market characteristics and institutional environments.

Similarly, Cerutti, Claessens and Laeven (2017) shed light on the usage of macroprudential policy instruments in 119 countries from 2000 to 2013 by drawing on the IMF data. The study results suggest that emerging market economies use macroprudential policy instruments most often – particularly those which influence the foreign exchange rate. Advanced economies seem to rely more on borrower-based policies. The imposition of a macroprudential policy instrument usually leads to a decline in household credit growth. Macroprudential policy effects are weaker in open, financially more developed countries. The implementation of macroprudential policy instruments tends to result in an increase in cross-border borrowing, which points at regulatory arbitrage if other countries do not reciprocate changes in policy instruments. Another empirical finding is that macroprudential policies are more effective during economic upturns and less effective during economic downturns. Overall, the results of the study suggest that macroprudential policies can substantially impact credit growth in the financial system. Furthermore, the effect on credit growth varies across instruments and countries.

Along the same lines, Olszak, Roszkowska and Kowalska (2018) investigate how effective several macroprudential policy instruments are in dampening the procyclicality of loan-loss provisions (LLPs) by drawing on individual bank information from more than 65 countries and by using the two-step GMM Blundell-Bond approach. The study results are three-fold: First, borrower-based macroprudential policy measures are more effective than other macroprudential policy instruments in dampening the procyclicality of loan-loss provisions. Second, macroprudential policy instruments which are likewise effective in reducing the procyclicality of loan-loss provisions are dynamic provisions, large exposure concentration limits and taxes on specific assets. Third, debt-to-income and loan-to-value caps are particularly effective in dampening the procyclicality of loan-loss provisions of large banks. For large banks, taxes and concentrations limits are likewise effective in reducing the procyclicality of loan-loss provisions. Dynamic provisions decrease the procyclicality of loan-loss provisions for banks of all sizes.

Data Specification, Hypotheses, and Methodology

In this paper we use the following data (and variables created based on these data):

- Quarterly growth rate of household credit (source: Statistical Data Warehouse of the European Central Bank, henceforth ECB SDW, 2021);
- Quarterly growth rate of non-financial corporate sector credit (source: ECB SDW, 2021);
- Capital – solvency ratio, calculated as equity capital divided by total assets (source: ECB SDW, 2021);
- GDP growth rate (source: Eurostat, 2021);
- Unemployment rate (source: Eurostat, 2021);
- House price index – quarterly rate of change (source: Eurostat, 2021);
- Size – logarithm of total assets of all banking groups in an economy (source: ECB SDW, 2021);
- y2008 – a dummy variable which takes the value 1 if the year is equal to 2008; and value 0 if the year is different from 2008 (source: Own creation of a dummy variable);
- Crisis – a dummy variable which takes the value 1 if the year is equal to 2008 or 2009; and value 0 if the year is different from 2008 or 2009 (source: Own creation of a dummy variable);
- MPI (macroprudential policy index) – takes the value of -1, 0 or 1. If the sum of macroprudential policy action indicators for 17 macroprudential policy instruments is positive, the MPI index takes the value 1; if the sum is negative, the MPI index takes the value -1; if there are no policy actions in a given quarter or if they offset each other, the MPI index takes the value 0. Each tightening event is coded as a +1, each loosening event is coded as a -1, and no or neutral action is coded as a zero (source:

Integrated Macroprudential Policy (iMaPP) of the International Monetary Fund; henceforth IMF iMaPP, 2021).

MPI (macroprudential policy index) is a sum of loosening and tightening measures of the following 17 macroprudential policy instruments in a particular country in a specific quarter (IMF iMaPP, 2021; Zohair et al., 2019):

- *Countercyclical capital buffer*[1]: Banks must maintain a countercyclical capital buffer. Implementations at 0% are not considered as a tightening in dummy-type indicators.
- *Capital conservation buffer*: Requirements for banks to maintain a capital conservation buffer, including the one established under Basel III.
- *Capital requirements*: Capital requirements for banks, which include risk weights, systemic risk buffers, and minimum capital requirements. Countercyclical capital buffers and capital conservation buffers are captured in their sheets respectively and thus not included here. Subcategories of capital measures are also provided in separate sheets, classifying them into household sector targeted (Capital_HH), corporate sector targeted (Capital_Corp), broad-based (Capital_Gen), and FX-loan targeted (Capital_FX) measures.
- *LVR – leverage limits*: A limit on leverage of banks, calculated by dividing a measure of capital by the bank's non-risk-weighted exposures (e.g., Basel III leverage ratio).
- *LLP – loan loss provisions*: Loan loss provision requirements for macroprudential purposes include dynamic provisioning and sectoral provisions (e.g., housing loans).
- *LCG – limits on credit growth*: Limits on growth or the volume of aggregate credit, the household-sector credit, or the corporate-sector credit by banks, and penalties for high credit growth. Subcategories of limits to credit growth are also provided, classifying them into household sector targeted (LCG_HH), corporate sector targeted (LCG_Corp), and broad-based (Gen) measures.
- *Loan restrictions*: Loan restrictions are more tailored than those captured in "LCG". They include loan limits and prohibitions, which may be conditioned on loan characteristics (e.g., the maturity, the size, the LTV ratio and the type of interest rate of loans), bank characteristics (e.g., mortgage banks), and other factors. Subcategories of loan restrictions are also provided, classifying them into household sector targeted (LoanR_HH), and corporate sector targeted (LoanR_Corp) measures. Restrictions on foreign currency lending are mostly captured in "LFC".
- *LFC – limits on foreign currency*: Limits on foreign currency (FC) lending, and rules or recommendations on FC loans.
- *LTV – limits on the loan-to-value ratio*: Limits to the loan-to-value ratios, including those mostly targeted at housing loans, but also includes those targeted at automobile loans, and commercial real estate loans.
- *DSTI – limits to the debt-service-to-income ratio*: Limits to the debt-service-to-income ratio and the loan-to-income ratio restrict the size of debt services or debt relative to income. They include those targeted at housing loans, consumer loans, and commercial real estate loans.
- *Tax measures*: Taxes and levies applied to specified transactions, assets, or liabilities, which include stamp duties, and capital gain taxes.
- *Liquidity requirements*: Measures taken to mitigate systemic liquidity and funding risks, including minimum requirements for liquidity coverage ratios, liquid asset ratios, net stable funding ratios, core funding ratios and external debt restrictions that do not distinguish currencies.
- *LTD – Limits on the loan-to-deposit ratio*: Limits to the loan-to-deposit (LTD) ratio and penalties for high LTD ratios.
- *LFX – Limits on foreign exchange positions*: Limits on net or gross open foreign exchange (FX) positions, limits on FX exposures and FX funding, and currency mismatch regulations.
- *RR – Reserve requirements*: Reserve requirements (domestic or foreign currency) for macroprudential purposes. Please note that this category may currently include those for monetary policy as distinguishing those for macroprudential or monetary policy purposes is often not clear-cut. A subcategory of reserve requirements is provided for those differentiated by currency (RR_FCD), as they are typically used for macroprudential purposes.
- *SiFi* – Measures taken to mitigate risks from global and domestic systemically important financial institutions (SIFIs), which include capital and liquidity surcharges.
- *Other*: Macroprudential measures not captured in the above categories—e.g., stress testing, restrictions on profit distribution, and structural measures (e.g., limits on exposures between financial institutions).

The data are used for nine Euro Area economies (Austria, Belgium, Finland, Germany, Ireland, Italy, Netherlands,

[1] *Klinger and Teply (2014) demonstrate that sufficient capital buffers are key for safeguarding the stability of the financial system as a whole.*

Slovenia, and Spain) over the time span 2008Q4 to 2018Q4.

We test the following two hypotheses:

H_1: The tightening of macroprudential policy measures reduces non-financial corporate sector credit growth rate.

H_2: The tightening of macroprudential policy measures reduces the growth rate of household credit.

In the first model (to which the first hypothesis applies), two explanatory variables are used: Capital and MPI. The dependent variable is the growth rate of non-financial corporate sector credit (henceforth NFIGR). We assume that Capital will have a positive impact on NFIGR, since banks which are better capitalized are better able to absorb losses (and hence may be able to extend loans to riskier clients); satisfy regulatory capital requirements (and hence do not face any supervisory restrictions for extension of loans) and are overall in a better position to extend loans and expand their scope of business activities. We expect that MPI[2] will have a negative effect on NFIGR, since the tightening of macroprudential policy measures should impose direct and indirect limits on banks' credit activity.

In the second model (to which the second hypothesis applies), three explanatory variables are used: Size, MPI, and Unemployment. The dependent variable is the growth rate of household credit (henceforth HHGR). We postulate that Size (logarithm of total assets of all banking groups in an economy) will have a positive impact on HHGR, since in a bigger banking sector, there should be more interdependencies among banks, the banking sector should be more important relative to other sectors, and the households may be more dependent on banks to satisfy their credit needs. We expect that MPI will have a negative effect on NFIGR, since the tightening of macroprudential policy measures should impose direct and indirect limits on banks' credit activity. We presume that Unemployment will have a negative impact on NFIGR, since a higher unemployment rate indicates that a greater proportion of the population has a lower (or no) income; there is greater uncertainty in the economy; the employed part of the population might be more concerned about losing their job and might therefore be less willing and/or less able to take out a loan (depending on their job security). Table 1 summarizes our expectations concerning the sign of the regression coefficients.

Table 1

Expected signs of regression coefficients

Explanatory variable	Expected sign of regression coefficient
Capital	+
MPI	-
Size	+
Unemployment	-

To test our hypotheses, we use the one-step system generalized method of movements (GMM), an empirical research method used for dynamic panel-data estimation. GMM is a dynamic panel data estimator and a generic method for estimating parameters in statistical models. It uses moment conditions which are functions of the data and the model parameters such that their expectation is equal to 0 at the parameters' true value (Roodman, 2009, 2014; Mileva, 2007). GMM controls for correlation between the explanatory variable and the error term in a model (i.e. for the endogeneity of the lagged dependent variable in a dynamic panel model). Furthermore, it controls for omitted variables bias, unobserved panel heterogeneity, and measurement errors (Roodman, 2009, 2014; Mileva, 2007). Hence, GMM is suitable for use in settings characterized by independent variables which are not strictly exogenous (but are correlated with the error term); arbitrarily distributed fixed effects, heteroscedasticity, and autocorrelation within groups or panels.

In GMM models, the number of groups or cross-sections (N) must exceed the time span (T). Instrumental variables (IV) are used in the model. The instruments (Z) must be exogenous (E(Z^' u)=0). The number of instruments (Z) must be lower than or equal to the number of groups (N). There are two sets of GMM estimators: Difference GMM and system GMM. They were developed by Holtz-Eakin, Newey, and Rosen (1988); Arellano and Bond (1991); Arellano and Bover (1995); and Blundell and Bond (1998).

Difference GMM, proposed by Arellano and Bond (1991), corrects endogeneity in the model by transforming all regressors through differencing and removing fixed effects. However, the disadvantage of the first difference GMM is that it subtracts the previous observation from the current one, thereby increasing the gaps in an unbalanced panel. System GMM, developed by Arellano and Bover (1995) and Blundell and Bond (1998), corrects endogeneity in

[2] *The more macroprudential policy measures were tightened in a particular quarter, the higher (more positive) value the MPI has.*

the model by introducing more instruments to improve efficiency and by transforming the instruments to make them uncorrelated (exogenous) with fixed effects. It creates a system of two equations: The original and transformed. It uses orthogonal deviations: The average of all future available observations of a variable is subtracted from the current observation. Regardless of the number of gaps in the data, this can be calculated for all observations apart from the last one, which minimizes data loss.

System GMM is an augmented estimator: One equation is expressed in levels form with first differences used as instruments. The second equation is expressed in first differenced form with levels as instruments. One-step system GMM is simply an augmented version of the one-step difference GMM. It uses more moment conditions than the one-step difference GMM. Moreover, it is efficient and robust to autocorrelation and heteroscedasticity (Roodman, 2009, 2014; Mileva, 2007). To implement the system GMM in Stata, we used the "xtabond2" command. We did not use the "small" option in Stata; hence the z-statistics/Wald statistics were reported (instead of t-statistics/F-statistics).

Empirical Results and Discussion

In this section, we present the results of two models: One with the quarterly growth rate of non-financial corporate sector credit as the dependent variable ("NFI model") and one with the quarterly growth rate of household credit as the dependent variable ("HH model"). Both models were estimated with one-step system GMM. Both models are applied to nine Euro Area economies (Austria, Belgium, Finland, Germany, Ireland, Italy, Netherlands, Slovenia, and Spain) and to time period 2008Q4–2018Q4.

There are two tests for the validity of instruments: Hansen's (1982) J test and Sargan's (1958) test for the validity of over-identifying restrictions. The null hypothesis (H_0) is: "The instruments used are valid." The alternative hypothesis (H_1) is: "The instruments used are not valid." Not rejecting H_0 (i.e. "accepting" H_0; $p > 0.1$) supports the choice of the instruments. The most favorable values of the Hansen and Sargan tests are between 0.1 and 0.6. However, values up to 0.9 are still acceptable, whereas values exceeding 0.9 indicate that the model may be misspecified (Roodman, 2009).

Moreover, there is a test for serial correlation and autocorrelation of the error term: The null hypothesis (H_0) is: "The differenced error term is not first order (AR(1)) serially correlated." The alternative hypothesis (H_1) is: "The differenced error term is first order (AR(1)) serially correlated." For the second order serial correlation, the hypotheses are comparable, only AR(1) is replaced by AR(2). Not rejecting H_0 (i.e. "accepting" H_0; $p > 0.1$) means that the error term is serially uncorrelated and that the moment conditions are correctly specified.

Three instruments are used in the NFI model: GDP growth rate; unemployment rate; and house price index. The number of instruments (3) is less than the number of groups (9). The NFI model uses two explanatory variables: Capital L1 and MPI L2.

The explicit form of the model is (level equation):

$$y_{i,t} = \delta y_{i,t-1} + X'_{i,t} + \mu_i + \varepsilon_{i,t} \quad (1)$$

differenced equation:

$$y_{i,t} - y_{i,t-1} = \alpha_0 + \alpha_1 (y_{i,t-1} - y_{i,t-2}) + \\ + \alpha_2 (X_{i,t} - X_{i,t-1}) + (\varepsilon_{i,t} - \varepsilon_{i,t-1}) \quad (2)$$

where:

$y_{i,t}$ – endogenous variable
$X_{i,t}$ – strictly exogenous covariates
μ_i – the panel-level effects
$\varepsilon_{i,t}$ – i.i.d. over the whole sample
$\alpha_\cdot$ – estimation parameters

Table 2
Results of the one-step system GMM estimation for the NFI model

Statistics	NFI model
Wald chi2(2)	8.38 (0.015)**
Capital L1	0.012831 (0.006)***
MPI L2	-0.1274296 (0.063)*
Constant	-0.196045 (0.004)***
AR(1)	-2.02 (0.043)**
AR(2)	0.71 (0.479)
Sargan chi2(1)	0.19 (0.666)

*Notes: "L1" denotes one lag, whereas "L2" indicates two lags. The z-/chi2-statistics are given in brackets below the coefficients and the p-values are given in brackets below the z-/chi2-statistics. Significance levels are denoted as: ***Significant at 1%. **Significant at 5%. *Significant at 10%.*

In the NFI model, the explanatory variables Capital L1 and MPI L2 are statistically significant at 1% and 10%, respectively. The constant is likewise statistically significant at 1%. The model as a whole is statistically significant at 5%. The p value of the Arellano-Bond test for AR(1) in first differences is equal to 0.043, which indicates that the differenced error term could be first order serially correlated at 5%. However, the p value of the Arellano-Bond test for AR(2) in first differences exceeds 0.1, which indicates that the differenced error term is not second order (AR(2)) serially correlated. Hence, the p value for AR(1) being less than 0.05 is not a problem. The p value of the Sargan test is greater than 0.1 and less than 0.9, implying that we cannot reject H0, hence it can be concluded that the instruments used are valid. Both explanatory variables (Capital L1 and MPI L2) have the expected signs of regression coefficients (Capital: a positive sign and MPI a negative sign). Since the regression coefficient of MPI is negative, the first hypothesis (H1: Tightening of macroprudential policy measures reduces the growth rate of non-financial corporate sector credit.) can be confirmed.

Four instruments are used in the HH model: GDP growth rate; house price index; y2008; and Crisis. The number of instruments (4) is less than the number of groups (9). The HH model uses three explanatory variables: Size L1; MPI L1; and Unemployment L1.

Table 3

Results of the one-step system GMM estimation for the HH model

Statistics	HH model
Wald chi2(3)	17.62 (0.001)***
Size L1	-0.0160128 (0.040)**
MPI L1	0.0173952 (0.565)
Unemployment L1	-0.0031554 (0.093)*
Constant	0.1232222 (0.007)***
AR(1)	-1.43 (0.153)
AR(2)	-0.84 (0.399)
Sargan chi2(1)	0.51 (0.474)
Hansen chi2(1)	0.53 (0.465)

*Notes: "L1" denotes one lag, whereas "L2" indicates two lags. The z-/chi2-statistics are given in brackets below the coefficients and the p-values are given in brackets below the z-/chi2-statistics. Significance levels are denoted as: ***Significant at 1%. **Significant at 5%. *Significant at 10%.*

In the HH model, the explanatory variables Size L1 and Unemployment L1 are statistically significant at 5% and 10%, respectively. The constant is likewise statistically significant at 1%. On the other hand, the explanatory variable MPI L1 is not statistically significant, which implies that it is not possible to confirm or reject our second hypothesis (H2: Tightening of macroprudential policy measures reduces the growth rate of household credit.) based on the available data and results. The model as a whole is statistically significant at 1%. The p value of Arellano-Bond test for AR(1) and for AR(2) in first differences exceeds 0.1, which indicates that the differenced error term is neither first order (AR(1)) nor second order (AR(2)) serially correlated. The p value of the Sargan and Hansen tests is greater than 0.1 and less than 0.5, implying that we cannot reject H_0, hence it can be concluded that the instruments used are valid. Only one explanatory variable (Unemployment L1) has the expected sign of regression coefficient (a negative sign).

Conclusion

The aim of macroprudential policy, tools, instruments and measures is to build up (capital and liquidity) buffers in expansionary periods such that they can be drawn down in periods of financial distress. This dampens the pro-cyclicality[3] of the financial system, which in turn improves financial stability (Borio, 2011). The macroprudential policy objective is to prevent systemic risk from taking shape and unfurling in the financial system, and hence to reduce the probability of financial crises with significant output losses for the economy as a whole. By identifying and restraining channels of formation and spread of systemic risk, macroprudential policy acts preventively against any signs of financial instability and mitigates their impacts if preventative measures falter (Frait & Komarkova, 2011). In the post-crisis era, interconnectedness among banks and sovereigns has declined, albeit unevenly across the euro area countries. Moreover, the institutional reforms intending to cut the bank-sovereign nexus are incomplete (Stawasz-Grabowska, 2020). Since the macroprudential policy came to the forefront of the economic profession only recently, evidence on the effectiveness of macroprudential tools is still scarce. Our paper is a contribution to this field.

According to Mérö (2017), macroprudential targets are slightly ambiguous (decreasing systemic risk versus increasing macroprudential shock-absorbing capacity of banks); we do not yet know or have evidence if the new macroprudential rules are suitably calibrated; if the usage of new instruments amplifies the possibilities for regulatory arbitrage; what are the interactions between macroprudential and monetary policy; and if the usage of macroprudential tools can create certain risks – for instance, those which arise from economic agents increasingly resorting to the use of unregulated shadow banking that is (currently) outside the purview of macroprudential legislation. Our paper contributes to

[3] *Pro-cyclicality is defined as the inclination of the financial system to reinforce the business cycle (Festić, 2006).*

investigating the effectiveness of macroprudential policy measures and hence to closing some of the existing gaps in the economic scientific community.

We tested two hypotheses: H_1: The tightening of macroprudential policy measures reduces non-financial corporate sector credit growth rate. H_2: The tightening of macroprudential policy measures reduces the growth rate of household credit. Based on our empirical results, we can confirm the first hypothesis. In contrast, the second hypothesis can be neither confirmed nor rejected, since the explanatory variables of interest (MPI) is statistically insignificant. In the NFI model where quarterly growth rate of non-financial corporate sector credit is employed as the dependent variable, the explanatory variable MPI has the expected sign (negative) and is statistically significant. As such, it can be concluded that macroprudential policy measures do play an important role in stymying non-financial corporate sector credit growth, and, by extension, in cooling down the economy, and safeguarding financial stability. On the other hand, in the HH model where quarterly growth rate of household credit is employed as the dependent variable, the explanatory variable MPI does not have the expected sign and is not statistically significant. Thus, no conclusion can be drawn about the impact of macroprudential policy measures on household credit growth rate.

This paper was taking its final shape in 2021, a year marked by COVID-19 and its economic downturn (Nakatani, 2020). Macroprudential policy measures and capital controls can be used during the coronavirus turmoil to help prevent economic crisis from transitioning into a financial crisis (ibid., 2020). There are concerns that emerging and developing economies could experience substantial capital outflows which may cause liquidity problems in domestic or foreign currencies in the banking and corporate sectors, particularly in economies where currency mismatches and exchange rate depreciations are widespread (ibid., 2020). The coronavirus crisis could also adversely affect the real estate sector and lead to a decline in asset prices (Nakatani, 2020). While we do not examine the use and effectiveness of macroprudential policy measures in 2020 and 2021 (because the data which would be required for an empirical analysis were not available), this period is likely to be extensively studied in the future.

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Vpliv makroprevidnostne politike na rast posojil v devetih gospodarstvih evroobmočja

Izvleček

V članku raziskujemo vpliv ukrepov (ki so združeni v indeks makroprevidnostne politike, MPI) makroprevidnostne politike na stopnjo rasti kreditov, danih sektorju nefinančnih podjetij in sektorju gospodinjstev, z uporabo empirične raziskovalne metode enokoračnega sistema GMM. Cilj pričujočega članka je preveriti, ali kontrakcijska makroprevidnostna politika zmanjša stopnjo kreditne rasti in ali ekspanzivna makroprevidnostna politika spodbudi stopnjo kreditne rasti v izbranih državah evroobmočja (v Avstriji, Belgiji, Finski, Nemčiji, Irski, Italiji, Nizozemski, Sloveniji in Španiji) v časovnem obdobju od 2008Q4 do 2018Q4. Preverimo dve hipotezi: H1: Poostritev ukrepov makroprevidnostne politike zmanjša stopnjo kreditne rasti v sektorju nefinančnih podjetij in H2: Poostritev ukrepov makroprevidnostne politike zmanjša stopnjo kreditne rasti v sektorju gospodinjstev. Na osnovi naših empiričnih rezultatov lahko potrdimo prvo hipotezo. Po drugi strani pa druge hipoteze ne moremo niti potrditi niti zavrniti, saj pojasnjevalna spremenljivka MPI, ki nas zanima, ni statistično značilna v našem drugem modelu.

Ključne besede: makroprevidnostna politika, sistemsko tveganje, finančna stabilnost, dinamični panelni podatki, enostopenjski sistem GMM