Bank of Finland Research Discussion Papers
8 • 2025

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Bank of Finland
Research

Bank of Finland Research Discussion Papers
Editor-in-Chief Esa Jokivuolle

Bank of Finland Research Discussion Papers 8/2025
27 August 2025

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ISSN 1456-6184, online

Bank of Finland
Research Unit

PO Box 160
FIN-00101 Helsinki

Phone: +358 9 1831

Email: research@bof.fi
Website: www.suomenpankki.fi/en/research/research-unit/

Effect of the countercyclical capital buffer on firm loans - Evidence from Germany

Eeva Kerola and Anni Norring[1]

August, 2025

Abstract

We use confidential loan-level data from the European Central Bank to investigate how changes in the countercyclical capital buffer requirement in Germany affect lending to firms. We find evidence showing that tightening the countercyclical capital buffer leads German banks to reduce the volume of corporate loans and increase the price of new loans. These effects take place immediately after the announcement, given 12 months before the change was implemented. Importantly, we find that the reduction in credit availability notably affects small and medium-sized enterprises, which experience both a significant decrease in available credit and an increase in credit costs. In contrast, large firms are not affected.

JEL classification: E58, G21, G28
Keywords: Macroprudential policy, Countercyclical capital buffer, Loan level data

[1]Kerola: Bank of Finland, eeva.kerola@bof.fi.
Norring: Bank of Finland; University of Helsinki, anni.norring@bof.fi.

This working paper has been previously circulated in the SSM-EUI Banking Supervision Policy Working Paper Series as European University Institute Robert Schuman Centre for Advanced Studies Working Paper No. 2025/23.

We wish to thank Steven Ongena, Merike Kukk, Denis Davydov, Konstantins Benkovskis, Esa Jokivuolle and Antti Ripatti for their insightful comments, as well as feedback provided by referees of the EUI-SSM Banking Supervision Policy Working Paper Series and the editorial assistance of Leopoldo Pérez Obregón. The helpful comments by seminar participants at the 2025 Annual Meeting of the Finnish Economic Association, 2025 Baltic Economic Association's Annual Meeting, and the Bank of Finland have also benefited our paper.

1. Introduction

During the decade after the Global Financial Crisis, macroprudential policy established itself as a powerful tool for policymakers to curb the excesses of the financial cycle. Macroprudential policy measures have been found to be effective in making the financial system more resilient to vulnerabilities (Galati and Moessner, 2018; Beck and Gambacorta, 2019; Ampudia et al. 2021; Kim and Mehrotra, 2022) and in curbing credit growth (Boar et al. 2017; Cerutti, Claessens and Laeven, 2017; Akinci and Olmstead-Rumsey, 2018). However, the menu of macroprudential policy measures is wide and varied, with different tools having different transmission mechanisms. While it is important to understand the aggregate effects of the different macroprudential policy measures combined, policymakers also need precise information on the specific effects of different policy measures. This is important, as the aggregate effects may mask widely different effects on different actors and even unintended consequences. Another key characteristic of macroprudential policy is that changes in policy are often announced well in advance of the implementation, allowing market participants to adjust their behaviour already before the change comes into effect. These more granular effects of macroprudential policy remain less well understood.

In this paper, we take a detailed look at the effects of a single macroprudential policy measure, bridging several gaps in research. We examine the effects of the countercyclical capital buffer (CCyB) which is based on the Basel III recommendations (Basel Committee on Banking Supervision, 2010). This specification of the CCyB is nowadays widely used and broadly recommended by institutions such as European Systemic Risk Board (ESRB) and International Monetary Fund (IMF). It is relatively similar across different countries, making our conclusions relevant also for other countries. As the 'positive neutral' approach to setting the CCyB – establishing a positive buffer rate early in the financial cycle to enhance resilience and stability of the financial system – gains traction among European countries (ESRB, 2025), the use of CCyB is likely to become even more prevalent. Thus, it is important to consider all implications of these policy decisions. Crucially, if the effects are different for the lending outcomes of firms of varying characteristics, it is important to acknowledge that some of the effects might have distributional implications. The CCyB is not designed to lead to different outcomes for different firms and thus varied outcomes can tell of unintended consequences the policy makers should be aware of.

To attain as sharp identification as possible, we focus on a carefully chosen single event: a tightening of the CCyB in Germany in 2022. We have a difference-in-differences setup with the CCyB decision as the treatment for German banks. To be able to focus on the aggregate effect of the CCyB change on banks' credit policies, we exploit country-level heterogeneity. Thus, we use the banking sector of another country with CCyB set at zero as the control group for German banks. After carefully reviewing our options, we choose Austrian banks as the control group.[2] To examine the effects of this decision at the firm and bank level we use confidential loan-level data from the European Central

[2] For a thorough discussion on why Austrian banks make a good control group for German banks, refer to Section 4.

Bank. We consider whether banks wait to change their behaviour after the policy is implemented or whether they do so already after the announcement and thereby anticipate the eventual implementation. Importantly, we also investigate whether the effects vary by firm size.

Our main findings are as follows. First, German banks reduce the volume of corporate lending and increase the price of new corporate[3] loans following a tightening in the CCyB requirement. Second, these effects occur already after the announcement of the change, as banks anticipate the application[4] of the new CCyB requirement. Third and most importantly, the effects vary significantly by firm size: while SMEs face substantially more constrained credit supply conditions and higher lending rates after the announcement and application of the CCyB change, large firms are not affected. These effects are economically significant. Banks facing a CCyB tightening reduce the share of corporate loans to total assets by 1.4 percentage points post-announcement and 1.8 percentage points post-application relative to banks not subject to CCyB requirements. This effect seems to be solely driven by reduced lending to SMEs. Banks facing a CCyB tightening rebalance their assets away from SME loans by 1.1 percentage points post-announcement. The post-application effect is slightly smaller, a reduction of 1 percentage point. In contrast, we find no effect on the share of corporate loans to large companies of total assets post-announcement and even a small positive effect (0.2 percentage points) post-application. Following an announcement of a CCyB tightening banks also increased their lending rates to new SME loans by 0.47 percentage points. The effect is statistically significant after the announcement and fades away after the application. At the same time, large firms are not affected.

Our findings make several contributions to literature. We provide evidence of the effects of CCyB changes in a major euro area country. We achieve very sharp identification by focusing on a single policy tool and on a single policy event. By utilizing loan-level data from the European Central Bank, we are able to directly observe the amount of loans granted each month and the lending rates paid on them. This offers a very comprehensive understanding of the dynamic impact of a change in the CCyB on both firm credit volumes and prices. Importantly, the data allows us to study heterogeneity in the transmission mechanism by controlling for firm size. By considering both the announcement and application effects simultaneously, we can see whether either of the effects dominates. Our approach of utilizing country heterogeneity also allows us to identify the aggregate effect of the CCyB change, extending previous research that mostly focuses on bank-level heterogeneity by comparing well and poorly capitalized banks. These contributions are discussed in more detail and linked to previous literature in Section 2.

The rest of the paper is organized as follows. Section 2 motivates our set-up and research questions building on relevant existing literature. Section 3 sketches the transmission channels and formulates our hypotheses. Section 4 presents our methodology and the data we use. Our main results are

[3] By corporate we mean non-financial corporations. We use the terms ‘corporate’ and ‘firm’ interchangeably.
[4] In this paper “application” refers to the implementation of the previously announced change in the CCyB level, not e.g. an application for a loan. We follow the terminology used by e.g. European Systemic Risk Board.

presented and discussed in Section 5. Robustness checks are discussed in section 6. Section 7 concludes.

2. Research questions and relevant literature

We pose three research questions in this paper. First, we want to know *how the change in the German CCyB rate influenced lending to firms by German banks*. Second, we want to know *whether the effects took place already after the announcement or only after the application of a change*. Finally, we want to know *whether the effects are different for firms of different sizes*. Each of these questions is aimed at a gap in the existing literature.

The first research question is related to the literature on the effects of prudential capital requirements on bank lending (Gropp, Mosk, Ongena and Wix, 2019; De Jonghe, Dewachter and Ongena, 2020; Degryse, Karapetyan and Karmakar, 2021; Gropp, Mosk, Ongena, Simac and Wix, 2024), of which the literature on the effects of CCyB is a relatively novel strand. The CCyB has been found to be effective in reducing credit growth when tightened, and to attenuate credit contraction when released (Drehmann and Gambacorta, 2012; Benes and Kumhof, 2015; Benbouzid et al., 2022). The exceptional economic crisis caused by the Covid-19 pandemic provided an interesting case for studying widespread easing of CCyB. It has been shown that the reduction in CCyBs in Europe led to significant increase in lending by banks on average (Dursun-de Neef, Schandlbauer and Wittig, 2023; Bedayo and Galán, 2024). Earlier studies however must contend with data that is less granular on of lower frequency than what we can use. We are able to provide evidence of the effects of a recent tightening in a CCyB based on the Basel III regulation in a large euro area country using the most up-to-date and detailed data, which has been made available only recently.[5] Our approach further allows us to pin down the aggregate effect of a change in the CCyB, because we use country-level heterogeneity instead of bank-level heterogeneity, which is the identification strategy of e.g. Bedayo and Galán (2024), Marek and Stein (2022), Auer, Matyunina and Ongena (2022) and Basten (2020).

Related to the second research question, we add to existing research by considering the announcement of the decision as well as the application of the change. This is important because changes to macroprudential regulation are often implemented with considerable lags of up to a full calendar year to allow time for market participants to adjust. Thus, the announced and applied rates of for example the CCyB can differ for extensive periods of time (Figure 1 for illustration). Research on the effects and effectiveness of macroprudential policy mostly concentrates on the application of a policy change, as this is what the commonly used data sources record (see e.g. Meuleman and Vander Vennet, 2020; Forbes 2021; Ćehajić and Košak, 2022, and Bergant et al. 2024), but these results potentially underestimate the effects of a policy change by a large margin. We are aware of only two studies which consider the effects from an announcement of the change in CCyB. Auer, Matyuina and Ongena (2022) do this for Switzerland by considering the Swiss special CCyB with a sectoral focus. Bedayo and Galán (2024) consider the effects of announcements of CCyB releases during the Covid-19-crisis as well as the tightening decisions taken before the crisis. We extend their approach by

[5] Anacredit, the ECB's confidential loan-level data we are using for this study begins in September 2018. However, due to initial data quality issues, including a high number of missing data points and outliers, the data becomes more reliable and usable for research purposes around the start of 2020.

considering both the announcement and application effects of a change in the CCyB side-by-side. This allows us to determine whether one or the other of the effects dominates.

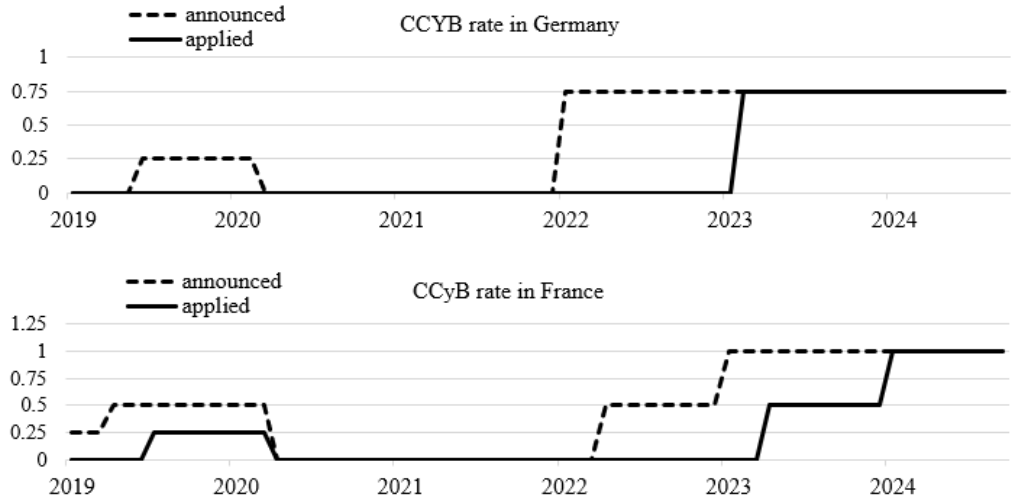


Figure 1: Announced and applied countercyclical capital buffer rates in Germany and France.

Finally, our third research question may be the most important in terms of policy implications. On this, we contribute to understanding how firms of different size could face very different consequences of macroprudential policy. The aim of tightening macroprudential capital requirements is that banks extend less credit, and this consequence has been confirmed empirically by e.g. Andrieş, Melnic and Sprincean (2022). When firms receive less credit, their ability to invest and grow also diminishes, as it is well established that access to finance is important for firms and their growth (Rahaman, 2011; Didier et al. 2021; Madeira, 2024). This is especially true for SMEs (Beck and Demirgüc-Kunt, 2006). SMEs tend to also be more dependent on bank financing (Kim, Lin and Chen, 2016, Boccaletti et al. 2024; Sommer, 2024), and thus their growth is especially vulnerable to weakening access to bank financing. Moreover, the share of SMEs of the whole non-financial corporate sector is high in the euro area (Botsari, Gvetadze and Lang, 2024) and the SMEs in euro area are especially dependent on bank financing (Al-Eyd et al., 2015; Kaya and Masetti, 2018; Wouters, 2021; Botsari, Gvetadze and Lang, 2024).[6]

Only a few studies have thus far documented the different effects of macroprudential policy measures on corporate financing to firms of different sizes. However, the results are not conclusive. Ćehajić and Košak (2022) use bi-annual firm-level responses from the EU-level Survey on the Access to Finance of Enterprises and find that as macroprudential policy, and capital-related measures in particular, are tightened, smaller firms more often report their loan applications to be rejected. However, in addition to using lower frequency, survey-based data, their approach aggregates a wide-

[6] This is also true for Germany (OECD, 2024, Marek and Stein, 2022).

ranging menu of different macroprudential tools into one index. Ayyagari et al. (2018) use annual firm-level data for a large group of both developed and emerging economies and find that macroprudential tools targeted at financial institutions are associated with lower financing growth for micro firms but higher financing growth for SMEs, compared with large firms. Marek and Stein (2022) use granular data from Germany and find that after the introduction of the risk-based capital ratio, lending growth decreased to both SMEs and large firms, with SMEs suffering slightly more. On the other hand, a tightening of the leverage ratio increased collateralization for all firms, with a more substantial impact on larger firms. Auer, Matyunina and Ongena (2022) consider the effects of a CCyB targeting banks' exposure to mortgages in Switzerland with loan-level data. They find that mortgage lending decreased, while lending shifted to non-financial corporates, with a stronger impact on smaller firms. Shahhosseini (2022) analyses how banks in the U.S. respond to the higher regulatory capital requirements of stress tests and finds that stress-tested banks reduce credit supply to small firms relative to large borrowers. Finally, Amado (2022) also uses granular microdata to analyse the impact of a special reserve requirement for dollar lending in Peru and finds a clear deterioration of access to finance for smaller firms. However, her paper concentrates on a very different financial system from Europe.

Our data allows us to make several contributions to this developing literature. Concentrating on a single decision of a specific macroprudential tool and using confidential granular datasets by the European Central Bank, we are able to unveil the dynamic effects on both loan volumes and interest rates for new loans at monthly frequency. This is a substantial improvement on previous studies with annual frequency or survey data. Additionally, to our knowledge, only Auer, Matyunina and Ongena (2022) and Basten (2020) have previously considered interest rates in the European context, but they focus on a unique sectoral CCyB targeting only mortgage lending in Switzerland. Furthermore, the loan-level data allows us to precisely identify the firms receiving the loans. This way we have accurate information on whether the firms are large, medium, small, or micro companies.[7] Thus, we do not have to rely on proxies such as loan size to construct samples of firms of different size.

[7] We focus on large firms and SMEs. We exclude micro companies from our analysis because they are highly heterogeneous across countries and industries. This way we expect more accurate and reliable results, providing clearer insights into the effects of macroprudential policies.

3. The transmission channels and hypotheses

To formalize our approach, we follow the conceptual framework on the transmission of raising capital and provisioning requirements laid out by Bank for International Settlements Committee on the Global Financial System (BIS CGFS 2012). This framework sketches the transmission of increasing capital requirements or provisions to the credit cycle via multiple channels. We concentrate on two specific transmission channels in the framework, the credit demand and credit supply channels. Both channels are related to the options banks have to address the shortfall in capital requirements arising from tightening requirements by reducing supply of credit. Banks can decrease their assets, especially those with a high risk-weight, thus decreasing the supply of credit. Another option is for the banks to increase lending spreads via repricing loans. This will tighten credit conditions on the loan market and thereby eventually decrease the demand for credit. Thus, both channels work towards dampening the credit cycle.

The countercyclical capital buffer (CCyB) fits this framework well, as we sketch in a visualisation of a simplified version of the BIS CGFS framework in Figure 2. The CCyB has been designed to counter procyclicality in the financial system, in the sense that when the financial cycle is in expansion, the CCyB is gradually built up, with the aim of increasing resilience in the whole system. In a crisis, when there is a sharp downturn in the financial cycle, the CCyB is released to support the system by allowing banks to extend more credit. The CCyB is based on the Basel recommendations (Basel Committee on Banking Supervision, 2010), and thus it is comparable across different countries and years. For other macroprudential measures, the details and scope of the regulation can differ substantially across countries, which can restrict comparative analysis.

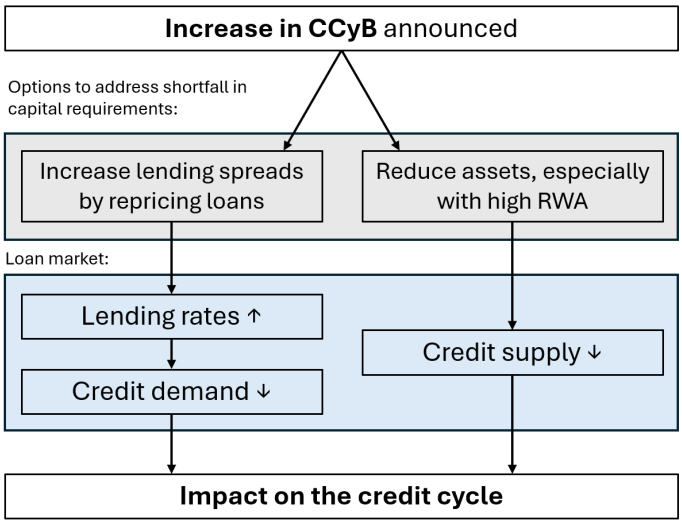


Figure 2: Transmission map of raising capital requirements. RWA = risk-weighted asset. Based on BIS CGFS 2012.

Based on how the CCyB has been formulated and how its effects transmit into the credit cycle, we formulate four hypotheses on what we expect to find. First, related to our first research question on how the changes in CCyB influence firm loans in the aggregate, we have two hypotheses. As the CCyB is implemented or tightened, banks can address the shortfall in capital requirements by either

decreasing their assets, especially the ones with high risk-weight or by increasing lending spreads by repricing loans. Thus, banks reduce corporate lending (H1A in Figure 3) or increase lending rates of new loans (H1B in Figure 3). Next, related to our second research question on the timing of the effect, we expect that as authorities announce an implementation of or a tightening in CCyB with an application at a later date, banks change their behaviour already in anticipation of the implementation. Thus, banks reduce lending to firms and increase interest rates already after the announcement date (H2 in Figure 3). Finally, related to our third research question on the role of firm size, we note that SME lending is riskier for banks than lending to large firms. E.g. NPLs are more frequent with SMEs than with large firms (Beck, Demirgüç-Kunt and Martinez Peria, 2008). As CCyB is tightened, banks reduce riskier lending to contain risks and adjust capital requirements, and thus they lend less and at a higher price to SMEs compared to large companies (H3 in Figure 3). The hypotheses are summarized in Figure 4.

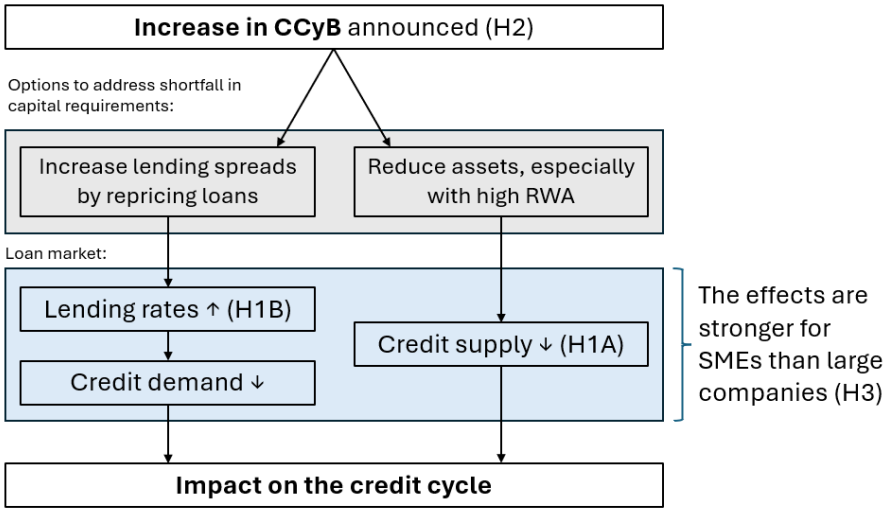


Figure 3: Our hypotheses in the transmission map of raising capital requirements.

We formulate our framework and hypothesis mainly with an implementation or an increase, i.e. a tightening, of the CCyB in mind because such decisions have so far been more prevalent and are thus our prime interest. There is however no reason per se why our approach would not work for easing decisions also – albeit in reverse. Crucially, CCyB easings are mostly expected to take place during crisis times, when the financial system requires extra support. Thus, the transmission mechanism is likely to be different compared to tightening decisions taken during normal times. Moreover, so far in the euro area tightening decisions have as a rule been announced with long lags of e.g. 12 months, whereas easing decisions that mostly happened during the Covid-10 crisis, where implemented much faster after being announced (see Table A2 in Annex 1).

4. Methodology and data

Methodology

We use a difference-in-differences approach with a bank-month panel dataset, pre- and post-treatment time periods, and treated and control groups. The announcement and application of a CCyB decision are considered the treatment. A country with no positive CCyB implemented is chosen as the control country. The model equation thus is

$$y_{i,t} = \beta_0 + \beta_1(d_i * p_t) + \beta_2 d_i + \beta_3 p_t + u_{i,t},$$

where y is the response variable for bank *i* at time *t*, d is the treatment group indicator, and p is the post-treatment indicator. β_0 is a constant, β_2 contains the controls for permanent differences between the groups, β_3 contains the controls for trend common to both groups, and finally β_1 is the difference-in-differences estimate, i.e. the remaining differences in y between the two groups.

The next step in our set-up is to find what we call a "clean" CCyB decision. These are decisions where a change was made to the level of the CCyB, where the announced decision eventually came into force and where there were no decisions with overlapping announcement-to-application periods. We formulate and discuss our strict criteria for a clean decision in Annex 1. There are only a few CCyB decisions that fulfil our strict criteria for a clean CCyB decision taken by euro area countries (table A1 in Annex 1) after 2020 when the data we use becomes available. Of these four clean CCyB decisions, we choose the decision announced by Germany in January 2022 and applied in 2023. At this time Germany increased its CCyB rate from 0 percent to 0,75 percent.

This decision is a good choice for us for multiple reasons. The effects of this particular decision were not affected by the Covid-19 crisis, or any other major changes in macroprudential policy that would have affected all German banks. In 2022, Germany made two other tweaks into its macroprudential regulation framework: The Other Systematically Important Institution Buffer (O-SII) was set for 16 banks in November 2022, with an application date in January 2023, and the Systemic Risk Buffer was set at 2 % for exposures related to residential real estate exposure in March 2022, with an application date in February 2023. (ESRB, 2022a, 2022b) However, the transmission mechanism of these changes is likely to be slightly different from the change in the CCyB, as the first one targeted only a handful of large banks and the other did not target all lending. They were also announced at a later date than the CCyB decision. Finally, the high number of banks in Germany and good data quality make this decision a good case for our approach. Thus, we choose the German 2022 CCyB decision as our event of interest in this paper.

We want to pin down the aggregate effect of a change in the CCyB, meaning that we need to find a way to exploit country level heterogeneity instead of within-country heterogeneity. To this end, we need to find a *control country* that does not have a positive CCyB. By the end of 2023, there were seven euro area countries that had not yet adopted the CCyB: Austria, Finland, Greece, Italy, Malta, Portugal, and Spain. We need to find a country where the business and financial cycles, as well as the banking sector development, are similar enough to Germany, when comparing key banking sector variables. Most importantly, we need the response variables to exhibit similar trends before the

announcement of a CCyB tightening in Germany. The assumption of the pre-treatment parallel trends must hold for our identification strategy to be valid.

The most suitable single control country for Germany is Austria, with the CCyB set at zero. Otherwise, the macroprudential capital buffer frameworks of Germany and Austria are quite similar. Austria also made similar, more limited changes to its macroprudential regulation as Germany in 2022: An O-SII buffer was announced in Austria November 2022 for 7 banks, with and application date in January 2023, and a Systemic Risk Buffer related to sectoral vulnerabilities in the commercial real estate sector was announced in March 2022 for 11 banks and applied in February 2023 (ESRB, 2022c, 2022d). We visually conclude the development of the banking sectors in these two countries to be similar enough for our setup to be sensible. (See Figures A3 in Annex 2) We also visually conclude that the pre-treatment parallel trends assumption is plausible for our response variables (See Figures A2 in the Annex 2). Finally, we formally check the validity of our identification strategy and the pre-treatment parallel trend assumption by adding month-treatment dummy interactions to the estimations, plotting the coefficients as well as their confidence intervals. These are provided in Section 5 with the estimation results.

The limitation of using the banking sector of another country as the control group could be that the results are driven by the choice of the control. For example, it could be that there are underlying differences in the credit cycles of the two countries that explain our findings instead of our setup picking up the effect the CCyB change. To alleviate this concern, we construct a synthetic control for Germany from the group of euro area countries without CCyBs to ensure that our results are not specific to choosing Austria as the control country. Our results are robust to this check, which we discuss more thoroughly in Section 6.

Data

To understand how a change in the CCyB affects bank corporate lending overall and to firms of different sizes, we use three response variables. Our first response variable is the volume of outstanding corporate loans in logs. To examine changes in the composition of bank lending, our second response variable is the share of firm loans outstanding relative to the bank's total assets. We also want to evaluate whether changes in the CCyB impact the price firms pay for their bank loans. Thus, our third response variable is the lending rate for new firm loans. We analyse these response variables separately for SMEs, large companies, the combined sum of SMEs and large companies, and aggregate non-financial corporates.

Data on the volumes and prices of firm loans is obtained from three confidential datasets compiled by the ECB. The two more aggregate-level datasets, iBSI and iMIR, provide us with unconsolidated bank-level data at a monthly frequency. From these, we obtain data on the aggregate non-financial corporate lending volumes and prices. From the database of individual balance sheet items (iBSI), we utilise bank-level information on the volume of outstanding corporate lending as well as the size of the banks' balance sheet (total assets) and capitalisation (equity to total assets). From the database of individual monetary and financial institutions interest rates (iMIR), we obtain bank-level average interest rates for new non-financial corporate loans issued each month. It is worth noting that the sample of banks in iBSI is larger than in iMIR (1,541 German and 484 Austrian banks in iBSI vs. 63

German and 13 Austrian banks in iMIR). In both datasets, banks are classified based on the residential principle. The third confidential dataset is Anacredit, which contains detailed information on all individual bank loans to firms above €25 000, harmonized across member states. Most importantly for our analysis, Anacredit provides information on borrower firms' size classifying them as micro, small, medium or large.[8] Additionally, we have detailed information on the industry of each borrower firm.

We include small and medium companies in our group of SMEs and create a separate group for large companies. Micro companies are excluded from our analysis due to their high heterogeneity, especially across countries, to ensure more accurate and reliable results. Altogether, our balanced panel Anacredit dataset covers 963 banks' lending to 228,168 SMEs and 34,360 large companies in Germany, and 456 banks' lending to 41,157 SMEs and 6,569 large companies in Austria. We aggregate the daily loan-level data to a balanced panel of bank-level observations at a monthly frequency and obtain bank-level information on outstanding lending volumes and the prices of new loans for SMEs, large companies, and these two firm types aggregated together. In our estimations we use data from January 2021 to December 2023. The descriptive statistics and data sources are presented in Table 2. Summary statistics for Germany and Austria separately can be found in Annex 3, Table A3.

Variable	Source	# obs	Mean	Std dev	Min	Max
Total assets (EUR mln)	iBSI	60 763	8 810	68 100	0.00	1 590 000
Bank size (log of total assets)	Authors' calculations based on iBSI	60 673	20.84	1.61	9.68	28.09
Capitalization (equity/total assets)	iBSI	60 073	0.11	0.08	0.00	1.13
Large company lending (EUR mln)	Anacredit	38 117	442	2 110	0.00	54 300
SME lending (EUR mln)	Anacredit	39 500	326	1 090	0.00	21 900
NFC aggregate lending (EUR mln)	iBSI	60 760	1 320	10 600	0.00	324 000
Large company lending to total assets	Authors' calculations based on Anacredit and iBSI	38 117	0.04	0.04	0.00	0.48
SME lending to total assets	Authors' calculations based on Anacredit and iBSI	39 500	0.07	0.04	0.00	0.56
Large company + SME lending to total assets	Authors' calculations based on Anacredit and iBSI	38 900	0.11	0.07	0.00	0.98
NFC aggregate lending to total assets	Authors' calculations based on iBSI	60 668	0.17	0.12	0.00	0.96
Loan rate for new loans to large companies	Anacredit	36 612	3.60	2.32	0.00	21.38
Loan rate for new loans to SMEs	Anacredit	39 294	3.70	2.34	0.00	41.88
Loan rate for new loans to NCFs in aggregate	iMIR	3 752	2.91	1.76	0.06	11.28

Germany and Austria, data from January 2021 to December 2023

Table 2. Descriptive statistics

Our treatment variable is the change in the countercyclical capital buffer (CCyB) in Germany which was announced in January 2022 and applied in February 2023. We use data from the European Systemic Risk Board (ESRB), which includes detailed information on CCyBs decisions. We also use the ESRB data to control for any other changes in the macroprudential framework made at the same time as the CCyB was changed.[9]

[8] SME category is comprised of enterprises which employ fewer than 250 persons, and have either an annual turnover not exceeding €50 million, or an annual balance sheet total not exceeding €43 million. Microenterprises are enterprises employing fewer than ten persons and whose annual turnover and/or annual balance sheet total does not exceed €2 million. An enterprise is classified as large enterprise if it is not qualifying as a microenterprise or SME.

[9] There are multiple other sources for macroprudential policy measures. Our choice of using the ESRB is discussed further in Annex 4.

5. Main results

We estimate the following equation:

$$Y_{i,t} = \beta_0 + \beta_{1A}(post\ ann_t * DE_i) + \beta_{1B}(post\ app_t * DE_i) + \beta_2 DE_i + \beta_{3A} post\ ann_t + \beta_{3B} post\ app_t + X_{i,t-1} + \delta_i + \theta_{c,t} + u_{i,t}$$

where $Y_{i,t}$ is in turn one of the response variables: ln(loan stock), share of loans to total assets, and lending rate of new loans, for bank *i* at time *t*. We have two post-treatment periods: the post-announcement and the post-application period. Variable $post\ ann_t$ is a dummy for post-announcement period, having the value of one from February 2022 to January 2023 and zero otherwise. Variable $post\ app_t$ is a dummy for post-application period, having the value of one from March 2023 to December 2023 and zero otherwise. The actual months of announcement and application, January 2022 and February 2023, are omitted from the estimations. DE_i is a dummy for Germany. The estimations include bank and country-month fixed effects (δ_i and $\theta_{c,t}$), as well as lagged bank-specific controls in $X_{i,t-1}$ for bank size and capitalisation. By including country-month fixed effects, we allow for within-country heterogeneity – specifically, that some banks in Germany may be more exposed to changes in the CCyB than others.[10] We run the estimations for a three-year period from January 2021 to December 2023. Standard errors are clustered at the bank level.

We are mainly interested in the difference-in-difference estimators, which are the post-announcement and post-application effects (coefficients β_{1A} and β_{1B}). If the tightening of the CCyB were to have an adverse impact on bank corporate lending, as we expect, these coefficients should be statistically significant and negative for volumes and positive for prices. Moreover, if β_{1A} is statistically significant, banks alter their behaviour already post-announcement, confirming our hypothesis.

Impact on the volume of outstanding loans

The first estimations are conducted using the log of loan stock as the response variable. We estimate the effect for four different samples differentiated by the size of the firms receiving loans: SME lending, large company lending, the sum of SME and large company lending using loan-level data from Anacredit, and total non-financial corporate (NFC) lending, using bank-level data from iBSI. Table 3 presents our estimation results for the average effect of the CCyB tightening on firm lending during post-announcement and post-application periods.

[10] Our results remain robust when country-month fixed effects are excluded.

	(1)	(2)	(3)	(4)
Dependent variable: ln(loan stock)	Total NFC lending	SME lending	Large company lending	SME + large company lending
Post-announcement effect	-0.069***	-0.166***	0.030	-0.123***
	(0.018)	(0.032)	(0.046)	(0.023)
Post-application effect	-0.119***	-0.141***	0.094*	-0.080**
	(0.027)	(0.036)	(0.053)	(0.040)
Observations	53,247	36,162	34,876	35,578
R-squared	0.228	0.138	0.118	0.146
Number of banks	1,642	1,140	1,112	1,123
Bank controls	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES
Country_time FE	YES	YES	YES	YES

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Estimation of equation presented in Section 5. Estimation period Jan 2021-Dec 2023. Post-announcement effect is the interaction between post-announcement (equals one from Feb 2022 to Jan 2023) and the Germany-dummy (equals one for German banks). Post-application effect is the interaction between post-application (equals one from Mar 2023 to Dec 2023) and the German-dummy. Actual months of announcement and application (Jan 2022 and Feb 2023) are omitted from the estimations.

Table 3: Results for volume of outstanding loans as the response variable.

Column 1 presents the effect that the CCyB announcement and subsequent application had on total NFC lending by German banks compared to Austrian banks. The negative effect on total NFC lending was on average 6.9 percent post-announcement and 11.9 percent post-application. This means that German banks facing a CCyB tightening decreased their lending to non-financial corporations by an average of 6.9 percent more after announcement and 11.9 after application compared to Austrian banks which did not face a tightening in capital requirements. This confirms our hypothesis H1A, namely that when CCyB is tightened, banks react to a shortfall in capital requirements by reducing corporate lending. These effects are highly significant statistically as well as economically large. In addition, the effects are negative and statistically significant already in the post-announcement period, indicating that banks change their behaviour already following the announcement of a CCyB tightening. This confirms our hypothesis H2, which states that banks change their behaviour in anticipation of the application immediately after a CCyB tightening is announced. This means that the pass-through of an announced, forthcoming change in the CCyB rate to lending volumes is very rapid.

Importantly, when we examine the composition of corporate lending to SMEs and large companies, it becomes clear that banks primarily reduce lending to SMEs (column 2). Post-announcement, German banks facing a CCyB tightening decreased their lending to SMEs by 16.6 percent compared to Austrian banks. Post-application, the reduction was nearly as large, 14.1 percent. In contrast, there was no effect on large company lending post-announcement, but even a slight positive effect after the

CCyB application (column 3). Post-application, German banks with tightened capital requirements increased their lending to large companies by 9.4 percent (statistically significant at the 10 % level) compared to Austrian banks. On average, bank lending to both SMEs and large companies reduced by 12.3 percent post-announcement and by 8 percent post-application (column 4) in Germany compared to Austria. These results confirm our hypothesis H3: as the CCyB is tightened, banks adjust for higher capital requirements by reducing riskier lending, thus lending less to SMEs without negatively affecting lending to large companies. It is thus clear that SMES carry most of the burden in terms of reduced lending.

The internal validity of our empirical strategy requires that the assumption of pre-treatment parallel trends holds. In our set-up this means that in the absence of the treatment (CCyB announcement and application in Germany), the difference in loan volumes between German and Austrian banks needs to remain constant over time. Visual inspection of lending volumes already indicated that this assumption is likely to hold (see figures in Annex 2). We confirm this by a formal test by estimating a version of our estimation equation, where the treatment dummy interactions $post\ ann_t * DE_i$ and $post\ app_t * DE_i$ are replaced with monthly dummy interactions $month_t * DE_i$. The coefficients of the interaction terms estimate the change in the dependent variable relative to the omitted baseline period (first quarter of 2021). This also allows us to observe the dynamic effects of the CCyB announcement and application. Figure 4 plots the coefficients for each category of lending.

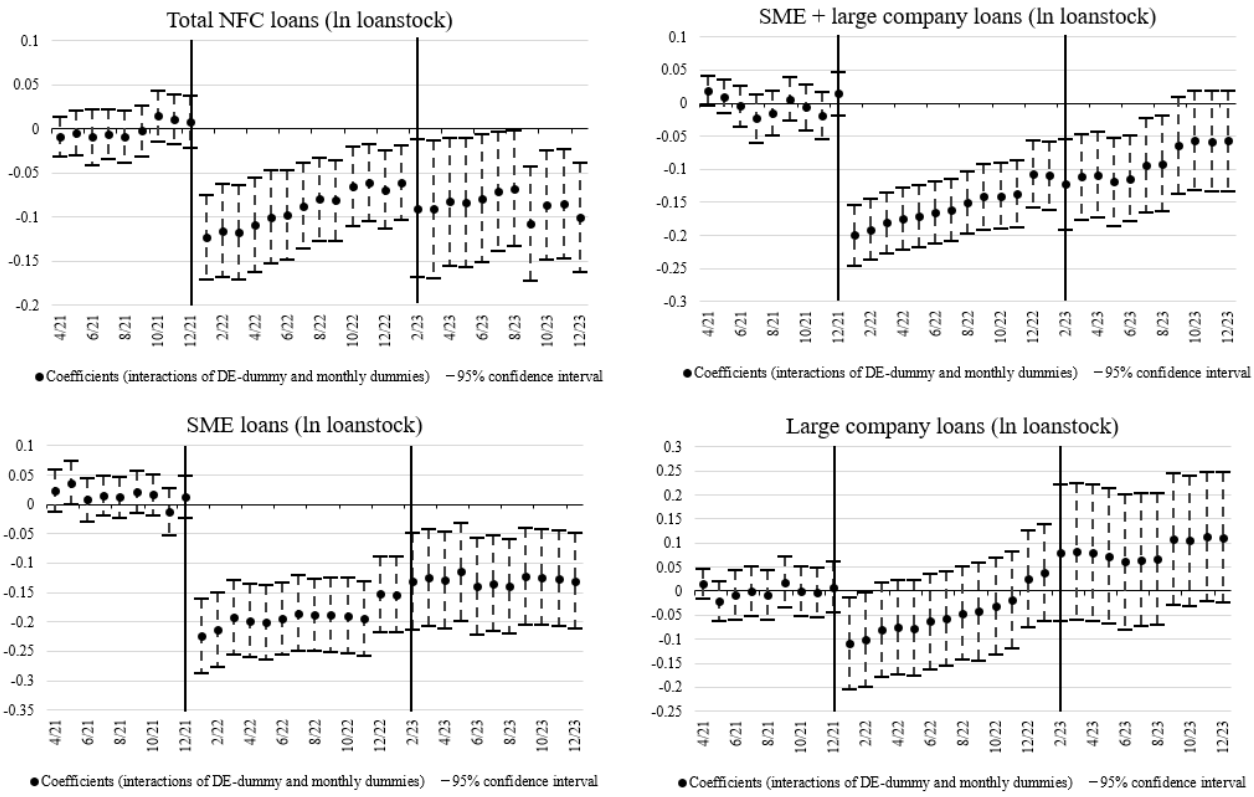


Figure 4: Dynamic effect of CCyB tightening on outstanding loan volumes.

We can confirm that the parallel trend assumption holds, as the pre-treatment coefficients (before January 2022) are not statistically different from zero. Before the CCyB was announced in Germany in January 2022, the difference between the lending volumes of German and Austrian banks did not change. Right after the announcement of the CCyB tightening, the difference becomes negative and statistically significant (with the exception of large company loans), indicating that German banks were lending less to firms and SMEs in particular compared to their Austrian counterparts. The impact of the CCyB tightening on bank loan volumes is stronger during the post-announcement period compared to the post-application period for all loan categories. Looking at the monthly effects, we can also see that the largest monthly effects are witnessed immediately after the announcement, with the effects petering out as more time passes. Interestingly, the application of the change does not make a marked change in this trend. The aggregate effect is clearly driven by loans to SMEs, as the effect for lending to large companies is not statistically significant.

Impact on the share of corporate loans to total assets

We next turn to our second response variable, the share of corporate loans to total assets, to further study the change in banks' loan portfolio composition. The dependent variable in our estimation equation is now the shares of different types of firm loans in banks' total assets: SME loans, large company loans, the sum of SME and large company loans, and total NFC loans. Table 4 presents the results for the average effect of a CCyB tightening during the post-announcement and post-application periods for German banks compared to Austrian banks. Overall, the results continue to be very well aligned with our hypotheses.

Column 1 in Table 4 presents the effect that the CCyB announcement and application had on the share of total NFC lending to banks' total assets. German banks facing a CCyB tightening reduced the share of non-financial corporation loans to total assets by 1.4 percentage points post-announcement and 1.8 percentage points post-application compared to Austrian banks. This confirms our hypothesis H1A that banks react to tightened capital requirements by reducing corporate lending. Again, the effects are significant already in the post-announcement period confirming our hypothesis H2 that banks change their behaviour already right after the announcement, in anticipation of the implementation.

Hypothesis H3 is also confirmed, as German banks reduce the share of SME lending on their balance sheets compared to Austrian banks (column 2). Post-announcement, banks facing a CCyB tightening rebalanced their assets away from SME loans by 1.1 percentage points. The post-application effect was slightly smaller, 1 percentage point. We can identify a small shift by German banks facing a CCyB tightening towards large company lending by 0.1 percentage points already post-announcement, although the coefficient is statistically insignificant (column 3). After application, the effect is twice as large, 0.2 percentage points, and statistically significant at the 10% level. These shifts resulted in a reduction of SME and large company loans to total assets by 1.2 percentage points post-announcement and 0.9 percentage points post-application by German banks compared to Austrian banks (column 4).

Dependent variable: loans / total assets	(1) Total NFC lending	(2) SME lending	(3) Large company lending	(4) SME + large company lending
Post-announcement effect	-0.014***	-0.011***	0.001	-0.012***
	(0.002)	(0.002)	(0.001)	(0.002)
Post-application effect	-0.018***	-0.010***	0.002*	-0.009***
	(0.003)	(0.002)	(0.001)	(0.003)
Observations	55,602	36,170	34,889	35,643
R-squared	0.133	0.135	0.086	0.126
Number of banks	1,688	1,141	1,112	1,124
Bank controls	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES
Country_time FE	YES	YES	YES	YES

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Estimation of equation presented in Section 5. Estimation period Jan 2021-Dec 2023. Post-announcement effect is the interaction between post-announcement (equals one from Feb 2022 to Jan 2023) and the Germany-dummy (equals one for German banks). Post-application effect is the interaction between post-application (equals one from Mar 2023 to Dec 2023) and the German-dummy. Actual months of announcement and application (Jan 2022 and Feb 2023) are omitted from the estimations.

Table 4: Results for share of corporate loans to total assets as the response variable.

We again replace the treatment dummy interactions in our estimation equation with monthly dummy interactions to reveal the dynamic effects of the CCyB announcement and application as well as to confirm the parallel trends assumption pre-treatment. The coefficients of the interaction terms estimate the change in the dependent variable relative to the omitted baseline period (first quarter of 2021). Figure 5 plots the coefficients for each category of lending. Also this time we can see similar dynamics: there is a large drop in the corporate loan share in German banks compared to Austrian banks right after the announcement and partial recovery towards the end of the period. The effect is driven by loans to SMEs. For large companies, the effects are not statistically different from zero.

We can confirm that the parallel trend assumption holds for the share of SME loans to total assets, large company loans to total assets, and the sum of these two categories to total assets. For the share of total NFC loans to total assets, there are some months before the CCyB announcement when the difference was statistically significant and different from zero, but the size of the coefficients is very small. After the CCyB tightening was announced in January 2022, the difference between German and Austrian banks becomes negative and statistically significant for the share of SME loans to total assets and the share of the aggregate categories (the upper charts of Figure 5). For large company loans, the difference is not statistically different from zero at the monthly level during neither the announcement nor the application periods.

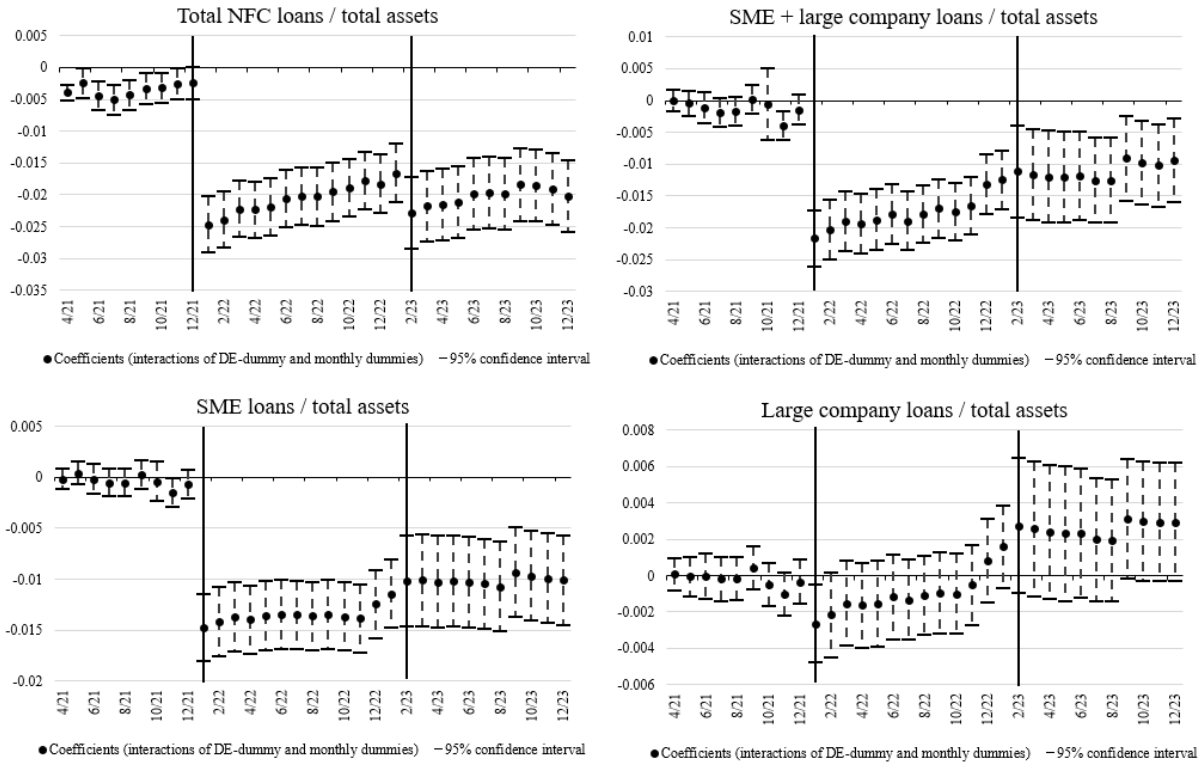


Figure 5: Dynamic effect of CCyB tightening on loan shares to total assets.

Impact on the cost of new credit

Finally, we consider how banks adjust the price of loans via lending spreads. The dependent variable in our estimation equation is now the average lending rate for new loans to SMEs, large companies, both of these company sizes together, and all NFC loans. Lending rates are bank-specific monthly averages weighted by the size of each loan contract. Table 5 presents the results for the average effect of a CCyB tightening during the post-announcement and post-application periods in Germany compared to Austria. Again, our hypotheses are clearly confirmed by the results.

For new loans to both SMEs and large companies in total, we see a positive and statistically significant effect during the post-announcement period (column 4). German banks facing a CCyB tightening increase the lending rate to new corporate loans by 0.3 percentage points compared to Austrian banks. The effect on loan rates of new loans to all NFCs (column 1) is also positive and overall of the same magnitude, but statistically not significant. However, in column 1, where the data comes from iMIR, the number of individual banks is much lower than in column 4, where the observations are derived from Anacredit.[11] This might contribute to the lack of significance. Still, these results confirm our hypothesis H1B of banks raising their lending rates following a tightening in capital requirements. Moreover, the effect is significant already and only in the post-announcement period, confirming our

[11] This dependent variable in column 1 derived from a bank-level aggregate ECB dataset is only available for a total of 63 banks in our balanced panel.

hypothesis H2 of banks changing their behaviour already following the announcement, but also highlighting that the announcement effect is clearly dominating.

	(1)	(2)	(3)	(4)
Dependent variable: loan rate for new loans	New loans to all NFCs	New loans to SMEs	New loans to large companies	New loans to SMEs + large companies
Post-announcement effect	0.228	0.465**	-0.179	0.299***
	(0.170)	(0.193)	(1.039)	(0.080)
Post-application effect	0.261	-0.148	-2.709	0.007
	(0.175)	(0.277)	(1.717)	(0.071)
Observations	2,031	6,475	1,030	6,705
R-squared	0.888	0.708	0.574	0.763
Number of banks	63	952	457	1,109
Bank controls	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES
Country_time FE	YES	YES	YES	YES

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Estimation of equation presented in Section 5. Estimation period Jan 2021-Dec 2023. Post-announcement effect is the interaction between post-announcement (equals one from Feb 2022 to Jan 2023) and the Germany-dummy (equals one for German banks). Post-application effect is the interaction between post-application (equals one from Mar 2023 to Dec 2023) and the German-dummy. Actual months of announcement and application (Jan 2022 and Feb 2023) are omitted from the estimations.

Table 5: Results for lending rate for new loans as the response variable.

Importantly, we see that this increase in lending rates of new loans post-announcement by German banks compared to Austrian banks is driven exclusively by changes in lending rates for SMEs (column 2). Banks facing a CCyB tightening increase their loan rates to SMEs by 0.47 percentage points. However, the effect disappears after the application of the CCyB. For large companies, the coefficients of the effects are negative, but statistically not significant. Thus, SMEs are again negatively affected, confirming our hypothesis H3.

Replacing the treatment dummy interactions from our estimation equation with monthly dummy interactions we again reveal the dynamic effects of the CCyB announcement and application as well as confirm the pre-treatment parallel trends assumption. The coefficients of the interaction terms estimate the change in the dependent variable relative to the omitted baseline period (first quarter of 2021). Figure 6 plots the coefficients for each category of new loans.

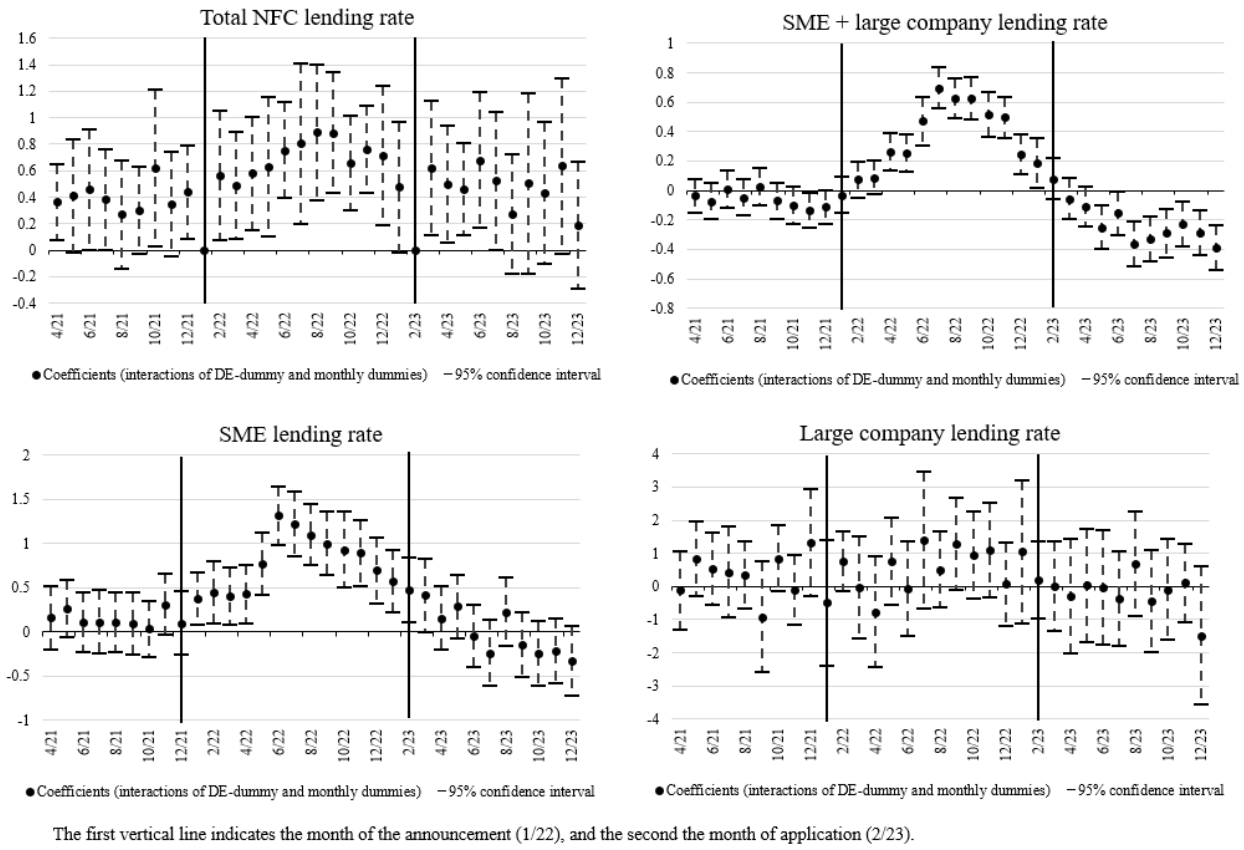


Figure 6: Dynamic effect of CCyB tightening to price of new loans.

We can confirm that the parallel trend assumption holds, as the pre-treatment coefficients (before January 2022) are not statistically different from zero. Before the CCyB was announced in Germany in January 2022, the difference between the lending rates of new corporate loans of German and Austrian banks did not change. Right after the announcement of the CCyB tightening, the difference becomes positive and statistically significant for the SME lending rate, indicating that German banks were raising their loan rates to SMEs relative to their Austrian counterparts. This effect on SME lending rates drives the aggregate lending rates in the upper panel. Although we didn't see any statistically significant effect on average post-announcement in Table 5 column 1, we do see from the upper left chart in Figure 6 how there are multiple months when also the aggregate lending rate to new NFC loans was positive and statistically significant. The impact of the CCyB tightening on bank loan rates seems to be statistically significant only during the post-announcement period. For the post-application period, there are only some separate months with significant effects.

Thus, interestingly the effects on loan rates appear much more short-lived than those on loan volumes and shares of firm loans to total assets, which we found to be rather persistent (Figures 4 and 5). This divergence could be driven by an underlying dynamic or a difference in the transmission mechanism. It could be that higher loan rates are mainly targeted to firms deemed riskier by banks, but the rise discourages loan demand by these firms and eventually dampens the effect. However, it could also be that the divergence is related to the smaller sample size available for loan rates compared to loan volumes or shares.

Comparison of our results to previous findings

Our results for loan volumes are not directly comparable to previous findings, as our approach compares the average impact on all banks within a country following the tightening of a capital-based macroprudential measure. In contrast, previous research primarily concentrates on differential impacts between banks with varying levels of capitalisation. However, our findings are qualitatively in line with previous research. Auer, Matyunina and Ongena (2022) find that after a tightening of the mortgage-targeting CCyB, a one-standard deviation increase in banks' Relative Residential Risk-Weighted Assets (RRRWA) is associated with a 0.87 percentage point reduction in the share of residential mortgages in the banks' total assets. Dursun-de Neef, Schandlbauer and Wittig (2023) found that a 1 percentage-point *reduction* of CCyB led to an increase in banks' lending by about 5.6 percentage points to their total assets, with the impact being stronger for mortgage loans and poorly capitalised banks. Basten (2020) finds that following a tightening in the mortgage-targeting CCyB, banks with smaller buffers end up with a 1.8 percentage point lower mortgage growth per annum and lose, on average, about half of their year-on-year mortgage growth. Bedayo and Galán (2024) find that the growth rate of lending by less capitalised banks decreases by up to 0.5 percentage points in the quarter following the announcement to increase the CCyB, and this effect diminishes towards the application date. Our finding that the announcement effect is even larger than the application effect is also in line with the brief consideration by Auer, Matyunina and Ongena (2022) on the difference between the two effects. We also confirm the findings of Ćehajić and Košak (2022) and Amado (2022) that SMEs are adversely impacted by the tightening of macroprudential policy, whereas large companies remain unaffected.

Comparing our results on loan rates to previous, although limited contributions on the effects of CCyB to lending rates, we can confirm that our findings are qualitatively aligned with previous research. Basten (2020) finds that banks with below-median capital cushions as well as banks with above-median mortgage specialisation each raise offered mortgage prices by an extra 8-9 basis points in response to the CCyB activation. Auer, Matyunina and Ongena (2022) find that following a 1 percentage point increase in the CCyB rate, the interest rate charged by a bank with RRRWA of 0.5 increases by 0.34 percentage points. Moreover, they also find that the announcement effect (0.47 pp) is stronger and statistically more significant than the post-application effect (0.25 pp). These are well-aligned with our findings of German banks charging on average 30 basis points higher rates than Austrian banks post-announcement.

6. Robustness checks

In this section, we conduct two formal robustness checks on our main estimations: first, by separately analysing post-announcement and post-application periods, and second, by replacing Austrian banks as the control group with a synthetic control composed of all euro area countries that have not implemented any CCyB decisions. As additional considerations, we shortly discuss two phenomena that could have an effect on our results: the role of cross-border lending and monetary policy.

Post-announcement and post-application periods separately

In our main estimations, we consider both post-announcement and post-application effects against the pre-treatment period in the same estimation. To ensure our empirical strategy is not sensitive to this, we perform a robustness check by examining these effects separately. Table 6 presents results for the volume of outstanding loans (Panel A), the share of corporate loans to total assets (Panel B), and the cost of new credit (Panel C). Both post-announcement and post-application effects are estimated against the pre-treatment period of January 2021 – December 2021, where the parallel trend assumption holds, ensuring the internal validity of our strategy.

Comparing the results in Table 6 with those in Tables 3–5, we observe overall similarity in both the size and statistical significance of the estimated coefficients. German banks facing a CCyB tightening decreased their lending to non-financial corporations compared to Austrian banks, an effect visible both post-announcement and post-application. German banks primarily reduce lending to SMEs. There is no effect on large company lending post-announcement, but a slight positive effect post-application. The results are similar irrespective of whether we consider the volume of outstanding loans or the share of loans to total assets. German banks facing a CCyB tightening also increase the lending rate to new corporate loans post-announcement compared to Austrian banks, the effect being statistically insignificant post-application. Moreover, the increase in lending rates is driven by new loans to SMEs.

Our results are also robust to extending the post-treatment period until September 2024 and incorporating additional bank-specific controls, such as the share of non-performing loans. These results are available upon request.

Panel A	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: ln(loan stock)	Total NFC lending		SME lending		Large company lending		SME + large company lending	
Post-announcement effect	-0.081***		-0.173***		0.012		-0.138***	
	(0.016)		(0.033)		(0.046)		(0.020)	
Post-application effect		-0.108***		-0.136***		0.111**		-0.068*
		(0.029)		(0.037)		(0.055)		(0.039)
Observations	37,086	33,913	25,225	23,015	24,312	22,153	24,820	22,612
R-squared	0.235	0.249	0.120	0.175	0.083	0.154	0.146	0.149
Number of banks	1,631	1,641	1,131	1,140	1,106	1,108	1,116	1,122
Bank controls	YES	YES	YES	YES	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES	YES	YES	YES	YES
Country_time FE	YES	YES	YES	YES	YES	YES	YES	YES
Robust standard errors in parentheses								
*** p<0.01, ** p<0.05, * p<0.1								

Panel B	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: loans / total assets	Total NFC lending		SME lending		Large company lending		SME + large company lending	
Post-announcement effect	-0.014***		-0.012***		0.001		-0.012***	
	(0.002)		(0.002)		(0.001)		(0.002)	
Post-application effect		-0.018***		-0.010***		0.003**		-0.008***
		(0.003)		(0.002)		(0.001)		(0.003)
Observations	38,742	35,395	25,226	23,023	24,316	22,163	24,867	22,650
R-squared	0.082	0.162	0.108	0.158	0.064	0.105	0.067	0.135
Number of banks	1,686	1,688	1,131	1,141	1,106	1,108	1,116	1,123
Bank controls	YES	YES	YES	YES	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES	YES	YES	YES	YES
Country_time FE	YES	YES	YES	YES	YES	YES	YES	YES
Robust standard errors in parentheses								
*** p<0.01, ** p<0.05, * p<0.1								

Panel C	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: loan rate for new loans	Total NFC lending		SME lending		Large company lending		SME + large company lending	
Post-announcement effect	0.258		0.400*		-0.802		0.294***	
	(0.173)		(0.208)		(1.155)		(0.080)	
Post-application effect		0.201		-0.403		-2.652		0.006
		(0.187)		(0.301)		(1.762)		(0.071)
Observations	1,422	1,291	4,132	3,817	2,230	2,016	4,475	4,252
R-squared	0.776	0.917	0.475	0.767	0.308	0.661	0.517	0.823
Number of banks	63	63	910	910	370	335	1,101	1,108
Bank controls	YES	YES	YES	YES	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES	YES	YES	YES	YES
Country_time FE	YES	YES	YES	YES	YES	YES	YES	YES
Robust standard errors in parentheses								
*** p<0.01, ** p<0.05, * p<0.1								

Columns 1,3,5, and 7 estimate the post-announcement effect (interaction between post-announcement and the Germany-dummy) against the pre-treatment period (Jan 2023-Dec 2021). In these estimations post-application period is omitted. Columns 2,4,6, and 8 estimate the post-application effect (interaction between post-application and the Germany-dummy) against the pre-treatment period (Jan 2023-Dec 2021). In these estimations post-announcement period is omitted. Actual months of announcement and application (Jan 2022 and Feb 2023) are omitted from all estimations.

Table 6: Robustness check: estimating post-announcement effect and post-application effect separately.

Synthetic control group replacing Austrian banks

To further ensure that are results are not simply driven by our choice of Austrian banks as the control group, we employ the synthetic control method as a robustness check. This approach allows us to construct a synthetic control group that closely mirrors the characteristics (the response variables) of the treated group prior to the treatment. This method enhances the credibility of our results by addressing potential biases from unobserved confounders. Arkhangelsky et al. (2021) propose the Synthetic Difference-in-Differences estimator (SDID), a flexible modelling option that can be applied in panel data settings. SDID allows for treated and control groups to trend on entirely different levels prior treatment and seeks to optimally generate a matched control unit, considerably loosening the need for parallel trend assumptions.

In forming the synthetic control, we use banks from Austria, Finland, Greece, Malta, Portugal, and Spain –countries in the euro area that at the time of the German decision to tighten CCyB had not yet adopted the CCyB. We estimate the average treatment effects of the treated separately for pre-announcement and pre-application periods. Results are presented in Table 7.

Overall, the results from the synthetic control method confirm our main findings. German banks facing a CCyB tightening decreased their lending to non-financial corporations compared to the synthetic control group, with the effect visible both post-announcement and post-application. German banks primarily reduce lending to SMEs, whereas there is no effect on large company lending. The results are consistent whether considering the volume of outstanding loans or the share of loans to total assets. The largest difference in the results is between column 1 in Table 3 and columns 1 and 2 in Panel A of Table 7. Table 7 has a positive post-announcement effect for total NFC lending significant at the 5 % level, and no significant effect post-application. In Table 3, the effect was negative and significant for both post periods. Overall, our main findings of the announcement effect and SMEs suffering most are clearly confirmed.

Regarding the cost of new credit, Panel C in Table 7 presents positive and significant coefficients for the post-announcement effect on the cost of new SME loans (column 3) and new SME and large company loans on aggregate (column 7). Compared to insignificant coefficients in other columns and rows in Table 3, Table 7 shows that post-application, German banks facing a CCyB tightening decrease the lending rates to large company loans compared to the synthetic control group.

Panel A	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: ln(loan stock)	Total NFC lending		SME lending		Large company lending		SME + large company	
Post-announcement effect	0.019**		-0.034*		0.033		-0.048***	
	(0.008)		(0.018)		(0.024)		(0.012)	
Post-application effect		0.011		-0.101***		0.014		-0.095***
		(0.020)		(0.030)		(0.041)		(0.023)
Observations	42,850	39,422	27,200	25,024	25,850	23,736	26,850	24,633
Bank controls	YES	YES	YES	YES	YES	YES	YES	YES
Robust standard errors in parentheses								
*** p<0.01, ** p<0.05, * p<0.1								

Panel B	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: loans / total assets	Total NFC lending		SME lending		Large company lending		SME + large company lending	
Post-announcement effect	-0.003***		-0.004***		0.000		-0.004***	
	(0.001)		(0.001)		(0.000)		(0.001)	
Post-application effect		-0.005***		-0.007***		0.001		-0.007***
		(0.002)		(0.001)		(0.001)		(0.001)
Observations	45,775	42,113	27,200	25,024	25,850	23,782	26,850	24,702
Bank controls	YES	YES	YES	YES	YES	YES	YES	YES
Robust standard errors in parentheses								
*** p<0.01, ** p<0.05, * p<0.1								

Panel C	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: loan rate for new loans	Total NFC lending		SME lending		Large company lending		SME + large company lending	
Post-announcement effect	0.201**		0.187***		-0.241		0.267***	
	(0.080)		(0.051)		(0.173)		(0.035)	
Post-application effect		0.227*		-0.001		-0.635**		0.005
		(0.126)		(0.096)		(0.260)		(0.071)
Observations	2,450	2,254	4,625	4,255	1,500	1,380	5,250	4,830
Bank controls	YES	YES	YES	YES	YES	YES	YES	YES
Robust standard errors in parentheses								
*** p<0.01, ** p<0.05, * p<0.1								

Results of the synthetic difference-in-differences estimator using bootstrap procedure to calculate standard errors. Columns 1,3,5, and 7 estimate the post-announcement effect (interaction between post-announcement and the Germany-dummy) against the pre-treatment period (Jan 2023-Dec 2021). In these estimations post-application period is omitted. Columns 2,4,6, and 8 estimate the post-application effect (interaction between post-application and the Germany-dummy) against the pre-treatment period (Jan 2023-Dec 2021). In these estimations post-announcement period is omitted. Actual months of announcement and application (Jan 2022 and Feb 2023) are omitted from all estimations.

Table 7: Robustness check: synthetic diff-in-diff estimators. Estimating post-announcement effect and post-application effect separately.

Additional considerations

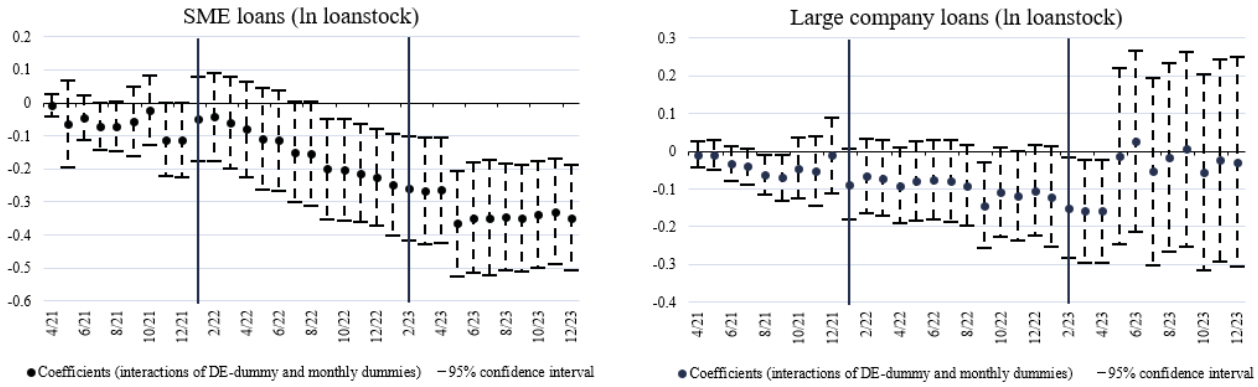
Until now, our analysis has focused exclusively on domestic lending, abstracting from the fact that banks can operate across borders. The German CCyB applies to all German banks as well as to subsidiaries of foreign banks established in Germany.[12] If German banks were to shift part of their lending activity to Austrian firms – where the CCyB would not apply – this would fall outside the scope of our sample. However, such a shift would only reinforce our main findings, as it would amplify the observed difference in lending between German and Austrian firms.

Similarly, banks in other member states of the European Economic Area (EEA) are required to apply the CCyB to their exposures to Germany, up to a maximum of 2.5%, under the reciprocity framework. This means that Austrian banks that lend to German firms must apply the German CCyB to those exposures. Since our analysis is limited to domestic lending, foreign exposures are excluded from the sample. However, such lending is rather limited. In total, Austrian banks' exposures to German firms account for approximately 7.5% of their corporate loan portfolios. This lending is highly concentrated: roughly 20 Austrian banks account for over 90% of the loans extended to German companies.

Following the CCyB tightening in Germany, Austrian banks may also have reduced their lending to German firms due to the reciprocity requirement. If this is the case, it would further support our main finding regarding the negative impact of CCyB tightening on lending. To investigate this, we re-estimate our equations using a sample restricted to Austrian banks, examining their lending to both domestic and German firms before and after the announcement and application of the CCyB increase in Germany.

Figure 7 presents the dynamic effects of the CCyB tightening on Austrian banks' exposures to German firms. We confirm that the parallel trend assumption holds prior to the CCyB announcement, as the difference in lending volumes to German versus Austrian firms remained stable. After the CCyB announcement, this difference becomes increasingly negative and reaches statistical significance by autumn 2022, suggesting that Austrian banks became less willing to lend to German firms relative to domestic ones. Moreover, this effect is more pronounced for SMEs than for large firms, with statistically significant results for large firms observed only in select months. These findings provide additional support for our main conclusion that CCyB tightening has a negative impact on lending, particularly to SMEs.

[12] In our sample, all subsidiaries of foreign banks in Germany are considered German and the CCyB tightening directly applies to them.



Estimation of equation presented in Section 5 where we now only include lending of Austrian banks to Austrian and German firms (SMEs and large companies separately). Treatment dummy interactions are between monthly dummies and the German-dummy that equals one if loans are granted to German firms. First quarter of 2021 omitted from the estimations. Estimations include bank and time fixed effects. The first vertical line indicates the month of the announcement (1/22) , and the second the month of application (2/23).

Figure 7: Dynamic effect of CCyB tightening to German exposures of Austrian banks.

Another point to consider is the role of monetary policy. Given that the steep cycle of monetary policy tightening by the ECB coincides with our period of interest, the pass-through of monetary policy could be a potential driver of our results on the rates of new loans. This would not constitute a problem, if German and Austrian banks are assumed to react similarly to monetary policy tightening. There is however preliminary evidence indicating that the reaction to monetary policy tightening might be different in Austria than in Germany, as the weighted average maturity of the risk-free rate for newly issued loans of NFCs was slightly lower in Austria compared to Germany in 2022-2023 (Vilerts et al., 2025). It could thus be that during monetary tightening Austrian banks increase the rate for new loans more than German banks do. However, also this would only mean that our results are a lower limit to the true effect.

7. Conclusions

We investigate the impact of a change in the countercyclical capital buffer (CCyB) on bank lending for firms in Germany. Utilising the granularity of confidential loan-level data alongside more aggregated datasets and a difference-in-differences approach, we provide robust evidence on the effects of the CCyB tightening. Our findings indicate that tightening the CCyB rate leads to a significant reduction in the volume of corporate loans and an increase in the lending rates for new loans. This suggests that banks respond to higher capital requirements by curtailing credit supply and raising loan prices, thereby affecting firms' access to finance.

We show that these effects materialise not only upon the application of the new CCyB rate but already following its announcement. The effect on loan rates in particular is statistically significant only after the announcement and fades away after the application. This anticipatory behaviour by banks underscores the importance of considering both the announcement and implementation phases of macroprudential policy changes for policymakers and researchers alike. Our results highlight that banks adjust their lending practices in anticipation of regulatory changes, which can have immediate implications for credit availability. If policymakers are oblivious to these dynamics, their attempts to manage the credit cycle with cyclical macroprudential policy measures such as the CCyB may be severely hampered.

Importantly, our analysis reveals a heterogeneous impact on firms of different sizes. Small and medium-sized enterprises (SMEs) experience more pronounced credit constraints and higher borrowing costs, whereas larger firms are not affected. This different effect underscores the vulnerability of SMEs to changes in macroprudential policy and a possible need for targeted measures to support this segment of the economy. This is of high policy relevance in Germany, with a high share of SMEs, that are also more dependent on bank lending. Our findings suggest that while tightening capital requirements makes the banking system more resilient, it may have the unintended consequence of more severe credit constraints for SMEs.

In conclusion, we contribute to the understanding on how macroprudential policies, specifically the CCyB, influence bank lending behaviour and firm financing conditions. The evidence of the announcement effect being clearly larger than the application effect and the different impact on SMEs vs. large companies provide valuable insights for policymakers. A natural next step is to make use of these findings to expand the analysis to the announcement effects of decisions made in other euro area countries, as well as whether the SMEs in other countries also face similar asymmetric repercussions from macroprudential policy. Future research could also further explore the long-term implications of these findings on bank lending behaviour and firm performance.

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Annex 1

We define "clean" CCyB decisions as decisions where a change was made to the level of the CCyB, where the announced decision eventually came into force and where there were no decisions with overlapping announcement-to-application periods. For example, as illustrated in Figure A1, in Germany in June 2019 a tightening of the CCyB was announced with an application date in July 2020. However, before the new CCyB rate came into force, the tightening was reversed due to the Covid-19 pandemic, with a new decision in March 2020 that was applied immediately in April 2020. Thus, the June 2019 decision is not a clean CCyB decision we can make use of.[13] There are also decisions of the same direction that overlap in the sense that their announcement-to-application periods overlap: a second decision of the same direction was announced before the first decision was applied. Again, Figure A1 illustrates an example of France announcing and applying two overlapping CCyB decisions during 2022–2024.

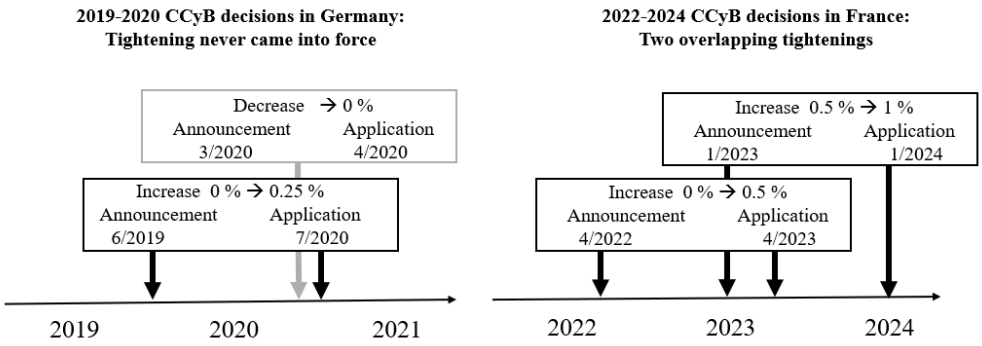


Figure A1: Examples of overlapping CCyB decisions.

However, to keep our identification as sharp as possible, we need a single clean CCyB decision with no overlaps with other CCyB decisions. We also want to avoid decisions related to the economic crisis caused by the Covid-19 pandemic, because these decisions were applied with lags of only some weeks and thus their transmission mechanism should be quite different from the decisions announced and applied during normal times and with lags of on average 12 months. To reduce the risk of the peculiarity of the Covid-19 crisis driving our results, we want to choose a decision not related to the crisis. There are only a few CCyB decisions that fulfil our strict criteria for a clean CCyB decision taken by Euro area countries (Table A1) during our sample period of 2020 to 2024. Incidentally these are all tightening decisions, but there is no reason per se why our approach would not work for easing decisions also.

[13] Moreover, Anacredit data of sufficiently good quality is not available for mid-2019. Otherwise, we could use this reversed decision as a validation for the announcement effect we uncover.

Country	Date of Announcement	CCyB rate	Type of setting	Application since
Germany	31.1.2022	0,75	Increase	1.2.2023
Latvia	18.12.2023	0,5	Increase	18.12.2024
Lithuania	5.10.2022	1	Increase	1.10.2023
Slovakia	22.6.2022	1,5	Increase	1.8.2023

Table A1: Clean CCyB decisions by Euro area countries. See Table A2 for the full sample of CCyB decisions by Euro area countries. Source: ESRB.

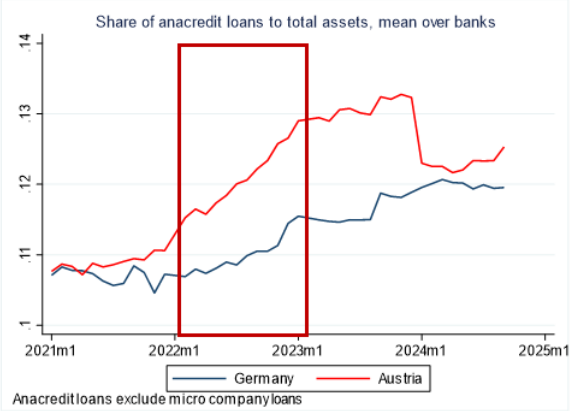
Country	Date of Announcement	CCyB rate	Type of setting	Application since
Belgium	28.6.2019	0,5	Increase	1.7.2020
Belgium	27.3.2020	0	Decrease	1.4.2020
Belgium	29.9.2023	0,5	Increase	1.4.2024
Belgium	29.9.2023	1	Increase	1.10.2024
Croatia	30.3.2022	0,5	Increase	31.3.2023
Croatia	16.12.2022	1	Increase	31.12.2023
Croatia	30.6.2023	1,5	Increase	30.6.2024
Cyprus	1.12.2022	0,5	Increase	30.11.2023
Cyprus	2.6.2023	1	Increase	2.6.2024
Estonia	30.11.2021	1	Increase	7.12.2022
Estonia	29.11.2022	1,5	Increase	1.12.2023
France	1.7.2018	0,25	Increase	1.7.2019
France	3.4.2019	0,5	Increase	2.4.2020
France	1.4.2020	0	Decrease	1.4.2020
France	7.4.2022	0,5	Increase	7.4.2023
France	2.1.2023	1	Increase	2.1.2024
Germany	28.6.2019	0,25	Increase	1.7.2020
Germany	31.3.2020	0	Decrease	1.4.2020
Germany	31.1.2022	0,75	Increase	1.2.2023
Ireland	5.7.2018	1	Increase	5.7.2019
Ireland	1.4.2020	0	Decrease	1.4.2020
Ireland	15.6.2022	0,5	Increase	15.6.2023
Ireland	24.11.2022	1	Increase	24.11.2023
Ireland	7.6.2023	1,5	Increase	7.6.2024
Latvia	18.12.2023	0,5	Increase	18.12.2024
Lithuania	21.12.2017	0,5	Increase	31.12.2018
Lithuania	21.6.2018	1	Increase	30.6.2019
Lithuania	31.3.2020	0	Decrease	1.4.2020
Lithuania	5.10.2022	1	Increase	1.10.2023
Luxembourg	31.12.2018	0,25	Increase	1.1.2020
Luxembourg	27.12.2019	0,5	Increase	1.1.2021
Netherlands	25.5.2022	1	Increase	25.5.2023
Netherlands	31.5.2023	2	Increase	31.5.2024
Slovakia	29.7.2016	0,5	Increase	1.8.2017
Slovakia	21.7.2017	1,25	Increase	1.8.2018
Slovakia	10.7.2018	1,5	Increase	1.8.2019
Slovakia	26.7.2019	2	Increase	1.8.2020
Slovakia	30.4.2020	1,5	Decrease	1.5.2020
Slovakia	17.7.2020	1	Decrease	1.8.2020
Slovakia	22.6.2022	1,5	Increase	1.8.2023
Slovenia	30.12.2022	0,5	Increase	31.12.2023
Slovenia	19.12.2023	1	Increase	1.1.2025

	"Clean" CCyB decisions
	Overlapping decisions
	Decisions that were not applied
	Decreases related to Covid-19

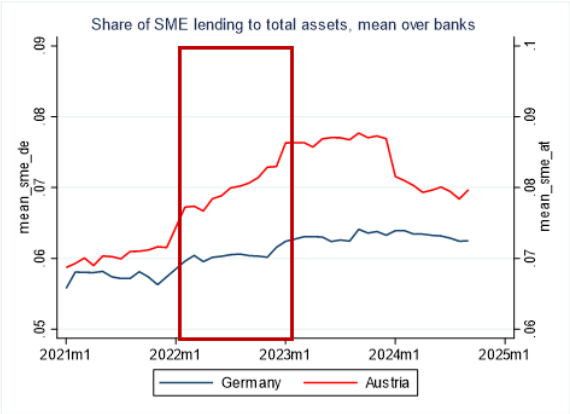
Table A2: All CCyB decisions announced by Euro area countries 2018-2024. Source: ESRB.

Annex 2

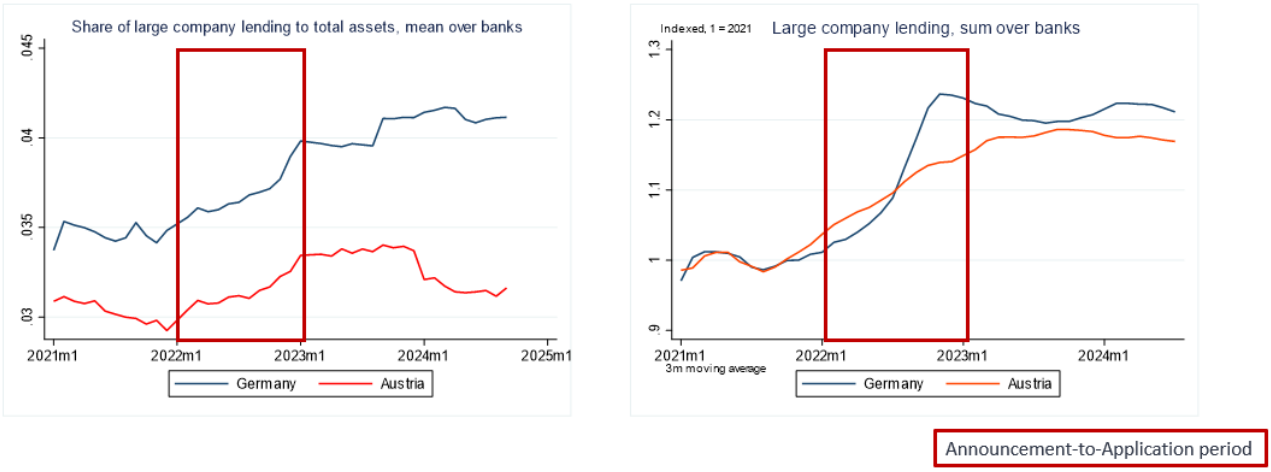
Announcement-to-Application period



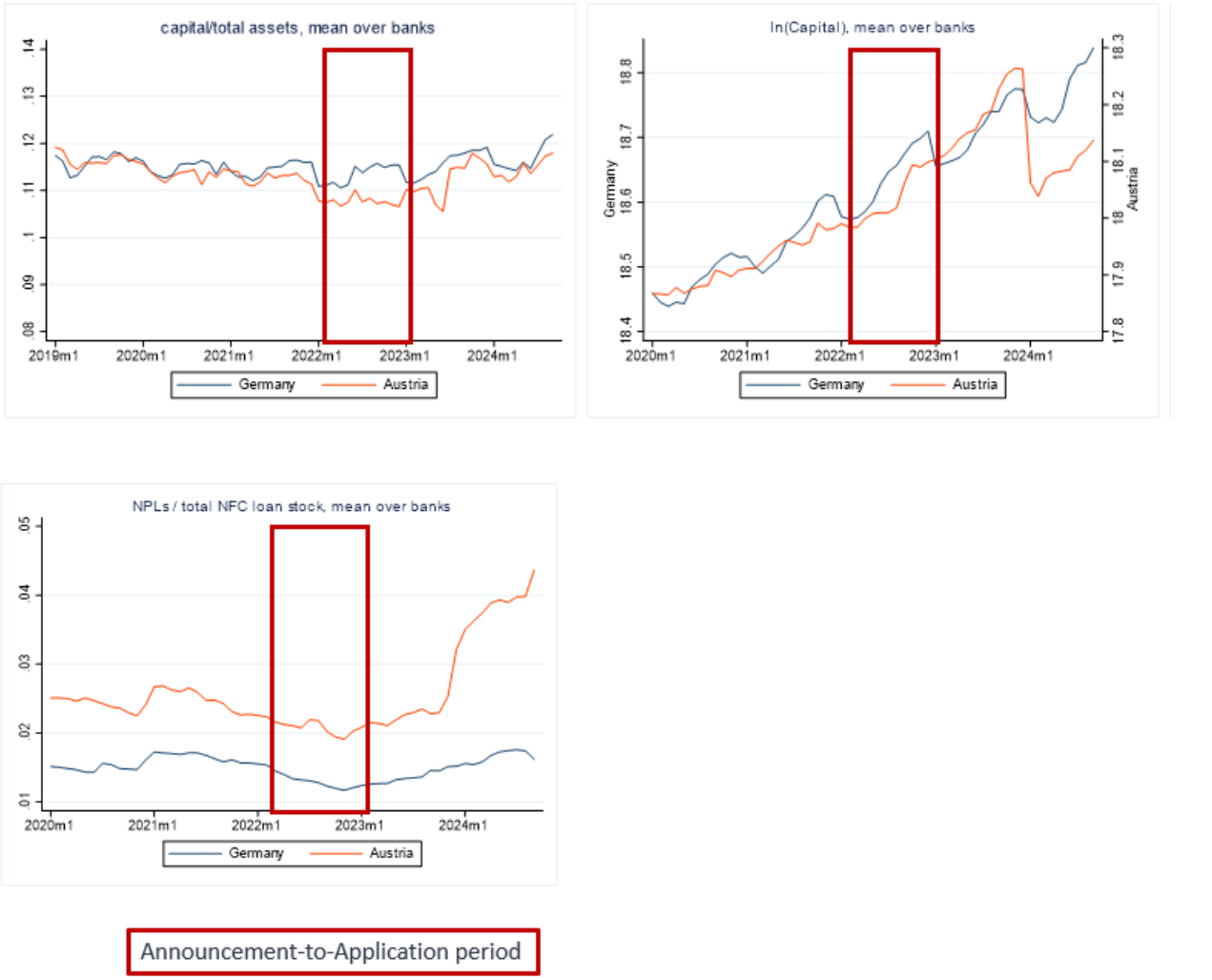
Announcement-to-Application period



Announcement-to-Application period



Figures A2: Visual inspection of pre-treatment parallel trends in response variables for Germany and Austria



Figures A3: Visual inspection of pre-treatment parallel trends in bank characteristics for Germany and Austria

Annex 3

	Germany					Austria				
Variable	# obs	Mean	Std dev	Min	Max	# obs	Mean	Std dev	Min	Max
Total assets (EUR mln)	47 335	10 200.00	76 500.00	0.00	1 590 000.00	13 428	3 920.00	18 900.00	0.00	261 000.00
Bank size (log of total assets)	47 246	20.99	1.64	9.68	28.09	13 425	20.31	1.40	13.82	26.29
Capitalization (equity/total assets)	46 845	0.11	0.08	0.00	1.13	13 228	0.12	0.05	0.00	1.00
Large company lending (EUR mln)	26 507	525.00	2 380.00	0.00	54 300.00	11 610	255.00	1 270.00	0.00	18 300.00
SME lending (EUR mln)	27 021	399.00	1 260.00	0.00	21 900.00	12 479	167.00	494.00	0.15	5 840.00
Large company + SME lending (EUR mln)	27 716	1 270.00	4 590.00	0.00	66 200.00	12 592	544.00	2 020.00	0.15	27 200.00
NFC aggregate lending (EUR mln)	47 332	1 460.00	11 800.00	0.00	324 000.00	13 428	827.00	3 840.00	0.00	55 900.00
Large company lending to total assets	26 507	0.04	0.04	0.00	0.39	11 610	0.03	0.04	0.00	0.48
SME lending to total assets	27 021	0.06	0.04	0.00	0.56	12 479	0.08	0.06	0.00	0.50
Large company + SME lending to total assets	26 459	0.11	0.07	0.00	0.98	12 441	0.12	0.08	0.00	0.67
NFC aggregate lending to total assets	47 243	0.15	0.12	0.00	0.96	13 425	0.22	0.11	0.00	0.73
Loan rate for new loans to large companies	711	3.91	2.44	0.01	11.66	321	2.89	1.67	0.32	8.68
Loan rate for new loans to SMEs	4 302	3.53	1.88	0.01	13.71	2 175	3.37	1.75	0.31	9.31
Loan rate for new loans to large companies + SMEs	4 543	3.17	1.77	0.01	13.71	2 252	3.07	1.69	0.31	9.31
Loan rate for new loans to NFCs in aggregate	1 651	2.85	1.72	-	11.28	442	2.65	1.64	0.23	7.22

Germany and Austria separately, data from January 2021 to December 2023

Table A3. Summary statistics for Germany and Austria separately.

Annex 4

The ESRB data has many advantages over other sources of information on the use of macroprudential measures, such as the *iMaPP by the International Monetary Fund* (Alam et al., 2025, used by e.g. Ćehajić and Košak, 2021, Forbes, 2021, Bergant et al., 2024, Madeira, 2024), *IBRN Prudential Database* (Cerrutti et al., 2017) *Global Macroprudential Index or GMPI* (Cerutti, Claessens, Laeven, 2017, used by e.g. Hu and Gong, 2019; Belkhir et al., 2022; Brana et al., 2024), or the *Macroprudential Policies Evaluation Database or MaPPED by the ECB* (Budnik and Kleibl, 2018, used by e.g. Meuleman and Vander Vennet, 2020; Ćehajić and Košak, 2022). The GMPI records only the number of macroprudential policy tools implemented by a country in a given year, thus making it a very coarse measure of macroprudential policy. iMaPP, IBRN Prudential Database and MaPPED record macroprudential decisions, coding tightening and easing decisions with different signs. Crucially, all of these data record changes in macroprudential policy only once the decision has been implemented, that is by application date, not announcement date.

The ESRB data provides much more precise information as it includes the exact level of the CCyB and the announcement date of each change. The data indicates whether a decision related to the CCyB was an implementation, a tightening, or an easing. It also includes the exact level of the CCyB rate, the dates when a decision was announced and applied, and whether an announcement eventually came into effect. The information is supplemented with rich metadata, allowing us to trace back to the original motivation and arguments used by macroprudential authorities when they were making the decision. Finally, the ESRB data is very up to date, as European countries need to notify the ESRB of macroprudential decisions within a set timeframe. Of the other widely used data sets, GMPI and MaPPED end in 2017 and are not currently updated, and the iMaPP and the IBRN Prudential Database are updated with considerable lag given the large country samples involved.

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ISSN 1456-6184, online

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