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Tim Sepp / Karl-Friedrich Israel /
Benjamin Treitz / Tom Hartl

Monetary Policy and Bank-Type Resilience in Germany from 1999 to 2022

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Monetary Policy and Bank-Type Resilience in Germany from 1999 to 2022*

Tim Sepp†
Leipzig University
sepp@wifa.uni-leipzig.de

Karl-Friedrich Israel
Saarland University
UCO Angers
kisrael@uco.fr

Benjamin Treitz
BNP Paribas
benjamin.treitz@ca.bnpparibas.com

Tom Hartl
DIW Berlin
thart@diw.de

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Abstract

This paper examines the heterogeneous effects of the ECB's monetary policies on the resilience of the German banking system between 1999 to 2022. We distinguish between the main bank types in Germany: Large Banks, Regional Banks, Sparkassen, Landesbanken and Credit Unions. We proxy bank-type resilience by a z-score measure. We use structural monetary policy shocks relying on high-frequency identification methods. Unconventional monetary policy shocks are decomposed into three parts: timing shocks, forward guidance, and quantitative easing. We estimate the resilience of German bank types in response to expansionary monetary policy shocks by producing impulse response functions through local projections. Conventional monetary easing is associated with weakened resilience for all bank types. Unconventional monetary policies have heterogeneous effects on German bank types. Shocks to short-term interest rate expectations (i.e. timing shocks) are associated with increasing resilience of Large Banks, Regional Banks and Landesbanken, but with decreasing resilience of the others. Forward guidance only has a positive impact on the resilience of Sparkassen. Large-scale asset purchases through quantitative easing tend to the increase resilience of Large Banks and Sparkassen, but decrease the resilience of Regional Banks, Credit Unions and Landesbanken, in both, the short and long run.

Keywords: Resilience, Financial Stability, Monetary Policy, Unconventional Monetary Policy, Banking System, Germany.
JEL-Codes: E42, E52, G21, M41.

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†Corresponding author e-mail address: sepp@wifa.uni-leipzig.de

1 Introduction

Economies around the world seem to have become more vulnerable to crises. In this context, resilience has become the new hot topic in public discourse and policy debates (de Guindos 2023a, Schnabel 2023). Financial stability has become an important monetary policy goal (ECB 2007, Bundesbank 2021, FED 2021, IMF 2023). Recently, however, there has been a conceptual and terminological shift from *financial stability* to *resilience*, emphasizing more specifically the capacity to cope with exogenous threats. On this basis new justifications for policy interventions into the monetary and financial system have been formulated (Lagarde 2021, Lagarde 2022).

Resilience generally refers to the capacity of a system to respond and adapt to unexpected external shocks. It can be broken down into two key aspects: robustness and adaptability (Aligica and Tarko 2014, Salter and Tarko 2019). Robustness refers to a system's ability to absorb shocks, recover quickly, and get back to normal. It captures how much stress a system can withstand before collapsing. Strong robustness alone, however, can lead to over-optimization to outdated conditions (Carlson and Doyle 1999, 2000, 2002). It can prevent necessary adjustments to a changing environment. Adaptability refers to a system's capacity to adjust, evolve and respond to new conditions and constraints. Hence, adaptability, too, is an integral part of a resilient economy.

Studying the resilience of banks is crucial as they form the backbone of the financial system that is supposed to coordinate activities in the real economy. Monetary policy is widely seen as the primary tool for stabilizing the economy during downturns. Empirical evidence confirms that in a typical economic downturn, monetary policy can effectively stabilize conditions in the short run (Leigh and Stehn 2009, Kannan et al. 2009, Bech et al. 2012, Sanchez et al. 2015, Israel 2017).

However, the efficacy of conventional monetary policy diminishes in financial crises, when the transmission channels[1] through which monetary policy unfolds are impaired

[1]Regarding the relevance of the topic, it is not surprising that there exists a growing literature on the channels through which unconventional monetary policies impact the banking system and financial stability. The most prominent channels considered in this work are the credit channel and risk-taking channel (Kashyap and Stein 2000, Gambacorta and Marques-Ibanez 2011, Borio and Zhu 2012, Dell'Ariccia et al. 2017).

(Borio 2012, Sanchez et al. 2015, Sepp et al. 2024). Unconventional monetary policies are then often deemed necessary to mitigate the adverse effects of a collapsing financial system on the real economy (Mishkin 2009, Borio 2012). However, excessively loose monetary policies, especially the unprecedented expansion of central banks' balance sheets, can introduce unforeseen risks. Prolonged monetary easing may delay necessary balance sheet adjustments of financial intermediaries and prolong financial fragility (Borio and Disyatat 2010, Borio 2012, Bouis et al. 2013). Unconventional monetary policy measures, such as (targeted) longer-term refinancing operations ((T)LTROs), large-scale asset purchases through quantitative easing (QE), negative interest rate policies and forward guidance, can lead to excessive credit growth, distortions in financial markets, conflicts in sovereign debt management, the amplification of economic inequalities and moral hazard (Caruana 2012, Sanchez at al. 2015, Salter and Tarko 2017, 2019, Schnabl 2019, Israel and Latsos 2020, Israel et al. 2022, 2023).

Our study builds on the existing literature to offer new insights into the relationship between unconventional monetary policy and bank resilience. We provide new evidence from Germany showing that monetary policy has not generally improved the resilience of banks. Measuring resilience is not straightforward. Following Avalos and Mamatzakis (2023) and Sepp et al. (2024), we draw upon the z-score as a measure of a bank's loss-absorbing buffer. We therefore focus on the first of the two aspects of resilience, that is, robustness. We estimate impulse response functions (IRFs) of the z-score for different German bank types to investigate the propagation of monetary policy shocks on bank resilience over time.

We make several contributions to the literature. First, we focus on the leading economy of the Euro area, studying the resilience of its banking system on a semi-aggregated level, over the entire Euro period from 1999 to 2022. Second, we study the effect of (un)conventional monetary policy shocks on German bank type resilience in detail. Our empirical approach allows us to analyze the effects of conventional interest rate cuts, shocks to short-term rates, forward guidance and QE, separately. Third, we estimate IRFs on monetary policy shocks based on the high-frequency identification method of

Altavilla et al. (2019) and Baumgärtner and Klose (2021).

The main findings of our study suggest heterogeneous effects of (un)conventional monetary policies on banks depending on the bank type and the time horizon. Overall, we cannot conclude that monetary policy has generally enhanced the resilience of banks.

The paper is structured as follows. Section 2 contains a review of the literature connected to monetary policy, banking, and financial stability. We then present our data in Section 3. The estimation framework and results are outlined in Section 4. We draw policy implications from our analysis at the end.

2 Literature Review

Research on the impact of monetary policy on banking is vast. There are two crucial transmission channels of monetary policy on banks discussed in the literature: the bank-lending channel (Kashyap and Stein 2000, Ashcraft and Campello 2007, Gambacorta and Marques-Ibanez 2011, Jimenez et al. 2012, De Santis and Surico 2013, Ciccarelli et al. 2013, Ciccarelli et al. 2015, Buch et al. 2019) and the risk-taking channel (Instefjord 2005, Borio and Zhu 2012, Jimenez et al. 2014, Bruno and Shin 2015, Dell'Ariccia et al. 2017, Adrian et al. 2019).

The bank-lending channel highlights what happens to the asset side of MFIs' balance sheets and emphasizes the importance of differences in balance sheet characteristics of heterogeneous bank types (Kashyap and Stein 2000, Gambacorta and Marques-Ibanez 2011, Jiminez et al. 2012, De Santis and Surico 2013, Buch et al. 2019). The risk-taking channel of monetary policy suggests that variations in monetary policy affect financial intermediaries' readiness to assume risk which alters the supply of credit to the real economy. For example, low interest rates might encourage bankers' propensity to take risks as they positively affect the valuation of assets and collaterals (Gambacorta and Marques-Ibanez 2011, Borio and Zhu 2012, Adrian et al. 2019).

Using quarterly data from 1976 to 1993 on all insured U.S. commercial banks, Kashyap and Stein (2000) show that the transmission of monetary easing is more pronounced for

banks that hold overall fewer liquid assets.[2] Gambacorta and Marques-Ibanez (2011) show that the bank-lending channel in the US and Europe structurally changed during the Great Financial Crisis. Banks restricted the loan supply more strongly that had lower levels of core capital, relied more heavily on market funding and generated a significant portion of their income from non-interest sources. Using a micro dataset on loan applications from Spain, Jiminez et al. (2012) analyse the impact of monetary policy on the supply of bank credit. They find that a tighter monetary policy stance significantly reduces loan granting, especially for banks with lower capital or liquidity ratios. De Santis and Surico (2013) show that the bank-lending channel is highly heterogenous in the eurozone. Specifically, in Germany, monetary policy seems to have a more pronounced impact on the credit provision of Credit Unions and Sparkassen, which have limited liquidity and lower capital ratios. Similarly, in Italy, monetary policy seems to have stronger effects on savings banks, which are smaller in size. In a similar vein, Altavilla et al. (2019) show that more liquid and better capitalized eurozone banks are more resilient to monetary contractions.

Using two extensive datasets on Spanish and Bolivian Banks' credit register, Jimenez et al. (2009) and Ioannidou et al. (2009) provide evidence that an accommodative monetary policy stance has encouraged elevated levels of risk-taking by banks before the Great Financial Crisis, possibly leading to excessive risk exposure. Jimenez et al. (2014) study the impact of monetary policy on the composition of banks' supply of credit using data on Spanish bank loans for the period between 2002 and 2008. They find that lower short-term interest rates induce weakly capitalized banks to grant more loans to risky firms. These findings are consistent with the risk-taking channel of monetary policy. Using loan level data of U.S. banks between 1997 and 2011, Dell'Ariccia et al. (2017) analyse the risk-taking channel of monetary policy for the U.S. banking system. They find that banks' risk-taking is positively associated with decreases in short-term policy rates. Monetary policy directly impacts the risk level of banks and thus has broader implications for overall financial stability. Adrian et al. (2019) provide further

[2]Kashyap and Stein (2000) measure liquid assets as the ratio of securities to assets

evidence for the risk-taking channel of monetary policy. They find that the effectiveness of monetary policy depends on the risk-taking behaviour of financial intermediaries through their management of balance sheets in response to changing economic conditions.

More recently, Grimm et al. (2023) show that when the monetary policy stance is accommodative over an extended period, the probability of financial crises increases significantly. Abadi et al. (2023) provide evidence that there is a rate – the so-called reversal interest rate – at which an accommodative monetary policy becomes contractionary for lending. This is because further monetary easing (i.e. through unconventional monetary policies) cuts into banks' profitability, curtailing their credit supply and financial stability on the long line. Avalos and Mamatzakis (2023) examine the impact of unconventional monetary policies on the resilience of the banking sector in the eurozone between 2007 and 2018. They find that unconventional monetary policies are overall positively associated with the resilience of banks.

Monetary policy is generally seen as the primary tool for stabilizing the economy and the financial system during downturns. In a narrow sense, the financial system can be characterized as stable in the absence of excessive volatility, stress, or crises. In a broader sense, financial stability encompasses the smooth functioning of the complex relationships between financial markets, financial institutions, households, firms and non-market institutions (Gadanecz and Jayaram 2008).

Goodhart (1987) stresses the importance of central banks in providing liquidity during times of financial stress. The lender-of-last-resort function is considered a crucial aspect of monetary policy for maintaining stability in the banking sector. Among others, Bernanke and Gertler (1995), White (2009) and Mishkin (2011) emphasize the role of monetary policy in influencing financial stability. Regarding unconventional monetary policies, Carpenter et al. (2014) find that unconventional monetary easing is associated with an increase in bank lending as bank funding volatility is reduced, and thus bank stability is enhanced. In the same vein, Markmann and Zietz (2017) show that the ECB's covered bond purchase program (CBPP) contributed to stabilizing banks.

Expansionary (un)conventional monetary policies can also increase the risk-appetite of

financial intermediaries by encouraging the search for yield (Gambacorta 2009, Jimenez et al. 2009, Ioannidou et al. 2009, Borio and Zhu 2012, Altunbas et al. 2014, Sahuc 2016). In a low interest rate environment, banks possibly underestimate the risk of holding certain assets. This is because the value of equity to debt increases with rising asset prices. Moreover, increased bank lending activity occurs as a result of relaxed lending standards (Darracq-Paries and De Santis 2015). Relaxed lending standards, in turn, introduce higher risks to banks' balance sheets (Ioannidou et al. 2015, Heider et al. 2019). Hence, banks tend to embrace greater risks in their pursuit of elevated expected returns that were formerly attainable when interest rates were higher (Rajan 2005, Avalos and Mamatzakis 2023). The perceived commitment to support financial markets during downturns can exacerbate financial intermediaries risk-taking behaviour, compromise banks' risk-absorbing capacities, and thus jeopardize financial stability (Borio and Zhu 2012).

In light of these heterogeneous results, Bernanke (2011), Bayoumi et al. (2014) and Svensson (2018) argue that monetary policy is too broad an instrument to address financial (in)stability appropriately. Targeted microprudential and macroprudential measures are deemed necessary. It is argued that microprudential and macroprudential tools reduce incentives for risk-taking and promote the proactive establishment of buffers. Targeted microprudential and macroprudential measures can increase the robustness of the banking system to withstand shocks. However, if such measures are to be implemented, it is important to localize the areas of the banking system that should be targeted by them. The following empirical study tries make a step in that direction.

3 Data Description

We have created a panel dataset of semi-aggregated data on the German banking system, paired with variables indicating the monetary policy stance of the ECB and macroeconomic covariates. The semi-aggregated data on the German banking system consist of monthly balance sheet information on the main German bank types running from 1999

to 2022. The monetary policy variables include a variety of indicators, most importantly high-frequency shocks to identify conventional and unconventional monetary policy actions. To control for the macroeconomic environment, the covariates included are the CPI, industrial production, the German stock market index (DAX) and the yield on 10-year German government bonds.[3]

3.1 *The German Banking System*

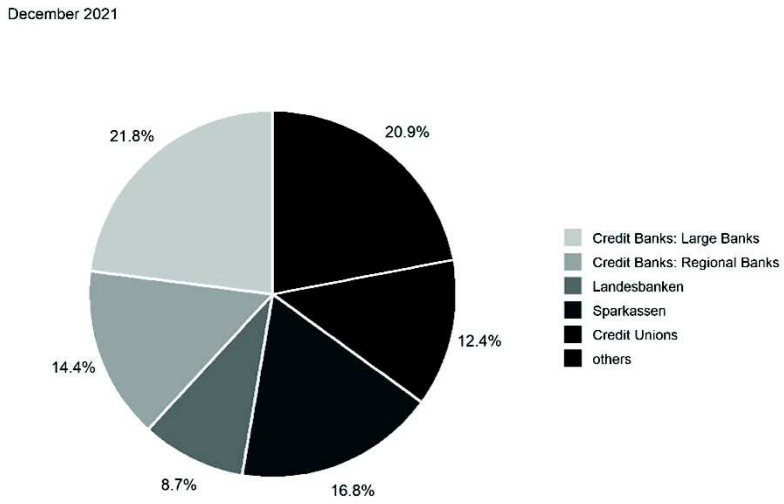
The German banking system is organized in two tiers. The first tier is the Deutsche Bundesbank, which is integrated into the European System of Central Banks (ESCB). The ESCB pursues the primary policy goal of a 2% inflation target. The second tier of the German banking system consists of customer-oriented credit institutions, which can be further divided into three groups. The first group are public-sector savings banks, i.e. Sparkassen and Landesbanken. The second group comprises credit cooperatives, i.e. Credit Unions. The third group consists of privately organized Credit Banks that are separated into Large Banks, i.e. Deutsche Bank and Commerzbank, and Regional Banks, i.e. Volkswagen Bank and ING-DiBa (Sepp et al. 2024). In December 2021, Large Banks, Regional Banks, Sparkassen, Landesbanken and Credit Unions held 79% of the German banking sector's total assets (9.23 billion euro).

The public-sector savings banks' (Sparkassen and Landesbanken) main objective is to accommodate the saving behavior of households, to finance private real estate purchases and the business activities of small and medium-sized enterprises. Sparkassen are bound to the so-called regional principle, which restricts them to operate exclusively in their business territory. The rationale is to avoid the channeling of financial resources solely into economically advanced areas, thereby denying structurally weaker regions the access to financing (Gärtner 2003). Landesbanken perform a supra-regional central bank function for Sparkassen. In December 2021, the share of Sparkassen amounted to 15% (1.5 billion euro) and that of Landesbanken to 8.4% (0.8 billion euro) of total assets of the German

[3]The data source for the bank type data is the Deutsche Bundesbank. For the monetary policy variables, the data sources are Krippner (2020), Altavilla et al. (2019) and the Deutsche Bundesbank. The data source for the macroeconomic covariates is the Deutsche Bundesbank.

banking sector (Figure 1).

Figure 1
Share of Total Assets of German Banking Sector



Source: Deutsche Bundesbank, own calculations.

The primary objective of Credit Unions is to support the business activities of their members. Consequently, the primary operational focus of Credit Unions lies in retail and corporate banking. Credit Unions play a significant role in financing small and medium-sized enterprises in their business territory (Sepp et al. 2024). With 1.1 billion euro, the share of Credit Unions of total assets of the German banking sector was 11% in December 2021 (Figure 1).

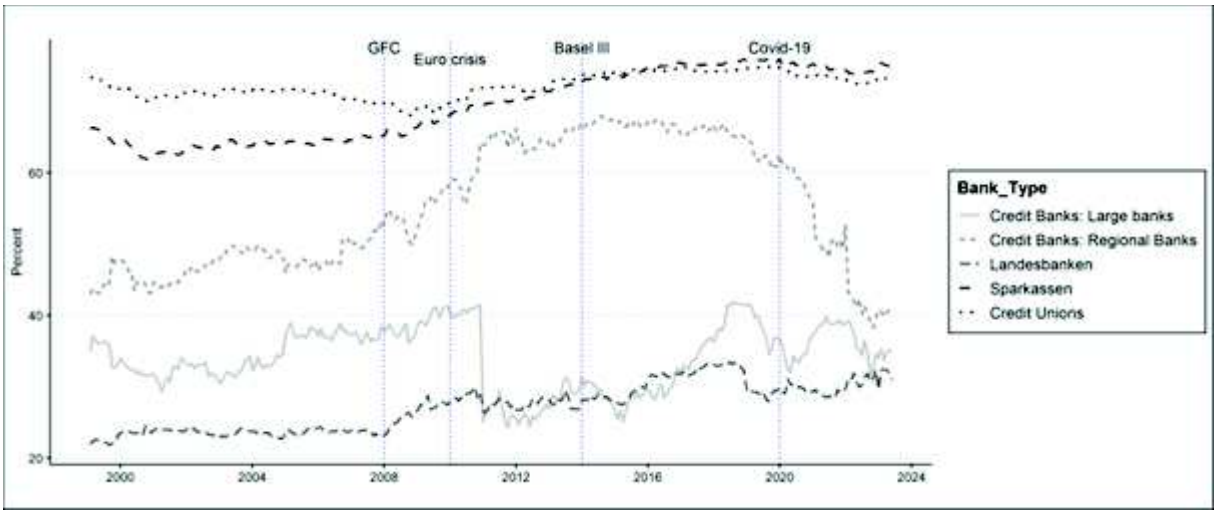
Large banks comprise privately organized money and credit institutions, such as Deutsche Bank and Commerzbank. They conduct their business activity supra-nationally through a nationwide and international branch network. Regional Banks[4], i.e. Volkswagen Bank or ING-DiBa, are privately organized money and credit institutions, whose business activity is or was limited to a specific region. Large Banks and Regional Banks are organized in the form of stock companies indicating a significant alignment with the capital market. In contrast to Sparkassen and Credit Unions, they actively engage in foreign and securities business as well as investment banking (Sepp et al. 2024). With

[4]Although Regional Banks do not anymore conduct their business activities exclusively in one region, they are still referred to as Regional Banks in the Bundesbank statistics. Direct banks, such as ING-DiBa, are included in the aggregate "Regional Banks" too.

total assets of 3.3 billion euro, the share of Large Banks and Regional Banks accounted for 36.3% of total assets of the German banking sector in December 2021 (Figure 1).

Unlike Sparkassen and Credit Unions, Large Banks are particularly active in foreign markets and the securities business. Some of these differences are reflected in the deposit ratio, the real economy funding ratio, the foreign business ratio and the inter-financial linkage ratio.

Figure 2
Deposit Ratio



Source: Deutsche Bundesbank, own calculations.

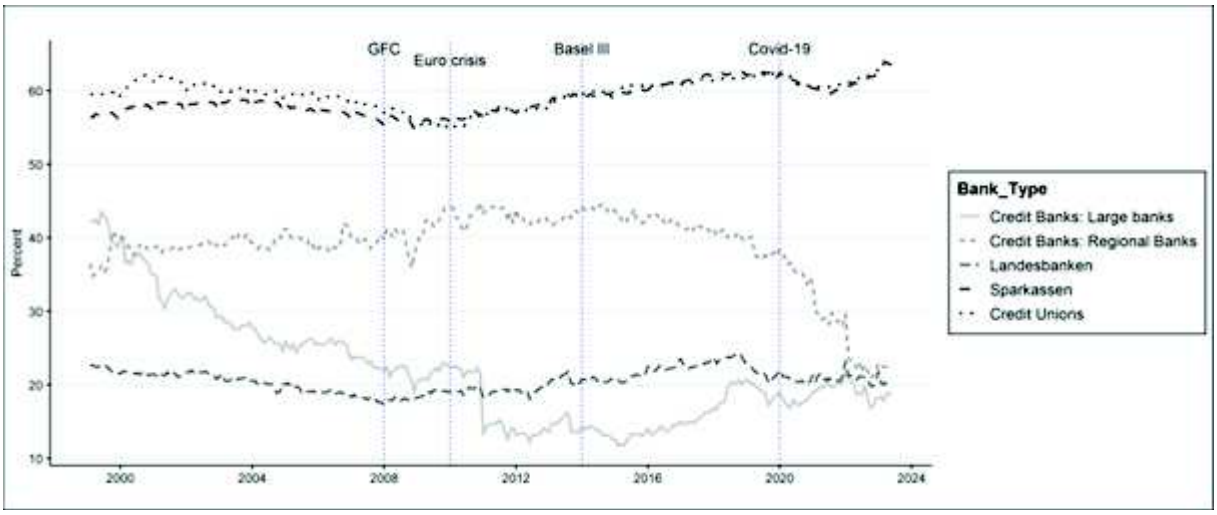
Figure 2 shows the deposit ratio of Credit Unions, Sparkassen, Landesbanken, Large Banks and Regional Banks. The deposit ratio is calculated as total deposits by non-monetary financial institutions (non-MFIs) as a share of total assets. Over the whole observation period, the deposit ratio of Credit Unions and Sparkassen has remained relatively stable around 75%. Regional Banks' deposit ratio has steadily increased until December 2019, but has fallen sharply since, while the deposit ratio of Landesbanken has increased slightly over the whole observation period. In contrast, the deposit ratio of Large Banks reveals some fluctuations but has a declining long-term trend.

Small and medium-sized banks such as Credit Unions and Sparkassen facilitate access to capital for small and medium-sized enterprises (SMEs) and, thus promote regional growth (Slotty 2009, Hasan et al. 2017, Marsch et al. 2007).[5] Due to their local con-

[5]Transaction and regulatory costs for issuing publicly traded shares or debt securities are high, so

nection, small and medium-sized banks are better able to overcome risks caused by information asymmetries (i.e. adverse selection and moral hazard) as they can collect soft and hard information through relationship banking (Baas and Schrooten 2006, Berger and Udell 2006, de la Torre et al. 2010, Shinozaki 2012, Canales and Nanda 2012, Hasan et al. 2014). Overcoming adverse selection in lending translates to lower probabilities of credit default and therefore more resilience. This is particularly true if the foreign risks of banks are comparatively low, and their financing activities lean more towards the domestic economy.[6]

Figure 3
Domestic Real Economy Funding Ratio



Source: Deutsche Bundesbank, own calculations.

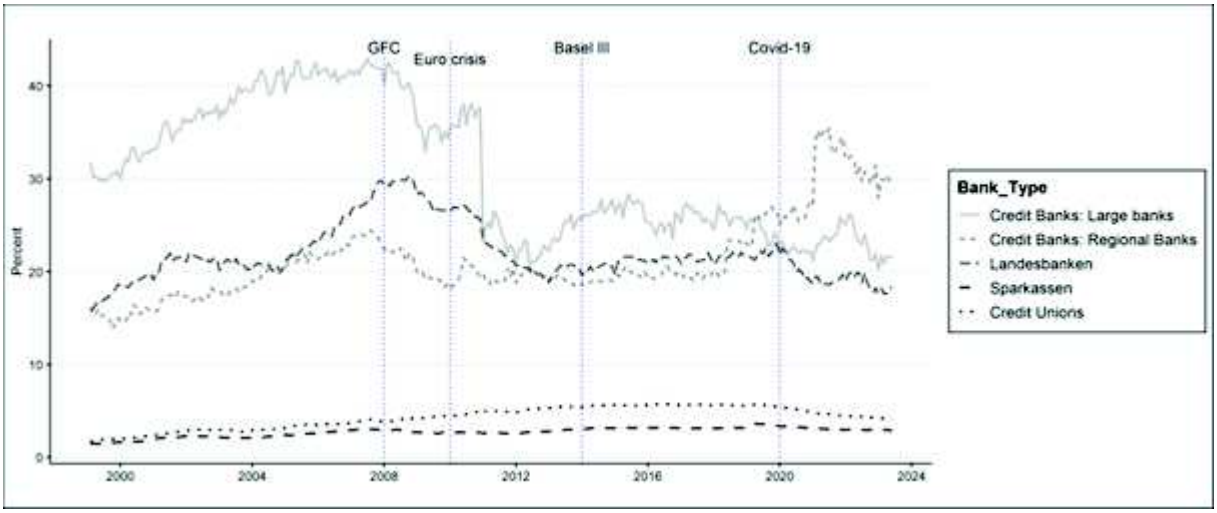
Figure 3 shows the domestic real economy funding ratio. It is calculated as the share of loans to domestic companies and private individuals in total assets. The core business activity of Credit Unions and Sparkassen is indeed the financing of domestic companies and private individuals. The domestic real economy funding ratio averages around 60% and has even been increasing since the Euro Crisis. For Large Banks and Regional Banks, the domestic real economy funding ratio has significantly diminished. In 1999, the ratio of Large Banks and Regional Banks was 42%, and 37% respectively. It more than halved and now stands at 18% for Large Banks and 23% for Regional Banks. For Landesbanken

that small and medium-sized enterprises are discouraged from issuing them (Coleman 2006). Therefore, compared to large companies, SMEs are dependent on financing through financial intermediaries.

[6]It is assumed that information asymmetries are more difficult to overcome and that default risks are higher when lending abroad due to exchange rate, regulatory and legal risks.

the ratio has remained more or less constant.

Figure 4
Foreign Business Ratio



Source: Deutsche Bundesbank, own calculations.

The foreign business ratio is defined as total deposits and borrowing from foreign MFIs and non-MFIs and total credit to foreign MFIs and non-MFIs as a share of total assets (Figure 4). The foreign business ratio of Credit Unions and Sparkassen has slightly increased over the observation period but is comparably low with a maximum of 6% of total assets. In contrast, the foreign business ratio of Large Banks, Regional Banks and Landesbanken is much higher. Large Banks' foreign business ratio strongly increased to 42% in 2007. In the aftermath of the Great Financial Crisis, it decreased considerably but still hovers between 21% and 28%. A similar development can be seen for Landesbanken. Regional Banks' foreign business ratio has increased strongly over the whole observation period and now stands at 30% of total assets.

Assuming that information asymmetries are more difficult to resolve and default risks are higher in foreign business, Large Banks, Regional Banks and Landesbanken are more prone to contagion effects from international economic developments due to their comparatively large foreign exposure (Krugman 1998, Corsetti et al. 1999, Hofmann and Schnabl 2008). Credit Unions and Sparkassen, however, are mostly focused on domestic investment activities and have almost no foreign exposure in their balance sheets, which may imply higher resilience of these bank types.

3.2 *Monetary Policy*

The ECB started to introduce unconventional monetary policy measures to counter the long-lasting effects of the Great Financial Crisis of 2008 (Driffill 2016). At the core of the ECB's unconventional monetary policy measures are LTROs, asset purchase programs, negative interest rate policies and forward guidance.

Longer-term refinancing operations are transactions that provide liquidity to the banking system for a longer period than the main refinancing operations. They aim to support credit flows and stabilize financial markets during periods of economic stress and uncertainty. LTROs have been a regular instrument in the toolbox of the ECB's monetary policy. Typically, LTROs had maturities of three months. Since June 2009, these loans became increasingly unconventional due to prolonged maturities, first to a year and then to three years in December 2011 (Dwyrer et al. 2023).

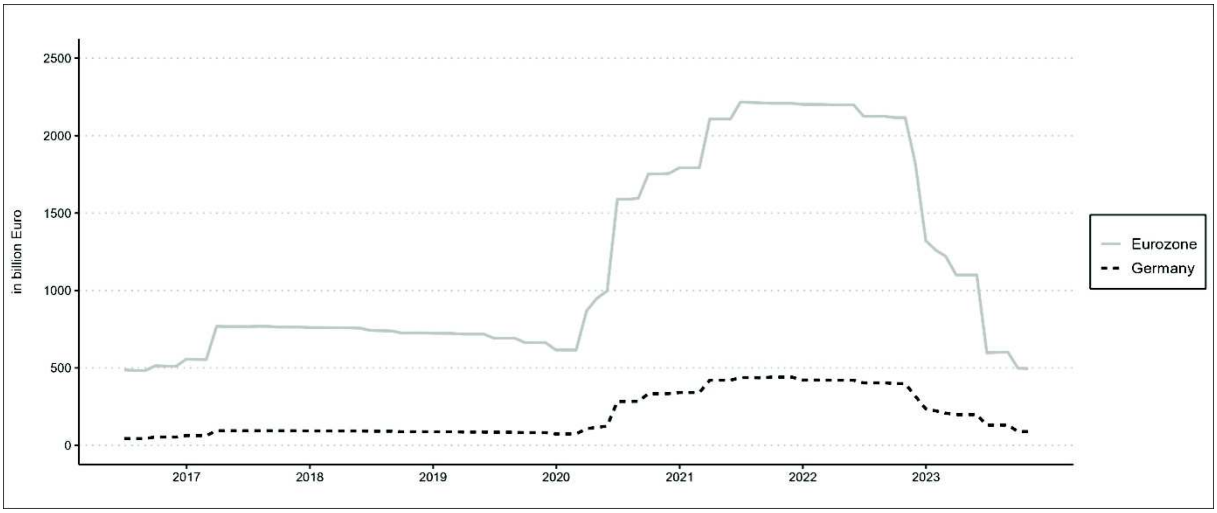
The unconventional LTROs were soon followed by targeted longer-term refinancing operations in 2014, 2016 and 2019. While both LTROs and TLTROs involve providing financial institutions with longer-term funding and liquidity, TLROs are designed to encourage banks to lend directly to the real economy. In contrast to generic LTROs, TLTROs offer funds at favorable rates to certain institutions. Dwyrer et al. (2023) find that TLTROs increased bank loans by 16.4% of total assets in non-crisis countries and by 14.6% of total assets in crisis countries. From 2016 until 2022, (T)LTROs increased from 507 billion euros to 2,062 billion euros. Over the same time, the share of (T)LTROs provided to the German banking system averaged 14.7% (Figure 5).

The asset purchase programs of the ECB can be categorized into the purchases of covered bonds, the purchase of public sector securities, the purchase of corporate sector securities and the purchase asset-backed securities.

To counter the negative impact of the Great Financial Crisis on the covered bond market[7], the ECB initiated its first unconventional asset purchase program - the covered bond purchase program - in 2009. The objective of the CBPP was to enhance liquidity in the covered bond market, reduce money market term rates, address challenges in bank

[7]The covered bond market has become an important source of funding for the banking sector in the European Monetary Union.

Figure 5
(T)LTROs



Source: ECB.

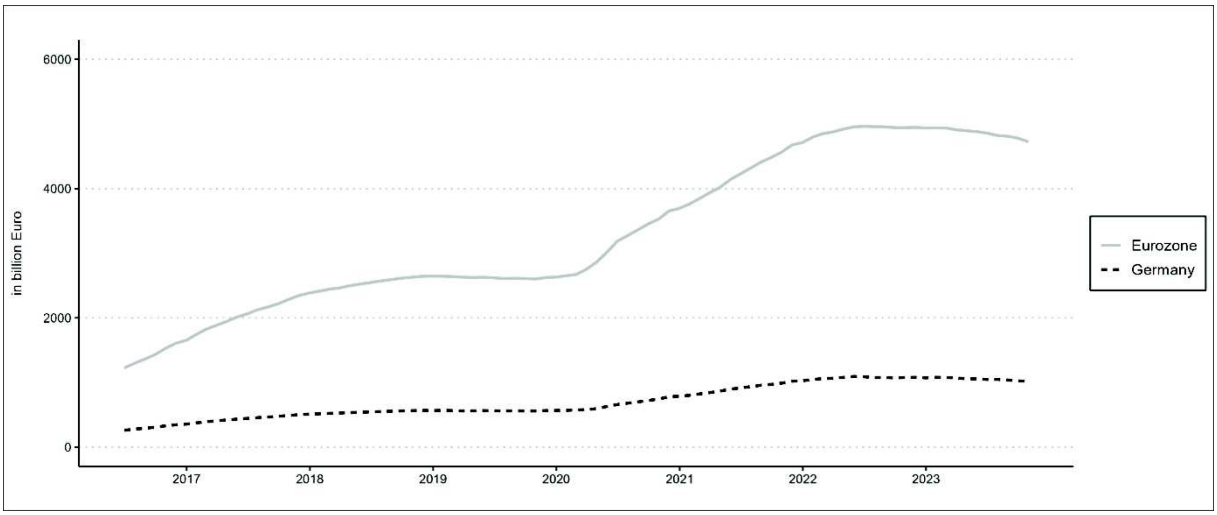
funding, and mitigate adverse credit conditions, with the aim of promoting growth (Driffill 2016). The CBPP was laid out in three phases. In July 2009, the ECB announced the first CBPP and purchased 60 billion euros of covered bonds until June 2010. To respond to the Sovereign Debt Crisis, the Euro system bought 16.4 billion euros of covered bonds from November 2011 to October 2012 under CBPP II to stimulate funding to credit institutions and enable lending. Finally, under CBPP III the Euro System purchased covered bonds from October 2014 to December 2018 in the size of 262 billion euros. These measures were reintroduced in November 2019 until June 2022 to mitigate the economic consequences of Covid-19 (Dwyrer et al 2023) amounting to 302 billion euros.

The asset purchase program (APP), known as quantitative easing, was announced in September 2014. Quantitative easing aims to lower long-term interest rates by large-scale purchases of securities.[8] The increased money supply is intended to support growth, combat deflationary pressures, and enhance overall financial stability. The APP consists of the CBPP III, the asset-backed securities purchase program (ABSPP), the public sector purchase program (PSPP) and the corporate sector purchase program (CSPP). Under the ABSPP, the ECB bought asset-backed securities, including loans to households and businesses. In November 2014, the ECB started to purchase asset-backed securities under

[8]Quantitative easing mainly works through the portfolio rebalancing channel and signalling channel of monetary policy (Dell'Ariccia et al. 2018).

the ABSPP until December 2018, and restarted net-purchases from November 2019 until June 2022. Under the PSPP, the ECB bought public sector securities such as nominal and inflation-linked government bonds. The first purchases under the PSPP started in March 2015 until December 2018. Between January 2019 and October 2019, the ECB only reinvested the principal payments[9] from maturing securities before restarting net purchases between November 2019 and June 2022. The CSPP[10] was introduced to purchase corporate bonds issued by non-financial institutions. The purchases started in June 2016 and ended in December 2018 to be restarted between November 2019 and June 2022. Since 2016, the asset purchases under the APP have increased from 1,445 billion euros by 240% to 4,921 billion euros of which 21% were allocated to Germany (Figure 6).

Figure 6
ECB's Securities Held for Monetary Policy Purposes



Source: ECB.

The ECB's negative interest rate policy is the third unconventional monetary policy measure. The idea of negative interest rates on excess reserves is to incentivize commercial banks to increase lending and purchase financial assets (Dell'Ariccia et al. 2018).[11] In June 2014, the ECB lowered the deposit facility to -10 basis points. The deposit facility remained negative (-50 basis points) until June 2022 (Figure 7). The large-scale

[9]Such is the case for the ABSPP and CSPP.

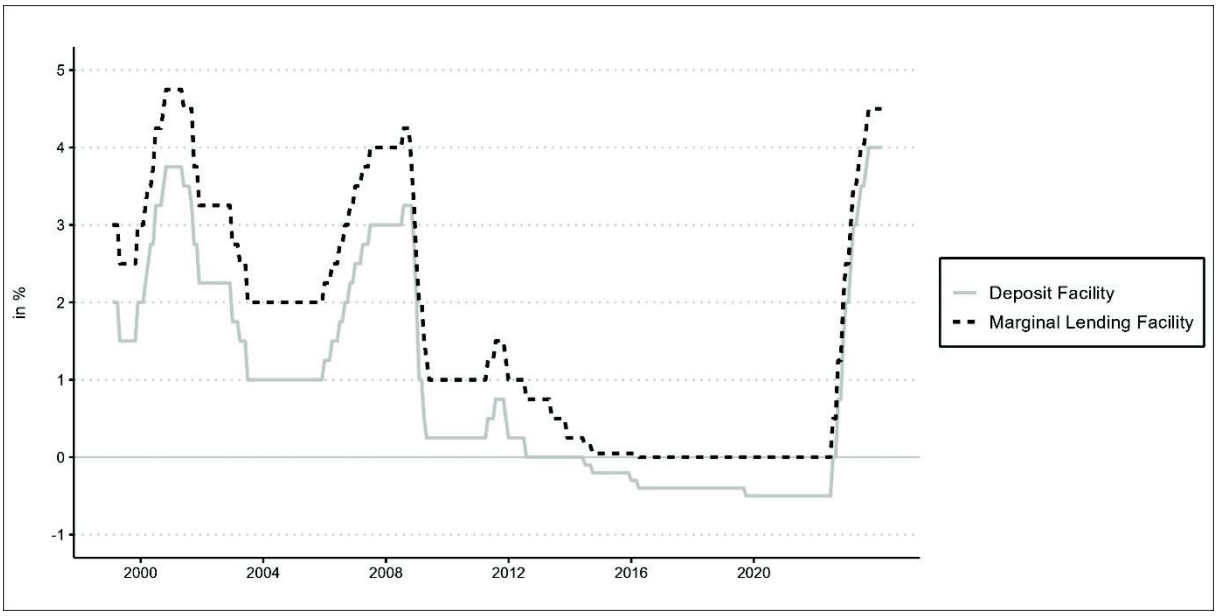
[10]According to the ECB, the objective of the CSPP is to enhance the impact of the Euro system's asset purchases on the financing conditions of the real economy. There are concerns that the CSPP over-proportionally benefits large enterprises in contrast to SMEs (Betz and de Santis 2021).

[11]When central banks charge for holding excess reserves, it becomes costly for financial institutions to do so. Thus, banks are motivated to either lend out these reserves or to purchase financial assets instead.

asset purchases of the ECB increased the excess reserves of commercial banks instead of reducing them.[12]

In order to reinforce the effect of unconventional liquidity provision, the ECB used forward guidance as an additional monetary policy tool to inform market participants about the future trajectory of monetary policy, for instance by announcing that interest rates will remain low for a specific time or that a certain amount of assets will be purchased (Dell'Ariccia et al. 2018).

Figure 7
ECB Interest Rates



Source: ECB.

To capture the multidimensional nature of the ECB's unconventional monetary policy, we use the monetary policy shock series by Altavilla et al (2019) and follow the approach by Baumgärtner and Klose (2021) to decompose the monetary policy shocks into a conventional and an unconventional component. The unconventional shock in turn comprises of three dimensions: a timing, a forward guidance, and a QE part.

Following Baumgärtner and Klose (2021), we use the high-frequency dataset by Altavilla et al. (2019). This dataset is used to extract monetary policy shocks from changes in returns of various financial instruments around ECB press releases and ECB press

[12]In the wake of rising interest rates, the excess reserves have become the object of controversy (De Grauwe and Ji 2023a, De Grauwe and Ji 2023b, Sonnenberg 2023, Schnabl and Sepp 2023).

conferences. These changes are assumed to be driven by information from these events exclusively. Baumgärtner and Klose (2021) use principal components to identify and isolate latent factors in the high-frequency dataset by Altavilla et al. (2019), similar to Brand et al. (2010) and Swanson (2017). The factor model employed is of the form:

$$X^{\omega} = F^{\omega}\Lambda^{\omega} + \epsilon^{\omega} \tag{1}$$

Where X^{ω} is the change in the financial market variable, F^{ω} is a (N*T) matrix of latent factors, Λ^{ω} denominates factor loadings and ϵ^{ω} represents idiosyncratic variation. The superscript ω denominates the press release window and press conference window, respectively.

Using the rank test of Cragg and Donald (1997), we find a total of four factors: one during the press release window, which represents a conventional monetary shock (because it loads heavily on the 1-month overnight index swap (OIS) rate), and three during the press conference window, which represent unconventional monetary policy shocks. The second factor loads onto all the other OIS rates with a maturity under 1-year in the press conference window, which is why it is interpreted as short-term forward guidance factor, named "timing". The third factor heavily loads on OIS-rates of a 2–5-year maturity, which corresponds to medium term path of interest rates, which is called "forward guidance". The fourth factor, called "QE", loads on OIS rates with a 10-year maturity, which corresponds to the QE-mechanism via purchases of long-term securities by the ECB.

3.3 *Resilience*

Robustness is a key aspect of resilience. It refers to the ability of a system to absorb shocks and recover quickly (Holling 1973, Holling 1996, Aligica and Tarko 2014, Salter and Tarko 2019). An appropriate measure of resilience should therefore reflect a system's ability to tame or even prevent disruptive events (Rose and Liao 2005, Erol et al. 2010).

In the banking context, an appropriate measure to capture the robustness of the banking system is an adapted version of Altman's z-score (Altman 1968). In its adapted

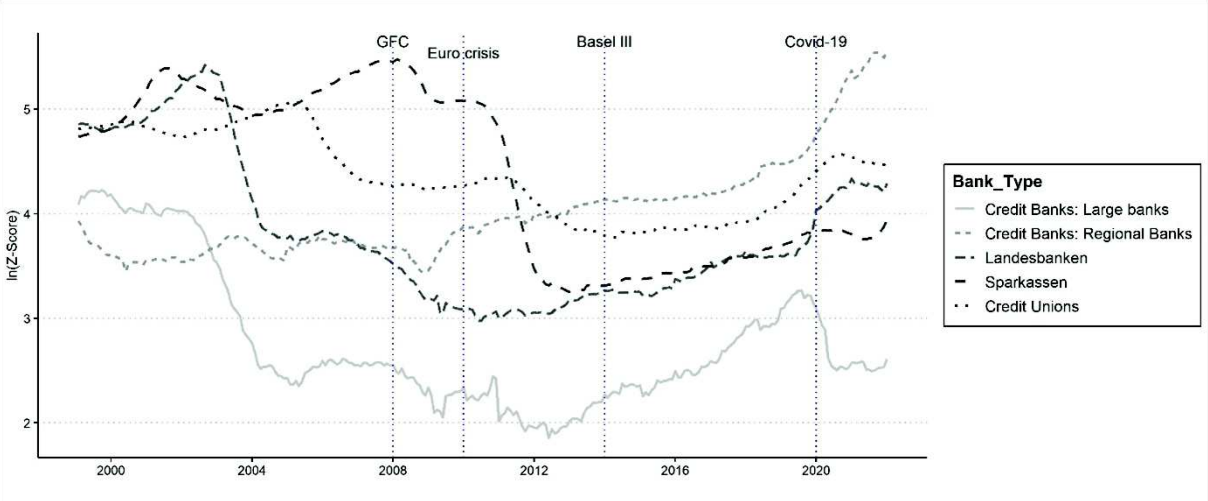
version, it measures the number of standard deviations the return realization of a bank can fall before its equity is depleted (Cihak and Hesse 2010). Therefore, the z-score captures how much a bank can endure before breaking down.

Unlike previous research (Beck et al. 2013, Fiordelisi and Mare 2014, Avalos and Mamatzakis 2023), we calculate an aggregated z-score for each bank type instead of each individual bank. Therefore, our z-score is suitable to assess the stability and resilience of different bank types and the whole banking system. It is given by:

$$z_{i,t} = \frac{roa_{i,t} + er_{i,t}}{\sigma(roa_i)} \tag{2}$$

where $z_{i,t}$ is the z-score of bank type i at time t, $roa_{i,t}$ is the return on assets of bank type i at time t, $er_{i,t}$ is the equity ratio of bank type i at time t, and $\sigma(roa_i)$ is the standard deviation of the return on assets calculated for each bank type over a 10-year rolling window looking back in time.[13]

Figure 8
Bank Type Resilience



Source: Deutsche Bundesbank, own calculations.

Our sample uses semi-aggregated data on the main bank types in Germany. This implies that our sample indirectly includes all banks (of which the majority are not listed) in the German banking sector instead of only using micro data on listed banks

[13] At a monthly frequency, the z-score exhibits considerable fluctuation. To facilitate less noisy estimates, we smoothen the series by taking the 10-year rolling window looking back in time.

(Koutsomanoli-Filippaki and Mamatzakis 2009, Anginer et al. 2014).

Figure 8 shows the monthly bank type z-score for the five main bank types in Germany since 1999. We can see that over the whole period, all bank types exhibit a considerable volatility with periods of downward and upward trending trajectories. Regional Banks are the only bank type that have experienced a continuous rise in resilience. The z-score of Large Banks has decreased significantly until 2012 and only started to increase slowly since then. For Landesbanken there also has been a significant decrease in the z-score, but an uprising trajectory since 2012. The z-score of Sparkassen was on a rising trend until they took a double hit of the Great Financial Crisis and the Euro Crisis, which resulted in sharp decline in their resilience. Since then, Sparkassen have been on a rising trajectory. Between 2005 and the introduction of Basel III, Credit Unions' resilience was on a steady decline. Since then, their z-scores have increased. There are many ways in which monetary policy could affect bank resilience. It is unclear what the net effect is. The following empirical exercise aims to identify some evidence.

4 Empirical Model

We use local projections (Jordá 2005) to estimate the effect of (un)conventional monetary policy on bank resilience on the semi-aggregated level. We estimate the heterogeneous impact on the five major bank types in Germany: Credit Unions, Sparkassen, Landesbanken, Regional Banks and Large Banks.

In the first step, we employ Krippner's (2020) short-term shadow rate to gauge the cumulated impact of both conventional and unconventional monetary policies on bank type resilience. Shadow rates are a summary measure for the monetary policy stance that is unrestricted by the zero lower bound of market or policy interest rates. It translates unconventional monetary policy measures into hypothetical short term interest rate cuts.[14]

[14]In the absence of unconventional monetary policy measures, the shadow rate coincides with the actual short-term rate. It is permitted to take on lower and even negative values to capture unconventional expansionary monetary policy. It can fall far below the zero lower bound. For the eurozone, the Krippner (2020) short-term shadow rate is calibrated using yield curve data. The decreasing effect of unconventional policies on the long end of the yield curve is translated into a corresponding hypothetical

In the second step, we compare the results of short-term shadow rates as a summary measure of conventional and unconventional monetary policy with those of using exogeneous shocks. We start with the total monetary policy shock, capturing both conventional and unconventional shocks.

In the third step, we decompose the shock variable isolating the impact of conventional and unconventional monetary policy shocks on bank type resilience. We start by assessing the separate effects of conventional shocks and unconventional shocks before zooming in on the three dimensions of unconventional monetary policy shocks: short-term interest path expectations, forward guidance, and QE.

4.1 *Local Projections*

We use a vector-autoregression (VAR) of the type:

$$y_t = c + B_1 * y_{t-1} + B_2 * y_{t-2} + ... + B_\rho * y_{t-\rho} + e_t \tag{3}$$

with vector y_t of length k, $E(e_t) = 0, E(e_t' e_t) = \Omega$, and $E(e_t' e_{t-k}) = 0$. This approach has become the workhorse tool to empirically examine macroeconomic dynamics. Impulse response functions (IRFs) are the comparison of two conditional means of the future state of the system, i.e. to investigate the propagation of policy interventions over time. Using VARs to calculate impulse responses requires the complete structural specification of equation (3). This burden is overcome with local projections, which allow the direct estimation of impulse responses, without referring to the remaining elements of (3).

For exposition, consider a simplified shortened version of a VAR-System with only one lag and no constant:

$$y_t = A y_{t-1} + e_t \tag{4}$$

with $e_t \sim D(0, \Omega)$, and let's label element j in vector y_t as y_t^j. After a shock (intervention) δ_i in element i, the response (R_{ij}) of element j will be:

decrease on the short end.

$$R_{ij} = E[y^j_{t+h}|e_t = \delta_i, y_{t-1}] - E[y^j_{t+h}|e_t = 0, y_{t-1}] = A^h_{[j]}\delta_i \tag{5}$$

Where $A_{[j]}$ denotes the $j-th$ row of A and h to the $h-th$ power. Because the errors in e_t are uncorrelated, δ_i can be seen as their linear combination that uncovers the structural shock of variable i.

As long as the data approximately follow (4), the only requirement to estimate (5) is a consistent estimate of matrix A. Local Projections achieve this by recursive substitution: $y_{t+h} = A^{h+1}y_{t-1} + A^h e_t + ... + A^0 e_{t_h}$ and $A_0 = I$. Focusing again on element j in vector y_t:

$$y^j_{t+h} = c^j_h + \beta^j_{h+1}y_{t-1} + B_h e_t + ... + B_0 e_{t+h} \tag{6}$$

and thus (5) becomes $R_{ij} = E[y^j_{t+h}|e_t = \delta_i, y_{t-1}] - E[y^j_{t+h}|e_t = 0, y_{t-1}] = \beta^j_h \delta_i$.

The critical advantage of local projections is that they can be estimated equation-by-equation, which allows for more flexibility and more robustness to misspecification, since each element in y_t can be modeled separately. Moreover, it unburdens from making strong structural assumptions about the underlying system, such as those imposed by the variable order in a VAR-system that calculates impulse responses using a Cholesky decomposition, for instance. Lastly, the local projection method acknowledges that projections may be local to the projection horizon.

In the following section, we discuss the impact of our monetary policy measures onto the resilience indicators of various bank types: Credit Unions, Sparkassen, Landesbanken, Regional Banks, and Large Banks. In the regressions, we control for the annualized growth rate of industrial production, the consumer price index, the German stock market index (DAX), and the yield on 10-year German government bonds.[15]

The equation in the VAR-system is thus:

[15]We include the industrial production as a proxy of monthly GDP and the consumer price index to control for the macroeconomic environment in Germany. The German stock market index controls for economic expectations. The yield of 10-year German government bonds is included to control for the liquidity and funding conditions in German financial markets.

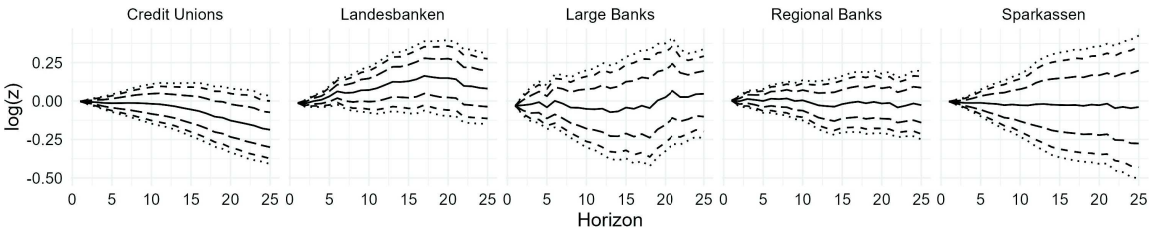
$$log(z_t) = c + \sum_{\rho} \gamma_{t-\rho} * log(z_{t-\rho}) + \sum_{\rho} \Theta_{t-\rho} * i_{t-\rho} + \beta'_{t-p}(\frac{x_t}{x_{t-12}} - 1) + e_t \qquad (7)$$

where z_t is the z-score, i contains the monetary policy shock variable, ρ is the lag order (here $\rho = 12$), and X contains the covariates, and $E(e_t) = 0, E(e'_t e_t) = \Omega$, and $E(e'_t e_{t-k}) = 0$. To ensure stationarity, we transform the z-scores into natural logarithms, and use the annual growth rate of the covariates, whereas the 10-year bund yield remains in levels.

4.2 *Results*

Using Krippner's (2020) short-term shadow rate as monetary policy measure, we see distinct effects across the banking types in our sample (Figure 9). The IRFs shown in Figure 9-15 are from a 1 percentage point decrease in the monetary policy instrument over the period of 24 months.

Figure 9
Impulse Responses - Short-Term Shadow Rate



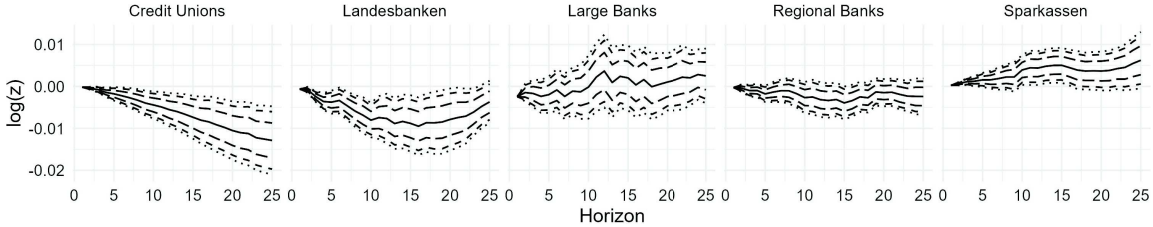
Source: Own calculations.

The impulse responses of the resilience indicator for Large Banks and Regional Banks exhibit similar patterns. After hovering just below the baseline after the initial decrease in the shadow rate, the z-score returns close to the baseline at the end of the response period. Large banks' resilience, on average, is 5% above baseline, and Regional Banks' resilience hovers around it. Sparkassen experience a slight, but continuous, decrease throughout the projection period, resulting in an average reduction of resilience of 5%. Credit Unions experience a steady decline in resilience during the response period. By the end of the projection horizon, the response function is about 30% below baseline. The resilience of Landesbanken experiences a hump-shaped response after an expansionary monetary

policy measure that leads to a decline of the shadow rate by 1 percentage point. It peaks at 15% above baseline 20 months into the projection horizon. The response then decreases by the end of the projection horizon. All results, except for Credit Unions, are associated with considerable variation around the mean response.

Using the total monetary policy shock, which also combines conventional and unconventional monetary policies, we see noticeable differences compared to the short-term shadow rate as shown in Figure 10.

Figure 10
Impulse Responses - Total Monetary Policy Shock



Source: Own calculations.

First, the magnitude of responses decreases by a factor of about 10 for all bank types. Second, Sparkassen now react strongly and positively to an expansionary monetary policy shock leading to an increase in resilience by 0.5% on average. Third, the response of Landesbanken is inverted to the previous results showing a temporary decrease in resilience, but a return towards the baseline at the end of the projection period. On average, the resilience of Landesbanken decreases by 0.5%.

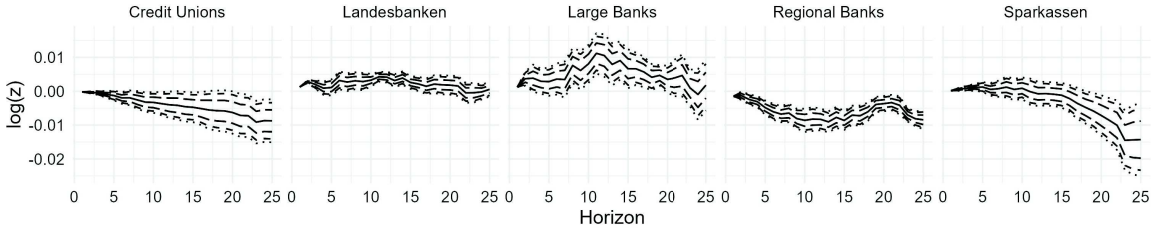
However, the trajectory of the impulse responses of Large Banks, Regional Banks and Credit Unions are comparable to the results using the short-term shadow rate. In response to an expansionary monetary policy, Large Banks' and Regional Banks' resilience fluctuates around zero, with a slightly positive average response of 0.5% for the former and a slightly negative average response of 0.25% for the latter. Over the entire projection horizon, Credit Unions' resilience shows a steady decline with an average response of -1%.

The differences in the results using Krippner's (2020) short-term shadow rate and the total monetary policy shock as a monetary policy instrument might be indicative of the endogeneity issue arising in the context of monetary policy applications. Using the short-term shadow rate leads to larger coefficients for Large Banks, Regional Banks and

Credit Unions, and potentially biased results for Sparkassen and Landesbanken.

Compared to the total monetary policy shock, the impulse responses of our resilience indicator to a conventional monetary policy shock (Figure 11) are characterized by much tighter confidence bands across all bank types, and by an inverted response for Sparkassen and Landesbanken.

Figure 11
Impulse Responses - Conventional Monetary Policy Shock



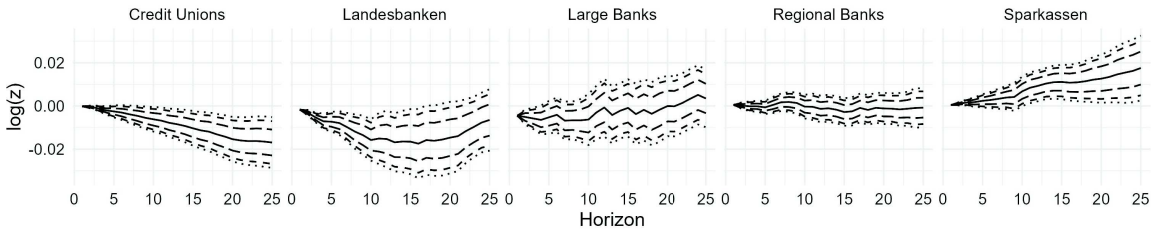
Source: Own calculations.

As before, Large Banks and Regional Banks show hovering responses around the baseline throughout the projection period. Large Banks' resilience remains above baseline for the first 20 months, then shortly falls below zero, before returning slightly above baseline towards the end of the projection horizon. Regional Banks' response fluctuates within a tighter band around the baseline. Interestingly, Sparkassen now experience a steady and significant decrease in resilience throughout the projection period. In response to conventional monetary easing, the resilience of Sparkassen declines by 1% on average over 2 years. Credit Unions also experience a steady and significant decrease in resilience of the same magnitude as Sparkassen. As compared to the total monetary policy shock, Landesbanken show an inverted and jittery response, with an initially significant increase in resilience.

Isolating conventional and unconventional monetary shocks from the combined monetary policy shock, it becomes visible that the response in bank type resilience to total monetary policy shocks is outweighed by the response to unconventional monetary policy shocks (Figure 12).

Large Bank's resilience decreases initially but increases steadily over the projection period until the response is on average 0.5% over the baseline. An inverted pattern holds for Regional Banks. After a slightly positive response early on, the average response

Figure 12
Impulse Responses - Unconventional Monetary Policy Shock

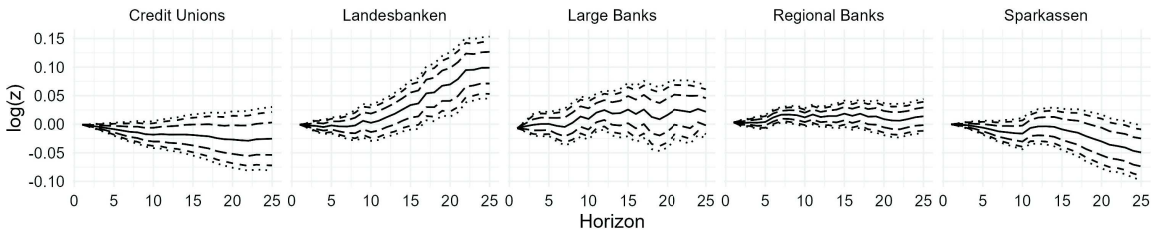


Source: Own calculations.

decreases below baseline just to return close to baseline levels at the end of the projection period. Sparkassen experience a steady increase in resilience following an expansionary unconventional shock to monetary policy. Their resilience increases by 1.5% on average. The opposite is true for Credit Unions. Their resilience decreases steadily over the whole projection horizon. Again, Landesbanken exhibit a hump-shaped response, with the minimum being reached about halfway through the projection period and approaching baseline resilience levels from below afterwards.

Next, we turn to the three dimensions of unconventional monetary policy: timing, forward guidance, and QE. A response to the "timing"-factor isolates the effect of shocks to short-term interest path expectations from monetary policy decisions. Using expansionary shocks to short term interest rate expectations as policy variable, we see clear differences in the responses of resilience indicators across bank types (Figure 13).

Figure 13
Impulse Responses - Timing Shock



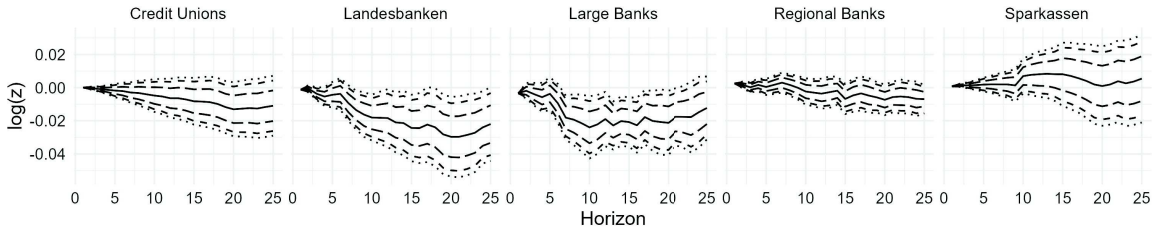
Source: Own calculations.

Large Banks and Regional Banks respond in unison: Their resilience increases first gradually, then sharply, ending on average above baseline, but with considerable uncertainty throughout the projection period. On average, a negative one-percentage point shock to the short-term interest rate results in a 2.5% increase in Large Banks' resilience

and in a 1.25% increase for Regional Banks' resilience. The responses of Sparkassen and Credit Unions to shocks of short-term interest paths are negative. Their resilience steadily declines over the projection period, resulting in a decrease in resilience of 5% on average for Sparkassen and 3% for Credit Unions. Contrary to prior results, the response of Landesbanken is not hump-shaped. A shock to short-term interest rate expectations leads to a steady increase in resilience that reaches 10% by the end of the projection horizon.

Forward guidance shocks isolate the unconventional monetary policy effect of shocks to medium-term interest rate path expectations (between 2-5-years maturity). We see yet again a different response across the bank types (14).

Figure 14
Impulse Responses – Forward Guidance Shock



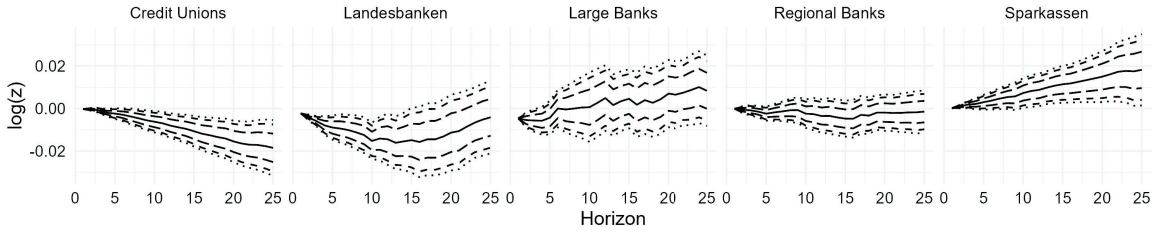
Source: Own calculations.

Large Banks and Regional Banks exhibit long-run declines. Large Banks' resilience reaches a minimum of a 2% decrease 5 periods after the initial shock, before slightly increasing towards the end of the projection period. Regional Banks' decline in resilience is steadier and sets in after an initial small and insignificant increase. The increase in resilience for Sparkassen is small at first, before increasing and falling suddenly, but tempering out around 1% above baseline on average. The response of Credit Unions and Landesbanken is that of a steady decrease, flattening out towards the end of the projection horizon. For Credit Unions resilience decreases on average by 1% and for Landesbanken it decreases on average by 2% after a forward guidance shock.

Lastly, we estimate the effect of a QE shock (a 10-year maturity) on the resilience of different bank types (14).

Large banks experience an initial decrease in resilience but return to and exceed the baseline by 0.5% on average at the end of the period. Regional Banks' resilience levels,

Figure 15
Impulse Responses – Quantitative Easing Shock



Source: Own calculations.

on the other hand, decrease initially and remain below baseline at -0.25% on average. Sparkassen and Credit Unions react in opposite ways to QE shocks. The resilience of Sparkassen steadily and significantly increases throughout the projection period yielding an average 2% increase in resilience relative to baseline. For Credit Unions, the exact opposite is true. In response to a QE shock, their resilience decreases steadily over the projection horizon showing a 2% long-run decrease in resilience on average. Landesbanken again experience a hump-shaped reduction in resilience. An initial significant decrease turns around after 10-15 months, approaching, but not reaching, baseline resilience levels on average.

Table 1 summarizes the short-term (first arrow) and long-term (second arrow) effects of monetary policy shocks on bank type resilience in Germany.

Table 1
Summary of Qualitative Results

Bank Type/ Instrument	Large Banks	Regional Banks	Sparkassen	Credit Unions	Landesbanken
Shadow Rate	↓↑	↑↓	↓↓	↓↓	↓↑
Total Monetary Policy	↓↑	↓↓	↑↑	↓↓	↓↓
Conventional Monetary Policy	↑↓	↓↓	↓↓	↓↓	↑↓
Unconventional Monetary Policy	↓↑	↑↓	↑↑	↓↓	↓↓
Timing	↓↑	↑↑	↓↓	↓↓	↑↑
Forward Guidance	↓↓	↓↓	↑↑	↓↓	↓↓
Quantitative Easing	↓↑	↓↓	↑↑	↓↓	↓↓

Source: Authors' presentation.

First, we note that the results for the short-term shadow rate potentially suffer from endogeneity problems, since the policy instrument incorporates market information of expected changes to the interest rate. In other words, it does not isolate a "surprise" or "shock" element. Both the quantitative and qualitative results for the total monetary policy shock are somewhat different. With separation of conventional and unconventional shocks we can see that the results for the overall shocks seem to be driven primarily by its unconventional parts.

Within the German banking system, Large Banks are not only the largest, but also the most diversified banks with the most international financial linkages. We note that in the short-run, Large Banks' resilience goes down in response to any of the expansionary monetary policy shocks. The only exception are conventional interest rate cuts. In the long-term, however, the initially negative effect turns around. There is a positive long-run effect for most shock types. The two exceptions are the conventional and forward guidance shocks.

Regional banks' resilience mostly suffers from expansionary monetary policy. This might be because their investment opportunities are locally restricted even though their asset base can, but need not, be diversified. Some expansionary measures (short-term shadow rate, unconventional monetary policy shocks, and timing shocks) tend to increase resilience in the short run.

Except for timing shocks, unconventional monetary policy tends to increase the resilience of Sparkassen in both the short and the long run. Conventional monetary expansion, however, reduces the resilience of Sparkassen as they are affected from reduced margins. The negative short-term and long-term effect of shocks to the timing-factor of unconventional monetary policy may be explained by the exposure to assets paying variable rates and thus reducing net income.

The effects of monetary easing on the resilience of Landesbanken appear to be inverted to those of Sparkassen. Since Landesbanken are the institutional backbone of Sparkassen, one could interpret this pattern as risk-shifting between these two bank types.

For Credit Unions, any expansionary monetary policy measure reduces resilience.

This is because lower interest rates lower the margins earned on credit products these institutions are specialized in, which in turn lowers their return on assets and thus their z-score. In contrast to Sparkassen, unconventional monetary easing is ineffective in raising Credit Unions' resilience. We suppose that this is because Credit Unions do strictly stick to their statutory objective of promoting the business of their members.

5 Conclusion

Germany is the largest economy in the eurozone. The resilience of its banking system is of great importance not only to the German economy but to the common European market. Our results suggest that the ECB's monetary policies have not been conducive to stabilizing the German banking system and enhancing its resilience overall. Conventional interest rate cuts have beneficial short-term effects on the resilience of Large Banks and Landesbanken but weaken the resilience of all bank types in the long run. Unconventional monetary easing had very heterogeneous effects across the main bank types in Germany. Shocks to short-term interest rate expectations and QE negatively impact Large Banks in the short run but help them to increase their resilience in the longer run. Forward guidance negatively impacts Large Banks' resilience in the short and long run. Regional Banks and Landesbanken respond positively to timing shocks but take a hit from forward guidance and QE. The response functions of Sparkassen are inverted. Negative shocks to short-term interest rate expectations diminish, but forward guidance and QE increase their resilience. In terms of resilience, Credit Unions always respond negatively to monetary easing.

We suppose that banks which are more prone to adverse incentives introduced through the risk-taking channel of monetary policy, i.e. Large Banks and Sparkassen, can increase their resilience through large-scale asset purchases as risks are taken off their balance sheets. Banks that maintain their traditional business objectives, i.e. Credit Unions and Regional Banks, which support the business of their members or constituent corporation, tend to be negatively impacted by QE.

The presented results suggest that the low-interest-rate environment coupled with unconventional monetary policies have not generally alleviated financial risk in the German banking system. Loose monetary policy is overall associated with less resilience. Policy makers should reconsider ways of returning to a tighter monetary policy stance, in so far as the resilience of the banking system is an important policy objective.

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