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ECB MONETARY POLICY AND THE TERM STRUCTURE OF BANK DEFAULT RISK

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ECB Monetary Policy and the Term Structure of Bank Default Risk

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Abstract

Euro Area banks have been confronted with unprecedented monetary policy actions by the ECB. Monetary policy may affect bank risk profiles, but the consequences may differ for short-term risk versus long-term or structural bank risk. We empirically investigate the association between the ECB's monetary policy stance and market-perceived short-term and long-term bank risk, using the term structure of default risk captured by bank CDS spreads. The results demonstrate that, during the period 2009-2020, ECB expansionary monetary policy diminished bank default risk in the short term. However, we do not observe a similar decline in long-term bank default risk, since we document that monetary stimulus is associated with a steepening of the bank default risk curve. The reduction of bank default risk is most pronounced during the sovereign debt crisis and for periphery Euro Area banks. From 2018 onwards, monetary policy accommodation is associated with increased bank default risk, both short term and structurally, which is consistent with the risk-taking hypothesis under which banks engage in excessive risk-taking behavior in their loan and securities portfolios to compensate profitability pressure caused by persistently low rates. The increase in perceived default risk is especially visible for banks with a high reliance on deposit funding.

JEL classification: C58; G21; G32; E52.

Keywords: Monetary policy; ECB; Bank default risk; Term structure of credit risk;

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1 Introduction, motivation and hypotheses

How does a prolonged period of accommodative monetary policy affect the risk profile of banks? Since banks are the dominant channel of financial intermediation in the Euro Area, this question is not only relevant to assess the effectiveness of the transmission of monetary policy, but also to assess the ultimate impact of monetary policy on financial stability. Since the issue is high on the agenda of central banks and macroprudential authorities, it has received increasing attention in academic research. While there is little doubt about the beneficial effect of lower policy rates on the risk profile of banks in the short run, there is a lively debate about the consequences of long spells of low or even negative interest rates on bank risk taking, both theoretically and empirically. We contribute to this literature by distinguishing between short-run and longer-term effects of ECB monetary policy on bank default risk, using the entire term structure of bank CDS spreads. Since CDS spreads are a market-based measure of bank credit risk, analyzing not only the level of default risk, as has been done in almost all prior studies, but also the slope of the risk curve across the maturity structure allows us to disentangle how monetary policy affects bank risk profiles in the short run and in the longer run, as judged by market participants.

Monetary policy may affect bank profitability and bank risk through various channels. In order to formulate hypotheses, we consider the different channels and argue how they influence bank risk in the short run and in the long run. In the short run, there is little doubt that stimulating monetary policy benefits banks. Lower short-term interest rates cause higher net interest margins, since a decrease in interest rates affects short-term bank liabilities, such as demand and savings deposits, immediately while lower interest rates are only applied on new loans (Jäger and Grigoriadis, 2017; Saunders and Cornett, 2018). Moreover, banks relying on wholesale funding benefit from the lower interbank rates (Szczerbowicz, 2015). At the same time, lower interest rates increase asset prices, allowing banks to realize capital gains in their securities portfolio, boosting profits and capital (Falagiarda and Reitz, 2015). Lower policy rates are typically associated with better macroeconomic conditions through the interest rate channel (Peersman, 2004). The more benign economic environment is associated with lower non-performing loans (NPL) for banks and hence lower bank asset risk. Lower interest rates also increase the value of real assets, such as plant and equipment or house prices, which serve as collateral, so that collateralized bank loans become more secure. All these effects should improve the risk profile of banks in the short run.

In the literature, there is broad agreement that the accommodative monetary policy of the ECB stimulated the economy (Altavilla et al., 2018, 2019b) and that bank funding and lending conditions were eased considerably (Rostagno et al., 2019). Moreover, the monetary policy actions taken by the ECB during the banking and sovereign crisis contributed positively to bank stability because they restored the capacity of the banking system to provide financial intermediation services and they acted as a circuit breaker of adverse macro-financial feedback loops (Albertazzi et al., 2020). The hypothesis is that these beneficial effects should be reflected in lower short-run bank default risk. Hence, our expectation is that accommodative monetary policy is associated with lower bank risk, reflected in lower CDS spreads (Soenen and Vander Vennet, 2022).

In the longer run, however, persistently low interest rates may affect bank risk behavior and, hence, alter the banks' risk profile. First, most banks still derive the largest part of their profits from their core intermediation activity. When interest rates remain low for longer periods, the net margin compresses because there is a zero lower bound on retail deposit rates (Heider et al., 2019). Moreover, when the central bank undertakes asset purchases, this pushes down the yield curve, which causes bank interest margins to contract even more. Banks may try to maintain profitability by cutting costs and shifting to non-interest income (Lopez et al., 2020; Brei et al., 2020), but eventually low policy rates are associated with lower bank profitability (Borio and Gambacorta, 2017; Claessens et al., 2018; Molyneux et al., 2019). Altavilla et al. (2019a) argue that, initially, the ECB's Asset Purchase Program and negative deposit facility rates had a close to zero net effect on banks' ROA since positive effects (capital gains on securities and better credit quality) compensated the decline in the banks' net interest margins, but they acknowledge that a low-for-long interest rate environment eventually does hurt bank profitability. In a low for longer interest rate environment, capital gains are temporary in nature. Once realized, they are gone. Worse, when QE stops interest rates may rise and cause valuation losses on securities accounted at fair value. In the same vein, once banks have absorbed their legacy NPLs, the positive effect on profitability diminishes. Or, when policy rates are increased and the business cycle turns, banks may be confronted with new bad loans (Bonfim and Soares, 2018).

How do these longer-term effects translate into the banks' risk profile? From a risk perspective, the pressure on bank profitability implies a lower capacity to generate capital internally, which adversely affects bank risk and impairs the transmission of monetary policy (Gambacorta and Shin, 2018). More importantly, beyond this static effect, bank risk behavior may change. Over a longer horizon, compressing margins may cause a search for yield and push banks to increase their risk appetite (Adrian and Shin, 2009; Borio and Zhu, 2012). One concern relates to the potential increase in risk taking reflected in the underpricing of risk. Indeed the objective of accommodating monetary policy measures is to promote bank portfolio rebalancing away from safe assets, hence a higher bank risk appetite may be warranted as it is an important part of the transmission mechanism. The relevant question is whether or not monetary policy causes excessive risk taking by banks, since this could hamper financial stability and this may be reflected in higher bank CDS spreads. Rajan (2006) argues that accommodative monetary policy implies lower market rates which may induce a search-for-yield by financial institutions. Banks confronted with diminishing revenues as a consequence of lower rates may increase their risk appetite and invest in higher-risk loans and securities (Altunbas et al., 2012; Jiménez et al., 2014; Paligorova and Santos, 2017). Finally, prolonged periods of low policy rates, accompanied by depressed long-term interest rates due to quantitative easing, may induce banks to extrapolate low risk assessments into their lending decisions and this may increase their risk tolerance (Adrian and Shin, 2009; Borio and Zhu, 2012).

For the Euro Area banking system, the evidence on risk-taking behavior is mixed. For the case of the ECB's negative deposit facility rate, Heider et al. (2019), Demiralp et al. (2021) and Schelling and Towbin (2022) find that banks more reliant on retail deposit funding cut lending relative to their peers but also that these intermediaries tilted their loan supply towards more risky borrowers. Also, it has been shown that lower policy rates induce risk taking more for banks with lower capital ratios (Jiménez et al., 2014; Bonfim and Soares, 2018). However, Albertazzi et al. (2020) examine how banks price risk and they conclude that the additional risk taken in the post-2014 period was not inadequately priced. Similar mixed evidence is reported for the rebalancing of bank securities portfolios. Bubeck et al. (2020) report that since the introduction of negative policy rates, banks reliant on deposit funding exhibit search-for-yield behavior in the composition of their securities portfolios. Crosignani et al. (2020) and Carpinelli and Crosignani (2021) show that banks have used cheap ECB LTRO funding to increase their exposures to domestic government bonds, thereby exacerbating the bank-sovereign nexus. This behavior caused the emergence of the bank-sovereign doom loop. Albertazzi et al. (2020) confirm that, since the start of the APP, banks' bond portfolios have shifted through an active rebalancing out of the safest categories of securities into other investment grade bonds. However, they argue that over the same period, this effect was more than offset by positive rating migration caused by improved macroeconomic conditions. Moreover, they show that banks' portfolio rebalancing has not translated into a loading up of domestic sovereign debt securities, not even in those economies where such securities offer higher yields. Lamers et al. (2022) show that, after a period of risk-seeking behavior in the sovereign crisis era, banks shifted towards a more sound risk-return trade-off in the management of their sovereign portfolios post 2014, i.e. the period of asset purchases by the ECB which is characterized by declining long-term rates and hence higher incentives for yield-seeking behavior.

From this overview, we conclude that the impact of stimulating monetary policy on bank default risk may depend on the time horizon. Some of the risk-taking incentives may play in the short run, but they may be compensated by higher profitability, which may allow banks to increase their capital buffers. The lower short-run default risk should be reflected in lower CDS spreads. Some risk-taking effects may only become apparent over a longer time horizon. When banks accumulate risky assets, investors may exert market discipline by reassessing the banks' risk profile, which should be observable in the CDS market. The contribution of this study is that we explicitly distinguish between short-term and long-term effects on bank credit risk associated with monetary policy. Since the ECB gradually implemented stronger measures aimed at credit easing and quantitative easing, and even introduced negative policy rates, this time-varying policy setting should offer fertile ground to investigate the impact off ECB policies on perceived short-term and structural Euro Area bank risk. To the best of our knowledge, we are the first to use the entire term structure of bank default risk captured by their CDS spreads for different maturities to analyze this research question. Moreover, we extend the analysis by investigating differences across core and periphery Euro Area banks and by considering the reliance of banks on deposit funding as a distinctive characteristic determining the relationship between monetary policy and the banks' perceived credit risk profile.

We test the following hypotheses:

- H1: Accommodative monetary policy is associated with lower bank risk in the short run. We expect a negative relationship between accommodative monetary policy and short term bank default risk.
- H2: Accommodative monetary policy is associated with an increasing slope of the credit risk yield curve. Due to incentives for risk-taking, bank CDS spreads for longer maturities increase more or decline less than short term CDS spreads.
- H3: Banks with a higher reliance on deposit funding have stronger incentives for risk-taking behavior due to the zero lower bound on retail deposits.

The paper unfolds in the following way. In section 2 and 3 we provide details on the data and the empirical specification. Section 4 contains the empirical results. Section 5 concludes the paper and formulates policy considerations.

2 Data and sample selection

We construct a dataset containing daily CDS spreads of banks, daily market variables and yearly bank-specific control variables. CDS spreads are retrieved from Markit. The bank-specific and market variables are obtained from BankFocus and Refinitiv, respectively. We limit the sample to banks that meet selection criteria with regard to their CDS spreads[1] and bank-specific variables[2].

The application of the selection criteria results in a sample of 45 banks from 9 Euro Area countries during the period of 2009-2020. These banks represent a large share of the

[1] If the frequency of the CDS spread quotes is less than 25% over the sample period 2008-2018, the bank is omitted from the sample.

[2] We include only those banks with Loans/Assets or Deposits/Liabilities ratios above 20% to ensure that we focus on banks engaged in financial intermediation.

Euro Area banking sector. The sample period covers the post-crisis era and includes both the great financial crisis, the sovereign debt crisis in Europe and the start of the corona pandemic. An overview of the banks in the sample is provided in Table 1.

Table 1: Overview of the bank sample.

Name	Country
Erste Group Bank	Austria
Raiffeisen Bank International	Austria
Raiffeisen Zentralbank osterreich	Austria
UniCredit Bank Austria	Austria
BNP Paribas Fortis	Belgium
KBC Bank	Belgium
Banque Federative du Credit Mutuel	France
BNP Paribas	France
Credit Agricole	France
Credit Lyonnais	France
Natixis	France
Societe Generale	France
Bayerische Landesbank	Germany
Commerzbank	Germany
Deutsche Bank	Germany
Hamburg Commercial Bank	Germany
IKB Deutsche Industriebank	Germany
Landesbank Baden-Wurttemberg	Germany
UniCredit Bank	Germany
Governor and Company of the Bank of Ireland	Ireland
Permanent TSB Group Holdings	Ireland
Banca Italease	Italy
Banca Monte dei Paschi di Siena	Italy
Banca Nazionale del Lavoro	Italy
Banca Popolare di Milano Societa per Azioni	Italy
Banco BPM	Italy
Banco Popolare Societa Cooperativa	Italy
Intesa Sanpaolo	Italy
Mediobanca - Banca di Credito Finanziario	Italy
UniCredit	Italy
Unione di Banche Italiane	Italy
ABN AMRO Group	Netherlands
Cooperatieve Rabobank	Netherlands
ING Bank	Netherlands
NIBC Bank	Netherlands
Banco Comercial Portugues	Portugal
Caixa Geral de Depositos	Portugal
Novo Banco	Portugal
Banco Bilbao Vizcaya Argentaria	Spain
Banco de Sabadell	Spain
Banco Popular Espanol	Spain
Banco Santander	Spain
Bankia	Spain
Bankinter	Spain
CaixaBank	Spain

2.1 Term structure of bank default risk

We capture bank default risk by their CDS spreads because they are a market-based, unbiased measure of bank default risk (Altavilla et al., 2018). Our dataset consists of CDS spreads on senior bonds with maturities between 6 months and 20 years, which we use to estimate the term structure of bank default risk, i.e. banks' default risk at different maturity dates. Similar to the yield curve estimation of government bonds, we use a regression analysis where CDS spreads are explained by a number of factors. This method, first applied in Nelson and Siegel (1987) and refined in Svensson (1994) and Diebold and Li (2006) allows the identification of various yield curve shapes. In this paper, we use the yield curve estimation method developed in Svensson (1994), which is also used by the ECB. The shape of the yield curve is explained by a four-factor model, which are interpreted as the level, slope and two curvatures. We aggregate daily CDS spreads into a weekly default risk curve[3]. Hence, for each bank and each week in our sample we estimate the following model:

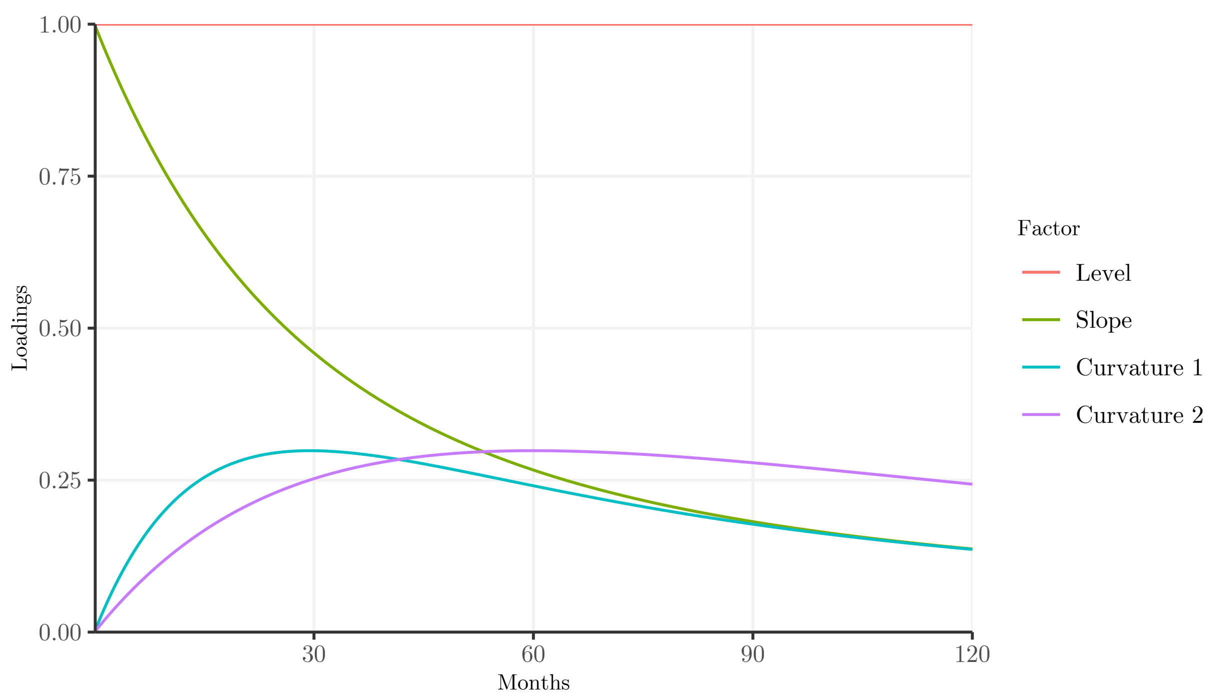
$$CDS_{i,t,w}(\tau) = \beta_{i,0,w} + \beta_{i,1,w}\left(\frac{1-e^{-\lambda_1\tau}}{\lambda_1\tau}\right) + \beta_{i,2,w}\left(\frac{1-e^{-\lambda_1\tau}}{\lambda_1\tau} - e^{-\lambda_1\tau}\right) + \beta_{i,3,w}\left(\frac{1-e^{-\lambda_2\tau}}{\lambda_2\tau} - e^{-\lambda_2\tau}\right) \quad (1)$$

where $CDS_{i,t,w}(\tau)$ is the CDS spread of bank i on day t in week w, with a remaining maturity τ. The first loading $\beta_{i,0,w}$ captures the long-run level of the default risk curve of bank i in week w. Similarly, the loading on the slope of the default risk curve is captured by $\beta_{i,1,w}$. The loadings on the first and second curvature factors are $\beta_{i,2,w}$ and $\beta_{i,3,w}$, respectively. In Figure 1 we show a graphical representation of the four factors. The level of the default risk curve can be interpreted as the long-run credit risk of the bank, since the other factors affect the default risk curve in the short and medium term. Hence, after both the slope and curvature factors have converged to 0, the level is the only factor which remains to capture the shape of the default risk curve. The slope of the default risk curve is captured by the second factor, since this factor decays from 1 at a hypothetical maturity of 0 months towards 0. Negative values for the loading of the slope factor, $\beta_{i,2,w}$, represent an upward-sloping default risk curve. Finally, the curvatures of the default risk curve are identified by the third and fourth factor. The factor increases from zero, reaches a maximum and subsequently converges back towards 0. The speed of adjustment of both the slope and curvature factors is determined by the decay rate λ_1 and λ_2. Similar to Diebold and Li (2006), we choose

[3]We aggregate daily CDS spreads in order to have a sufficient number of observations.

the value of the decay rate such that it maximizes the curvature loading in the medium term, which we approximate as maturities between 30 and 60 months. The values which maximize the loadings on the medium-term at exactly 30 and 60 months are $\lambda_1 = 0.0609$ and $\lambda_2 = 0.0299$, respectively[4]. Figure 1 displays the evolution of each factor in the four-factor model at a number of maturity dates. The level remains 1 at each maturity date, while the slope converges from 1 at a maturity of 0 months towards zero as the maturity of the CDS spread increases. The curvature factors load minimally on very short-term and long-term maturities, but increase medium-term CDS spreads, which load more heavily on it. Throughout this paper we use the level (β_0) and slope ($-\beta_1$) parameter of the Svensson (1994) model to disentangle short-term and long-term effects. We derive that $CDS_{i,t,w}(+\infty)$ equals β_0. As a result, we use the level parameter to capture long-term effects in the CDS market. Mathematically, the slope parameter ($-\beta_1$) corresponds to $CDS_{i,t,w}(+\infty)$ - $CDS_{i,t,w}(0)$. It follows that the sum ($\beta_0 + \beta_1$) captures short-term effects on bank CDS spreads.

Figure 1: Yield curve factors of the four-factor Svensson model (Svensson, 1994). The graph shows the evolution of each factor: level, slope and two curvatures with a decay rate of $\lambda_1 = 0.0609$ and $\lambda_2 = 0.0299$ respectively.



[4]The results with alternative decay rates are qualitatively similar.

Figure 2: The mean bank default risk curve of our sample.

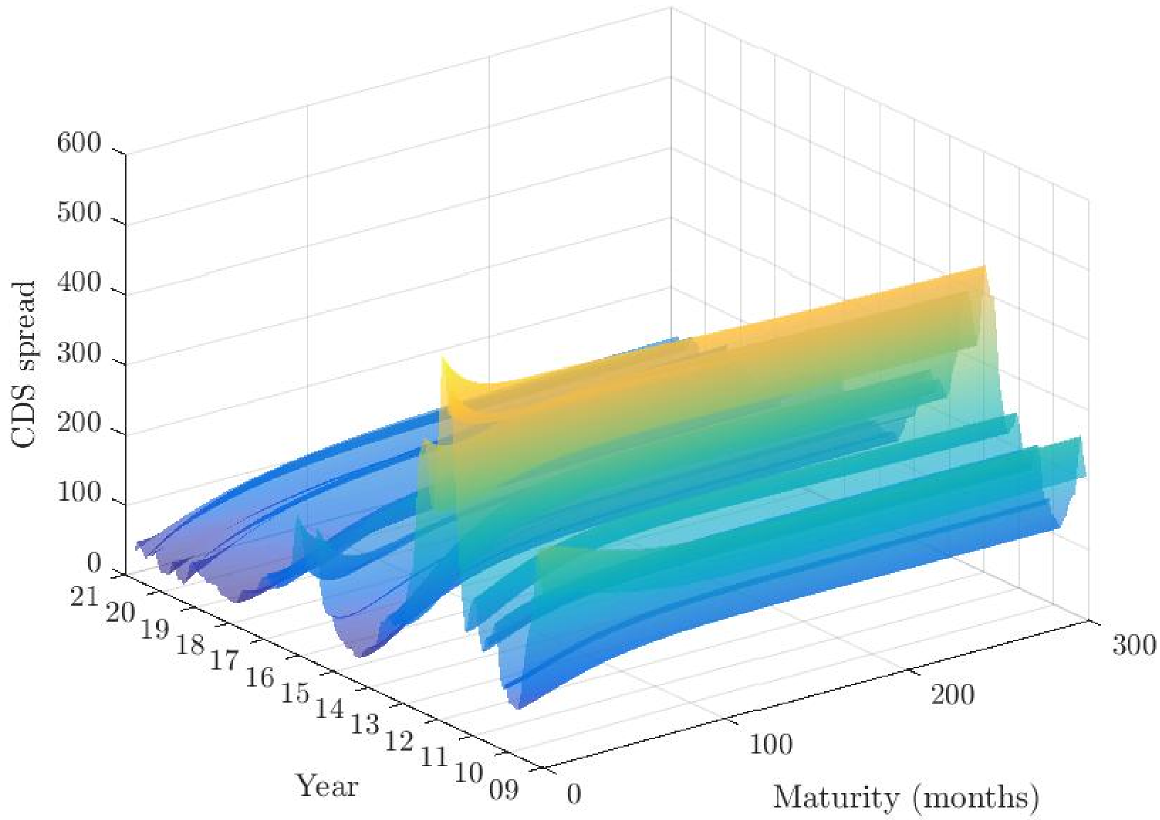
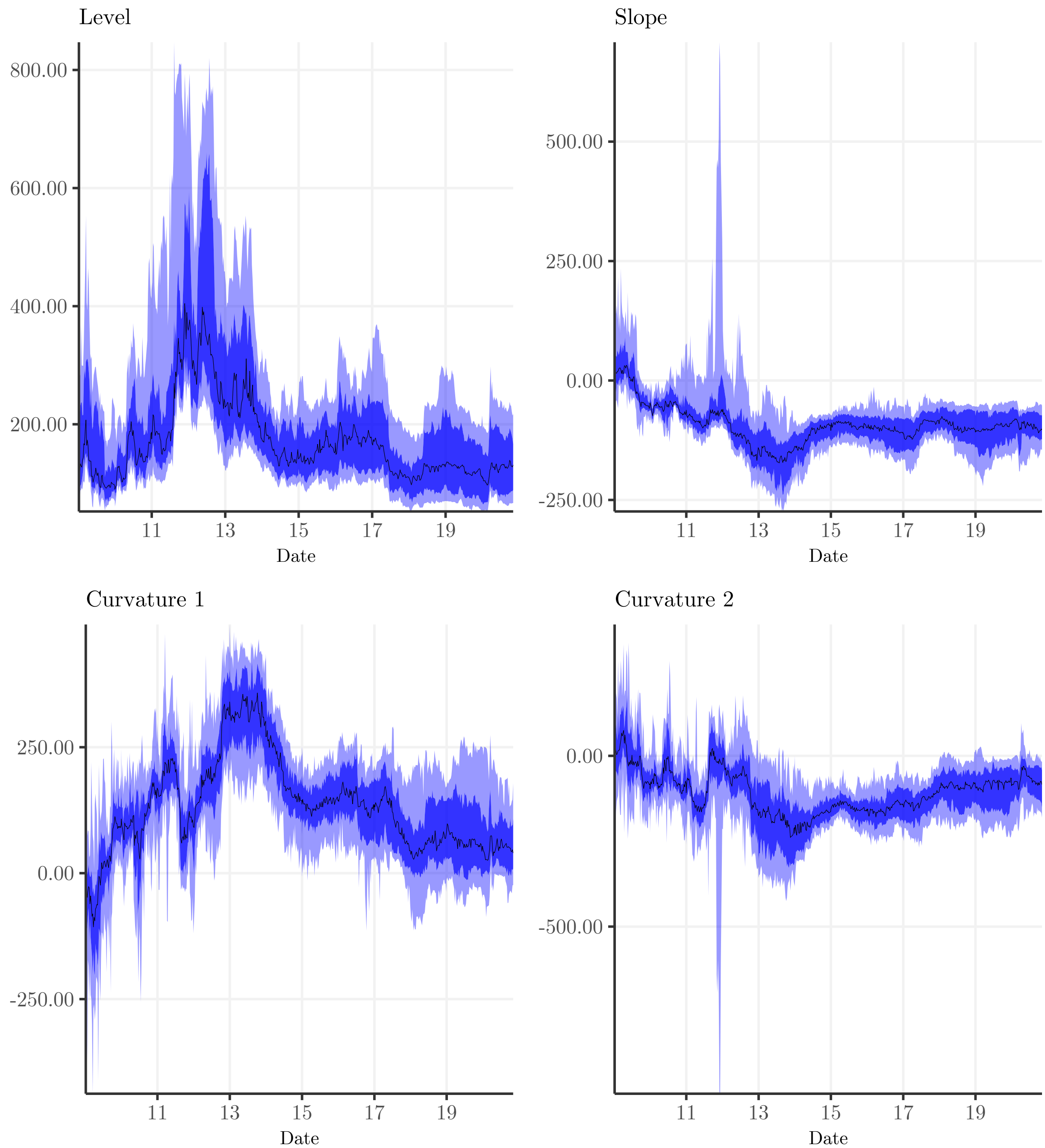


Figure 2 shows the evolution of the mean default risk curve over the sample period. On average, CDS spreads with a shorter maturity yield a lower spread, as bank default risk in the short term is also captured by longer maturities. The global financial crisis and the sovereign debt crisis led to pronounced increases in perceived bank default risk, both in the short and long term. Also the 2016-2017 period is characterized by an increase of bank CDS spreads caused by uncertainty with regard to the viability of certain bank business models in the Euro Area. Finally, the start of the corona pandemic is not associated with an increase in perceived default risk of banks. In Figure 3 we show the evolution of the parameters of the default risk curve and its dispersion between the banks in our sample. The level of the default risk curve captures the long-term default risk of banks as perceived by markets which shows similar dynamics as in Figure 2. The slope parameter is on average negative and notably lower during the sovereign debt crisis. A negative slope parameter translates into a higher increase of the default risk curve of banks, which means that during the sovereign debt crisis spread difference between short-term and long-term default risk of banks was higher.

Figure 3: Bank default risk curve loadings. The top row displays the time series of the level and slope parameters, whilst the bottom row shows the first and second curvature loadings. The solid black line represents the median value of the variables on a given week, while the darker and lighter blue areas show the 25-75% and the 10-90% percentiles for a given day.



2.2 Identifying monetary policy

Since our focus is on the impact of monetary policy on bank risk, we need to identify the monetary policy stance in the Eurozone in the post-2008 period. We cannot use the policy rate because of the zero lower bound constraint and, similarly, we cannot use the ECB balance sheet because some important monetary policy measures did not affect the balance sheet (e.g., OMT was pre-announced by the Draghi 'whatever it takes ' speech in July 2012, operationally implemented in September 2012 but subsequently never activated). And finally, different conventional and unconventional policy measures were announced simultaneously (e.g. in January 2015, APP was announced jointly with a decrease in the Deposit Facility Rate and strengthened forward guidance) and were often largely anticipated. When reviewing the potential approaches to identify monetary policy (Rossi, 2021), we opt for a structural VAR because incorporating a broad set of financial market indicators allows us not only to identify actual ECB monetary policy decisions, but also to capture anticipation effects and instances in which financial markets judge that monetary policy actions were insufficient, given the prevailing market conditions. For the CDS market, current and future financial conditions are relevant to assess the default risk of banks.

Therefore we estimate a time series of exogenous monetary policy shocks by modeling a set of relevant financial market variables in a structural VAR model at daily frequency as in Wright (2012), Rossi (2021) and Lamers et al. (2019):

$$Y_t = A_1 Y_{t-1} + \ldots + A_p Y_{t-p} + R v_t \tag{2}$$

where Y_t is an N-dimensional vector of endogenous variables, v_t an N-dimensional vector of orthogonal structural innovations with mean zero and $A_1, \ldots, A_p$ and R are $N \times N$ time-invariant parameter matrices. The reduced-form residuals corresponding to this structural model are given by the relationship $\varepsilon_t = R v_t$.

To estimate the structural VAR we use a set of variables that capture the pass-through of monetary policy to the financial sector. Following Rogers et al. (2014), we select those variables that are expected to respond most to a monetary policy shock. More specifically, as we conduct the analysis for the Euro Area, we include the German 10-year bond yield, the

VSTOXX, the CDS spread of Spain, a market index and the 5-year 5-year forward inflation expectation. The identification of the policy shock is based on the identification-through-heteroscedasticity strategy, proposed by Rigobon and Sack (2004), which assumes that a structural monetary policy shock is more volatile on announcement days of a central bank. The main idea is that a structural monetary policy shock for the Euro Area has a higher volatility on days where the ECB makes monetary policy announcements. Based on the differences in the volatility of the shock during both regimes, the structural VAR is uniquely identified. The only assumption is that there is some kind of heteroskedastic pattern in the monetary policy shock while all other shocks are homoskedastic:

$$Var\left(v_t\right) = \Omega_t = \begin{cases} \Omega^{(0)} = \operatorname{diag}\left(\omega_1, \omega_2, \ldots, \omega_N\right) & \text{if } \textit{no announcement} \\ \Omega^{(1)} = \operatorname{diag}\left(\omega_1^*, \omega_2, \ldots, \omega_N\right) & \text{if } \textit{announcement} \end{cases} \tag{3}$$

It can be shown that, as long as the covariance matrix of the reduced form errors v_t changes on announcement days, these assumptions suffice to uniquely identify the first column of the structural impact multiplier R and the structural monetary policy shocks except for their scale and sign. The model can be estimated following the iterative estimation procedure outlined in Lanne and Lütkepohl (2008)[5]. We normalize the monetary policy shock by fixing the response on impact of one of the included variables to a unit monetary policy shock. We define a unit expansionary monetary policy shock as a shock that decreases the 5-year CDS spread of Spain with 5% points[6]. This identification-through-heteroskedasticity approach is widely used in the literature to identify monetary policy shocks, for example Rogers et al. (2014), Arai (2017), Lamers et al. (2019) and Rossi (2021). We estimate a VAR of order 2 over a sample period from 1 October 2008 to 31 December 2020. This methodology allows us to identify monetary policy shocks that capture the effect of the main ECB announcements and potential anticipation effects, e.g. the OMT program has been implemented in September 2012, yet it was already announced two months earlier. The financial variables in the VAR capture these potential anticipation effects. It is the

[5] For details on the estimation procedure we refer to Lamers et al. (2019).

[6] Using other variables to identify a unit shock and using the CDS spread of e.g. Italy to calibrate an accommodative shock yields an almost identical shock series.

combination of actual ECB announcements and anticipation effects that determines the macro-financial environment in which the CDS market assesses bank default risk.

Figure 4: ECB Monetary Policy Stance. Time series of the cumulative monetary policy shocks for the Euro Area, estimated using an identification-through-heteroskedasticity approach proposed by Rigobon and Sack (2004). An increase in the monetary policy stance reflects an accommodative monetary policy change, a decrease captures restrictive monetary policy changes. We highlight some of these announcement dates: (a) the ECB starts its first covered bond purchase program (CBPP1) and announces a one-year LTRO; (b) the ECB announces its Securities Markets Program; (c) the ECB increases its MRO interest rate; (d) ECB President Mario Draghi states that the ECB "is ready to do whatever it takes to preserve the euro"; (e) the ECB introduces the Outright Monetary Transactions (OMT) program; (f) the ECB announces it will start buying public-sector securities (EUR 60 billion per month until September 2016); (g) the ECB decreases the deposit facility rate to -0.3% and extends its APP program until the end of March 2017; (h) the ECB extends its APP for EUR 30 billion until at least September 2018; (i) the ECB offers forward guidance that interest rates will remain low until the summer of 2019; (j) the ECB announces its pandemic emergency purchase programme (EUR 750 billion until end 2020).

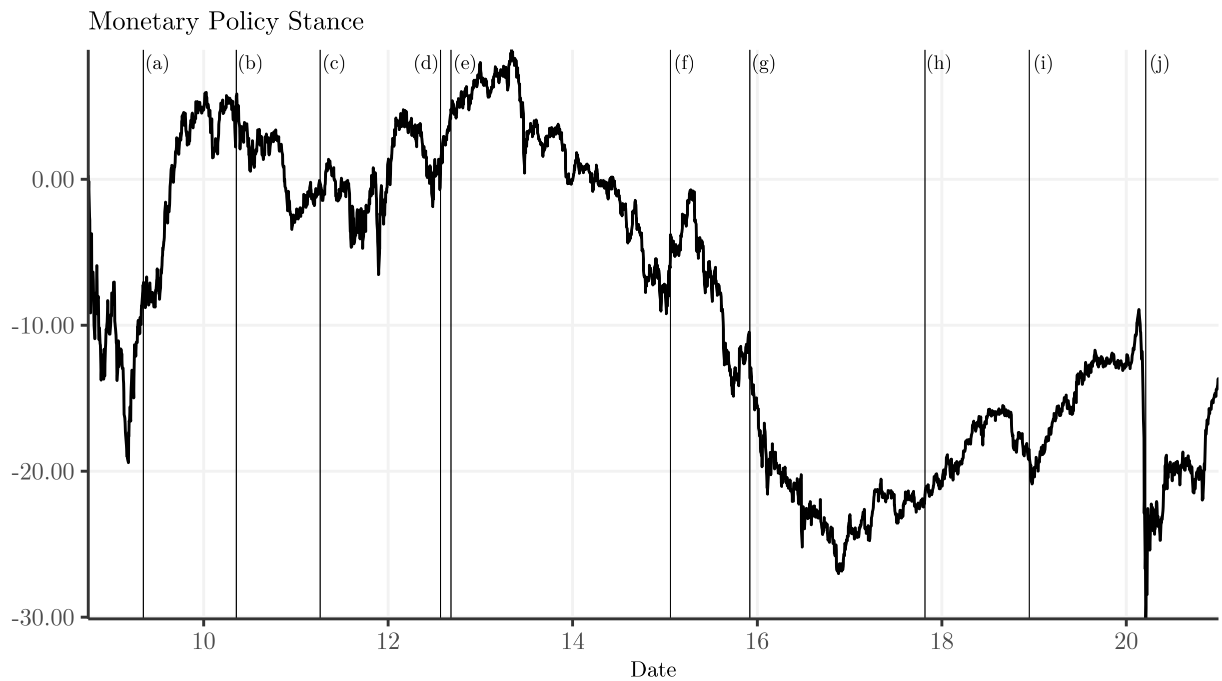


Figure 4 shows cumulative monetary policy shocks, which we label as the monetary policy stance. A sequence of positive monetary policy shocks indicates that monetary policy becomes more expansionary and therefore the cumulative series reflects the monetary policy stance with respect to the prevailing economic environment and expectations of financial markets. Similarly, a drop in the series may reflect a tightening of monetary policy but may also capture the lack of monetary policy action, or even that there were expansionary announcements that failed to live up to financial market expectations. Figure 4 shows that the shocks are able to capture important monetary policy announcements, as well as the anticipation of some measures. In October 2008, the financial crisis hit the economy and monetary policy was initially perceived to be not sufficiently expansionary. Once the ECB stepped up its policy actions with substantial repo rate decreases and the launch of longer-term refinancing operations, the monetary policy stance reverted to expansionary. The LTRO and Covered Bond Purchase Program (CBPP1) announcement in May 2009 and the SMP announcement in May 2010 are among the largest expansionary daily shocks and can therefore be considered as surprises to financial markets. In the following years, the monetary policy stance is somewhat volatile, with periods of restrictive monetary regimes followed by expansionary shocks in the monetary policy stance, caused by events such as the ECB president Mario Draghi London speech in July 2012. The OMT announcement in September 2012 appears to have been largely anticipated following this July Draghi speech in which he alluded to the implementation of additional unconventional monetary policy measures. The QE period which started in 2015 is sometimes perceived as a period of restrictive monetary policy, probably because of economic uncertainty stemming from the economic and political environment (e.g. Brexit). From 2017 onwards until March 2020, the sustained monetary easing is considered by financial markets as effectively stimulating the economy, although the ECB kept interest rates unchanged and primarily used forward guidance that interest rates would remain low until at least the summer of 2019. In March 2020, the corona pandemic worsened the prevailing economic conditions which resulted in a significant negative shock to the overall stance of monetary policy until the ECB introduced the Pandemic Emergency Purchase Program (PEPP). An interesting example of the potential divide between policy intentions and market perception is described by Rostagno et al. (2019) in their account of the first 20 years of ECB monetary policy. In December 2015 the Governing Council decided to lower the deposit facility rate by 10 basis points. However, the authors conclude that the markets expected a larger reduction in the deposit facility rate, hence despite the intention of the ECB to be accommodating, the policy actions did not meet the expectations of financial markets (Rostagno et al., 2019). This resulted in a tightening of the monetary policy stance, as is reflected in our Figure 4, illustrating that our indicator of the monetary policy stance succeeds in identifying divergences between intended policy outcomes and actual market perceptions. This is an important value added of the identification approach since our objective is to assess the impact of the monetary policy stance on a market-based indicator of the banks' risk profile.

2.3 Control variables: bank-specific and market variables

Next to the prevailing macroeconomic conditions, the risk profile of a bank is determined by the strategic choices which constitute the bank's business model and affect the associated performance outcomes in terms of profitability and risk. To control for bank fundamentals, we include variables capturing the asset structure, funding mix and the bank's capital strength. The balance sheet control variables are the loans to assets ratio (LTA) as a proxy for the importance of the bank's lending activity and the proportion of deposits in total liabilities (DEP) as a measure of the funding mix. Capital strength is captured by the unweighted capital ratio (CAP). Capital buffers have been shown to decrease banks' market beta (Baele et al., 2007), as well as their systemic risk (Laeven et al., 2016) and several papers have demonstrated that higher capital before the crisis increased the likelihood of survival and enhanced bank performance in distress periods (Berger and Bouwman, 2013; Vazquez and Federico, 2015). Finally, we include the natural logarithm of total assets (SIZE) as a proxy for any potential size-related benefits in terms of banks' perceived risk profile. In terms of outcome variables we focus on profitability, i.e. return on assets (ROA), and we include a measure of the quality of the bank's lending portfolio, i.e. non-performing loans to total loans (NPL).

The risk profile of the bank may be affected by prevailing financial market conditions. We include the Vstoxx as a measure of market volatility, since it has been shown to be an indicator of uncertainty and risk (Nave and Ruiz, 2015; Baele et al., 2020). Additionally, we include the Euro Stoxx 50 stock index to capture financial market conditions.

The descriptive statistics for the bank factor loadings, bank-specific variables and market volatility are reported in Table 2.

Table 2: Descriptive statistics. Bank-specific data, market data and CDS spreads are obtained from SNL, Refinitiv and Markit respectively.

Variables	MEAN	SD	P1	P50	P99
Level	203.50	151.73	50.25	165.05	811.48
Slope	−65.23	296.27	−265.02	−92.42	955.14
Curvature 1	150.81	302.72	−299.68	135.68	686.45
Curvature 2	−150.19	505.32	−1,059.96	−118.02	301.84
Monetary Policy Stance	−8.37	10.34	−26.02	−6.90	7.84
Euro Stoxx 50	1,066.09	252.62	585.43	1,090.25	1,553.88
Vstoxx	22.42	8.12	11.64	20.82	48.59
CAP	6.36	2.07	2.53	6.34	12.85
Size	19.27	1.20	16.63	19.23	21.45
LTA	57.51	16.72	15.33	60.80	88.87
NPL	7.80	8.23	1.13	5.48	36.91
ROA	0.09	0.73	−2.68	0.25	1.06
DEP	47.31	16.83	5.85	48.56	85.20
NIM	1.77	0.71	0.46	1.71	3.66

3 Methodology

Since we hypothesize that monetary policy may be associated with differential effects on short-term versus long-term bank default risk, captured by the term structure of bank credit risk, our empirical analysis proceeds as follows. First, we estimate a baseline model of banks' default risk term structure components with the monetary policy stance of the ECB and bank-specific control variables as main explanatory variables. More specifically, we analyze the impact of the monetary policy stance on the short-term and long-term default risk, which we derive from the bank default risk curve. As described in Section 2, short-term bank default risk is described as the sum of the level and slope parameter ($\beta_{0,i,w} + \beta_{1,i,w}$) of Equation 1, whilst banks' long-term default risk is captured by the level parameter ($\beta_{0,i,w}$) only. Second, we analyze whether or not the impact of monetary policy on short-term and long-term bank default risk is significantly different by estimating the impact of the monetary policy stance on the slope of the bank default risk curve.

We estimate the impact of monetary policy stance on short-term and long-term bank default risk, measured by bank CDS spreads, using the following model:

$$\begin{aligned} DefaultRisk_{i,t} &= \alpha_i + \beta \ MonetaryPolicy_t \\ &+ \sum_{k=1}^{K} \zeta_k \ BankControls_{k,i,t} + \sum_{l=1}^{L} \gamma_l \ MacroControls_{l,t} + \varepsilon_{i,t} \end{aligned} \tag{4}$$

where $DefaultRisk_{i,t}$ represents bank i's short-term or long-term bank default risk in week t. $MonetaryPolicy_t$ captures the monetary policy stance of the first day of week t, estimated with a SVAR and identification-through-heteroscedasticity approach. We control for the banks' business model by including a number of bank control variables ($BankControl$) and for macroeconomic conditions with the inclusion of the Eurostoxx 50 index and the Vstoxx ($MacroControls$). The model controls for unobserved heterogeneity at the bank level by including bank fixed effects (α_i). We do not include a time fixed effect, since this would not allow us to identify the impact of the monetary policy stance on bank default risk. With this methodological setup we answer our main research questions. First, if there is a negative association between the monetary policy stance and short-term and long-term bank default risk, we argue that accommodative monetary policy of the ECB reduces bank default risk, both immediate as well as structurally. Second, if there is a positive association between the monetary policy stance and the slope of the banks' default risk curve, we infer that the impact of monetary policy is heterogeneous between short-term and long-term bank default risk, which may signal bank risk-taking behavior. Therefore we estimate the following model:

$$
\begin{aligned}
Slope_{i,t} = \alpha_i + \beta \ MonetaryPolicy_t \\
+ \sum_{k=1}^{K} \zeta_k \ BankControls_{k,i,t} + \sum_{l=1}^{L} \gamma_l \ MacroControls_{l,t} + \varepsilon_{i,t} \qquad (5)
\end{aligned}
$$

where $Slope_{i,t}$ is the second factor of the four-factor model in Equation 1. To make the interpretation of the results more intuitive, we estimate the impact of monetary policy on $-\beta_1$. Hence, a positive association between the slope and monetary policy indicates an increase of the slope and thus also a widening of short-term and long-term bank default risk due to a accommodative monetary policy shock.

Finally, we analyze our third hypothesis, i.e. whether or not the transmission of monetary policy towards bank default risk, both in the short and long-term, is different for banks with a high and low reliance on deposits. We argue that banks with a high reliance on deposits are more induced to exhibit risk-taking behavior after a prolonged period of low interest rates, based on Heider et al. (2019) who find that when the ECB's deposit facility rate turned negative, banks with high deposits tilted their loan supply towards more risky borrowers.

To analyze whether or not accommodative monetary impacts high and low deposit banks differently we estimate Model 4 for banks situated in the highest and lowest deposits-to-liabilities quartile separately.

4 Results

4.1 ECB monetary policy and bank credit risk

In Table 3, we analyze the impact of monetary policy shocks on bank default risk, based on Equations 4 and 5. The results in columns (1) and (2) show the impact of the stance of monetary policy on the banks' short-term and long-term default risk, captured with CDS spreads, while column (3) displays the impact on the slope of the banks' default risk curve. We define short-term default risk as the instantaneous market-perceived default risk of the bank, which is captured by $\beta_{0,i,w} - \beta_{1,i,w}$ from the Svensson model in Equation 1. Long-term default risk is represented by $\beta_{0,i,w}$. We saturate each model with bank fixed effects and additionally control for observable bank characteristics and the macroeconomic environment. We cluster the standard errors at the bank level.

Our main result in Table 3 is that an accommodative monetary policy shock is associated with declining bank CDS spreads in the short term (minus 4.44 basis points per unit of monetary stimulus), but does not affect long-term bank default risk[7]. Hence, CDS market investors judge that monetary stimulus is associated with a decline in the immediate default probability of banks, but this beneficial effect is not extended to the banks' structural tail risk. The finding that ECB monetary stimulus lowers short-term bank default risk is consistent with Altavilla et al. (2018) who document declining bank CDS spreads following all major ECB monetary policy announcements and with Soenen and Vander Vennet (2022) who report a negative association between ECB monetary policy easing and Euro Area bank CDS spreads. These findings indicate that banks are perceived to benefit from the more

[7]The differences in banks' short- and long-term credit risk may be partly explained by a difference in their underlying liquidity. To check that this does not partly explain our results, we estimate the same model directly on the 1-year and 5-year CDS spreads, which have a more comparable liquidity. We interpret the 1-year CDS as short-term credit risk and the 5-year as long-term credit risk. The results remain qualitatively similar, so we assume that our results are not affected by possible differences in liquidity.

Table 3: Impact of ECB monetary policy on short-term and long-term bank default risk and on the slope of the default risk term structure curve. Short term default risk is estimated as the sum of the level (β_0) and slope (β_1) parameter from the Svensson model. Long term default risk is defined by the level parameter. All estimations use bank fixed effects to control for unobserved heterogeneity and macro variables to control for common macroeconomic shocks. Standard errors in parentheses are clustered at the bank level. *, ** and *** represent significance at the 10%, 5% and 1% percent level, respectively.

	(1)	(2)	(3)
	Short Term	Long Term	Slope
Monetary Policy	-4.44^{***}	-0.14	4.30^{***}
	(1.58)	(0.38)	(1.31)
CAP	21.60	-9.97	-31.57
	(27.29)	(10.01)	(21.77)
NPL	-4.13	0.85	4.98
	(3.34)	(0.77)	(3.28)
SIZE	146.26	-66.69	-212.95^{**}
	(112.23)	(43.69)	(88.16)
DEP	-11.79^{***}	-1.24	10.55^{***}
	(3.26)	(0.90)	(2.74)
ROA	-107.14^{***}	-50.02^{***}	57.12^{*}
	(34.05)	(9.58)	(29.46)
LTA	4.81	2.09^{**}	-2.72
	(4.46)	(0.98)	(4.08)
Eurstoxx	-0.18^{***}	-0.17^{***}	0.01
	(0.06)	(0.02)	(0.06)
Vstoxx	1.46	-0.29	-1.76^{*}
	(1.17)	(0.35)	(1.03)
Bank fixed effects	Yes	Yes	Yes
Time fixed effects	No	No	No
R^2	0.18	0.27	0.11
No. Obs.	23,505	23,505	23,505
No. Banks	45	45	45

benign economic conditions associated with monetary accommodation. The finding that this is not the case for long-term bank default risk is consistent with the arguments developed in Altavilla et al. (2019a), who assert that positive effects from monetary stimulus (positive effect on the macroeconomy and bank asset quality, capital gains due to lower interest rates) may be compensated by negative consequences of persistently low interest rates (pressure on banks' interest margins in general and the effect of the negative interest rate on the deposit facility in particular), leading to a zero net effect. To determine whether or not monetary policy alters the shape of the bank default risk term structure, the third column presents the impact of monetary policy shocks on the slope of the bank default risk curve ($-\beta_1$). We find a positive and significant coefficient indicating that the slope of the credit curve increases by 4.3 basis points per unit of monetary policy stimulus. In principle, a steepening of the default risk curve would be consistent with risk-taking behavior by the banks. However, the steeper slope is only caused by lower short-term banks CDS spreads, not a perceived increase in the longer-term default risk of the banks. Hence, we cannot conclude that the CDS market anticipates excessive risk-taking by banks caused by a protracted period of monetary accommodation. Nevertheless, finding that lower short-term risk is not accompanied by a similar decline in long-term default risk does point to market participants' concerns that the beneficial effect of monetary policy stimulus on bank default risk does not extend to the structural tail risk of Euro Area banks. In section 4.3 we further explore the time variation in the association between monetary policy and bank credit risk.

Another noteworthy result in Table 3 relates to the impact of the banks' deposit funding ratio on bank default risk. A higher deposit ratio is associated with lower short-term risk, indicating that markets consider that having access to stable funding makes banks more resilient. However, a higher deposit ratio is associated with a steeper credit risk curve, which is consistent with Heider et al. (2019) who argue that banks relying on deposit funding are confronted with compressing interest margins caused by monetary accommodation and this results in increased risk-taking behavior in their syndicated lending. Similarly, Bubeck et al. (2020) report that high-deposit banks exhibit higher risk taking in their securities portfolio (see section 4.4 for a more detailed analysis).

4.2 Core versus periphery: Euro Area banks

When analyzing the impact of ECB monetary policy, a natural extension is to consider potential differences between core and periphery Euro Area banks. Differences in the impact of monetary policy on bank risk profiles in the core versus the peripheral countries may be driven by the fact that monetary policy transmission differs across countries, e.g. OMT had a more pronounced downward effect on interest rates in the Euro Area periphery (Krishnamurthy et al., 2018). Moreover, Soenen and Vander Vennet (2022) show that there is a direct beneficial effect of monetary policy on the risk profile of banks, which is amplified by an indirect through-the-sovereign effect. Fratzscher and Rieth (2019) report that the bank-sovereign nexus works in both directions, with sovereign risk impacting bank risk and vice versa. Therefore, we analyze the heterogeneous impact of ECB monetary policy on short and long-term bank default risk depending on whether the banks are located in the periphery (i.e. Ireland, Italy, Spain or Portugal) or core countries. We interact the monetary policy stance with a dummy variable equal to one when a bank is headquartered in a periphery country, zero otherwise:

$$\begin{aligned} DefaultRisk_{i,t} = \alpha_i &+ \beta_1 \, MonetaryPolicy_t \\ &+ \beta_2 \, MonetaryPolicy_t \times Periphery_i \\ &+ \sum_{k=1}^{K} \zeta_k \, BankControls_{k,i,t} + \sum_{l=1}^{L} \gamma_l \, MacroControls_{l,t} + \varepsilon_{i,t} \end{aligned} \tag{6}$$

where $Periphery_i$ is a dummy variable that equals 1 if bank $iattime$t is located in either Ireland, Italy, Spain or Portugal.

The interpretation of the coefficients in Table 4 proceeds as follows. The first row (monetary policy without interaction) captures the effect of monetary policy shocks for core banks, the second row adds the interaction with periphery banks, hence the total effect on bank risk for the periphery banks is the sum of the first and second row. We find that an accommodative monetary policy shock has a beneficial effect on the default risk of banks in the short run. This effect is significant for core Euro Area banks and it is amplified for periphery banks, although the interaction term remains insignificant. For core banks, we even find that ECB monetary policy accommodation is associated with a lower long-term default risk, indicating that the CDS market attaches a lower default probability to their entire term structure of default risk, but the effect is more pronounced in the short run, as evidenced by the positive and significant coefficient on monetary policy in the slope regression in the first row of column 3. For periphery banks, the combination of the first two rows leads to a non-negative effect of monetary policy on long-term default risk. And since the periphery banks' interaction coefficient is positive and significant (at the 10% level) in the slope regression, this suggests that CDS market participants view that risk-taking incentives are particularly present for periphery banks.

Table 4: Impact of monetary policy on short-term and long-term bank default risk and on the slope of the default risk term structure curve for the core and peripheral Euro Area banks. Short term default risk is estimated as the sum of the level (β_0) and slope (β_1) parameter from the Svensson model. Long term default risk is defined by the level parameter. All estimations use bank fixed effects to control for unobserved heterogeneity and macro variables to control for common macroeconomic shocks. Standard errors in parentheses are clustered at the bank level. *, ** and *** represent significance at the 10%, 5% and 1% percent level, respectively.

	(1)	(2)	(3)
	Short Term	Long Term	Slope
Monetary Policy	-2.95^{***}	-0.81^{*}	2.14^{***}
	(1.06)	(0.46)	(0.77)
Monetary Policy × Periphery	-2.82	1.58	4.40^{*}
	(3.19)	(1.01)	(2.59)
Bank fixed effects	Yes	Yes	Yes
Time fixed effects	No	No	No
Bank control variables	Yes	Yes	Yes
Macro control variables	Yes	Yes	Yes
R^2	0.2	0.29	0.13
No. Obs.	23,505	23,505	23,505
No. Banks	45	45	45

4.3 Time variation of the effect of monetary policy on bank credit risk

In terms of time variation, it would be natural to hypothesize that bank risk-taking incentives associated with accommodative monetary policy would only materialize once the pressure on their profitability turns out to be persistent. Since the great financial crisis, the ECB has implemented various types of conventional (interest rate changes) and unconventional monetary policy instruments, ranging from credit easing (e.g. (T)LTROs), quantitative easing (e.g. the asset purchase programs) and forward guidance, to even implementing a negative interest rate policy (negative rates on the deposit facility) (Rostagno et al., 2019). These policies have been introduced at various stages over the period under investigation and they may impact the risk profile of banks differently. Interest rate decreases initially supported bank net interest margins and LTRO lowered the cost of funding of banks, but once the ECB started applying negative interest rates on its deposit facility and once forward guidance pointed at low-for-long interest rates, bank interest margins and profitability may be affected negatively (Borio and Gambacorta, 2017; Claessens et al., 2018; Molyneux et al., 2019). Moreover, Ampudia and Van den Heuvel (2018) report that the expected increase of stock valuations that usually accompanies policy rate decreases reverses for European banks in the period of low and even negative interest rates. Confronted with compressing interest margins, banks may seek to increase non-interest income or improve their cost efficiency (Brei et al., 2020; Lopez et al., 2020). Yet, the persistent pressure on profitability may incentivize banks to search for yield, activating a risk-taking channel (Borio and Zhu, 2012), which may become stronger as interest rates remain low for longer and even enter negative territory. Banks may seek higher yields in higher-risk pockets in their lending and securities portfolio (Heider et al., 2019; Bubeck et al., 2020). The ultimate effect of monetary policy on bank profitability and the banks' risk profile is the net result of beneficial effects (e.g. better economic conditions) and potential negative side effects (e.g. risk taking) (see Altavilla et al. (2019a) and Albertazzi et al. (2020)). If banks are considered to engage in excessive risk taking, i.e. taking risks that are not adequately priced, this should be associated with higher perceived bank default risk and, hence, higher long-term CDS spreads. To investigate this hypothesis, we examine whether or not the impact of changes in the monetary policy stance on the banks' risk profile differs in consecutive periods of ECB monetary accommodation.

In order to investigate the time-varying pattern of the impact of ECB monetary policy actions on bank risk, we interact the monetary policy variable with year dummies. We estimate the following model:

$$
\begin{aligned}
DefaultRisk_{i,t} = \alpha_i & \\
& + \sum_{k=1}^{K} \beta_k \; MonetaryPolicy_t \times Year_k \\
& + \sum_{l=1}^{L} \zeta_l \; BankControls_{l,i,t} + \sum_{m=1}^{M} \gamma_l \; MacroControls_{m,t} + \varepsilon_{i,t} \qquad (7)
\end{aligned}
$$

where $Year_k$ is a dummy variable which equals 1 during year k and 0 otherwise. Since we are interested in the transmission of monetary policy to bank risk in a given year, the dummy variables equal 1 during that year only.

Table 5 presents the results. We only show the coefficients of the interaction terms of monetary policy with the year dummies for short-term and long-term bank default risk. It is immediately clear that there is a distinct time pattern for the way in which ECB policy actions have impacted bank risk. In the years up to 2012, there is a significant negative association between monetary stimulus and bank default risk and this effect is more pronounced for short-term compared to long-term bank default risk. In other words, accommodative monetary policy was efficient in reducing perceived bank risk during the sovereign debt crisis 2010-2012. This reduction in perceived bank risk coincides with the execution by the ECB of its Securities Market Program (SMP) that was effective from May 2010 until September 2012 and that was designed to purchase government securities of stressed peripheral Euro Area countries, and the July 2012 Draghi 'whatever it takes' speech announcing the OMT program. In 2010 the ECB also launched its bank covered bond program and the first wave of LTRO aimed at easing the funding conditions of Euro Area banks. These findings are consistent with the results in Soenen and Vander Vennet (2022) who show that monetary policy is not only associated with lower bank CDS spreads directly but also indirectly, through lower sovereign spreads. In the period following the sovereign debt crisis, the impact of monetary policy shocks on bank risk is not significant, with the exception of 2016-2017 in the case of the long-term bank default risk. One possible explanation may be the impact of the asset purchase program launched in 2015 that was in full operation during those years and may have allowed banks to reap capital gains in their bond portfolios and may have enabled them to start selling parts of the non-performing loans, especially banks in distressed countries. From 2018 onwards, we observe a positive and significant coefficient on the interaction term and this holds for both short-term and long-term bank default risk. This finding is consistent with the risk-taking hypothesis under which banks shift to riskier assets in an attempt to compensate shrinking interest margins and pressure on their overall profitability.

In order to combine the geographical (core versus periphery) and the time dimension, we estimate Equation 7 for the core and periphery country banks separately and present the evidence in Figure 5. The results show that accommodative monetary policy was associated with a significant decline in perceived bank default risk in the sovereign crisis era, both for short-term risk and structural default risk and this beneficial effect was more pronounced for the banks in the periphery. From 2013 onwards monetary policy action no longer seem to significantly affect bank default risk. During the final years of the sample period, the beneficial impact totally disappears and turns into a positive association between ECB accommodation and bank default risk, indicating that a prolonged period of very low interest rates is perceived to incentivize banks to increase their risk profile. These results are consistent with evidence presented in Heider et al. (2019) and Bubeck et al. (2020), they also corroborate the finding in Lamers et al. (2019) that ECB monetary policy accommodation is associated with an increase of the systemic risk of periphery Euro Area banks.

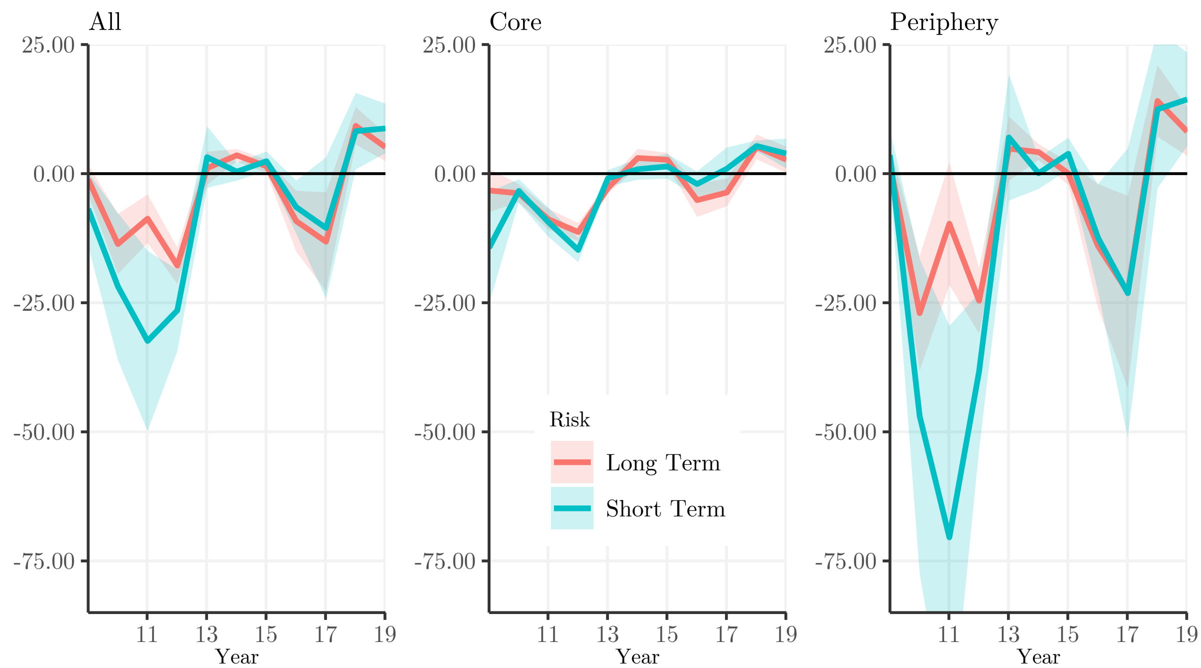
4.4 High versus low deposits

The final step in our analysis is to consider the reliance of banks on deposit funding. Most banks rely to a substantial degree on deposits as a stable source of funding and the deposit rates banks offer are affected by the central bank policy rate. The transmission of policy rates to deposit rates is usually stronger when interest rates decline, because this increases banks' net interest margins. Yet, ever since the ECB started applying a negative interest rate on its bank deposit facility in June 2014, we have observed a reluctance by banks to transmit these negative rates to their retail deposits (some banks do apply negative rates on corporate or institutional deposits). As a result, the zero lower bound on retail deposit funding combined with decreasing lending rates caused by monetary policy accommodation

Table 5: Time variation in the association between ECB monetary policy and short-term and long-term bank credit risk, using year dummies. Short term default risk is estimated as the sum of the level (β_0) and slope (β_1) parameter from the Svensson model. Long term default risk is defined by the level parameter. All estimations use bank fixed effects to control for unobserved heterogeneity and macro variables to control for common macroeconomic shocks. Standard errors in parentheses are clustered at the bank level. *, ** and *** represent significance at the 10%, 5% and 1% percent level, respectively.

	(1)	(2)
	Short Term	Long Term
Monetary Policy × 2009	−8.05*	−1.83
	(4.25)	(1.75)
Monetary Policy × 2010	−21.37**	−13.40***
	(8.61)	(3.54)
Monetary Policy × 2011	−37.50***	−11.44***
	(11.50)	(3.17)
Monetary Policy × 2012	−28.26***	−18.85***
	(5.09)	(2.16)
Monetary Policy × 2013	2.88	1.04
	(3.64)	(1.97)
Monetary Policy × 2014	−0.74	3.02***
	(1.04)	(0.74)
Monetary Policy × 2015	2.01*	1.15
	(1.10)	(0.78)
Monetary Policy × 2016	−4.61	−8.20**
	(2.82)	(3.60)
Monetary Policy × 2017	−9.40	−12.82**
	(8.20)	(5.79)
Monetary Policy × 2018	6.73	8.38***
	(4.36)	(2.16)
Monetary Policy × 2019	9.50***	5.24***
	(2.96)	(1.65)
Monetary Policy × 2020	10.60***	6.08***
	(2.40)	(0.95)
Bank fixed effects	Yes	Yes
Time fixed effects	No	No
Bank control variables	Yes	Yes
Macro control variables	Yes	Yes
R^2	0.24	0.46
No. Obs.	23,505	23,505
No. Banks	45	45

Figure 5: Evolution of the impact of monetary policy on short-term and long-term bank CDS spreads over time.

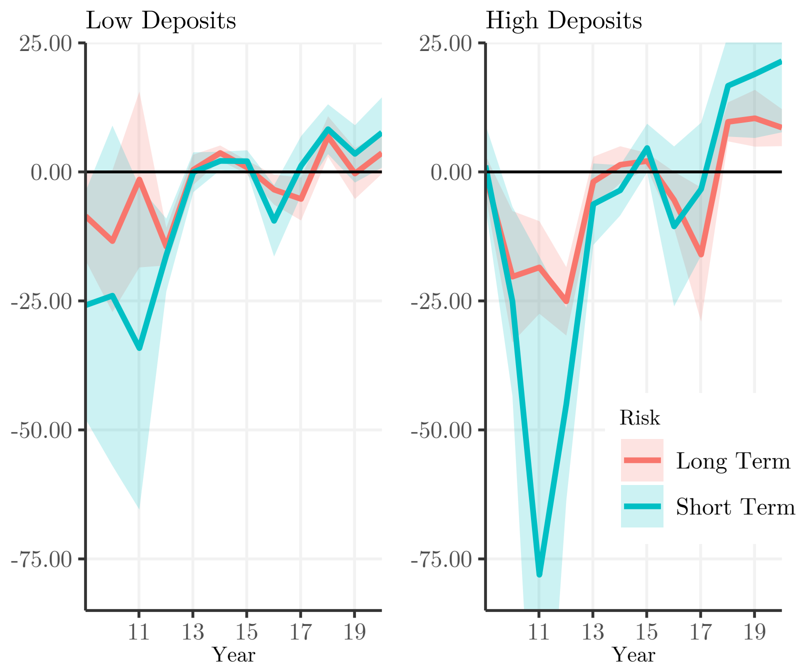


puts pressure on banks' interest margins and may increase their appetite for higher risk in their asset portfolio (Heider et al., 2019; Bubeck et al., 2020; Demiralp et al., 2021; Schelling and Towbin, 2022). In order to investigate the time-varying impact of monetary policy on bank default risk depending on the banks' reliance on deposit funding, we adopt a similar estimation as in Equation 7 and now differentiate between high and low deposit banks. Based on the proportion of deposits over total liabilities we define high-deposit banks as those in the upper quartile of our sample, while low-deposit banks are those in the lowest quartile[8]. Figure 6 shows the results of the estimation of Equation 7 for high and low deposit banks. In the first time period (2010-2013) monetary policy stimulus was associated with lower perceived bank default risk, both short-term and long-term, but while the effect is only marginally significant for low-deposit banks, it is significant for high-deposit banks and very pronounced for the short-term default risk (up to 75 basis points per unit of monetary policy accommodation). Banks with a high reliance on deposit funding benefited from the

[8]In a similar vein, banks credit risk may be affected differently by monetary policy based on the level of capitalization of banks. However, including the banks' capital ratios with interaction terms yields no significant coefficients

lower interest rates in terms of net interest margins and this translated into a more benign risk profile. Moreover, banks with a high reliance on interbank funding, which in times of stress may turn out to be volatile, are regarded as more risky since the Great Financial Crisis (Huang and Ratnovski, 2011). Banks with access to stable deposits avoid the 'dark side of wholesale funding' and are perceived to be less risky. The beneficial effect of deposit funding reverses in the period 2018-2020 because persistently low interest rates induce high-deposit banks to increase the risk profile of their lending portfolio as well as their securities portfolio (Heider et al., 2019; Bubeck et al., 2020). This translates into a positive and significant association between monetary policy accommodation and perceived bank default risk, both short-term and long-term, and particularly pronounced for high-deposit banks (blue line in the right panel of Figure 6).

Figure 6: Evolution of the impact of monetary policy on short-term and long-term bank credit risk over time, for banks with a high and low reliance on deposit funding.



To confirm the significance of the deposit channel, we additionally analyze the heterogeneous impact of monetary policy on short-term and long-term bank default risk depending on the degree of bank deposit funding. This estimation is realised by the following specification:

$$\begin{aligned} DefaultRisk_{i,t} = \alpha_i &+ \beta_1 \; MonetaryPolicy_t \\ &+ \beta_2 \; MonetaryPolicy_t \times Deposits_{i,t} \\ &+ \sum_{k=1}^{K} \zeta_k \; BankControls_{k,i,t} + \sum_{l=1}^{L} \gamma_l \; MacroControls_{l,t} + \varepsilon_{i,t} \end{aligned} \tag{8}$$

where $Deposits_{i,t}$ is the deposit ratio of bank i in year t. The results in Table 6 confirm the presence of a deposit channel for banks' long-term default risk. The aggregated impact of an accommodative monetary policy measure on long-term bank default risk increases by 0.04 for each percentage point increase in the deposit ratio of banks.

Table 6: Impact of deposits on the transmission of monetary policy, based on Equation 8. This table shows the heterogeneous association between monetary policy, bank characteristics and macro controls on short and long term bank default risk based on bank deposits. Short term default risk is estimated as the sum of the level (β_0) and slope (β_1) parameter from the Svensson model. Long term default risk is defined by the level parameter. All estimations use bank fixed effects to control for unobserved heterogeneity and macro variables to control for common macroeconomic shocks. Standard errors in parentheses are clustered at the bank level. *, ** and *** represent significance a the 10%, 5% and 1% percent level, respectively.

	(1)	(2)
	Short Term	Long Term
Monetary Policy	-6.84^{**}	-2.29^{*}
	(2.78)	(1.36)
Monetary Policy × Deposits	0.05	0.04^{*}
	(0.05)	(0.03)
Bank fixed effects	Yes	Yes
Time fixed effects	No	No
R^2	0.18	0.27
No. Obs.	23,505	23,505
No. Banks	45	45

5 Conclusion

Euro Area banks have witnessed a stressful decade, with a banking crisis, a sovereign debt crisis and a global pandemic which led to unprecedented monetary policy actions by the

ECB. We argue that monetary policy may affect bank risk profiles and especially that the consequences of monetary accommodation may differ for short-term bank credit risk versus long-term or structural bank risk. This is our motivation to empirically investigate the association between the ECB's monetary policy stance and market-perceived short-term and long-term bank default risk, proxied by the short and long term component of the term structure of bank credit risk, captured by bank CDS spreads.

Our main findings can be summarized as follows. The results demonstrate that during the period 2009-2020, ECB expansionary monetary policy on average diminished bank default risk in the short term. However, we do not observe a similar decline in long-term bank default risk, since we document that monetary stimulus is associated with a steepening of the bank default risk term structure curve. The reduction of bank default risk due to accommodative monetary policy actions is most pronounced during the sovereign debt crisis, which can be ascribed to the fact that monetary policy actions not only decreased bank risk directly, but also loosened the nexus between banks and sovereigns. Our results further indicate that the beneficial impact of expansionary monetary policy actions during the sovereign debt crisis on bank default risk is most pronounced for peripheral banks. After 2013, the impact of monetary policy on bank default risk on average turns largely neutral until 2018. From 2018 onwards, the results suggest that monetary policy accommodation is associated with increased bank default risk, in the short term but also structurally. These results are compatible with the risk-taking hypothesis, suggesting that the CDS market perceives increased incentives for banks to engage in excessive risk-taking behavior in their loan and securities portfolios in an attempt to compensate the compression of their net interest margins due to persistently low interest rates. We document that the increase in perceived default risk, both short-term and structurally, is especially visible for banks with a high reliance on deposit funding, which confirms the hypothesis that banks with more deposit funding are affected by the zero lower bound on retail deposits and, as a result, are most prone to exhibiting excessive risk behavior.

Our findings have implications for the effectiveness of monetary policy, since the transmission of policy actions may differ for core and periphery countries and for high and low deposit banks. Since banks remain the most important channel of monetary policy transmission in the Euro Area, heterogeneous effects of policy actions on the banks' risk profiles may affect the transmission to the real economy. Our finding that a prolonged period of low interest rates may induce excessive risk-taking behavior by some banks suggests that macroprudential policy may have an important role to play since targeted macroprudential measures may be effective tools for curbing excessive risk taking by banks.

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