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DRIVERS OF BANK DEFAULT RISK: BANK BUSINESS MODELS, THE SOVEREIGN AND MONETARY POLICY

Nicolas Soenen
Rudi Vander Vennet

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GHENT UNIVERSITY

Department of Economics

Faculty of Economics and Business Administration
Campus Tweekerken, St.-Pietersplein 5, 9000 Ghent - BELGIUM

Drivers of Bank Default Risk: Bank Business Models, the Sovereign and Monetary Policy *

Nicolas Soenen†
nicolas.soenen@ugent.be

Rudi Vander Vennet†
rudi.vandervennet@ugent.be

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Abstract

In this paper we empirically analyze the determinants of bank default risk (measured by the banks' CDS spreads) for European banks during the period 2008-2018. We examine the effect of (1) bank business model characteristics, (2) sovereign default risk and (3) ECB monetary policy. We disentangle the effect of monetary policy in a direct channel and an indirect effect operating through a sovereign risk channel. In terms of business model variables, we find that the capital ratio and the reliance on stable deposits lowers the perceived default risk of banks, while non-performing loans significantly increase the CDS spreads. Hence, the CDS market distinguishes resilient banks from risky banks. In terms of monetary policy, we document that accommodative ECB actions in general lower bank default risk. We also show that the downward effect of monetary policy on bank risk is mainly transmitted through the sovereign risk channel. Our findings confirm the importance of the Basel 3 capital and stable funding rules and they suggest policy implications in terms of bank business model choices as well as approaches to tackle the bank-sovereign loop in Europe.

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†Department of financial economics, Ghent University, Sint-Pietersplein 5, 9000 Ghent, Belgium

1 Introduction

A decade after the Great Financial Crisis, concerns remain about the default risk of a substantial fraction of European Banks. Banks in several EU countries were not only hit by the banking crisis, they also suffered the adverse consequences of the subsequent sovereign debt crisis and the associated recession. Various international organizations and bank supervisors have raised concerns about the sustainability of certain bank business models [1]. When identifying the underlying causes of the deterioration in the risk profile of European banks, the following drivers are mentioned: a lack of business model restructuring, the persistence of the bank/sovereign loop, legacy issues of the banking crisis and the subsequent recession in the form of non-performing loans, and unintended negative consequences of unconventional monetary policy conducted by the ECB. In this paper we investigate how these forces have contributed to the default risk profile of European banks in the post-crisis era (2008-2018).

In our empirical analysis, we measure bank risk with their CDS spreads because they are a market-based, unbiased measure of bank default risk. In terms of determinants of bank default risk, we account for three interrelated effects: bank business model choices, the bank/sovereign loop and the impact of monetary policy.

First, we investigate the relationship between bank business model choices and their default risk profile by including indicators of the banks' asset structure, funding mix, income diversification and capital adequacy as well as performance variables such as asset quality and profitability. The expectation is that profitable banks with high capital buffers and access to stable funding sources are considered as relatively safe (Mergaerts and Vander Vennet, 2016), and less prone to risk taking (Altunbas et al., 2011). Conversely, banks with large exposures to loans and especially those with high levels of non-performing loans are expected to display a worse risk profile (Bogdanova et al., 2018).

Second, we account for the bank/sovereign loop. European banks have been accused of

[1]The European Banking Authority (EBA) points at persistently low profitability indicating that a substantial number of banks exhibits returns on equity well below their cost of equity (EBA, 2018). Similarly, the European Central Bank (ECB) reports that market-to-book values of a proportion of Eurozone listed banks have remained below one for an extended period of time (ECB, 2018). The International Monetary Fund (IMF) considers European banks amongst the weakest in the world (IMF, 2019). At the same time, supervisors voice concerns about non-viable bank business models and loathe the lack of restructuring and consolidation (De Guindos, 2019).

disproportionately investing in bonds issued by their home sovereign, especially in periods of sovereign stress. It is argued that some banks exhibit excessive exposures, thereby creating a potential doom loop between European banks and their sovereigns and exacerbating the risk of contagion (De Bruyckere et al., 2013; Stângă, 2014). The existing literature has identified several channels that may explain why banks invest in certain sovereign bonds: banks may search-for-yield or engage in carry trade and collateral trade behavior (Acharya and Steffen, 2015; Acharya et al., 2018; Altavilla et al., 2018; Crosignani et al., 2019), banks may be subject to moral suasion by their home sovereign (Horváth et al., 2015; De Marco and Macchiavelli, 2016; Ongena et al., 2019), or they can engage in a flight-to-safety strategy (Buch et al., 2016). Alternatively, even in the absence of banks' sovereign bond holdings, a negative bank/sovereign loop occurs through the presence of government guarantees, linking the financial stability of banks and sovereigns to each other (Leonello, 2018). To capture the effect of sovereign risk on the banks' default risk profile, we include sovereign CDS spreads to quantify the transmission of sovereign risk to bank risk.

Third, we incorporate monetary policy. Since 2008 the ECB has used various instruments of conventional and unconventional monetary policy to stimulate the economy and bring inflation back to its target (Hartmann and Smets, 2018; Rostagno et al., 2019). Some actions were designed to influence bank funding conditions, e.g. interest rate decreases and LTRO. Other types of measures have been introduced to affect the transmission of monetary policy to sovereign credit spreads, e.g. SMP and OMT (Falagiarda and Reitz, 2015; Krishnamurthy et al., 2018). Hence, they are designed to affect sovereign yields directly, but through this channel they also indirectly translate into more benign bank funding conditions (Acharya et al., 2014). Finally, a number of ECB unconventional policy measures, such as asset purchases and forward guidance are intended to affect the entire yield curve (Rostagno et al., 2019). Since various types of ECB monetary policy action were announced simultaneously and were often anticipated by market participants, we use a VAR methodology to indentify a monetary policy shock (see Lamers et al. (2019)). There is large agreement that the accommodative monetary policy of the ECB stimulated the economy (Altavilla et al., 2018, 2019) and that bank funding and lending conditions were eased considerably (Rostagno et al., 2019). However, there is also evidence that ECB policies may have induced banks to engage in risk-taking behavior. Accommodative monetary policy implies lower market rates which may in turn lead to a search-for-yield by financial institutions when they target rates of return (Rajan, 2006). Banks confronted with diminishing revenues as a consequence of lower rates may therefore increase their risk appetite and invest in higher-risk loans and securities (Altunbas et al., 2012; Jiménez et al., 2014; Paligorova and Santos, 2017; Heider et al., 2019) and increase bank funding risk (Angeloni et al., 2015). Furthermore, there is evidence that unusually low interest rates hamper bank profitability over time (Borio et al., 2017; Claessens et al., 2018). Finally, in times of accommodative monetary policy, banks tend to underestimate corporate credit risk. The underling mechanism is that prolonged periods of low policy rates, accompanied by depressed long-term interest rates due to quantitative easing, induce banks to extrapolate low risk assessments into their lending decisions (Adrian and Shin, 2009).

We apply our examination of the drivers of bank default risk on a sample of 60 European banks over the post-crisis period 2008-2018. Our preferred proxy for bank default risk are banks' CDS spreads and we alternatively use spreads on 1-year and 5-year CDS contracts to assess difference in short-term and long-term impacts. Similarly, we present evidence for senior and junior CDS contracts in order to investigate the role of seniority in the CDS market's assessment of the banks' risk profile. Our empirical analysis proceeds in three stages. First we focus on the association between bank default risk and bank business model features. This allows us to ascertain whether or not banks with certain characteristics are judged by the CDS market to exhibit a fundamentally different default risk profile. Second we include sovereign default risk, captured by the CDS spread of the banks' home sovereign, in order to account for the bank-sovereign loop that was partly responsible for the emergence and magnitude of the sovereign debt crisis in Europe. This setup allows us to gauge the magnitude of the transmission of sovereign risk to bank default risk. Third, we incorporate a monetary policy shock. Yet, assessing the ultimate effect of monetary policy on bank risk is not straightforward since the ECB not only implemented a series of actions specifically designed to affect bank funding conditions (credit easing measures such as LTRO), but also measures aimed at sovereign funding conditions (quantitative easing such as SMP, OMT and APP) and measures which may affect both banks and sovereign (forward guidance).

Therefore, we disentangle the overall effect of monetary policy by identifying a direct channel to banks and an indirect channel which affects bank default risk through the impact on the sovereigns.

The main findings of our empirical investigation can be summarized as follows. In terms of bank-specific determinants of bank CDS spreads, capital adequacy, deposit funding and non-performing loans display the highest contribution. The capital ratio of banks is consistently negatively related to perceived bank default risk. This provides further empirical justification for the higher capital requirements imposed by Basel 3. Additional capital buffers increase the resilience of banks and this is recognized by CDS markets. The proportion of deposit funding in total liabilities exerts a significant downward effect on bank CDS spreads, indicating that market participants regard stable funding as a risk-reducing feature, typically associated with retail banks. Obviously not all banks can be pure retail banks, but additional results indicate that mainly a lower reliance on interbank funding is associated with lower CDS spreads. Hence, markets push banks towards less reliance on potentially volatile sources of wholesale funding, thereby avoiding the dark side of this type of funding in periods of stress (Huang and Ratnovski, 2011). These results corroborate the usefulness of the net stable funding ratio introduced by the Basel 3 framework, imposing on banks a mandatory ratio of stable funding against long-term assets. Finally, the ratio of non-performing loans in total loans displays a significantly negative association with bank CDS spreads. This result is not surprising and it underscores the necessity of early intervention to tackle bad loans following a banking crisis, something that was clearly not implemented for a fraction of euro area banks [2].

In terms of sovereign risk transmission to banks, we find that over the entire post-crisis period the coefficient on the sovereign CDS spread in the level regressions ranges from 1.1 to 1.9, depending on the type and maturity of the bank CDS contract. This finding confirms the strong association between banks and some home sovereigns that has been documented in previous literature and suggests that a higher perceived sovereign default risk is transmitted

[2] Only in 2018 did the ECB launch a package of measures to force the banks to deal with their remaining NPL exposures (ECB Banking Supervision, 2017). Legal enforcement of bankruptcy claims, preventing forbearance of bad loans, setting up bad banks as a crisis resolution tool and promoting a secondary market for NPL are useful recommendations to tackle the NPL issue (see IMF (2015) and Garrido et al. (2016)).

to bank default risk with an amplification factor. This finding indicates that restoring bank health after a crisis requires decisive action in terms of severing the link between sovereigns and banks. In the euro area the negative feedback loop from sovereign risk to bank risk has been left unattended for too long. Several proposals have been launched, such as the introduction of a non-zero weighting scheme for sovereign securities for the calculation of bank capital requirements and the imposition of exposure limits for sovereign bond holdings (Lenarčič et al., 2016). The objective of such measures would be to incentivize banks to diversify their sovereign bond holdings, implying a lower bank-sovereign default risk contagion probability.

With regard to monetary policy, the results indicate that during the period 2008-2018, expansionary monetary policy shocks on average diminish bank CDS spreads. Moreover, our time-varying impact analysis shows that accommodative monetary policy by the ECB is always associated with lower bank CDS spreads, not only in the period 2012-2014 when the impact was most pronounced (see also Altavilla et al. (2018)), but also in the post-2014 era during which the ECB implemented its asset purchase program as well as started charging banks a negative deposit rate. Other studies have concluded that negative policy rates and the prospect of low for long interest rates may be detrimental for bank profitability and may induce bank risk-taking behavior (Borio and Gambacorta, 2017; Heider et al., 2019). Our findings do not imply that banks do not take more risk. They may e.g. rebalance their asset portfolios towards riskier loans, but if this would lead to higher levels of NPL, our results imply that this would be accompanied by higher observed bank CDS spreads. But our results are not consistent with the hypothesis that expansionary monetary policy causes excessive risk taking by banks, because such behavior would be reflected in higher CDS spreads. When we distinguish between a direct channel of monetary policy to bank credit risk and an indirect channel via sovereign risk, we document that both impacts are significant. Accommodative ECB monetary policy shocks are directly associated with lower bank CDS spreads. At the same time, stimulating monetary policy lowers sovereign risk, and since sovereign CDS spread changes in turn impact bank CDS spreads, the decline in sovereign CDS spreads is amplified.

This paper contributes to various strands of the literature on bank risk. First, our analysis is firmly situated in the literature on bank CDS spreads (Annaert et al., 2013; Chiaramonte and Casu, 2013; Samaniego-Medina et al., 2016; Drago et al., 2017). Most of these papers analyze the association between bank CDS spreads, bank-specific variables and market-based indicators. We extend the analysis by introducing the effect of ECB monetary policy, which is a defining feature of the macro-financial environment in the post-crisis era. Moreover, we consider not only the typical 5-year senior bond CDS spread, but also the 1-year CDS and we distinguish between CDS contracts on senior and subordinated bonds. This allows us to investigate differences in the dynamics of bank default risk based on the maturity and seniority of the CDS claims. By extension, our analysis is related to the literature investigating the determinants of bank funding costs based on CDS spreads (Babihuga and Spaltro, 2014). Second, our analysis contributes to the vast literature on the bank-sovereign nexus in Europe. Previous papers have documented the existence of a bank-sovereign negative feedback loop (De Bruyckere et al., 2013; Acharya et al., 2014; Caporin et al., 2019; Fratzscher and Rieth, 2019) and have investigated its causes (Acharya and Steffen, 2015; Buch et al., 2016; Leonello, 2018), its negative real effects (Bocola, 2016; Acharya et al., 2018) and how to regulate it (Alogoskoufis and Langfield, 2019; Laeven, 2019; Pancotto et al., 2019). Here, we analyze not only the transmission of monetary policy to bank credit risk directly, but also through its impact on sovereign credit spreads. It is important for central banks to identify the effectiveness of several transmission channels of their policy to the real economy. As banks and sovereigns have found themselves in a doom loop, it is natural to assume that monetary policy affects banks through this sovereign channel. Third, there is an extensive literature examining the effects of conventional and unconventional monetary policy on bank risk taking. Various channels have been documented, usually focusing on the incentives for banks to search for yield by engaging in riskier loans and investments (Jiménez et al., 2014; Paligorova and Santos, 2017; Heider et al., 2019). Here, we focus on the bank-sovereign risk nexus and we decompose the impact of monetary policy on bank default risk through a direct channel and indirect channel via sovereign risk. Finally, and although not the main focus of the paper, we contribute to a long-standing literature on market discipline of bank behavior by showing that bank business model characteristics are significantly related to a market-based measure of bank default risk. These findings corroborate the established conclusion that market participants, in this case in the CDS market, are able to distinguish bank risk profiles based on observable bank business model characteristics (see Bliss and Flannery (2002)).

The paper unfolds in the following way. In section 2 and 3, we provide details on the data and methodology. In section 4 we discuss the results of our estimations as well as some extensions focusing on cross-country differences and time variation. Section 5 concludes the paper and formulates some policy considerations.

2 Data and variable construction

We construct a dataset containing daily CDS spreads on banks and sovereigns, daily market variables and quarterly bank-specific variables. CDS spreads are retrieved from Markit. The bank fundamentals and market variables are obtained from SNL and Thomson Reuters Datastream, respectively. We limit the sample to banks that meet selection criteria with regards to their CDS spreads[3] and bank-specific variables[4].

The application of the selection criteria results in a sample of 60 banks from 14 European countries (out of which 9 are member of the euro area) during the period of 2008-2018. These banks represent a large share of the Western-European banking sector. The sample period captures the post-crisis era and includes both the great financial crisis and the subsequent sovereign debt crisis in Europe.

2.1 Bank- and Sovereign default risk indicator

CDS contracts are financial derivatives where the default risk on an underlying bond is swapped from the buyer to the seller of the swap. Within a CDS, different default events are contractually stipulated and if one of these events occurs, the seller of the swap is mandated to cover the losses from the defaulted bond to the seller. For this insurance, the buyer of the

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

[4]First, we limit the sample to banks for which relevant bank-specific data is available during the sample period. Second, we include banks which have Loans/Assets or Deposits/Liabilities ratios above 20% to ensure that we focus on banks engaged in financial intermediation.

swap pays a quarterly premium, the CDS spread. The higher the perceived risk of default on the underlying bond, the higher the premium.

In our dataset we exploit the CDS spread differences on senior and subordinated bonds and on 1-year and 5-year maturities. On average and within a bank, CDS spreads on subordinated bonds are higher than their senior counterparts since subordinated bonds bear a higher risk than senior bonds. CDS contracts with a shorter maturity yield on average a lower spread, as bank default risk on 1-year contracts is also captured by longer maturities. Figure 1 displays the evolution of the CDS spreads. First, CDS spreads with longer maturities and on subordinated bonds are higher. Second, the global financial crisis and the sovereign debt crisis led to marked increases in perceived default risk. Third, the 2016-2017 period is characterized by an increase of CDS spreads as this period was characterized by uncertainty with regards to the viability and profitability of bank business models in the euro area.

To capture sovereign credit risk, we use the sovereign CDS spread on 5-year senior bonds. Figure 2 shows the evolution of sovereign credit risk over the sample period. The graph illustrates differences in perceived credit risk for European sovereigns. More specifically, the peripheral countries diverged from the core euro area countries in the sovereign debt crisis. As the ECB took measures to restore confidence in peripheral sovereign bonds with e.g. the announcement of the OMT program, sovereign CDS spreads converge from mid-2012 onwards. The CDS spread of Portugal and Italy display a resurgence in 2016-2017, owing to concerns about debt sustainability. As of 2018, the Italian CDS spread is the highest of the sample, due to political uncertainty.

2.2 Explanatory variables: bank-specific and market variables

The risk profile of a bank is determined by the strategic choices which define the bank's business model and the associated performance outcomes in terms of profitability and risk. To analyze the impact of bank business model choices on their perceived risk profile, we include variables capturing the asset structure, funding mix, revenue composition and the bank's capital strength.

The loans to assets ratio (LTA) is a proxy for the importance of the bank's lending activity. Since loans are the most risky type of bank assets, we expect it to load positively on bank CDS spreads. The proportion of deposits in total liabilities (DEP) is a measure for the funding mix. A high DEP is a typical feature of a retail-oriented bank business model (Mergaerts and Vander Vennet, 2016) and we expect it to be associated with a lower perceived bank risk profile. As an alternative for DEP, we consider the impact of a bank's reliance on short-term interbank funding on the CDS spread. Banks relying on short-term market-based funding have been shown to be vulnerable to market distress, demonstrating the dark side of wholesale funding (Huang and Ratnovski, 2011). We expect that the interbank funding to liabilities ratio (INTERBANK) and senior- and subordinated debt to liabilities ratios (SEN DEBT-SUB DEBT) are positively correlated with bank CDS spreads.

The revenue structure is approximated by the proportion of non-interest income in total revenues (DIV) which captures the degree of diversification of the bank's income streams[5]. Mergaerts and Vander Vennet (2016) report that diversification is positively associated with bank profitability and negatively with bank risk. Köhler (2015) finds that increasing the share of DIV makes banks more stable and profitable, although retail banks experience no such benefits. In general the risk associated with different types of non-interest income may determine the ultimate impact on perceived bank risk (DeYoung and Torna, 2013).

Capital strength is estimated by the unweighted capital ratio (CAP) or alternatively, by the common equity tier 1 over risk weighted assets ratio (CET1). Since capital is a buffer against unexpected losses, a higher capital ratio should unambiguously be associated with lower bank default risk. 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). Gambacorta and Shin (2018) show that bank capital not only determines bank default risk, but also its ability to expand lending.

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. Large banks have been

[5]We fix the values of the DIV ratio between 0% and 100% to allow a meaningful economic interpretation. Instances occur where non-interest income is negative. We then assume that the share of non-interest income in the total income of the bank is 0%. Vice versa, when interest income is negative, we assume that non-interest income constitutes 100% of total income.

shown to benefit from a too big too fail effect, which we assume decreases bank risk. Yet, the ultimate effect is unclear since size increases bank systemic risk (Laeven et al., 2016) and any too big to fail benefits may be less relevant because of size-related (Basel 3 SIFI) capital regulation (Moenninghoff et al., 2015).

In terms of outcome variables we focus on profitability, i.e. return on assets (ROA), return on equity (ROE) and net interest margin (NIM). Finally, we include a measure of the quality of the bank's lending portfolio. A standard variable is non-performing loans to total loans (NPL). The proportion of loan loss provisions in non performing loans (LLP/NPL) indicates how well a bank is provisioned in case of actual loan impairments. Both the ECB and the EBA have emphasized the importance of the NPL coverage ratio (EBA, 2018).

We expect that market-perceived bank default risk, proxied by the CDS spread will be lower for deposit-funded banks, diversified banks and well capitalized banks as well as for banks with higher profitability and better loan quality. In Figure 3 we graphically document the evolution of the bank-specific variables over the post-crisis era. Banks clearly increased both their unweighted and risk-weighted capital ratio. With respect to their liability structure, there is a tendency to substitute short-term funding to more stable deposit funding. Non-performing loans first increased, peaking in the 2015-2016 period. From 2016-2018, NPLs declined mildly. However, the highest percentile banks still have significant levels of NPLs on the balance sheet.

The risk profile of the bank may be affected by prevailing financial market conditions. In our baseline estimations, which have a panel setup, common shocks from financial markets are controlled for by including time fixed effects. Alternatively, we include the VSTOXX as a measure of market volatility. The VSTOXX is the implied volatility of the EUROSTOXX50 index and is used in previous literature as an indicator of uncertainty and risk (Nave and Ruiz, 2015; Baele et al., 2019).

The descriptive statistics for the CDS spread of banks and sovereigns, bank-specific variables and market volatility are reported in Table 1. A detailed overview of the banks in the sample is provided in Table 2.

2.3 Monetary policy shock

For the identification of 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. Similarly, the ECB balance sheet cannot be used 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). The ECB also uses forward guidance and over time gradually switched from Delphic (advisory) to Odyssean (pre-commitment) and from time-dependent ('as long as needed') to state-dependent guidance (tying future actions to inflation outcomes) (Bernanke, 2017). And finally, different conventional and unconventional policy measures were announced simultaneously (e.g. in January 2015, PSPP 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, 2018), we opt for a SVAR 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 judget that monetary policy actions were insufficient, given the prevailing market conditions.

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 (2018) and Lamers et al. (2019):

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

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 SVAR 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 made announcements with regard to monetary policy. 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:

$$Var\left(v_t\right) = \Omega_t = \begin{cases} \Omega^{(0)} = \text{diag}\left(\omega_1, \omega_2, \ldots, \omega_N\right) & \text{if } \textit{no announcement} \\ \Omega^{(1)} = \text{diag}\left(\omega_1^*, \omega_2, \ldots, \omega_N\right) & \text{if } \textit{announcement} \end{cases} \tag{2}$$

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 therefore also the structural monetary policy shock except for their scale and sign. The model can be estimated following the iterative estimation procedure outlined in Lanne and Lütkepohl (2008)[6]. 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[7]. This identification-through-heteroskedasticity approach is widely used in the literature to identify monetary policy shocks, for example Rogers et al. (2014), Arai (2017) and Rossi (2018). We estimate a VAR of order 2 over a sample period from 1 October 2008 to 31 December 2018, i.e. the post-crisis period of unconventional monetary policy by the ECB.

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

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

[7] 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.

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

Figure 5 shows the absolute and cumulative monetary policy shocks. 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. Accordingly, a drop in the series can reflect a tightening of monetary policy but also the lack of monetary policy action, or even that there were expansionary announcements that failed to live up to financial market expectations. Figure 5 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/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 major monetary policy 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, the sustained monetary easing is considered by financial markets as effectively stimulating the economy. 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 it is also captured in our figure 5, illustrating that our indicator of the monetar 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.

3 Methodology

Since we hypothesize that bank default risk is determined by bank characteristics, sovereign risk and the impact of monetary policy on both bank and sovereign risk, our empirical analysis proceeds in two steps. First, we estimate a baseline model in which the explanatory variables are bank business model characteristics, market volatility and the perceived credit risk of the home sovereign. This model is estimated for the different types of CDS spreads separately (1- and 5-year maturities, and senior and subordinated underlying bonds). Second, we introduce monetary policy and estimate the impact of monetary policy shocks on the change of bank CDS spreads by examining a direct channel and an indirect effect via the sovereign risk channel.

Since we use a combination of market data, which are in principle available on daily frequencies, and bank accounting information, which is available on a quarterly frequency, we opt to conduct our analysis at the monthly frequency. Hence CDS spreads, VSTOXX and the monetary policy shock are monthly averages of daily observations. The bank-specific variables have a quarterly frequency for banks that report their balance sheet and income statement quarterly (typically listed banks), annually otherwise. The bank-specific variables are matched using the latest values from available (quarterly or annual) reports[8].

[8] E.g. if a bank reports quarterly, the data point used for bank-specific variables in Q1/2016 stems from the Q4/2015 report

3.1 Bank fundamentals, sovereign risk and bank credit risk

For the different types of CDS spreads, we estimate whether or not a series of bank-specific variables, market volatility and sovereign credit risk are relevant in determining the level of the CDS spread. Hence, the following model is estimated:

$$CDS_{i,s,m,t} = \alpha_i + \lambda_y + \sum_{k=1}^{K} \beta_k \, BSV_{k,i,t} + \gamma \, V_t + \delta \, CDS^{Sov}_{c,t} + \varepsilon_{i,t} \tag{3}$$

where $CDS_{i,s,m,t}$ represents the CDS spread with underlying bond s and maturity m of bank i at time t. The k^{th} fundamental of bank i is contained in the vector $BSV_{k,i}$. We control for market movements by including the VSTOXX and the CDS spread of the sovereign of the bank (CDS^{Sov}). The model controls for unobserved heterogeneity at the bank level by including bank fixed effects. We also include year fixed effects to filter out the effects of common shocks. We do not include time fixed effects at a monthly frequency since we would not be able to estimate the impact of the VSTOXX[9].

Next, we estimate the same model on the normalised bank CDS spreads. As indicated in the descriptive analysis of the data, CDS spreads on subordinated bonds and 5-year maturities tend to be higher in absolute value than their 1-year and senior counterparts. Therefore, the estimated coefficients tend to be higher for CDS spreads on subordinated bonds and/or 1-year maturities. In order to estimate whether the relation between bank-specific variables, market volatility and the sovereign CDS spread is different between CDS contracts, we normalise each dependent variable, by demeaning and dividing by the standard deviation. In this setup, each coefficient can be interpreted as the impact of a unit change in the explanatory variable on bank CDS spreads, expressed in number of standard deviations. The coefficients thus allow us to analyze whether a unit change leads to a larger than average change in bank default risk.

[9]The results with regards to the bank-specific variables and the sovereign CDS spread are robust to an estimation with monthly fixed effects

3.2 Monetary policy and bank credit risk

Next to the analysis of bank fundamentals and market variables, we assess the impact of monetary policy on bank default risk. We estimate whether or not monetary policy shocks affect bank CDS spreads. We conduct these estimations on the subset of eurozone banks, i.e. for 9 sovereigns and 49 banks in the euro area. We estimate the following model:

$$\Delta CDS_{i,s,m,t} = \alpha_i + \lambda_y + \sum_{k=1}^{K} \beta_k \, BSV_{k,i,t} + \gamma \, \Delta V_t + \delta \, \Delta CDS_{c,t}^{Sov} + \zeta \, \Delta MPS_t + \varepsilon_{i,t} \quad (4)$$

As we are estimating the impact of a change in the monetary policy stance, we argue that its impact should be analyzed on the change of bank credit risk. Hence, we use the first difference of the bank CDS spreads in this model. Since a positive monetary policy shock is interpreted as accommodative, the coefficient ζ is interpreted as a change in bank default risk due to an accommodative change in the monetary policy shock, all else being equal. It measures the direct transmission of monetary policy to bank credit risk.

In a second estimation, we assess the impact of an indirect transmission channel of monetary policy. We argue that some types of monetary policy actions by the ECB have been explicitly directed at decreasing bank credit risk, e.g. the various waves of LTRO (see (Hartmann and Smets, 2018)). As a consequence, these measures are expected to directly impact market-perceived bank default risk. Other measures were introduced to affect the transmission of monetary policy to sovereign credit spreads, e.g. SMP and OMT (Falagiarda and Reitz, 2015). They are designed to affect sovereign yields directly, but through this channel they also indirectly translate into more benign bank funding conditions (Acharya et al., 2014). Finally, a number of ECB unconventional policy measures, such as asset purchases and forward guidance are intended to affect the entire yield curve. These measures simultaneously affect sovereign yields, bank funding conditions and bank profitability. For this reason, in order to quantify the impact of monetary policy on bank risk, an important channel is the transmission of ECB actions through sovereign risk.

To analyze these channels, we disentangle the change in sovereign CDS spreads into a part that is driven by monetary policy, which we label monetary policy induced sovereign credit risk, and an autonomous sovereign credit risk part, which we interpret as a change in sovereign CDS spreads not caused by changes in the monetary policy shock and hence caused by country-specific political events or public finance conditions. For the euro area as a whole, disentangling the impact on the sovereign CDS spreads is based on the following estimation:

$$\Delta CDS^{Sov}_{c,t} = \alpha_c + \Delta MPS_t + \mu_{c,t} \tag{5}$$

Alternatively, since monetary policy actions produce heterogeneous impacts across countries, the following specification allows us to capture this heterogeneous impact on different sovereigns:

$$\Delta CDS^{Sov}_{c,t} = \alpha_c + \beta_c D_c \times \Delta MPS_t + \mu_{c,t} \tag{6}$$

where a country dummy D_c is included in order to estimate the impact of monetary policy on each sovereign separately. The fitted values of specifications 5 and 6 capture changes in $\Delta CDS^{Sov}_{c,t}$ caused by changes in the monetary policy shock, i.e. monetary policy induced changes in sovereign credit risk. The estimated residuals capture the autonomous change in $\Delta CDS^{Sov}_{c,t}$ spreads that are unrelated to movements of the monetary policy shock.

The fitted values and the residuals obtained in this first stage model are simultaneously introduced in a second stage:

$$\Delta CDS_{i,t} = \alpha_i + \sum_{k=1}^{K} \beta_k \; BSV_{k,i,t} + \gamma \; \Delta V_t + \delta \; \Delta \widehat{CDS^{Sov}_{i,t}} + \zeta \; \widehat{\mu_{c,t}} + \varepsilon_{i,t} \tag{7}$$

where δ measures the impact of monetary policy induced sovereign CDS changes on bank CDS spreads, while ζ captures the transmission of autonomous sovereign CDS changes to bank CDS spreads. We do not include changes in the monetary policy stance in this model. This would cause multicollinearity since the fitted values from the first stage model are a linear combination of the monetary policy shock.

Finally, we estimate a model which identifies both the direct and indirect effect of the monetary policy shock on bank CDS spreads. This estimation is realised by the following specification:

$$\Delta CDS_{i,t} = \alpha_i + \sum_{k=1}^{K} \beta_k \, BSV_{k,i,t} + \gamma \, \Delta V_t + \delta \, \Delta MPS_t + \zeta \, \widehat{\mu_{i,t}} + \varepsilon_{i,t} \tag{8}$$

In this model, we only include autonomous changes in the sovereign CDS spread, which are orthogonal to monetary policy shocks, combined with the monetary policy shock, which in this case captures the cumulative effect of monetary policy, both directly and indirectly through changes in sovereign credit risk.

3.3 Economic significance

Our analyses consist of estimating regressions on panel data, using cross sectional and time fixed effects to control for unobserved heterogeneity and common movements in the data. This implies that only part of the total variation in each variable is used to identify the coefficients of our models, i.e. only the within bank-year variation of each variable. First, this determines the interpretation of the coefficients. The estimated coefficients should be interpreted as the impact of a change within a bank of an independent variable. The coefficient is uninformative on differences between banks. Second, the economic significance of the variable should be estimated from the adjusted independent variables, i.e. filtered from cross sectional and time fixed effects. We show this graphically in Figure 4 with the distribution of the original (blue kernels) and filtered variables (red kernels). The filtered variable is the residualized independent variable with respect to the fixed effects used. The variation of the filtered variables is the one that is used to estimate the coefficients of interest (Mummolo and Peterson, 2018). The distribution of the filtered variables has a lower standard deviation than the original independent variables, as it now only contains the within bank and year variation. In the descriptives (Table 2), the adjusted standard deviation confirms this feature. For example, the size of banks has practically no within bank-year variation and it is therefore unrealistic that banks over time experience large increases or decreases in size. To assess the economic significance we assume that the adjusted standard deviation of the independent variables are realistic changes of this variable within a bank.

4 Results

4.1 Bank-specific variables and sovereign default risk

In Table 3, we analyze the drivers of bank default risk for four CDS contract types. The results for the baseline specification show the impact of bank-specific variables, market volatility and the sovereign CDS spread on the CDS spreads of the banks. The bank-specific variables are categorized into capital adequacy, asset structure, income diversification, asset quality, profitability and funding mix. The left panel contains the results of the original CDS spreads, whilst the right panel shows the results for the normalised CDS spreads. The coefficients are typically larger in absolute value for CDS spreads on subordinated bonds, which can be explained by the fact that CDS spreads on subordinated bonds are typically higher than their senior counterparts, as shown in Figure 1. To analyze whether or not the coefficients imply a different dynamic between senior and subordinated bonds, we normalise the dependent variables and these results are shown in the right panel of table 3. We saturate each model with bank- and year fixed effects and we cluster the standard errors at the bank level.

In the left panel, we find that that the unweighted equity/asset ratio CAP is negatively associated with the level of banks' CDS spreads, indicating that as a bank increases its capital ratio over time, this decreases its perceived default risk. Banks which increase their capital ratios build a stronger buffer against unexpected future losses and this is translated into lower perceived default risk. This result is consistent with the finding that banks with higher capital ratios are more resilient to adverse shocks (Berger and Bouwman, 2013), exhibit lower systemic risk (Laeven et al., 2016) have a lower Z-score as an indicator of overall bank risk (Mergaerts and Vander Vennet, 2016) and exhibit lower funding costs because of a more robust risk profile (Gambacorta and Shin, 2018). These findings support the enforcement of higher capital ratios for banks implemented via the Basel 3 capital adequacy rules. The size of the bank is positively associated with the CDS spread on subordinated bonds. However, this relationship is not confirmed for the CDS spreads on senior bonds. In the robustness section, we estimate the model with alternative bank characteristics, and the SIZE coefficients are relatively unstable across specifications. These results may reflect doubt of market participants about the value of a too-big-to-fail status versus the impact on the bank risk profile of regulations specifically designed to make big banks safer and resolvable (see Moenninghoff et al. (2015)). In terms of balance sheet structure, a higher LTA ratio implies higher bank default risk, suggesting that banks primarily focused on lending business are perceived as having a higher default risk than banks with a more diversified asset structure. Income diversification (DIV) remains insignificant in each specification, indicating that diversification towards non-interest revenues is not perceived as reducing the banks' risk profile. Previous studies have documented that more diversified banks exhibit a higher level of systematic risk (Baele et al., 2007) and that some types of non-interest income may be volatile (Stiroh, 2004). As expected, a higher ratio of NPLs pushes up banks perceived credit risk significantly. Since NPLs are an indicator of future loan impairments, they are associated with higher risk and lower bank market valuations, e.g. lower market/book ratios (Bogdanova et al., 2018).

In terms of profitability, the bank's pre tax return on assets is negatively related to bank CDS spreads. As expected, a higher profitability diminishes the banks' perceived risk profile, because internally generated profits are the main source of additional capital buffers. Banks that increase their reliance on deposits as a source of funding (higher DEP) experience a decrease of their perceived credit risk, since these banks rely less on market-based and potentially volatile funding (Huang and Ratnovski, 2011). However, this effect becomes insignificant for 5-year subordinated bond CDS spreads. The economic significance of changes in the capital ratio, ROA and deposits to liabilities is similar. A 1 standard deviation change within bank-year of these variables leads to a reduction of 5-year senior bank CDS spreads of approximately 10 basis points. With respect to LTA and NPL, a one standard deviation increase is associated with an increase of CDS spreads by 10 basis points.

Since the VSTOXX is a measure of stock market volatility, the interpretation is that increased market volatility is associated with higher CDS spreads. This result is expected, since market volatility is associated with an increased potential of downside risk in the corporate sector, which would hamper bank profitability (ECB, 2018). Finally, the coefficient on the sovereign CDS in the level estimations (left panel) is positive and highly significant, hence an increase in the sovereign CDS spread feeds through into bank CDS spreads. This can be explained by the well documented buildup of exposures of some Eurozone banks to their sovereign, leading to a home bias in these banks' sovereign bond portfolio, causing a negative feedback loop between perceived bank and sovereign credit risk (De Bruyckere et al., 2013; Horváth et al., 2015). An average within bank-year change of the VSTOXX has a similar economic impact as ROA and LTA, i.e. approximately 10 basis points per standard deviation. Yet, a within bank-year standard deviation change of the sovereign CDS spread has an economic impact which is 7 times higher. Hence, the most dominant driver of bank credit risk in our sample period is the sovereign CDS spread.

In the right panel of Table 3, the model is estimated on normalised variables and the results confirm the signs and magnitudes of the impact of the explanatory bank and market variables on each type of CDS spreads. The coefficients, which indicate the number of standard deviation changes in bank CDS spreads implied by a unit change in the independent variables, are fairly similar across the different CDS types, indicating that the market assessment of bank default risk is reflected in a similar way. An increase in the capital ratio of a bank has a larger decreasing effect on subordinated CDS spreads, reflecting the fact that a higher equity buffer is the only protection against losses for subordinated bonds. Conversely, an increase in the DEP ratio is associated with a larger decrease of senior bond CDS spreads, indicating that market participants consider the presence of stable deposit funding as an attractive feature for senior bond investors. Furthermore, the decrease on the 1-year senior bond CDS spread (-0.019) is almost twice as high as its 5-year counterpart (-0.011), suggesting that bank credit risk in the short term is considered to be negatively related to the stability of the funding structure of the bank. Interestingly, the relationship between normalized sovereign CDS spreads and bank spreads is almost identical for the four CDS types.

In Table 3 we analyze how standard bank business model characteristics are related to bank CDS spreads. As a robustness check we want to consider alternative bank variables and examine components of bank profitability. These results are presented in the appendix. Since capital adequacy is a major driver of bank default risk, we show in Table 9 the results for the unweighted equity ratio as well as for the weighted CET1/RWA ratio. While the unweighted CAP ratio is significantly related to bank CDS spreads, the Basel-type risk-weighted ratio is not significant for CDS spreads on senior bonds. This indicates that both ratios may capture a different dimension of capital adequacy and that market participants consider the unweighted capital against total assets the more reliable metric. This may be due to the finding that banks may use their internal ratings to affect their risk-weighted assets (Mariathasan and Merrouche, 2014). In Table 10 we complement the NPL ratio, which is shown to be associated with higher CDS spreads, with the coverage ratio, i.e. loan loss provision divided by NPL as an indicator of how accurately banks have provisioned to cushion potential losses. The coverage ratio is negative and highly significant for all CDS types, indicating that adequate provisioning in relation to expected losses is strongly appreciated by markets. This suggests that timely and adequate provisioning may contribute to financial stability because it avoids procyclicality (Laeven and Majnoni, 2003). With respect to including an alternative profitability measure, ROE instead of ROA, or including the net interest margin (NIM) because it is the main component of ROA, the finding that profitability is inversely related to bank CDS spreads is confirmed in Table 11. Finally, Table 12 explores the results for the different bank funding sources next to deposits, such as senior or subordinated debt to liabilities (SEN DEBT, SUB DEBT) and the interbank funding ratio (INTERBANK). The most important finding is that deposit funding is associated with lower bank CDS spreads because markets consider access to stable funding as beneficial for the bank's risk profile. Conversely, higher ratios of interbank funding are associated with higher bank credit risk, indicating that a higher reliance on potentially volatile market funding increases perceived bank default risk (Huang and Ratnovski, 2011).

4.2 Monetary policy and bank default risk

In Tables 4-7 we report the impact of monetary policy on and bank CDS spreads. In order to fully capture the transmission to bank credit risk, it is important to distinguish two channels: a direct effect of monetary policy on perceived bank credit risk and an indirect channel operating via the sovereign risk channel. The first step in the sequence is to estimate the direct impact of monetary policy on sovereign risk. In Table 4 we report the impact of a monetary policy shock on sovereign credit risk based on the specification in equation 5, i.e. the orthogonalization of changes in sovereign credit risk into a part driven by monetary policy and an autonomous part, which we label autonomous sovereign credit risk. This estimation is done for 49 euro area banks from 9 countries[10]. The results in Table 4 indicate that an accommodative monetary policy shock is associated with declining sovereign CDS spreads in the euro area, as expected. However, since previous studies report that euro area monetary policy had a differential impact on sovereign credit risk across countries (Rostagno et al., 2019), we interact the monetary policy shock with a country dummy. Table 5 confirms that the impact is heterogeneous across countries, ECB monetary policy shocks have a more pronounced downward impact on sovereign credit risk for the peripheral countries of the euro area (Portugal, Italy, Spain and Ireland), compared to the core countries. The effect is even insignificant for Germany, which can be explained by the fact that the CDS spread of Germany remained largely stable during the sovereign debt crisis (see Figure 2). This first-stage regression partitions variation in sovereign credit risk into a component caused by monetary policy shocks (monetary policy induced sovereign credit risk) and a residual country-specific component (autonomous sovereign credit risk).

The results of the second-stage regressions, where we estimate both the direct and indirect transmission of monetary policy shocks on bank credit risk are reported in Tables 6 (using the euro area impact of monetary policy from Table 4) and Table 7 (using the heterogeneous impact of monetary policy across countries in Table 5). We show the results of three specifications for each CDS type. The first column for each type displays the results of equation 4 (i.e. the impact of monetary policy combined with the impact of sovereign credit risk on bank credit risk). The second column contains the coefficients for the impact of monetary policy combined with the autonomous sovereign credit risk (as described in equation 8). The third column displays the effects of a monetary policy induced change in sovereign risk combined with the impact of the autonomous part of sovereign credit risk (as described in equation 7). The difference between the first and second column is the sovereign credit risk variable. In the first column, the unpartitioned sovereign CDS spread is used as our measure of sovereign credit risk, which means that this regressor will be correlated with the monetary policy shock (in Tables 4 and 5 we report that the monetary policy shock

[10]For these estimations a monthly frequency is maintained, although a daily frequency would also be possible, as both the CDS spreads and the monetary policy shock are available on daily frequencies. As a robustness check, the results in daily frequencies are shown in the appendix (Tables 13-14)

significantly lowers sovereign credit risk). The indirect transmission of the monetary policy shock, i.e. the effect of monetary policy on bank credit risk through its impact on sovereign credit risk, is therefore captured by the sovereign credit risk measure. Consequently, the coefficient of the change in monetary policy only contains its direct impact on bank credit risk. In the second column, we only include the autonomous sovereign part of changes in sovereign credit risk. Therefore, as the sovereign credit risk measure no longer correlates with the monetary policy shock the estimated impact of a monetary policy shock now contains both the direct and indirect (through the sovereign transmission channel) effects. Hence, the coefficient of the monetary policy shock in the second column contains both the direct and indirect effects. In the third column, we analyze whether or not the two sources of sovereign credit risk are translated differently into bank credit risk, i.e. does a monetary policy induced change in sovereign credit risk impact bank credit risk differently than when the change in sovereign credit risk stems from events affecting sovereign risk other than monetary policy (e.g. political events).

Since the estimation results in Table 6 and Table 7 (heterogeneous across countries) are broadly similar, we focus our interpretation of the findings on Table 7. The results in the first column of Table 7 indicate that the direct effect of a unit accommodative monetary policy shock is associated with a decrease of bank default risk. This effect is slightly higher for subordinated bond CDS spreads and for shorter maturities. Thus, the subordinated bond 1-year CDS spread experiences the most pronounced beneficial impact associated with monetary policy stimulus. To guide the reader through the interpretation of the three columns we focus on the coefficients for the 5-year bank CDS spreads. Bank CDS spreads on 5-year senior bonds decrease with 1.825 basis points after an accommodative unit monetary policy shock, controlling for sovereign risk. In the second column the sovereign risk variable is the autonomous sovereign credit risk measure and in this case the estimated impact of a unit monetary policy shock on bank credit risk is -4.501, which now captures both the direct (-1.825) and the indirect effect of a monetary policy shock. Hence, the aggregate direct and indirect (via the sovereign channel) impact of a monetary policy shock is associated with lower bank default risk. Moreover, the cumulative effect of both transmission channels is stronger than the standalone direct effect. This indicates that both channels work in the same direction and even amplify each other. This argument is confirmed by the results of the third column, where the monetary policy shock is omitted and sovereign risk is now partitioned into the monetary policy induced effect and the autonomous sovereign effect. We observe that both terms are significant and positively affect bank CDS spreads, which is a straightforward finding since higher sovereign risk pushes up bank risk. Yet, changes in sovereign risk are translated more strongly into the CDS spread of banks when that change is caused by monetary policy shocks (1.017 for the 5-year senior CDS spreads, versus 0.347 for non monetary policy induced changes in sovereign credit risk). Consequently, the picture that emerges can be summarized as follows. Accommodative ECB monetary policy shocks are directly associated with lower bank CDS spreads. At the same time, stimulating monetary policy lowers sovereign risk, and since sovereign CDS spread changes impact bank CDS spreads with a factor larger than one, the decline in sovereign CDS spreads is amplified into more pronounced decreases in bank CDS spreads. Hence, ECB monetary policy actions exert their beneficial effect on the banks' perceived risk profile through a combination of a direct effect and an indirect-through-the-sovereign effect.

By construction, the results of the three columns in Tables 6 and 7 are linked to each other. We show this link graphically in Figure 6, again using the coefficients for the 5-year bank senior CDS spreads to illustrate the transmission channels. The direct impact of a unit monetary policy shock on the 5-year senior CDS spread of banks is -1.825. The cumulative impact of both the direct and indirect transmission channel on bank credit risk is -4.501. The difference between both estimations is interpreted as the indirect impact of monetary policy on bank credit risk via sovereign risk and this effect is approximated by multiplying the estimated coefficient of the first stage regression of bank CDS spreads on sovereign CDS spreads (Table 4 shows that this coefficient is -4.394) with the impact of the monetary policy induced change in sovereign credit risk on bank credit risk (1.017 for 5-year senior CDS spreads). Finally, and next to the monetary policy impact, changes in sovereign risk unrelated to ECB actions (e.g. political events) affect bank CDS spreads with an estimated coefficient of 0.347.

4.3 Extensions: geography and time variation

When analyzing the impact of ECB monetary policy, two natural extensions of the impact analysis may provide deeper insight: core versus periphery and variation over time. Differences in transmission of monetary policy to bank risk profiles in the core versus the peripheral countries of the euro area may be driven by two related factors. The first is that the overall health of the banking sector may be driven by structural country-specific factors, e.g. low interest margins due to the banking sector market structure or non-performing loans caused by periods of housing market distress. The second is that monetary policy transmission differs across countries, e.g. OMT had a more pronounced downward effect on interest rates in the euro area periphery. In terms of time variation in the transmission of monetary policy, it is important to take into account that the ECB has implemented policies aimed at credit easing (e.g. LTRO) and quantitative easing (e.g. asset purchases) and that these policies have been introduced at various stages in the post-crisis period. Interest rate decreases may initially have supported bank net interest margins and LTRO lowered the funding costs of the 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 profitability may be affected negatively and this may be reflected in a worsening bank risk profile (Borio and Gambacorta, 2017; Heider et al., 2019). A similar reasoning holds for the ECB asset purchase programs; they may initially have benefited sovereign as well as bank funding conditions, but when long term interest rates remain low for long or even turn negative, this may hurt banks asset returns and, as a result, induce risk-taking behavior and deteriorate their perceived credit risk profile.

4.3.1 Monetary policy and bank risk profile: Core versus GIIPS

In Table 8, we analyze the heterogeneous impact of monetary policy on bank default risk depending on whether the banks are located in a core euro area country or in the periphery, which we define based on the commonly used GIIPS perimeter. We estimate the effect on bank risk of the monetary policy shock and the sovereign CDS spread, both interacted with a dummy variable equal to one when a bank is headquartered in a GIIPS country, zero otherwise. The first column of the 4 types of bank CDS spreads in Table 8 displays the results for the combination of the direct impact of monetary policy and the sovereign CDS spread. To facilitate the interpretation, Table 8 only reports the coefficients of monetary policy, sovereign risk and their interaction with country dummies, but bank controls and fixed effects are also included in the estimations. The results are indicative of pronounced heterogeneity, especially with respect to the direct impact of monetary policy. Accommodative monetary policy shocks have a larger decreasing impact on credit risk for banks headquartered in GIIPS countries. Considering the 5-year senior bond CDS spreads, the effect is twice as large. Hence, the perceived risk profile of banks in stressed countries benefits most from ECB actions that are considered as stimulating. We find no evidence that changes in sovereign credit risk display a stronger transmission to bank CDS spreads for GIIPS banks. These results suggest that especially monetary policy actions exert a significant downward effect on the markets' assessment of default risk of banks in the peripheral countries. The second column of Table 8 displays the results for monetary policy in combination with the autonomous sovereign credit risk measure. The results confirm the finding in the first column that accommodative monetary policy impacts the CDS spreads of peripheral banks more than those located in the core euro area. Finally, the third column presents the coefficients for the impact of sovereign CDS spreads on banks, now partitioned into a part induced by monetary policy and an autonomous part. The main finding is that changes in the sovereign CDS spread induced by monetary policy exhibit a higher impact for banks in peripheral countries, but more pronounced for senior bonds. Considering the autonomous part of sovereign risk, the results indicate that the association between non-monetary-policy associated sovereign credit risk is transmitted more strongly to bank risk in the core countries. Overall, the findings of Table 8 suggest that beneficial effects on bank CDS spreads in peripheral euro area countries are predominantly driven by accommodative ECB monetary policy.

4.3.2 Monetary policy and bank risk profile: time-varying impact

Figure 7 displays the evolution of the results for the direct and the indirect effect of ECB monetary policy on bank CDS spreads over the post-crisis period. In order to investigate the time-varying pattern of the impacts across periods characterized by different types of ECB actions, we estimate 3-year rolling window regressions. Figure 7 is constructed such that it mimicks the structure of Table 7, i.e. the two graphs in each of the three rows of Figure 7 correspond to the combination of pairs of variables in the three columns in Table 7. The two graphs in the first row show the evolution of the coefficients of the monetary policy shock combined with those for the sovereign CDS spread. The second row displays the coefficients of the monetary policy shock and the autonomous sovereign credit risk. The third row reports the evolution of the effect of the monetary policy induced change in sovereign risk combined with that of the autonomous sovereign credit risk.

The findings for the direct effect of ECB monetary policy on bank CDS spreads and the indirect effect via the sovereign channel can be summarized as follows. The left panels of rows (1) and (2) demonstrate that accommodative monetary policy has a pronounced downward effect on bank credit risk. The confidence intervals show that this is the case for the entire post-2008 period, but the effect is especially visible in the period 2012-2014 during which the ECB undertook unprecedented actions to avoid a break-up of the eurozone and diminish the bond spreads of the vulnerable countries (e.g. the Draghi speech and OMT, see Rostagno et al. (2019)). These actions are associated with a pronounced decrease in bank CDS spreads an this can be interpreted as the direct effect since we control for the sovereign spread, which is itself positively related to bank CDS spreads (right panel in row (1)), and for bank business model characteristics. The direct effect of monetary policy to bank credit risk remains significantly negative (i.e. associated with a downward pressure on bank CDS spreads) in the post-2014 period, but the magnitude is lower. The indirect effect of monetary policy through the sovereign risk channel is depicted in row (3). We observe that both the monetary policy induced changes in sovereign CDS spread (left panel) as well as the autonomous part of sovereign risk (righ panel) are positively related to bank credit risk, i.e. higher (lower) sovereign CDS spreads are associated with higher (lower) bank CDS spreads and the effect is larger for the monetary policy induced part (as in table 7). Yet, the impact of the monetary policy induced part is clearly much more pronounced in the 2012-2014 period, again confirming that the decisive actions of the ECB in that period contributed to alleviating stress in the banking system, through its moderating effect on sovereign risk. These results confirm that ECB monetary policy in those days operated through the strong feedback loop between sovereigns and banks (see Acharya et al. (2014)). In the post-2014 period the positive relationship between sovereign risk and bank risk remains significant in row (3), suggesting that actions by the ECB such as the asset purchases keep on contributing to lowering bank credit risk. Overall, our time-varying results confirm that from the perspective of the CDS market, accommodative monetary policy by the ECB is associated with lower bank credit risk, very pronounced during the sovereign crisis, but also significant in the rest of the post-2008 period.

5 Conclusion

Since 2008 European banks have witnessed a stressful decade, with a banking crisis, a sovereign debt crisis and several unprecedented policy actions by the central banks. These rough waters may have consequences for the viability of part of the banking industry. This is our motivation to empirically investigate the evolution of bank default risk, proxied by bank CDS spreads, and its determinants in Europe. In this paper we investigate three potential drivers of bank default risk: bank-specific variables, capturing the banks' business models, sovereign default risk, capturing the feedback loop between sovereign and banks, and monetary policy, capturing the incidence of unconventional monetary policy actions undertaken by the ECB. When focusing on the impact of monetary policy, we disentangle the effect on bank default risk through a direct transmission channel and via an indirect channel operating through sovereign credit risk. Our main findings can be summarized as follows.

With respect to the bank-specific variables, which capture the business model of the banks and hence their fundamental risk profile, we find evidence suggesting that a higher capital ratio, better profitability and a higher reliance on deposit funding lowers banks' CDS spreads, implying a lower perceived bank default risk. Both a higher exposure to loans in total assets as well as higher non-performing loans are associated with higher bank default risk. The negative effect of non-performing loans is stronger as the maturity of CDS contracts increases, indicating that CDS market participants consider NPLs as a drag on future profitability. Our findings support the enforcement of the Basel 3 capital and funding rules, i.e. higher capital ratios and requirements in terms of stable funding because they strengthen the resilience of the banks. Similarly, our findings support supervisory efforts to speed up the resolution of non-performing loans, but such action was undertaken by the Single Supervisory Mechanism of the ECB only in 2017 (ECB, 2017).

With respect to sovereign default risk, our results confirm the feedback loop between the health of banks and that of their home country that has been documented in many previous studies. However, in view of the fact that sovereign risk is not only determined by the state of the domestic economy and public finances in particular, but also by monetary policy actions aimed at influencing the funding conditions of governments, we design a methodology that allows us to partition total sovereign risk into a part that is driven by monetary policy and a part that is due to country-specific circumstances and policies. Our results show that both components of sovereign risk affect bank CDS spreads, but that the effect of monetary policy induced changes in sovereign CDS spreads played a predominant role in decreasing bank CDS spreads in the 2012-2014 period. These findings illustrate that the central bank can effectively use unconventional monetary policy actions, in particular asset purchases, to influence not only sovereign spreads, but also bank credit risk. Nevertheless, the results do not imply that the correlation between bank health and the condition of the sovereign diminishes. A loosening of the bank-sovereign loop requires action beyond monetary policy, e.g. imposing diversification requirements on bank sovereign portfolios or improving the public finance conditions of stressed countries.

With regard to monetary policy, the results indicate that during the period 2008-2018, expansionary monetary policy shocks on average diminish bank CDS spreads. Moreover, our time-varying impact analysis shows that accommodative monetary policy by the ECB is always associated with lower bank CDS spreads, not only in the period 2012-2014 when the impact was most pronounced, but also in the post-2014 era during which the ECB implemented its asset purchase program as well as started charging banks a negative deposit rate on their excess liquidity holdings at the central bank. Other studies have concluded that negative policy rates and the prospect of low for long interest rates may be detrimental for bank profitability and may induce bank risk-taking behavior. Our findings do not imply that banks do not take more risk. They may e.g. rebalance their asset portfolios towards riskier loans, but if this would lead to higher levels of NPL, our results imply that this would be accompanied by higher observed bank CDS spreads. But our results are not consistent with the hypothesis that expansionary monetary policy causes excessive risk taking by banks, because such behavior would be reflected in higher CDS spreads. When we distinguish between a direct channel of monetary policy to bank credit risk and an indirect effect via the sovereign risk channel, our main finding is that both impacts are significant. Accommodative ECB monetary policy shocks are directly associated with lower bank CDS spreads. At the same time, stimulating monetary policy lowers sovereign risk, and since sovereign CDS spread changes in turn impact bank CDS spreads, the decline in sovereign CDS spreads is amplified into more pronounced decreases in bank CDS spreads. Hence, ECB monetary policy actions exert their beneficial effect on the banks' perceived risk profile through a combination of a direct effect and an indirect-through-the sovereign effect. Moreover, we demonstrate that these effects are stronger for banks in peripheral countries of the euro area and that the downward effect of monetary policy on bank default risk was especially pronounced in the 2012-2014 period when the euro area was under severe stress. Our results indicate that ECB monetary policy is a powerful tool to contain bank credit risk, especially in stress periods. Based on the assessment of CDS markets, the risk profile of European banks has benefited from the post-2008 actions of the ECB.

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Tables

Table 1: Descriptive statistics. CDS spread data, bank-specific variables and market data are obtained from Markit, SNL and Datastream respectively. SD shows the standard deviation of the variables, whilst the AdjSD shows the standard deviation of the variables after controlling for bank- and year-fixed effects.

Variable	Abbrevation	Mean	SD	AdjSD	P1	P50	P99
CDS Senior 1 Year	CDS SEN 1	120.45	184.74	134.02	6.08	56.84	1,183.44
CDS Subordinated 1 Year	CDS SUB 1	210.70	296.71	194.26	14.04	103.82	1,749.04
CDS Senior 5 Years	CDS SEN 5	165.66	160.95	104.36	24.08	115.10	975.75
CDS Subordinated 5 Years	CDS SUB 5	270.61	238.14	138.89	48.53	187.72	1,265.44
CDS Sovereign	CDS^{SOV}	74.35	99.10	61.48	5.55	37.57	579.91
Equity/Assets	CAP	5.62	2.19	1.08	1.10	5.46	13.18
CET1	CET1	11.73	4.35	2.30	4.60	11.44	31.50
Size	SIZE	19.36	1.15	0.23	16.77	19.37	21.48
Loans to Assets	L/A	58.16	16.42	5.03	20.23	61.40	88.38
Deposits to Liabilities	DEP	45.63	15.53	5.38	10.73	45.46	79.28
Interbank Funding	INTERBANK	14.78	9.32	4.21	1.24	12.83	44.46
ROA	ROA	0.08	0.52	0.38	−2.12	0.13	1.15
ROE	ROE	1.42	10.29	8.23	−45.11	2.27	22.80
Net Interest Margin	NIM	0.68	0.53	0.27	0.15	0.46	2.14
Diversification	DIV	37.83	16.01	10.00	0.00	38.09	78.16
Cost to Income	C/I	65.49	24.45	16.93	2.18	61.94	182.52
NPL	NPL	5.66	5.72	2.88	0.35	3.66	26.65
LLP to NPL	LLP/NPL	52.37	20.72	14.13	13.86	50.75	140.48
Subordinated Debt	SUB DEBT	2.18	1.19	0.67	0.08	2.07	6.27
Senior Debt	SEN DEBT	21.00	11.05	4.89	1.76	19.46	52.04
Vstoxx	VSTOXX	23.37	8.76	5.99	12.44	21.93	60.60
Monetary Policy	MPS	0.00	0.12	0.11	−0.31	0.00	0.30

Table 2: Descriptive overview of the sample. The left column indicates the name of the banks, the right column shows the location of the banks' headquarters.

Name	Country
Erste Group Bank	Austria
Raiffeisen Bank International	Austria
Raiffeisen Zentralbank Österreich	Austria
UniCredit Bank Austria	Austria
BNP Paribas Fortis	Belgium
KBC Bank	Belgium
Danske Bank	Denmark
BNP Paribas	France
Banque Fédérative du Crédit Mutuel	France
Crédit Agricole	France
Crédit Lyonnais	France
Natixis	France
Société Générale	France
Bayerische Landesbank	Germany
Commerzbank	Germany
Deutsche Bank	Germany
Hamburg Commercial Bank	Germany
IKB Deutsche Industriebank	Germany
Landesbank Baden-Württemberg	Germany
NORD/LB Norddeutsche Landesbank Girozentrale	Germany
Portigon	Germany
UniCredit Bank	Germany
Governor and Company of the Bank of Ireland	Ireland
Permanent TSB Group Holdings	Ireland
Banca Monte dei Paschi di Siena	Italy
Banca Nazionale del Lavoro	Italy
Banca Popolare di Milano	Italy
Banco BPM	Italy
Banco Popolare	Italy
Intesa Sanpaolo	Italy
Mediobanca - Banca di Credito Finanziario	Italy
UniCredit	Italy
Unione di Banche Italiane	Italy
ABN AMRO Group	Netherlands
Coöperatieve Rabobank	Netherlands
ING Bank	Netherlands
NIBC Bank	Netherlands
DNB Bank	Norway
Banco BPI	Portugal
Banco Comercial Português	Portugal
Banco Espírito Santo	Portugal
Caixa Geral de Depósitos	Portugal
Novo Banco	Portugal
Banco Bilbao Vizcaya Argentaria	Spain
Banco Pastor	Spain
Banco Popular Español	Spain
Banco Santander	Spain
Banco de Sabadell	Spain
Bankia	Spain
Bankinter	Spain
CaixaBank	Spain
Nordea Bank	Sweden
Skandinaviska Enskilda Banken	Sweden
Svenska Handelsbanken	Sweden
Swedbank	Sweden
Credit Suisse Group	Switzerland
UBS Group	Switzerland
Bank of Scotland	United Kingdom
Barclays	United Kingdom
HBOS	United Kingdom
HSBC Bank	United Kingdom
Lloyds Bank	United Kingdom
Nationwide Building Society	United Kingdom
Royal Bank of Scotland Group	United Kingdom
Santander UK	United Kingdom
Standard Chartered	United Kingdom

Table 3: Baseline regression results. Both tables show the results of the regressions explaining the drivers of bank CDS spreads using bank-specific variables, the Vstoxx and sovereign credit risk, as outlined in model 3. The left and right panel show the results on the regular and normalised bank CDS spread respectively. All estimations use bank- and year fixed effects to control for unobserved heterogeneity and 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.

	CDS on senior bond		CDS on subordinated bond	
	1 year	5 years	1 year	5 years
CAP	−10.589***	−9.502***	−25.232***	−17.833***
	(2.788)	(1.718)	(5.687)	(3.378)
SIZE	19.363	−9.786	84.925***	41.333***
	(14.035)	(11.344)	(17.168)	(13.250)
LTA	3.781***	2.249***	5.296***	3.453***
	(1.084)	(0.786)	(1.218)	(0.744)
DIV	−0.291	−0.154	0.685	0.461
	(0.231)	(0.181)	(0.498)	(0.285)
NPL	3.363***	3.454***	5.448***	3.861***
	(0.995)	(0.780)	(1.749)	(1.149)
ROA	−15.074**	−25.153***	−26.183***	−40.469***
	(5.823)	(5.222)	(8.032)	(7.880)
DEP	−3.432***	−1.779**	−1.678*	−0.509
	(0.967)	(0.748)	(0.999)	(0.760)
VSTOXX	2.249***	1.769***	3.553***	3.513***
	(0.536)	(0.409)	(1.129)	(1.041)
CDS^{SOV}	1.467***	1.175***	1.934***	1.360***
	(0.077)	(0.041)	(0.118)	(0.077)
Bank fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
R^2	0.704	0.766	0.635	0.717
No. of banks	66	66	64	66
No. of obs	7,733	7,753	7,262	7,564

	CDS on senior bond		CDS on subordinated bond	
	1 year	5 years	1 year	5 years
CAP	−0.057***	−0.059***	−0.085***	−0.075***
	(0.015)	(0.011)	(0.019)	(0.014)
SIZE	0.105	−0.061	0.286***	0.174***
	(0.076)	(0.070)	(0.058)	(0.056)
LTA	0.020***	0.014***	0.018***	0.014***
	(0.006)	(0.005)	(0.004)	(0.003)
DIV	−0.002	−0.001	0.002	0.002
	(0.001)	(0.001)	(0.002)	(0.001)
NPL	0.018***	0.021***	0.018***	0.016***
	(0.005)	(0.005)	(0.006)	(0.005)
ROA	−0.081**	−0.156***	−0.088***	−0.170***
	(0.031)	(0.032)	(0.027)	(0.033)
DEP	−0.019***	−0.011**	−0.006*	−0.002
	(0.005)	(0.005)	(0.003)	(0.003)
VSTOXX	0.012***	0.011***	0.012***	0.015***
	(0.003)	(0.003)	(0.004)	(0.004)
CDS^{SOV}	0.008***	0.007***	0.007***	0.006***
	(0.000)	(0.000)	(0.000)	(0.000)
Bank fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
R^2	0.704	0.766	0.635	0.717
No. of banks	66	66	64	66
No. of obs	7,733	7,753	7,262	7,564

Table 4: Effect of the monetary policy shock on sovereign CDS spreads (monthly frequency). All estimations use country- and year fixed effects to control for unobserved heterogeneity and common macroeconomic shocks. Standard errors in parentheses are clustered at the country level. *, ** and *** represent significance a the 10%, 5% and 1% percent level, respectively.

Dependent Variable:	ΔCDS^{SOV}
Δ MPS	-4.394^{***}
	(0.421)
Country fixed effects	Yes
Year fixed effects	Yes
R^2	0.138
No. of Sovereigns	9
No. of obs	1,134

Table 5: Effect of the monetary policy shock on sovereign CDS spreads (monthly frequency). This table shows the coefficient estimates from OLS regressions relating the interaction of the monetary policy shock and a country dummy variable to sovereign credit risk, as presented in equation 6. All estimations use country- and year fixed effects to control for unobserved heterogeneity and common macroeconomic shocks. Standard errors in parentheses are clustered at the country level. *, ** and *** represent significance a the 10%, 5% and 1% percent level, respectively.

Dependent Variable:	ΔCDS^{SOV}
ΔMPS $\times$ Interaction Term:	
AUSTRIA	−4.005***
	(1.156)
BELGIUM	−3.547***
	(1.156)
FRANCE	−2.455**
	(1.156)
GERMANY	−1.840
	(1.156)
IRELAND	−7.445***
	(1.156)
ITALY	−5.991***
	(1.156)
NETHERLANDS	−1.995*
	(1.156)
PORTUGAL	−6.234***
	(1.156)
SPAIN	−6.031***
	(1.156)
Country fixed effects	Yes
Year fixed effects	Yes
R^2	0.158
No. of Sovereigns	9
No. of obs	1,134

Table 6: Direct and indirect effect of the monetary policy shock on bank CDS spreads (monthly frequency). For each bank CDS contract type, this table shows the results of the effect of the monetary policy shock and sovereign credit risk on bank credit risk. In the first column (1) the table shows the results of the monetary policy shock and changes in sovereign credit risk, column (2) shows the monetary policy shock and autunomous changes in sovereign credit risk and column (3) shows monetary policy induced changes in sovereign credit risk and autonomous changes in sovereign credit risk. All estimations use bank- and year fixed effects to control for unobserved heterogeneity and common macroeconomic shocks. Bank control variables capturing the business model and the profitability of the bank are included as well. Standard errors in parentheses are clustered at the country level. *, ** and *** represent significance a the 10%, 5% and 1% percent level, respectively.

	Δ CDS on senior bond						Δ CDS on subordinated bond					
	1 year			5 years			1 year			5 years		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
ΔMPS	-2.232^{***}	-5.360^{***}		-1.825^{***}	-4.587^{***}		-3.241^{***}	-8.364^{***}		-2.846^{***}	-6.899^{***}	
	(0.321)	(0.432)		(0.207)	(0.277)		(0.554)	(0.571)		(0.466)	(0.496)	
ΔCDS^{SOV}	0.861^{***}			0.760^{***}			1.374^{***}			1.101^{***}		
	(0.067)			(0.036)			(0.067)			(0.069)		
$\widehat{\mu_{c,t}}$		0.397^{***}	0.418^{***}		0.351^{***}	0.367^{***}		0.719^{***}	0.755^{***}		0.557^{***}	0.589^{***}
		(0.073)	(0.082)		(0.055)	(0.063)		(0.096)	(0.113)		(0.102)	(0.117)
$\Delta\widehat{CDS}^{Sov}$			1.235^{***}			0.997^{***}			1.947^{***}			1.546^{***}
			(0.101)			(0.058)			(0.117)			(0.096)
Bank control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.261	0.203	0.232	0.332	0.256	0.281	0.195	0.157	0.180	0.236	0.189	0.212
No. of banks	49	49	49	49	49	49	47	47	47	49	49	49
No. of obs	5,330	5,330	5,330	5,358	5,358	5,358	4,873	4,873	4,873	5,172	5,172	5,172

Table 7: Direct and indirect effect of the monetary policy shock on bank CDS spreads (monthly frequency), where monetary policy is estimated heterogeneously on each country in the sample. For each bank CDS contract type, this table shows the results of the effect of the monetary policy shock and sovereign credit risk on bank credit risk. In the first column (1) the table shows the results of the monetary policy shock and changes in sovereign credit risk, column (2) shows the monetary policy shock and autunomous changes in sovereign credit risk and column (3) shows monetary policy induced changes in sovereign credit risk and autonomous changes in sovereign credit risk. All estimations use bank- and year fixed effects to control for unobserved heterogeneity and common macroeconomic shocks. Bank control variables capturing the business model and the profitability of the bank are included as well. Standard errors in parentheses are clustered at the country level. *, ** and *** represent significance a the 10%, 5% and 1% percent level, respectively.

	∆ CDS on senior bond						∆ CDS on subordinated bond					
	1 year			5 years			1 year			5 years		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
∆MPS	−2.232***	−5.263***		−1.825***	−4.501***		−3.241***	−8.280***		−2.846***	−6.792***	
	(0.321)	(0.507)		(0.207)	(0.360)		(0.554)	(0.655)		(0.466)	(0.579)	
ΔCDS^{SOV}	0.861***			0.760***			1.374***			1.101***		
	(0.067)			(0.036)			(0.067)			(0.069)		
$\widehat{\mu_{c,t}}$		0.369***	0.391***		0.331***	0.347***		0.705***	0.735***		0.539***	0.567***
		(0.068)	(0.078)		(0.052)	(0.060)		(0.100)	(0.114)		(0.102)	(0.116)
$\Delta\widehat{CDS}^{Sov}$			1.274***			1.017***			1.846***			1.499***
			(0.086)			(0.044)			(0.136)			(0.098)
Bank control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.261	0.194	0.242	0.332	0.246	0.289	0.195	0.153	0.180	0.236	0.183	0.213
No. of banks	49	49	49	49	49	49	47	47	47	49	49	49
No. of obs	5,330	5,330	5,330	5,358	5,358	5,358	4,873	4,873	4,873	5,172	5,172	5,172

Table 8: Direct and indirect effect of the monetary policy shock on bank CDS spreads (monthly frequency), where monetary policy is estimated heterogeneously on each country in the sample. For each bank CDS contract type, this table shows the results of the effect of the monetary policy shock and sovereign credit risk on bank credit risk, both standalone and interacted with a GIIPS dummy variable. In the first column (1) the table shows the results of the monetary policy shock and changes in sovereign credit risk, column (2) shows the monetary policy shock and autunomous changes in sovereign credit risk and column (3) shows monetary policy induced changes in sovereign credit risk and autonomous changes in sovereign credit risk. All estimations use bank- and year fixed effects to control for unobserved heterogeneity and common macroeconomic shocks. Bank control variables capturing the business model and the profitability of the bank are included as well. Standard errors in parentheses are clustered at the country level. *, ** and *** represent significance a the 10%, 5% and 1% percent level, respectively.

	Δ CDS on senior bond						Δ CDS on subordinated bond					
	1 year			5 years			1 year			5 years		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
ΔMPS	−1.335***	−3.291***		−1.444***	−3.110***		−2.821***	−6.710***		−2.378***	−5.667***	
	(0.385)	(0.478)		(0.255)	(0.388)		(0.610)	(0.625)		(0.497)	(0.731)	
ΔMPS× GIIPS	−2.564***	−4.722***		−1.475***	−3.426***		−1.241	−3.782**		−1.340	−3.040**	
	(0.693)	(0.947)		(0.459)	(0.654)		(1.309)	(1.562)		(0.965)	(1.160)	
ΔCDS^{SOV}	0.702***			0.608***			1.344***			1.180***		
	(0.128)			(0.093)			(0.132)			(0.122)		
$\Delta CDS^{SOV}\times$ GIIPS	0.161			0.150			0.036			−0.112		
	(0.152)			(0.101)			(0.158)			(0.143)		
$\widehat{\mu_{c,t}}$		0.346***	0.640***		0.289***	0.546***		0.623***	1.182***		0.500***	1.020***
		(0.094)	(0.125)		(0.078)	(0.095)		(0.161)	(0.133)		(0.139)	(0.129)
$\widehat{\mu_{c,t}}\times$ GIIPS		0.066	−0.235		0.070	−0.191*		0.141	−0.424**		0.071	−0.446**
		(0.123)	(0.148)		(0.098)	(0.113)		(0.190)	(0.169)		(0.180)	(0.173)
$\Delta\widehat{CDS}^{Sov}$			0.913***			0.826***			1.845***			1.598***
			(0.129)			(0.092)			(0.153)			(0.157)
$\Delta\widehat{CDS}^{Sov}\times$ GIIPS			0.990***			0.619***			0.603*			0.297
			(0.246)			(0.155)			(0.339)			(0.221)
Bank control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.250	0.200	0.236	0.320	0.252	0.281	0.180	0.146	0.169	0.227	0.183	0.207
No. of banks	49	49	49	49	49	49	47	47	47	49	49	49
No. of obs	5,330	5,330	5,330	5,358	5,358	5,358	4,873	4,873	4,873	5,172	5,172	5,172

Figures

Figure 1: Time series of bank CDS spreads. The solid black line represents the median CDS spread value of a given month, whilst the darker and lighter blue areas resemble the 25%-75% and the 10%-90% percentiles for that month. It is clear that CDS spreads on subordinated bonds are higher than those on senior bonds on a given day for the same underlying maturity, as these bonds have a higher default probability. The differences in the term structure are less clear. There is a temporary increase in market-perceived bank default risk during the global financial crisis. It is during the sovereign debt crisis that CDS spreads are the highest in our sample period. From 2012 onward, CDS spreads declined. During 2016-2017 there is another increase in bank default risk, amidst concerns with regards to the viability of Deutsche Bank.

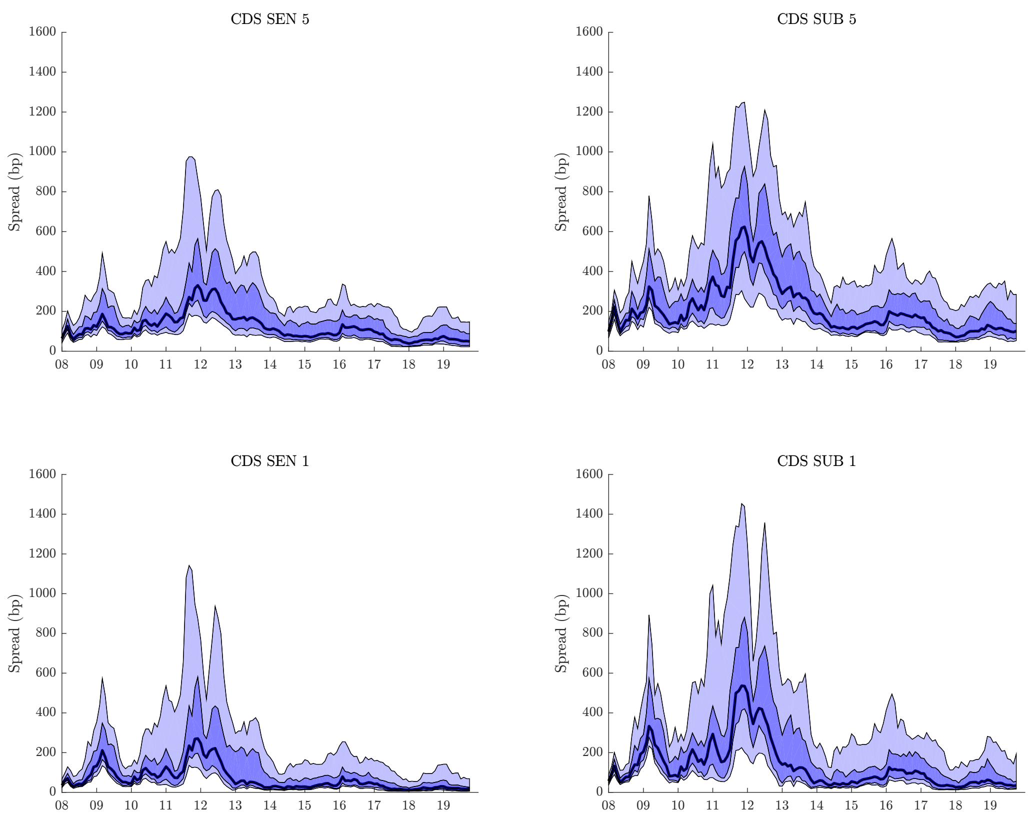


Figure 2: Time series of sovereign CDS spreads. This graph contains the home countries of the banks in the sample. The sovereigns in the periphery have the highest and most volatile CDS spreads. The CDS spread of the non GIIPS countries tend to be very low as the perceived probability of default for core Euro Area countries remained low over the sample period. Similar to bank CDS spreads, sovereign default risk was highest during the sovereign debt crisis.

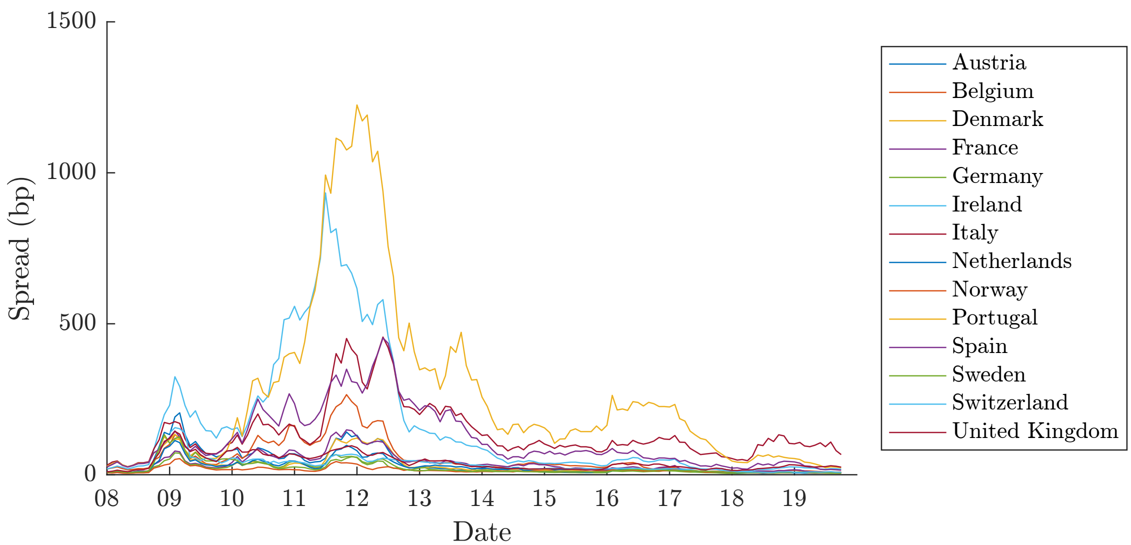


Figure 3: Time series of bank business model variables. The solid black line represents the median value of the variables of a given month, while the darker and lighter blue areas resemble the 25%-75% and the 10%-90% percentiles for a given month. In our sample period, capital ratio's have increased due to capital requirements. We also see a shift in the funding structure of the bank towards more deposit funding, and less reliance on interbank funding and bonds. NPLs clearly increased since the sovereign debt crisis and reached 20% at its highest level for the 90% percentiles. Yet, banks with high NPL ratios were able to decrease its level as of 2018.

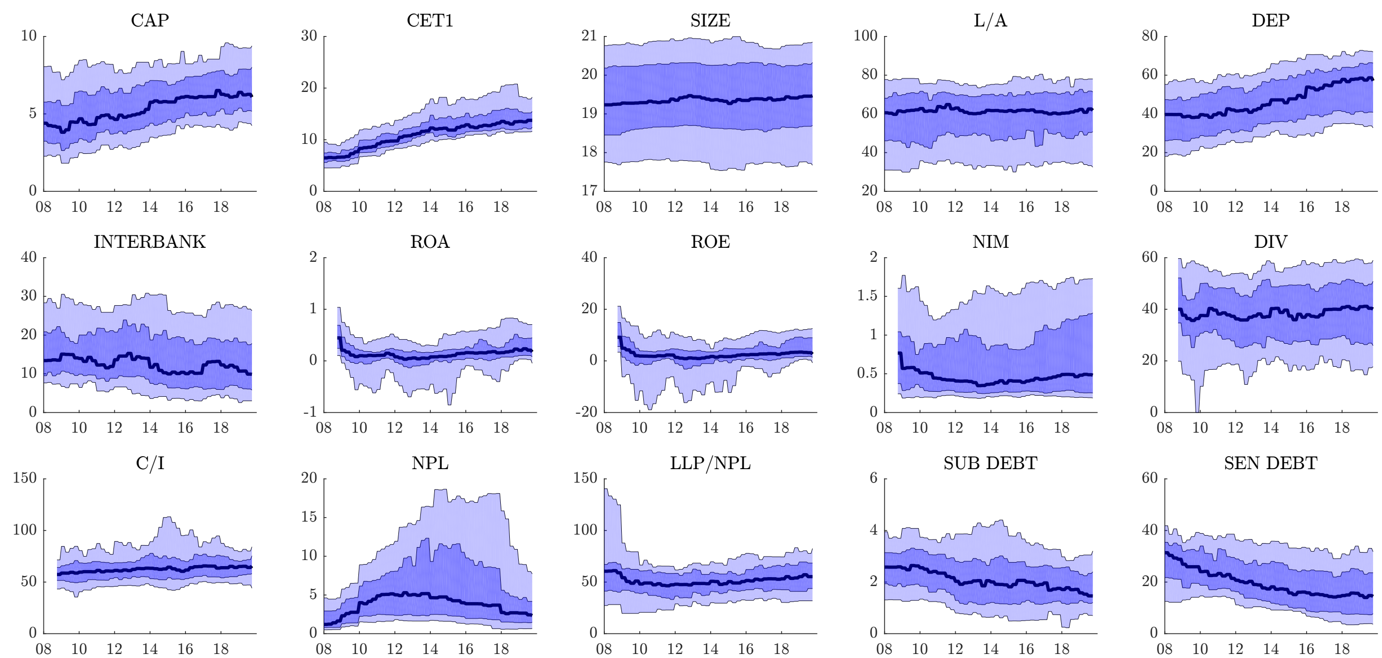


Figure 4: Kernel of the distribution of the independent variables. The blue kernel represents the distribution of the (demeaned) independent variables, whilst the red kernel represents the distribution of the independent variable after controlling for bank- and year-fixed effects. The figure shows that the standard deviation of the bank-year dimension of the data is lower than the standard deviation of the independent variables. Therefore, the economic significance of our estimated coefficients should be compared with the average change in the bank-year dimension of the data, which is less than the average changes of the variables as such. E.g. size has a lot of cross sectional variation (blue kernel), but the size of a bank during the course of a year changes considerably less (red kernel).

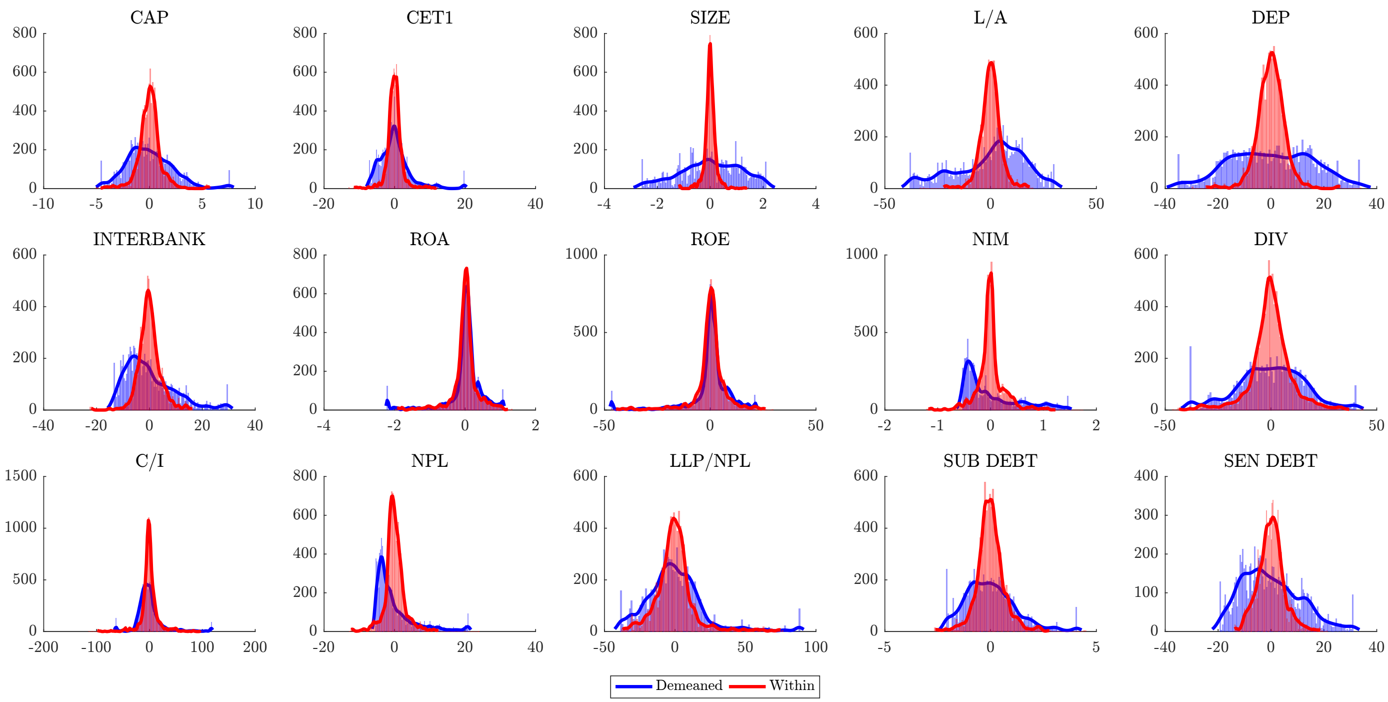


Figure 5: Time series of the absolute (red) and cumulative (blue) monetary policy shocks for the Euro Area. A unit monetary policy shock reflects an expansionary monetary policy announcement. We show the cumulative monetary policy shocks since it shows graphically whether or not an ECB announcement was anticipated. We highlight three announcements: (1) ECB announces its Securities Markets Program; (2) ECB President Mario Draghi states that the ECB "is ready to do whatever it takes to preserve the euro"; (3) the ECB announces it starts buying public-sector securities (EUR 60 billion per month until September 2016).

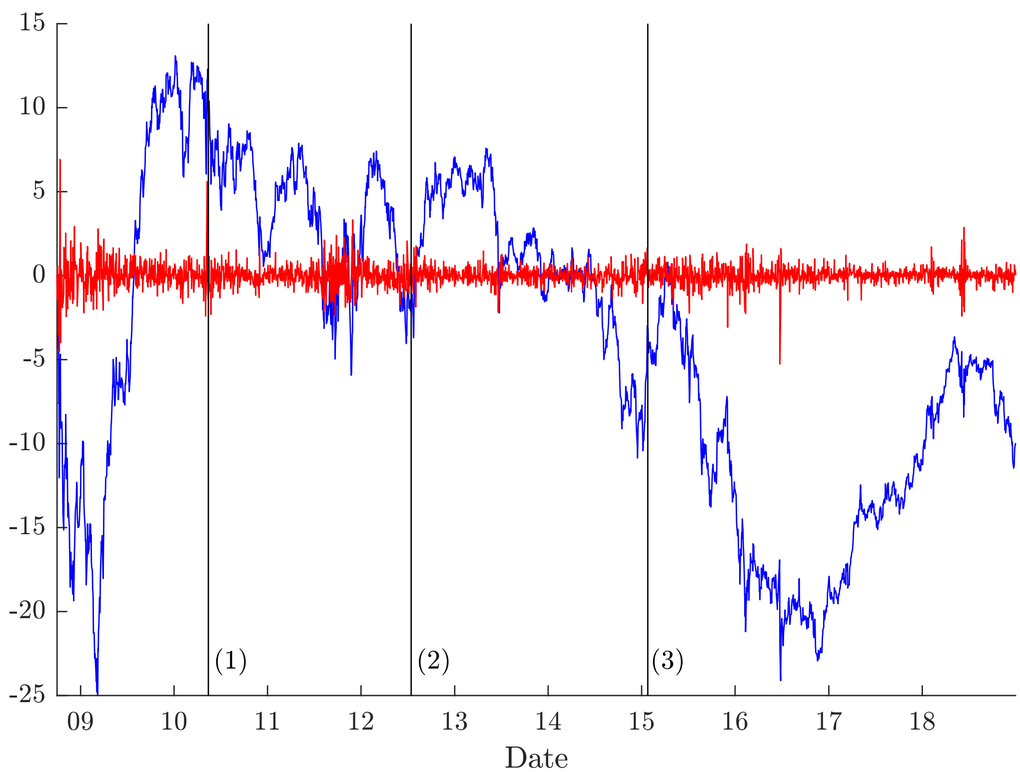


Figure 6: Graphical representation direct and indirect effect of monetary policy on bank CDS spreads (based on tables 4 and 6). The direct effect of a unit monetary policy shock on bank credit risk is -1.825. The indirect transmission works through the impact of a monetary policy shock on sovereign credit risk (-4.394). This change, which is labeled monetary policy induced changes in sovereign credit risk is translated into a change of bank credit risk by an estimated coefficient of 0.997. The combined effect of both transmission channels is estimated at -4.587. The shaded area in the sovereign credit risk node represents the explained variation of monetary policy shocks in the movements of sovereign CDS spreads.

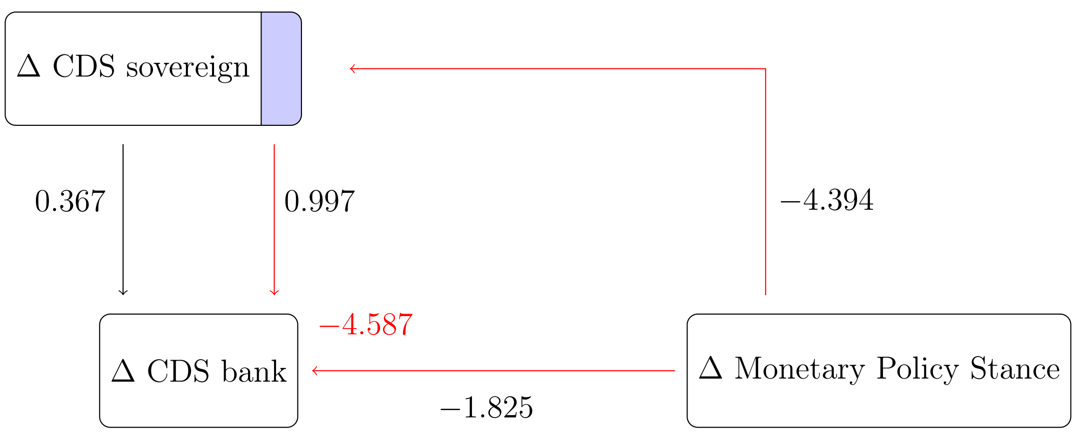
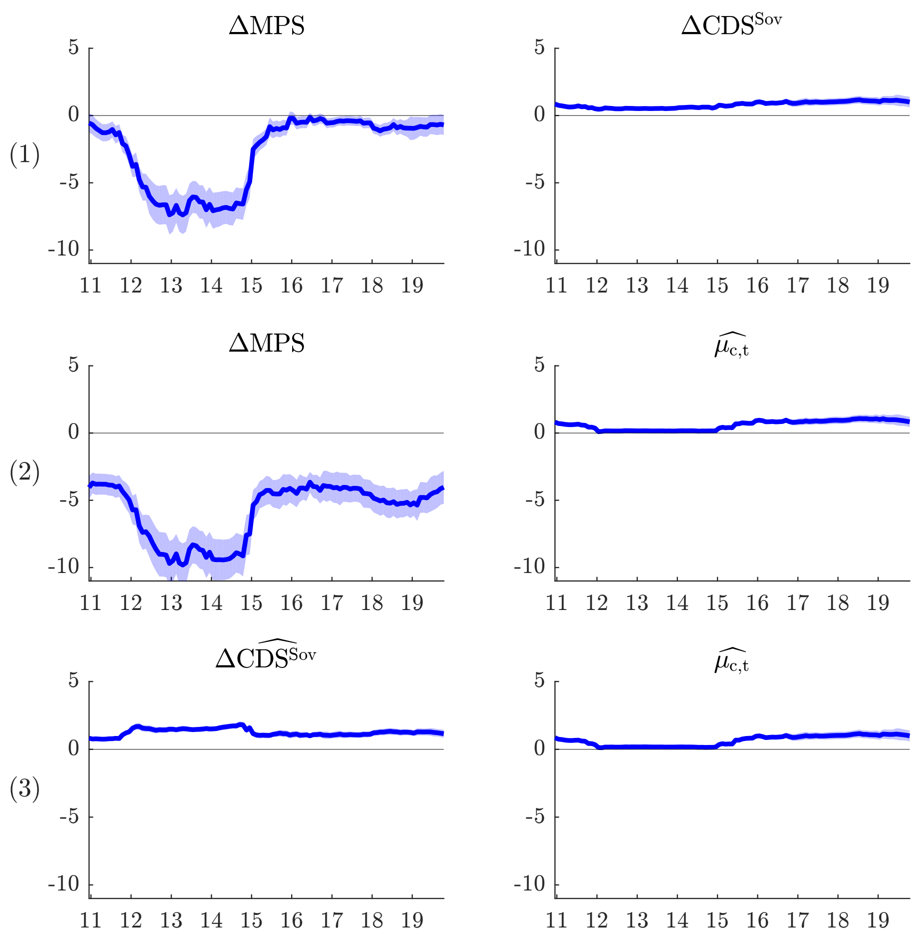


Figure 7: Effect of monetary policy and sovereign credit risk on bank CDS spreads. The figure shows the coefficient estimates of the OLS regressions relating the impact of monetary policy and sovereign credit risk on bank credit risk over a rolling window of 3 years in three different models. In model (1) bank credit risk is estimated by a monetary policy shock and sovereign credit risk. In the second model (2) we include the monetary policy shock and the autonomous changes in sovereign credit risk. In the third row (3) we estimate the model including both the monetary policy induced changes of sovereign credit risk and the autonomous changes in sovereign credit risk. The x-axis denotes the last observation of each estimation period. The coefficients are surrounded by the 95% confidence interval of each estimation.



Appendix

Table 9: Effect of capital specifications on bank CDS spreads. This table shows the results of the drivers of bank funding costs, as outlined in model 3. For each CDS contract type, we test alternative capital ratio specifications. The left column displays the results on the unweighted capital ratio (CAP), whereas the right shows the results on a risk weighted capital ratio (CET1). All estimations use bank- and year fixed effects to control for unobserved heterogeneity and 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.

	CDS on senior bond				CDS on subordinated bond			
	1 year		5 years		1 year		5 years	
SIZE	−10.364	2.376	−25.556**	−10.610	−6.544	36.153**	−20.120	12.238
	(15.148)	(12.697)	(12.024)	(10.308)	(16.555)	(16.521)	(14.008)	(13.839)
LTA	3.914***	3.767***	2.237***	2.087**	4.094**	3.915**	1.954*	1.837
	(0.853)	(1.001)	(0.686)	(0.807)	(1.702)	(1.953)	(1.076)	(1.264)
DIV	0.200	0.156	0.190	0.106	1.316***	1.011**	0.692***	0.530**
	(0.182)	(0.194)	(0.144)	(0.147)	(0.413)	(0.428)	(0.261)	(0.249)
NPL	3.873***	3.971***	3.683***	3.818***	3.859*	4.461**	3.172**	3.601**
	(1.223)	(1.205)	(0.952)	(0.971)	(2.059)	(2.058)	(1.371)	(1.412)
ROA	−24.841***	−37.243***	−22.791***	−32.783***	−40.482***	−55.735***	−33.888***	−44.446***
	(5.961)	(6.826)	(4.510)	(5.111)	(8.015)	(8.503)	(6.122)	(6.272)
DEP	−5.162***	−6.724***	−3.470***	−4.779***	−5.253**	−8.002***	−3.752***	−5.731***
	(0.977)	(1.075)	(0.808)	(0.844)	(2.013)	(2.163)	(1.382)	(1.396)
VSTOXX	4.993***	4.986***	3.915***	3.847***	7.719***	7.589***	5.681***	5.591***
	(1.128)	(1.202)	(0.937)	(1.013)	(1.779)	(1.905)	(1.600)	(1.688)
CAP	−34.881***		−28.829***		−52.649***		−38.158***	
	(4.735)		(3.723)		(8.410)		(5.964)	
CET1		−2.724		−2.427		−5.752*		−5.876**
		(2.235)		(1.790)		(3.245)		(2.358)
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.395	0.366	0.490	0.461	0.437	0.410	0.557	0.534
No. of banks	60	59	60	59	58	57	60	59
No. of obs	6,510	6,261	6,538	6,289	6,124	5,869	6,377	6,118

Table 10: Effect of asset quality specifications on bank CDS spreads. This table shows the results of the drivers of bank funding costs, as outlined in model 3. For each CDS contract type, we test alternative specifications of asset quality. The left column displays the results on NPL, whereas the right column shows the estimation of the non performing loans coverage ratio (LLP/NPL). All estimations use bank- and year fixed effects to control for unobserved heterogeneity and 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.

	CDS on senior bond				CDS on subordinated bond			
	1 year		5 years		1 year		5 years	
CAP	−34.881***	−35.754***	−28.829***	−29.336***	−52.649***	−52.287***	−38.158***	−37.853***
	(4.735)	(4.325)	(3.723)	(3.420)	(8.410)	(8.084)	(5.964)	(5.713)
SIZE	−10.364	−44.389***	−25.556**	−56.147***	−6.544	−59.436***	−20.120	−62.680***
	(15.148)	(13.222)	(12.024)	(9.332)	(16.555)	(16.356)	(14.008)	(14.564)
LTA	3.914***	3.340***	2.237***	1.651**	4.094**	3.631**	1.954*	1.596*
	(0.853)	(0.946)	(0.686)	(0.771)	(1.702)	(1.446)	(1.076)	(0.963)
DIV	0.200	0.437**	0.190	0.410**	1.316***	1.586***	0.692***	0.894***
	(0.182)	(0.211)	(0.144)	(0.168)	(0.413)	(0.392)	(0.261)	(0.254)
ROA	−24.841***	−32.344***	−22.791***	−29.645***	−40.482***	−48.987***	−33.888***	−40.557***
	(5.961)	(5.724)	(4.510)	(4.553)	(8.015)	(7.833)	(6.122)	(6.197)
DEP	−5.162***	−5.538***	−3.470***	−3.773***	−5.253**	−6.188***	−3.752***	−4.452***
	(0.977)	(0.991)	(0.808)	(0.794)	(2.013)	(1.956)	(1.382)	(1.303)
VSTOXX	4.993***	4.946***	3.915***	3.872***	7.719***	7.625***	5.681***	5.602***
	(1.128)	(1.127)	(0.937)	(0.937)	(1.779)	(1.793)	(1.600)	(1.613)
NPL	3.873***		3.683***		3.859*		3.172**	
	(1.223)		(0.952)		(2.059)		(1.371)	
LLP/NPL		−1.101***		−0.996***		−2.038***		−1.696***
		(0.270)		(0.208)		(0.403)		(0.292)
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.395	0.399	0.490	0.493	0.437	0.448	0.557	0.568
No. of banks	60	60	60	60	58	58	60	60
No. of obs	6,510	6,458	6,538	6,486	6,124	6,072	6,377	6,325

Table 11: Effect of different profitability specifications on bank CDS spreads. This table shows the results of the drivers of bank funding costs, as outlined in model 3. For each CDS contract type, we test alternative profitability. Per bank CDS contract type, we alternatively estimate the coefficent on return over assets (ROA), return on equity (ROA) and the net interest margin (NIM). All estimations use bank- and year fixed effects to control for unobserved heterogeneity and 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.

	CDS on senior bond						CDS on subordinated bond					
	1 year			5 years			1 year			5 years		
CAP	−34.881***	−35.079***	−38.109***	−28.829***	−28.995***	−30.329***	−52.649***	−51.855***	−54.025***	−38.158***	−37.806***	−38.604***
	(4.735)	(4.658)	(5.195)	(3.723)	(3.608)	(3.851)	(8.410)	(8.050)	(8.728)	(5.964)	(5.683)	(6.004)
SIZE	−10.364	−16.258	−4.469	−25.556**	−31.098**	−24.349**	−6.544	−18.253	−5.621	−20.120	−29.149**	−20.072
	(15.148)	(16.643)	(14.429)	(12.024)	(13.384)	(11.220)	(16.555)	(15.726)	(17.493)	(14.008)	(13.398)	(14.781)
LTA	3.914***	3.951***	4.102***	2.237***	2.261***	2.536***	4.094**	4.145**	4.696**	1.954*	1.971*	2.449**
	(0.853)	(0.849)	(0.932)	(0.686)	(0.683)	(0.739)	(1.702)	(1.680)	(1.813)	(1.076)	(1.073)	(1.148)
DIV	0.200	0.194	0.031	0.190	0.183	−0.127	1.316***	1.343***	0.623	0.692***	0.695***	0.108
	(0.182)	(0.186)	(0.214)	(0.144)	(0.146)	(0.164)	(0.413)	(0.412)	(0.431)	(0.261)	(0.260)	(0.278)
NPL	3.873***	3.920***	4.681***	3.683***	3.732***	4.328***	3.859*	3.725*	4.830**	3.172**	3.158**	4.000***
	(1.223)	(1.249)	(1.258)	(0.952)	(0.979)	(0.962)	(2.059)	(2.061)	(2.096)	(1.371)	(1.368)	(1.395)
DEP	−5.162***	−5.263***	−5.376***	−3.470***	−3.552***	−3.445***	−5.253**	−5.395***	−5.009**	−3.752***	−3.828***	−3.527**
	(0.977)	(0.992)	(1.036)	(0.808)	(0.826)	(0.880)	(2.013)	(2.030)	(2.121)	(1.382)	(1.399)	(1.474)
VSTOXX	4.993***	5.020***	5.066***	3.915***	3.939***	3.980***	7.719***	7.754***	7.851***	5.681***	5.712***	5.780***
	(1.128)	(1.136)	(1.161)	(0.937)	(0.943)	(0.965)	(1.779)	(1.789)	(1.838)	(1.600)	(1.606)	(1.646)
ROA	−24.841***			−22.791***			−40.482***			−33.888***		
	(5.961)			(4.510)			(8.015)			(6.122)		
ROE		−1.073***			−0.994***			−2.026***			−1.614***	
		(0.263)			(0.197)			(0.328)			(0.229)	
NIM			0.622			−21.579**			−55.127**			−50.255***
			(10.202)			(8.941)			(22.692)			(14.272)
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.395	0.396	0.390	0.490	0.491	0.485	0.437	0.441	0.434	0.557	0.559	0.554
No. of banks	60	60	60	60	60	60	58	58	58	60	60	60
No. of obs	6,510	6,507	6,438	6,538	6,535	6,466	6,124	6,121	6,052	6,377	6,374	6,305

Table 12: Effect of different bank funding specifications on bank CDS spreads. This table shows the results of the drivers of bank funding costs, as outlined in model 3. For each CDS contract type, we test alternative funding cost specifications. Per bank CDS contract type, we alternatively estimate the coefficent on deposits over liabilities (DEP), senior- and subordinated debt over liabilities (SEN DEBT - SUB DEBT) and interbank funding over liabilities (INTERBANK). All estimations use bank- and year fixed effects to control for unobserved heterogeneity and 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.

	CDS on senior bond								CDS on subordinated bond							
	1 year				5 years				1 year				5 years			
CAP	−34.881***	−40.896***	−42.370***	−37.065***	−28.829***	−33.030***	−33.833***	−29.606***	−52.649***	−58.625***	−60.397***	−53.451***	−38.158***	−42.418***	−42.525***	−38.668***
	(4.735)	(5.264)	(5.120)	(4.424)	(3.723)	(4.082)	(3.980)	(3.398)	(8.410)	(9.460)	(9.388)	(9.173)	(5.964)	(6.376)	(6.314)	(6.032)
SIZE	−10.364	12.165	21.833	25.572*	−25.556**	−8.201	−3.279	−2.443	−6.544	27.281	20.667	31.381	−20.120	1.902	7.067	5.803
	(15.148)	(17.231)	(14.840)	(14.890)	(12.024)	(13.420)	(10.823)	(11.026)	(16.555)	(24.405)	(29.040)	(29.653)	(14.008)	(17.411)	(22.390)	(23.231)
LTA	3.914***	2.747***	2.940***	2.182***	2.237***	1.457**	1.553***	0.923	4.094**	3.101**	3.225**	2.389	1.954*	1.220	1.290	0.719
	(0.853)	(0.745)	(0.761)	(0.794)	(0.686)	(0.570)	(0.588)	(0.643)	(1.702)	(1.434)	(1.551)	(1.641)	(1.076)	(0.822)	(0.894)	(0.960)
DIV	0.200	0.316*	0.380*	0.253	0.190	0.275*	0.309**	0.216	1.316***	1.364***	1.425***	1.220***	0.692***	0.715***	0.714***	0.640**
	(0.182)	(0.186)	(0.198)	(0.189)	(0.144)	(0.142)	(0.146)	(0.145)	(0.413)	(0.401)	(0.412)	(0.395)	(0.261)	(0.245)	(0.249)	(0.254)
NPL	3.873***	3.569***	3.085**	2.780**	3.683***	3.412***	3.160***	2.853***	3.859*	3.306	2.959	2.849	3.172**	2.821**	2.729**	2.426*
	(1.223)	(1.181)	(1.204)	(1.165)	(0.952)	(0.907)	(0.944)	(0.909)	(2.059)	(1.998)	(1.926)	(1.987)	(1.371)	(1.308)	(1.312)	(1.338)
ROA	−24.841***	−25.951***	−27.323***	−26.155***	−22.791***	−23.660***	−24.371***	−23.720***	−40.482***	−42.073***	−43.545***	−41.350***	−33.888***	−35.023***	−35.214***	−34.644***
	(5.961)	(6.324)	(6.422)	(6.341)	(4.510)	(4.833)	(4.832)	(4.688)	(8.015)	(8.393)	(8.228)	(8.141)	(6.122)	(6.474)	(6.355)	(6.140)
VSTOXX	4.993***	5.022***	4.963***	4.959***	3.915***	3.928***	3.897***	3.890***	7.719***	7.717***	7.668***	7.693***	5.681***	5.680***	5.667***	5.658***
	(1.128)	(1.111)	(1.108)	(1.118)	(0.937)	(0.925)	(0.924)	(0.933)	(1.779)	(1.768)	(1.755)	(1.763)	(1.600)	(1.596)	(1.592)	(1.593)
DEP	−5.162***				−3.470***				−5.253**				−3.752***			
	(0.977)				(0.808)				(2.013)				(1.382)			
SEN DEBT		2.361***				1.213*				0.802				0.689		
		(0.870)				(0.714)				(1.568)				(1.147)		
SUB DEBT			−12.557				−6.646				−20.618**				−0.245	
			(7.835)				(5.485)				(8.398)				(3.997)	
INTERBANK				4.060***				3.432***				4.441***				3.334***
				(1.081)				(0.836)				(1.647)				(1.097)
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.395	0.380	0.378	0.387	0.490	0.479	0.478	0.489	0.437	0.430	0.432	0.435	0.557	0.551	0.551	0.555
No. of banks	60	60	60	60	60	60	60	60	58	58	58	58	60	60	60	60
No. of obs	6,510	6,473	6,470	6,510	6,538	6,501	6,498	6,538	6,124	6,087	6,084	6,124	6,377	6,340	6,337	6,377

Table 13: Effect of the monetary policy shock on sovereign CDS spreads (daily frequency). This table shows the coefficient estimates from OLS regressions relating the interaction of the monetary policy shock and a country dummy variable to sovereign credit risk, as presented in equation 6. All estimations use country- and year fixed effects to control for unobserved heterogeneity and common macroeconomic shocks. Standard errors in parentheses are clustered at the country level. *, ** and *** represent significance a the 10%, 5% and 1% percent level, respectively.

Dependent Variable:	ΔCDS^{SOV}
ΔMPS $\times$ Interaction Term:	
AUSTRIA	−1.969***
	(0.214)
BELGIUM	−2.889***
	(0.214)
FRANCE	−1.631***
	(0.214)
GERMANY	−0.925***
	(0.215)
IRELAND	−5.450***
	(0.214)
ITALY	−6.402***
	(0.215)
NETHERLANDS	−1.130***
	(0.215)
PORTUGAL	−9.115***
	(0.214)
SPAIN	−6.242***
	(0.214)
Country fixed effects	Yes
Year fixed effects	Yes
R^2	0.160
No. of Sovereigns	9
No. of obs	24,339

Table 14: Direct and indirect effect of the monetary policy shock on bank CDS spreads (daily frequency). For each bank CDS contract type, this table shows the results of the effect of the monetary policy shock and sovereign credit risk on bank credit risk. In the first column (1) the table shows the results of the monetary policy shock and changes in sovereign credit risk, column (2) shows the monetary policy shock and autunomous changes in sovereign credit risk and column (3) shows monetary policy induced changes in sovereign credit risk and autonomous changes in sovereign credit risk. All estimations use bank- and year fixed effects to control for unobserved heterogeneity and common macroeconomic shocks. Bank control variables capturing the business model and the profitability of the bank are included as well. Standard errors in parentheses are clustered at the country level. *, ** and *** represent significance a the 10%, 5% and 1% percent level, respectively.

	Δ CDS on senior bond						Δ CDS on subordinated bond					
	1 year			5 years			1 year			5 years		
ΔMPS	-1.701^{***}	-3.206^{***}		-1.699^{***}	-3.079^{***}		-2.791^{***}	-5.153^{***}		-2.681^{***}	-4.724^{***}	
	(0.129)	(0.264)		(0.122)	(0.232)		(0.243)	(0.419)		(0.222)	(0.350)	
ΔCDS^{SOV}	0.465^{***}			0.428^{***}			0.701^{***}			0.624^{***}		
	(0.040)			(0.036)			(0.065)			(0.056)		
$\widehat{\mu_{c,t}}$		0.283^{***}	0.281^{***}		0.257^{***}	0.256^{***}		0.463^{***}	0.462^{***}		0.385^{***}	0.384^{***}
		(0.033)	(0.034)		(0.029)	(0.030)		(0.049)	(0.051)		(0.049)	(0.050)
$\Delta \widehat{CDS}^{Sov}$			0.610^{***}			0.553^{***}			0.924^{***}			0.832^{***}
			(0.059)			(0.054)			(0.085)			(0.073)
Bank control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.141	0.129	0.134	0.238	0.217	0.218	0.099	0.094	0.095	0.180	0.164	0.163
No. of banks	49	49	49	49	49	49	47	47	47	49	49	49
No. of obs	111,541	111,541	111,541	113,769	113,769	113,769	100,954	100,954	100,954	108,103	108,103	108,103