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ORIGINAL RESEARCH

Non-standard monetary policy measures and bank systemic risk in the Eurozone

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Abstract

Modern central banking offers policymakers innovative tools to safeguard price stability and the normal functioning of the financial system. However, the unintended impact of the implementation of non-standard monetary policy measures, especially on systemic risk, remains underexplored from a microeconomic point of view. This study investigates the effect of non-standard monetary policy measures on systemic risk of listed financial institutions in the Euro area. Our results show the presence of the systemic risk-taking channel of monetary policy, whereby systemic risk increases following further enforcement of non-standard monetary policy measures, with the effect being stronger for smaller and under-capitalised banks. The results are robust to various alternative measures of bank systemic risk and non-standard monetary policy. Our findings bear critical policy implications for financial stability.

Keywords Non-standard monetary policy measures · Bank systemic risk · Risk-taking channel · Eurozone · ECB

JEL Classification G21 · E52 · E58

1 Introduction

In the era of modern central banking, non-standard monetary policy measures (NSMP) have proved to be a significant tool in reversing economic downturns and ensuring the sound operation of the financial system. Although mostly implemented in advanced economies such as the US, the UK, the EU, and Japan, they are customised to accommodate different institutional settings. Their effectiveness in boosting aggregate demand and economic activity, improving liquidity, and reducing funding risk has been well documented

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in the literature (Giannone et al. 2012; Gambacorta et al. 2014; Darracq-Paries and De Santis 2015; Eser and Schwaab 2016; Bernhard and Ebner 2017; Michaelis and Watzka 2017; Cohen 2022).

Nevertheless, there exists a side effect of NSMP to the extent that they could jeopardise financial stability through asset bubbles, excessive credit growth, bank profitability, and the bank risk-taking channel (Gambacorta 2009; Borio and Zhu 2012; Altunbas et al. 2014; Constâncio 2017; Draghi 2017a, 2017b). Indeed, NSMP, with the implication of ample liquidity provision and government safety net, can induce banks to soften their lending attitude, alter their risk perception, and motivate risk-taking activities. NSMP resorting through asset purchase programmes in particular can have a direct impact on the riskiness of certain assets, as well as on how financial institutions address the risk, as they are often direct participants in these programmes, transmitting the impact of monetary policy to economic activities. As banks and non-bank financial institutions have become more complex in their roles and increasingly interlinked with other financial market participants, their financial distress can pronouncedly drive other sectors to abrupt disruption. Given the growing number of systemically important financial institutions and the too-interconnected-to-fail financial network, predicting and preventing the build-up of systemic risk has been one of the imperative policy tasks. Therefore, how their systemic risk alters as a result of NSMP implementation deserves empirical research attention.

Several studies have looked at the linkage between NSMP and bank risk-taking, where risk could be represented by credit risk, a bank stability measure (Z-score), or distance-to-default (Lambert and Ueda 2014; Mamatzakis et al. 2016; Mamatzakis and Vu 2018; Brana et al. 2019). Nevertheless, research conducted with systemic risk being the centred focus remains largely underexplored in this stream of literature. Among such few studies are those of Vu (2019), Bubeck et al. (2020), Kabundi and De Simone (2020), Faia and Karau (2021), Kabundi and De Simone (2022), and Iwanicz-Drozdowska and Rogowicz (2022). Past studies usually observe systemic risk and NSMP from a macroeconomic point of view. For instance, Kabundi and De Simone (2020) and Kabundi and De Simone (2022) use macro-financial time series data of the largest banks in the Euro area to detect systemic risk-taking behaviour, employing the structural factor-augmented vector autoregressive model. With microdata from the banking sector, there is limited empirical evidence. Specifically, Vu (2019) studies bank-level systemic risk of Japanese banks. A section of Fiordelisi et al. (2014) examines the effect of monetary announcements, including of NSMP, on stock prices rather than direct measures of systemic risk, of global systemically important financial institutions, using an event study approach. Faia and Karau (2021) focus on global systemically important banks and their securities holding as well as syndicated lending. On the other hand, Bubeck et al. (2020) and Iwanicz-Drozdowska and Rogowicz (2022) strategically look at negative interest rates.

Our study contributes to the scant literature on unconventional monetary policy and bank systemic risk as follows. First, we provide empirical evidence from a microeconomic perspective, employing bank-level data. We obtain a sample of listed financial institutions in the Eurozone over the period between 2008 and 2020 and investigate whether NSMP generate a desirable or detrimental impact on their systemic risk using the panel IV-GMM regression model (Baum et al. 2007). While past studies usually examine systemically important financial institutions (SIFIs) or the largest banks in a country or particular market(s), we believe it is crucial to include all listed[1] banks and other financial institutions when investigating systemic risk. The reason is that increased interconnectedness has made the financial services industry more vulnerable to negative externalities and exposed to dire consequences arising from the collapse of other incumbents. The fact that US regulators had to intervene and guarantee all deposits of Silicon Valley Bank and Signature Bank in March 2023 to contain the mini-banking crisis highlights that all bank failures have a potential systemic impact. Too-big-to-fail is no longer exclusive to mega banks. Second, we attempt to comprehensively address the effect of NSMP by providing abundant evidence using various metrics of bank systemic risk and NSMP. For systemic risk of individual banks/financial institutions, we estimate SRISK (Brownlees and Engle 2017), ΔCoVaR (Adrian and Brunnermeier 2016), and the Marginal Expected Shortfall (MES) (Acharya et al. 2017). In terms of NSMP, we employ several proxies to explore the sensitivity of different measures and to ensure the robustness of our results. In particular, we use the amount of assets purchased, the yield of the 10-year synthetic sovereign bonds of Euro area countries, the shadow rate for the Eurozone of Wu and Xia (2016), and a synthetic standardised monetary condition index (Kucharčuková et al. 2016; Lombardi and Zhu 2018; Sleibi et al. 2023). We further consider bank characteristics as potential determinants of systemic risk. Finally, we account for endogeneity concerns arising from different potential sources and produce results for a sub-sample of commercial banks, bank holding companies, co-operative banks, and savings banks. These banks are directly affected by monetary policies, hence, it is important that the impact of NSMP is also separately examined on them, such that policy implications are obtained based on conclusive evidence.

Our main results show that at the microeconomic level, expansionary NSMP can put financial stability at risk. When bank characteristics are taken into consideration, NSMP interact significantly with bank size and capital, affecting the systemic risk of smaller and undercapitalised banks more pronouncedly. The main results also hold in the sub-sample. Overall, there is consistent evidence for the presence of the systemic risk-taking channel during the sustained period of NSMP in the Eurozone. Our study, therefore, offers contemporary empirical evidence with respect to the connections between NSMP and systemic risk. Our results unfold the vulnerabilities of the banking system and call for enhanced monitoring of bank systemic risk by policymakers upon implementation of NSMP.

The remainder of this study is as follows. An overview of NSMP and their implementation is presented in Sect. 2. Section 3 reviews the theoretical framework and related empirical studies. Section 4 discusses the data and methodology. Results are discussed in Sect. 5. Section 6 concludes.

2 NSMP in the Eurozone

The context of the Economic and Monetary Union gives the European Central Bank (ECB) a critical role in maintaining price stability and safeguarding financial stability. As there is a limit of how low interest rates can go, the flexibility for central banks to manoeuvre the economy is also limited. As a result, the ECB has developed a toolbox of NSMP to help steer inflation and maintain price stability. These new tools include negative interest rates,

[1] Non-listed banks and financial institutions are excluded because of the lack of stock price data to estimate systemic risk measures.

forward guidance, asset purchases, and Targeted Longer-Term Refinancing Operations (TLTROs). In the Eurozone, NSMP were initiated in 2008 as a response of the ECB to the global financial crisis. Different programmes, e.g. TLTROs, Securities Market Programme (SMP), and Asset Purchase Programmes (APPs), were implemented between 2008 and 2018. In mid-2014, APPs became part of an NSMP package that included TLTROs. There were four programmes of APPs: (1) the Corporate Sector Purchase Programme (CSPP); (2) the Public Sector Purchase Programme (PSPP); (3) the Asset-Backed Securities Purchase Programme (ABSPP); and (4) the 3rd Covered Bond Purchase Programme (CBPP3). Net purchases under the APPs were restarted in November 2019 and discontinued in July 2022. In light of the Coronavirus disease 2019 (COVID-19) outbreak, the Pandemic Emergency Purchase Programme (PEPP) was in effect between March 2020 and March 2022, aiming to counteract the serious risks caused by the pandemic to the monetary transmission mechanism and to improve the outlook of the Euro area. ECB's PEPP holdings in October 2022 were over 1,683 billion EUR. Overall, the ECB's holding of asset purchases has increased significantly from less than 4.8 billion EUR in October 2014 to over 3,025 billion EUR in December 2023. Nonetheless, over the course of these asset purchase programmes, the ECB's Governing Council has acknowledged the latent risk of financial instability (Constâncio 2017; Draghi 2017a, 2017b).

3 Systemic risk-taking under NSMP

In this section, we review the literature on the possible transmission channels through which monetary policy can influence bank risk in general and systemic risk in particular. We first present the theoretical framework, followed by a review of the empirical studies that are related to ours. Overall, past studies mainly explore the effect of conventional monetary policy tools through interest rates on bank credit risk and bank stability. Only a limited number of them focus on bank systemic risk. Yet, the studies discussed in this section are relevant to the research topic, showing the mechanisms by which various impacts can be explained.

3.1 Underlying theories of the systemic risk-taking channel

As documented in Benoit et al. (2017), systemic risk-taking illustrates that banks (1) invest in the same assets (correlated investments); (2) over-invest in illiquid assets while their liabilities can be too liquid (liquidity risk); (3) are exposed to large risk (tail risk); and (4) tend to increase their risk in a procyclical manner. In their review, Benoit et al. (2017) show that there are two strands of the literature on the vulnerability of the banking system. The first one explores the underlying sources of systemic risk (Acharya 2009; Acharya and Merrouche 2012), while the second one derives global systemic risk measures, e.g. SRISK and ΔCoVaR (Acharya et al. 2017; Brownlees and Engle 2017).[2] As large, contemporary financial institutions have become increasingly complex and interconnected, their behaviour could significantly contribute to the systemic risk of the overall banking system and financial sector, the vulnerability of which may quickly spread to other economic sectors and damage their functioning.

[2] See Benoit et al. (2017) for a comprehensive list of papers on each source and measure.

Most of the existing studies on bank risk-taking and NSMP are developed on the literature of accommodative monetary policy stance. Our hypotheses are therefore built upon the theoretical foundation of the risk-taking channel of monetary policy, the too-low-for-too-long interest rate environment, and the different transmission mechanisms of expansionary monetary policy (see Maddaloni and Peydró (2011), Krishnamurthy and Vissing-Jorgensen (2011), Colletaz et al. (2018), and Mamatzakis and Vu (2018) for related literature in this stream). Colletaz et al. (2018) also incorporate these theories when investigating the existence of the systemic risk-taking channel of conventional monetary policy from a macroeconomic perspective.

In a low interest rate environment, lending policies tend to be softened to facilitate the impact of the expansionary monetary regime. NSMP usually come into effect when low interest rates are ineffective in stimulating demand and the macroeconomy. Policymakers, nevertheless, are aware of the unwanted side-effects of overly easy monetary policy. A number of keynote speeches delivered by the ECB's Governing Council addressed the risks that NSMP could pose to the financial system and economy (Constâncio 2017; Draghi 2017a, 2017b). Such risks include those related to asset bubbles, bank lending, excessive credit growth, and bank profitability. The transmission mechanisms of expansionary monetary policy which can explain its negative relationship with risk are detailed below.

The first transmission mechanism is the signalling channel, the portfolio effects, and the *search for yield* (Rajan 2005; De Nicolò et al. 2010; Nucera et al. 2017; Paligorova and Santos 2017; Pagliari 2024). If a central bank targets long-term government bonds in its asset purchase programmes, yields on safe assets will be lowered. Investors could be more inclined to rebalance their portfolio from safe assets to riskier assets in an attempt to reap greater returns from their higher yields. It is worth noting that when the demand for risky assets increases, their yields will subsequently decrease. Similar intuition applies to financial institutions with long-term liabilities. The low interest rates make safe assets less attractive as banks may not be able to produce their agreed rates on liabilities by investing in those assets, pushing them to divert their funds into riskier ones. Profitability pressure, especially in the prevalence of negative policy rates, could push banks with low net interest margins to stretch their risk tolerance (Stein 2013). Banks are no longer able to enjoy the great returns associated with higher interest rates. Hence, it could be tempting for bank managers, especially those with large remuneration packages, to take on increased risks to compensate for the forgone profits. This is linked with the bank risk-taking channel, as in the following discussion.

Low interest rates further lead to asset price appreciation. According to the risk-taking channel, another mechanism of monetary policy transmission (Gambacorta 2009; Stein 2013; Altunbas et al. 2014; Buch et al. 2014; Paligorova and Santos 2017), as interest rates decrease and asset prices increase, banks could free up some risk allowances and underestimate the riskiness of assets. Another way of viewing this is through the leverage channel (Adrian and Shin 2009). When NSMP are in place, we could conjecture similar institutional settings of low price volatility, higher market value of equity (or equivalently, lower financial leverage) and lower risk of holding assets (Steeley 2017). This could lead a certain number of banks to enter into high-risk transactions. The fall in leverage could also result in banks increasing their demand for assets, subsequently boosting asset values further. As the banking system could become more vulnerable to negative externalities, inflated asset prices could plant the seed for a financial crisis (Reinhart and Rogoff 2009). The ample liquidity provided by the central banks and the facilitating economic environment could also create an insurance effect (Altunbas et al. 2014), whereby bankers predict that additional measures will be in place to stop asset prices from falling further during economic downturns. These factors may mask the latent threats to bank soundness and alter bank risk perception. Past instances of bailouts could also give rise to banks' perception of implicit guarantees from the government, leading to issues of moral hazard.

Bank risk-shifting behaviour is also attributed to more risk tolerance. Banks could have the incentive to soften their credit policies in response to the government's additional monetary stimulus (Neuenkirch and Nöckel 2018) through monetary easing. As explained in Maddaloni and Peydró (2011), the existence of the *principal-agent* problem characterised by an implicit government safety net and liquidity injection from bailouts gives rise to greater bank risk-taking. When it is foreseen that ample liquidity is provided by the central bank (e.g. through NSMP), banks will likely relax their lending attitude, becoming less cautious in screening prospective borrowers in this accommodative environment. This in turn weakens bank balance sheets (Dell'Ariccia and Marquez 2006; Chodorow-Reich 2014). Indeed, findings from Maddaloni and Peydró (2011) indicate that banks in Europe and the US report an easing in credit policies in response to low short-term interest rates. Similarly, Filardo and Siklos (2020) find that credit standards are lower following NSMP in the US and the Eurozone. Perdichizzi et al. (2023) report that distressed borrowers received more investments in the form of capital expenditure following TLTROs, but their performance did not improve.

Nevertheless, banks expand their lending to riskier loan applicants not only because of their risk-shifting behaviour. Higher asset prices also mean greater collateral values, and subsequently higher loan-to-value ratios for new loans. Ultimately, the volume and the average riskiness of issued loans increase (Borio and Zhu 2012; Jiménez et al. 2014; Ioannidou et al. 2015; Bonfim and Soares 2018).

Based on these economic mechanisms, which are also mentioned in Colletaz et al. (2018) as the conduits of systemic risk-taking, our main hypothesis is:

H_0: The implementation of NSMP is associated with greater bank systemic risk.

Yet, it is important to acknowledge the benefits that NSMP can bring to the economy. For example, one of the main purposes of quantitative easing is to encourage socially desirable risk-taking so that bank lending can increase (Lucas and Vissing-Jorgensen 2014; Claeys and Darvas 2015; Sleibi et al. 2023). The accommodative environment generates higher income for households, businesses, and other economic agents, which in turn contributes to lowering their likelihood of default. Thereby, if NSMP are effective in stimulating the economy, we can expect lower default risk of corporations, borrowers, and financial institutions (Krishnamurthy and Vissing-Jorgensen 2011; Chodorow-Reich 2014; Soenen and Vander Vennet 2022). Thus, bank profitability is fostered, and financial stability is ensured. Another point worth noting is that the ECB also purchases risky assets. This implies, as explained by the signalling channel, that yields of risky assets are also expected to decline as the purchase programmes reduce their risk premium. If NSMP are able to spur economic activity and the economy can recover, the default risk of firms will fall, and so will that of banks. Therefore, the alternative hypothesis is:

H_a: The implementation of NSMP is associated with lower bank systemic risk.

3.1.1 Related empirical studies

Overall, existing empirical studies on systemic risk have been conducted mainly from a macroeconomic point of view. Extant empirical evidence at a microeconomic level is limited when it comes to bank-level systemic risk. Our study differs from past studies as we directly observe the impact of NSMP on individual bank systemic risk, and thus extends the literature by providing microeconomic empirical evidence for banks in the Eurozone. The studies that are loosely related to ours are those of Vu (2019), Kabundi and De Simone (2020), Bubeck et al. (2020), Faia and Karau (2021), Kabundi and De Simone (2022), and Iwanicz-Drozdowska and Rogowicz (2022). In more detail, using macro-financial time series data for the Euro area and the structural factor-augmented vector autoregressive model, Kabundi and De Simone (2020) find evidence of systemic risk-taking at the European monetary union by assessing the impact of shocks in conventional and unconventional monetary policies. In a similar vein, Kabundi and De Simone (2022) further detect indications of bank risk-taking behaviour as a result of monetary policy shocks. They employ a large macro-financial database which includes financial stability indicators of the 30 largest Euro area banking groups. Bank stability is characterised by expected profitability, lending standards, and correlation between banks' asset return and market return.

Regarding studies that employ bank-level data, Vu (2019) partly examines how systemic risk is affected by quantitative easing in Japan. Based on an instrumental-variables regression, the study finds that more aggressive quantitative easing is associated with lower bank systemic risk for Japanese banks. Using ΔCoVaR and the LRMES in a vector autoregression framework, Faia and Karau (2021) document that monetary tightening lowers the systemic risk of 29 global systemically important banks from seven countries. They employ the policy rate (money market rates) and the shadow rate to identify monetary policy shocks.

In a slightly different strand, using SRISK and ΔCoVaR as measures of systemic risk like in our study, but from the negative interest rate angle and employing a panel vector autoregression (pVAR) model, Iwanicz-Drozdowska and Rogowicz (2022) find that negative interest rate policy contributes more to systemic risk than positive nominal rates do in advanced economies. Bubeck et al. (2020) also evidence that, in response to negative interest rates, systemic banks in the Eurozone *reach for yield* via securities holdings. This study concentrates on the largest Euro area banking groups but employs securities holdings and syndicated lending as indicators for bank risk-taking.

All in all, the aforementioned studies either observe systemic risk from a macroeconomic perspective or use other proxies of systemic risk rather than SRISK, ΔCoVaR, or the MES. Moreover, a few focus on negative interest rates instead of asset purchases, long-term government bonds' yields or the shadow rate. Those that employ bank-level data aim at the largest banks in a market or global systemically important financial institutions (G-SIFIs). In our study, we provide empirical evidence at a microeconomic level, for listed financial institutions in the Euro area, and offer robust findings using alternative measures of both systemic risk and NSMP. Alongside SIFIs, it is necessary and of interest to include all other listed financial institutions in a market, where possible, when examining systemic risk. The reason is that banks and other financial institutions are increasingly intertwined in the era of modern banking, alternative finance, FinTech, and artificial intelligence. Systemic risk can also be present in non-SIFIs, such that to avoid a systemic crisis, maximise the effectiveness of monetary policies, and at the same time minimise the detrimental impact of their unintended consequences, all listed financial institutions should be considered. Sub-sample analyses are also conducted to reinforce the conclusions, especially the policy implications, drawn from our main results.

4 Data and methodology

Our main sources of data are the ECB Statistical Data Warehouse, Refinitiv, Datastream, and Orbis Bank Focus. We include all listed banks and financial institutions in the Eurozone between 2008 and 2020 in our analysis. We also identify SIFIs in our sample based on the information available on the European Systemic Risk Board's website. Table A1 (Appendix 1) reports the number of banks/financial institutions or SIFIs per category, while Table B1 (Appendix 2) displays this number per country.

4.1 NSMP

We use different variables to capture NSMP to ensure the robustness of our results. We construct the first proxy for NSMP, which is AP, by taking the natural logarithm of the sum of the total amount of asset purchases for the whole Eurosystem and the Longer-Term Refinancing Operation (LTROs), similar to Bluwstein and Canova (2016). Taking the total amount of quantitative easing or asset purchases to represent NSMP has been widely used in this stream of the literature (see, e.g., Jäger and Grigoriadis (2017), Lewis and Roth (2019) and Cenedese and Elard (2021), among others). The data are reported under the "Securities Held for Monetary Policy Purposes" and the LTROs in the ECB's balance sheets.

The second proxy is the yield of the 10-year synthetic sovereign bonds of Euro area countries extracted from Refinitiv/Datastream.[3] As explained in sub-Sect. 3.1, the signalling channel can capture the impact of NSMP on lowering the yield of safe assets. Jäger and Grigoriadis (2017) show that ECB's NSMP reduce the 10-year sovereign bond yield spreads of Eurozone countries. This is in line with Bowman et al. (2015)'s results of Fed's unconventional monetary policy reducing US sovereign bond yields.

The third proxy is the shadow rate for the Eurozone of Wu and Xia (2016)[4] (Sleibi et al. 2023). The shadow rate is an approximation of the conventional and unconventional monetary policy tools, can be negative, and tractable (Wu and Xia 2016; Wu and Zhang 2019). As described in Rossi (2021), it is *"the level of the short-term rate implied by a statistical model of the term structure with a zero lower bound"*. When the short-term interest rate is above zero, the shadow rate equals the short-term rate. When NSMP are in effect, the shadow rate takes negative values. Negative interest rates in the Eurozone are therefore accounted for in the shadow rate.

The final proxy is a synthetic standardised monetary condition index (SMCI), computed using a number of monetary and ECB's balance sheet data in a manner similar to Kucharčuková et al. (2016) and Lombardi and Zhu (2018). For the SMCI, there are 14 variables taken into account to generate factor loadings using the principal factor analysis, accounting for both standard and non-standard monetary measures. As detailed in Table 1, we use interest rates, money supply, selected assets and liabilities in the ECB balance sheet, and exchange rates as in Kucharčuková et al. (2016). Data on these variables are sourced from Refinitiv and Datastream.

[3] Euro area yields are calculated on the basis of harmonised national government bond yields weighted by the nominal outstanding amounts of government bonds in the maturity band.

[4] Available at https://sites.google.com/view/jingcynthiawu/shadow-rates.

Table 1 Variables used to obtain the SMCI

Variable groups	Variables	Data used
Interest rates	Main refinancing operation rate 3-month EURIBOR. 1-year EURIBOR. 10-year yields on synthetic sovereign bonds of euro area countries. Overnight index swap	As is
Money supply	M1, M2, M3	Year-on-year change multiplied by (– 1)
ECB Assets	Total assets. Securities held for monetary policy purposes. Long-term refinancing operations	Year-on-year change multiplied by (– 1)
ECB Liabilities	Currency in circulation. Liabilities of ECB to Euro area MFIs related to monetary operations	Year-on-year change multiplied by (– 1)
Exchange rates	Nominal exchange rate USD/EUR	Year-on-year change

This Table lists the variables and data used to construct the synthetic monetary condition index (SMCI). MFI: Monetary Financial Institutions. The data are in monthly frequency

Table 2 Factor loadings for the three factors retained

Variables	Factor 1	Factor 2	Factor 3	Uniqueness
Main refinancing operation rate	0.6947	0.6678	−0.1171	0.0214
3-month EURIBOR	0.7276	0.6827	−0.0032	-0.0016
1-year EURIBOR	0.7122	0.6816	−0.0077	0.0036
Synthetic Bond yield	−0.056	0.0646	0.1220	0.8636
Overnight index swap	0.7105	0.6822	0.0138	0.0123
Money supply M1	0.7861	−0.4787	0.2831	0.0250
Money supply M2	0.7628	−0.5554	0.3230	-0.0011
Money supply M3	0.7847	−0.4885	0.3620	-0.0022
ECB Total Assets	−0.3292	0.3263	0.8205	0.0789
Securities held for monetary policy purposes	−0.2183	0.0224	-0.0925	0.6155
Long-term refinancing operations	−0.2628	0.1789	0.8239	0.1497
Currency in circulation	−0.5053	0.0076	0.2639	0.1802
Liabilities of ECB to Euro area MFIs	−0.3212	0.3978	0.7111	0.1394
Nominal exchange rate USD/EUR	−0.7281	0.6222	-0.2216	0.0115

Factor	Eigenvalue	Proportion	Cumulative	Weight
Factor 1	4.95665	0.4204	0.4204	0.4679
Factor 2	3.30696	0.2805	0.7008	0.3122
Factor 3	2.32934	0.1976	0.8984	0.2199

This Table reports the factor loadings for the three (unrotated) factors retained from the principal factor analysis used to construct the synthetic monetary condition index (SMCI). SMCI is the weighted average of the three standardised factors, with the weights being the percentage of the overall data variability explained by each factor

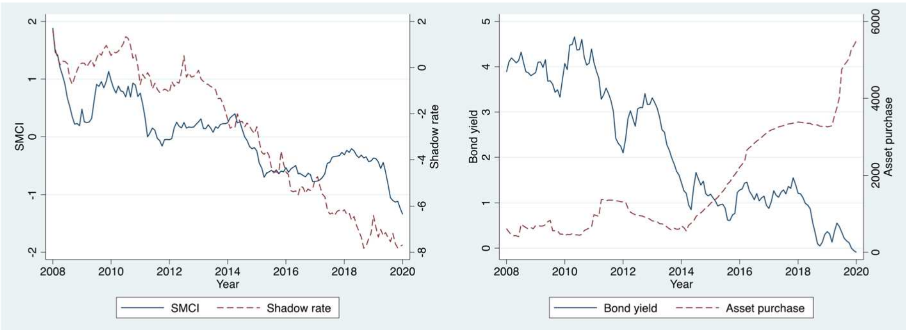

Fig. 1 Time plots of non-standard monetary policy measures. This Figure plots the monthly average shadow rate, the synthetic monetary condition index (SMCI), the yield of the 10-year synthetic sovereign bonds of Euro area countries, and the amount of asset purchases (bn EUR) over time.

An increase (a decrease) in interest rate variables denotes a tightening (an easing) monetary policy. Therefore, the year-on-year values of monetary aggregates and ECB assets and liabilities are multiplied by (-1) to reflect the same indication of monetary tightening and easing as in interest rates. The variables are standardised to obtain the SMCI via the principal factor analysis, thus retaining the consistency of monetary policy interpretation.

Based on the Kaiser eigenvalues, three (unrotated) factor loadings are retained to estimate the SMCI, as detailed in Table 2. The SMCI is thus calculated as the weighted average of the three retained factor loadings, with the weights being the percentage of the overall data variability explained by each factor. We employ the SMCI in our regression (Eq. 7) in a manner similar to the 10-year synthetic sovereign bond yield and the shadow rate.

Figure 1 plots the four proxies over time. The left-hand-side graph reveals that the SMCI and the shadow rate exhibited a similar trend before 2014, which remained decreasing overall until the end of the observed period. The SMCI, hence, could be regarded as an approximation of the shadow rate as it mostly follows the shadow rate over time. It can be conjectured that the SMCI mainly reflects the interest rate attribution of the monetary variables. The right-hand-side graph indicates that the logarithmic asset purchases generally increased over the course of more than a decade, particularly since 2015, in line with the low interest rate policy. The 10-year synthetic bond yield mirrors the trend of the logarithmic asset purchases. When there is monetary easing through increases in assets purchased, the bond yield is lower.

4.2 Systemic risk measures

In order to estimate systemic risk measures, we obtain data on returns, market returns, market value of equity, and total liabilities from Refinitiv. In our study, we employ three measures of systemic risk, namely SRISK, ΔCoVaR, and the MES, as detailed below.

4.2.1 SRISK

The first systemic risk measure that we use is SRISK, which has been a popular choice to represent systemic risk in the contemporary banking literature (Engle et al. 2015; Benoit et al. 2017; Buch et al. 2019; Iqbal and Vähämaa 2019; Jouida 2019; Jasova et al. 2024). SRISK is calculated at an individual level as the expected capital shortfall of a financial firm in a future systemic crisis. Therefore, it is technically of forward-looking nature, similar to the stress tests applied to financial firms by regulators.

We estimate SRISK based on Brownlees and Engle (2017)'s theoretical model. In summary, SRISK is derived from two steps. First, the Long-run Marginal Expected Shortfall (LRMES) is determined by "the expected fractional loss of the firm equity in a crisis when the aggregate market declines significantly in a six-month period".[5] Specifically, the LRMES is calculated as $1 - \exp(\log(1 - d)\beta)$, where d is the six-month crisis threshold for the market index decline with its default value being 40%, and β is the firm's beta coefficient. Then, the current market value of equity and outstanding measures of debt are incorporated to determine the expected capital shortfall in the event of a crisis. Hence, SRISK is formulated as follows:

$$SRISK = k \bullet DEBT - (1 - k) \bullet EQUITY \bullet (1 - LRMES) \tag{1}$$

where the capital requirement k equals 8%, $DEBT$ is the book value of debt (i.e., the book value of assets minus the book value of equity), and EQUITY is the current market value of equity of the firm. As we have a variety of bank types and sizes in our samples, to mitigate skewness and scaling issues of SRISK, we use the natural logarithm of SRISK, as in

[5] For the full definition, please refer to https://vlab.stern.nyu.edu/docs/srisk.

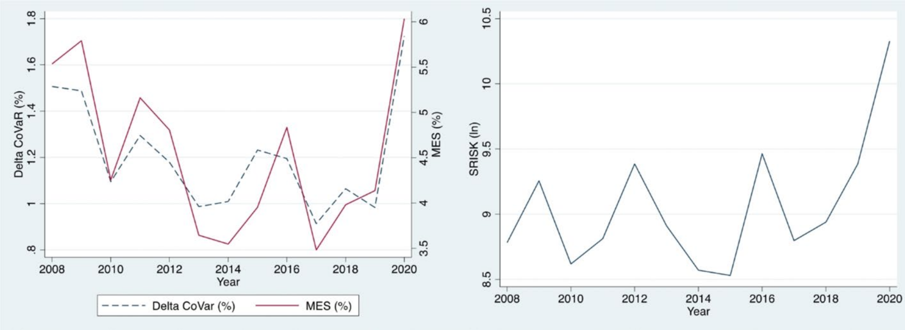

Fig. 2 Time plots of systemic risk measures. This Figure plots the yearly average SRISK(ln) (right diagram), Delta CoVaR (%), and the MES (%) of all banks/financial institutions in the sample.

Leroy and Lucotte (2017), Lin et al. (2018), Faia et al. (2019), Iqbal and Vähämaa (2019), and Adasi Manu and Qi (2023).

4.2.2 ΔCoVaR

The second measure of systemic risk employed in our study is ΔCoVaR. CoVaR captures the cross-sectional tail dependency between the whole financial system and a particular institution. It corresponds to the Value at Risk (VaR)[6] of financial system j conditional on some event $\mathbb{C}(X^i)$ observed for firm i, where X^i is the return loss of firm i for which the VaR is defined. Thus, $CoVaR_q^{j|i}$ is defined by:

$$\Pr\left(X^j \leq CoVaR_q^{j|\mathbb{C}(X^i)} | \mathbb{C}(X^i)\right) = q \tag{2}$$

Then, ΔCoVaR is defined as "the change in the value at risk of the financial system conditional on an institution being under distress relative to its median state" (Adrian and Brunnermeier 2016). Therefore, ΔCoVaR of firm i, or financial system j's systemic risk attributed to firm i, is:

$$\Delta CoVaR_q^{j|i} = CoVaR_q^{j|X^i=VaR_q^i} - CoVaR_q^{j|X^i=VaR_{50}^i} \tag{3}$$

4.2.3 MES

In our study, we further use the MES as an alternative measure of systemic risk. The MES is the marginal contribution of firm i to systemic risk, as measured by the expected shortfall (ES) of the financial system (Acharya et al. 2017). The ES at the confidence level $\alpha\%$ is the worst $\alpha\%$ of the scenarios. The conditional ES of the system with a threshold C is:

$$ES_{mt}(C) = \mathbb{E}_{t-1}\left(r_{mt} | r_{mt} < C\right) = \sum_{i=1}^{N} w_{it}\mathbb{E}_{t-1}\left(r_{it} | r_{mt} < C\right) \tag{4}$$

[6] The Value at Risk for firm i (VaR_q^i) is the q quantile and is typically a positive number when $q > 50$.

where r_{mt} denotes the weighted average market return at time t, calculated as:

$$r_{mt} = \sum_{i=1}^{N} w_{it} r_{it} \tag{5}$$

where r_{it} is the return of firm i, w_{it} is the weight of firm i based on market capitalisation, and N is the number of firms in the market. The MES is the partial derivative of the system's ES with respect to the weight of firm i (Scaillet 2004):

$$MES_{it}(C) = \frac{\partial ES_{mt}(C)}{\partial w_{it}} = \mathbb{E}_{t-1}\left(r_{it} | r_{mt} < C\right) \tag{6}$$

A higher MES value for firm i indicates its higher contribution to the risk of the financial system.

Figure 2 plots the yearly average systemic risk measures over time. The left graph illustrates ΔCoVaR and the MES, whereas the right diagram shows SRISK data. Overall, all three measures exhibit a similar fluctuating pattern between 2008 and 2020, with an upward trend since 2017 and a significant increase from 2019 to 2020.

4.3 Bank characteristics and macroeconomic determinants

For bank-specific variables, we download the data for all listed financial institutions (FIs) in the Eurozone from Orbis Bankfocus database. We further identify SIFIs using information from the European Systemic Risk Board's website. The final sample consists of 159 banks/FIs, among which 38 are SIFIs, with annual data available between 2008 and 2020.[7] The bank-specific variables include size, capitalisation, performance, and income diversification, as detailed in (Table 3).

Size (*"Total assets"*) is one of the most important determinants of systemic risk and computed as the logarithm of total assets. The literature has identified that bank size implies greater systemic importance (Tarashev et al. 2009; Anginer et al. 2014; Laeven et al. 2016; Varotto and Zhao 2018; Hedström et al. 2024; Mies 2024). Basel (2013) also proposes an indicator-based approach to define global systemically important financial institutions. According to this approach, size is the foremost indicator for those not being allowed to fail due to negative externalities. The size category is also assigned a weight of 20%, while other categories have multiple built-in indicators. Each of those indicators is equally weighted within their category, and thus is given less than 20% overall weight. Moreover, Buch et al. (2019) and Laeven et al. (2016) document that larger banks are more systemically important because of their organisational structure complexity and risk-taking due to government subsidy measures. Therefore, it is vital that bank size is accounted for when it comes to the determinants of systemic risk.

Capitalisation is used as another bank-characteristic variable. Specifically, we use the market capitalisation to total assets ratio[8] as a proxy for bank market capitalisation. Capitalisation could enforce either a positive or a negative effect on systemic risk. From the regulators' point of view, the more "skin-in-the-game" a bank has, the less risk it takes, hence, the rationale of bank capital regulation. From the bank shareholders' perspectives,

[7] See Appendix 1 for a breakdown of the number of SIFIs and observations.

[8] To aid the interpretation of the results, this variable is in the percentage format in the regression model.

Table 3 Variable definitions

Variables	Definitions	Data source
SRISK (ln)	The expected capital shortfall of a given financial institution, conditional on a crisis affecting the whole financial system (Brownlees and Engle 2017), in natural logarithm	Refinitiv/ Datastream
ΔCoVaR (%)	DeltaCoVaR of financial institution *i* is the difference between the Value at Risk (VaR) of the financial system conditional on financial institution *i* being in financial distress and the VaR of the financial system conditional on financial institution *i* being in its median state (Adrian and Brunnermeier 2016)	Refinitiv/ Datastream
MES (%)	The marginal contribution of financial institution *i* to systemic risk, as measured by the Expected Shortfall (ES) of the system (Acharya et al. 2017)	Refinitiv/ Datastream
AP (ln)	The sum of the amount of asset purchases for the whole Eurosystem and the Longer-Term Refinancing Operation, in natural logarithm	Refinitiv/ Datastream
Yield (%)	The 10-year synthetic sovereign bond yield	Refinitiv/Datastream
Shadow rate (%)	An approximation of the conventional and unconventional monetary policy tools (Wu and Xia 2016)	https://sites.google.com/view/jingcynthiawu/shadow-rates
SMCI (%)	Synthetic Standardised Monetary Condition Index (Kucharčuková et al. 2016; Lombardi and Zhu 2018)	Refinitiv/ Datastream
Total assets (ln)	Total assets of the financial institution, in natural logarithm	Orbis Bankfocus
Market capitalisation (%)	Market value of equity/Total assets	Orbis Bankfocus
Equity to assets (%)	Total equity/total assets	Orbis Bankfocus
Leverage (%)	Total liabilities/total equity	Orbis Bankfocus
Cost to income (%)	Total costs/Total operating income	Orbis Bankfocus
Income diversification (%)	Non-interest income/Total operating income	Orbis Bankfocus
Market concentration (%)	The Herfindahl–Hirschman index HHI	ECB Statistical Data Warehouse
CISS (%)	The composite indicator of sovereign systemic stress	ECB Statistical Data Warehouse
GDP growth (%)	The growth rate of the Gross Domestic Product	ECB Statistical Data Warehouse
SIFIs	Dummy = 1 for systemically important financial institutions, determined by the European Systemic Risk Board (ERSB)	ERSB's website

capital is a source of funds for starting up and expansion. On the one hand, having more capital implies lower risk-taking, as more risks would entail more losses for shareholders (Konishi and Yasuda 2004; Delis and Kouretas 2011). More capital limits speculative growth or expansion beyond the bank's ability to manage its assets, as a result, encouraging robust risk management practices. Bank shareholders are also subordinate compared to depositors and creditors in the distribution of assets should banks default (Hull 2015). On the other hand, as more capital indicates higher risk tolerance, there could exist risk-taking incentives from banks by switching from safer to riskier assets.[9] Therefore, in the short run, the relationship between capital and risk could be positive.

As for income diversification, this variable is calculated as the ratio of non-interest income to total income (Anginer et al. 2014; Louhichi et al. 2024). On the one hand, the more diversified a bank is in non-traditional activities, the higher the potential risk it is exposed to because those activities are perceived as riskier than loan making. Non-traditional sources of income also often come from increased business, structural, and operational complexity, which is more likely to raise a bank's systemic risk contribution. On the other hand, it is the very diversification activity that benefits banks in reducing their risk (Nguyen et al. 2012). A more diversified portfolio of assets can reduce idiosyncratic risk, but market-linked investments can expose the bank to greater market volatility (Buch et al. 2019). Thus, one can expect mixed findings in relation to the effect of income diversification on bank systemic risk.

On the accounting measure of performance as a driver of systemic risk, we use the cost-to-income ratio, which denotes cost effectiveness (Chortareas et al. 2012). Bank performance affects bank risk and bank stability in various ways. Being more cost efficient implies better capabilities of bank managers to manage cost and reduce credit risk (Berger and DeYoung 1997) as well as bank stability. This variable is expected to positively influence systemic risk, as being inefficient in managing cost could contribute to the build-up of systemic risk. Indeed, De Jonghe et al. (2015) and Bakkar and Nyola (2021) document that cost ineffective banks are systemically riskier. However, cost inefficiencies arising from prudent loan screening and careful loan documentation due to managers being more risk-averse can translate into lower risk in the future (Mamatzakis et al. 2016).

As in the monetary policy stream of literature (Kashyap and Stein 2000; De Nicolò et al. 2010; Jiménez et al. 2014; Bowman et al. 2015; Ioannidou et al. 2015), monetary policy, especially during expansion, may exert various impacts on banks with different characteristics. Therefore, we further include the interactions between NSMP and bank-level variables to observe any potential differences in the impact that NSMP may have on systemic risk. The interaction terms thus show the sensitivity of bank systemic risk to NSMP in accordance with the strength of the bank's balance sheet (Diamond and Rajan 2012; Ioannidou et al. 2015).

In terms of the impact of the macroeconomic environment, we control for bank concentration and country systemic risk. For the former, we choose the country-level Herfindahl–Hirschman index (HHI) (Leroy and Lucotte 2017). For the latter, we employ the country-level composite indicator of systemic stress (CISS)[10] (Hollo et al. 2012; Meuleman and Vander Vennet 2020; Gehrig and Iannino 2021). Data on these two variables are available from the ECB Statistical Data Warehouse. The degree of concentration reflects the market

[9] See Allahrakha et al. (2018) and Duffie (2018) for detailed explanations for this behaviour in response to larger capital requirements with respect to the Basel III leverage ratio.

[10] Please see https://data.ecb.europa.eu/data/datasets/CISS/data-information for further information on the description of CISS.

Table 4 Descriptive statistics

Variables	Observations	Mean	Standard deviation
SRISK (ln)	1278	10.2921	6.6898
ΔCoVaR (%)	1278	1.2891	0.8614
MES (%)	1278	4.6381	3.9548
AP (ln)	1278	21.2178	0.7620
Yield (%)	1278	1.7638	1.3640
Shadow rate (%)	1278	−3.3550	2.7268
SMCI (%)	1278	−0.0616	0.6065
Total assets (ln)	1278	16.2377	2.8056
Market capitalisation (%)	1278	24.4127	75.8587
Equity to assets (%)	1278	16.7691	21.6154
Leverage (%)	1278	1165.725	1133.042
Cost to income (%)	1278	82.5063	469.7256
Income diversification (%)	1278	61.4059	141.2065
Market concentration (%)	1278	8.3499	6.7226
CISS (%)	1278	20.4021	19.3041
GDP growth (%)	1278	0.3011	3.4388

This Table reports the descriptive statistics of the variables used in the IV-GMM analysis. The sample consists of data on Eurozone listed financial institutions for the period 2008–2020. The definitions of the variables are provided in Table 3

structure, which can influence how market participants perform (Bain 1951). There is no clear-cut evidence on the impact of bank concentration on risk (Faia et al. 2019). In a more concentrated market, it is easier for banks to collude and exercise their market power over product pricing. This, in turn, can bring excessive profits and reduce overall risk. Nevertheless, moral hazard can become a great concern as banks attain their "too-big-to-fail" status in a highly concentrated market, magnifying their systemic importance and creating further disruption should they fail. Besides, collusive behaviour could induce banks to take on correlated risks, reducing the system's diversification and thus increasing systemic risk potential (Nicoló et al. 2004). Regarding the CISS, as this variable captures the stressed market condition arising in the overall financial system, we expect a positive association between the CISS and individual bank systemic risk (Gehrig and Iannino 2021). As explained in Meuleman and Vander Vennet (2020), the CISS accounts for the bank-sovereign feedback loop that amplifies bank systemic risk. Table 4 reports the descriptive statistics of all the variables.

4.4 Methodology

We employ the instrumental variables and generalised method of moments estimation method (IV-GMM) (Baum et al. 2007) to test our hypotheses while addressing endogeneity concerns. An endogeneity issue can arise from banks being able to cheaply replenish their capital reserves in a low interest rate environment, coupled with NSMP implementation. Hence, banks can satisfy the new capital and liquidity requirements, which could then mechanically decrease their systemic risk metrics from their peak levels. In this regard, we consider market capitalisation as the endogenous variable and use the equity-to-assets ratio and country-level GDP growth as instruments. For robustness checks, we also use bank leverage (computed as total liabilities divided by total equity) as a potential source of endogeneity.[11] The estimated functional form is as follows:

$$SystemicRisk_{i,t} = \alpha_0 + \beta_1 NSMP_{i,t-1} + \beta_2 X_{i,t-1} + \beta_3 Macro_{i,t-1} + \beta_4 NSMP_{i,t-1} X_{i,t-1} + \varepsilon_{i,t} \tag{7}$$

where X is a vector of bank-specific variables (*Total assets*, *Market capitalisation*, *Income diversification*, *Cost to income*), and *Macro* is a vector of macroeconomic variables (*Market concentration*, *CISS*). Following Agoraki et al. (2011), Leroy (2014), and Buch et al. (2019), bank characteristics have been mean-centered to tackle the practical issues of collinearity between the interaction terms and their components. The parameters estimated on the single terms are therefore expressed as the effects for the average bank. With leverage as the endogenous variable, as it is also a bank-characteristic variable, we also use its deviation from the mean in the regressions. Pairwise correlations between all the variables are checked to ensure there is no multicollinearity.

The panel IV-GMM models are estimated with time-fixed effects, country-fixed effects, bank type dummies, a SIFI dummy, and robust standard errors. We perform the GMM distance endogeneity test on all model specifications and report the *p*-values in the corresponding tables. The null hypothesis is that the specified endogenous regressor can actually be treated as exogenous (Baum et al. 2007). The test confirms that the market capitalisation variable needs to be considered endogenous. The same is true for the bank leverage variable. We then test for the presence of weak instruments by employing the Kleibergen-Paap Wald test (F statistic), which should have a value of at least 10 for weak identification not to be considered a problem (Staiger and Stock 1997). We also report *p*-values of the first-stage F-test for weak identification to complement the Kleibergen-Paap Wald test and the Sargan-Hansen test for overidentifying restrictions.

5 Results and discussion

In this section, we discuss the estimation results. Specifically, the main results of our regressions with market capitalisation as the endogenous variable are presented in Tables 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16 and discussed in sub-Sects. 5.1–5.3, whereas the robustness check results with bank leverage as the endogenous variable are reported in Appendix 3 (Tables C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11 and C12) and discussed in sub-Sect. 5.4. In each of these tables, column 1 reports the results with the NSMP variable being proxied by the logarithmic asset purchases, while column 2 presents the results with the 10-year yields on synthetic sovereign bonds of Euro area countries. Results with the shadow rate and the SMCI used as proxies for NSMP are reported in columns 3 and 4, respectively.

In all model specifications, the following are confirmed. The *p*-values of the GMM distance endogeneity test suggest the rejection of the null hypothesis that the specified endogenous regressors can actually be treated as exogenous. The first-stage F-test *p*-values denote significance at the 1% level, thus suggesting the rejection of the null hypothesis that the instruments are unrelated to the endogenous regressors. Furthermore, the

[11] We thank an anonymous referee for this suggestion.

Table 5 The impact of NSMP on SRISK

Dependent variable: *SRISK (ln)*	1	2	3	4
	NSMP variables			
	AP	Yield	SR	SMCI
NSMP	0.8962***	−0.3937***	−0.2093***	−1.9342***
	(0.339)	(0.149)	(0.079)	(0.732)
Total assets	0.7545***	0.7545***	0.7545***	0.7545***
	(0.116)	(0.116)	(0.116)	(0.116)
Market capitalisation	−0.0308***	−0.0308***	−0.0308***	−0.0308***
	(0.006)	(0.006)	(0.006)	(0.006)
Cost to income	0.0121	0.0121	0.0121	0.0121
	(0.008)	(0.008)	(0.008)	(0.008)
Income diversification	−0.0411***	−0.0411***	−0.0411***	−0.0411***
	(0.007)	(0.007)	(0.007)	(0.007)
Market concentration	−0.0737	−0.0737	−0.0737	−0.0737
	(0.050)	(0.050)	(0.050)	(0.050)
CISS	0.0122***	0.0122***	0.0122***	0.0122***
	(0.004)	(0.004)	(0.004)	(0.004)
SIFIs	1.7068***	1.7068***	1.7068***	1.7068***
	(0.455)	(0.455)	(0.455)	(0.455)
Bank type dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes
N	1185	1185	1185	1185
Adjusted R^2	0.7168	0.7168	0.7168	0.7168
Sargan-Hansen test (*p*-value)	0.7237	0.7237	0.7237	0.7237
GMM distance endogeneity test (*p*-value)	0.0000	0.0000	0.0000	0.0000
Kleibergen-Paap Wald F-test statistic	25.5511	25.5511	25.5511	25.5511
First stage F-test (*p*-value)	0.0000	0.0000	0.0000	0.0000

This Table reports the IV-GMM estimation results for the entire sample. The dependent variable is the natural logarithm of SRISK. Column 1 shows results with NSMP as the natural logarithm of the sum of the total assets purchased and LTROs (AP). Column 2 shows results with the 10-year yields on synthetic sovereign bonds of Euro area countries. Column 3 shows results with the shadow rate (SR). Column 4 shows results with the SMCI. Bank-level variables are mean-centred. Explanatory variables are lagged one period, except for SIFIs which is a dummy variable for systemically important financial institutions. Variable definitions are as in Table 3. The Sargan-Hansen test is the test for overidentification. The null hypothesis tested under the GMM distance endogeneity test is that the specified endogenous regressors can actually be treated as exogenous. The Kleibergen-Paap Wald F-test statistic is a test for weak instruments and should have a value of at least 10 for weak identification not to be considered a problem (Staiger and Stock 1997). The First-stage F-test is another test of weak identification. The endogenous variable is market capitalisation. The instruments are the equity-to-assets ratio and GDP growth. Robust standard errors are in (), N is the number of observations, R^2 is R-squared. *,**, and *** denote significance at the 10%, 5%, and 1% levels, respectively

values of the Kleibergen-Paap Wald test (F statistic) are greater than 10, indicating that weak identification is not to be considered a problem (Staiger and Stock 1997). Finally,

Table 6 The impact of NSMP on SRISK—Regression with interactions

Dependent variable: *SRISK (ln)*	1	2	3	4
	NSMP variables			
	AP	Yield	SR	SMCI
NSMP	0.9902**	−0.3546**	−0.1649*	−1.8022**
	(0.421)	(0.168)	(0.097)	(0.775)
Total assets	2.473	0.6094***	1.0672***	0.7441***
	(2.298)	(0.148)	(0.139)	(0.116)
NSMP*Total assets	−0.0988	0.0719*	0.1225***	0.1372
	(0.109)	(0.042)	(0.034)	(0.110)
Market capitalisation	−0.3867	−0.0252***	−0.0067	−0.0312***
	(0.259)	(0.009)	(0.012)	(0.006)
NSMP*Market capitalisation	0.0156	−0.0035	0.0074**	−0.0143
	(0.012)	(0.005)	(0.003)	(0.011)
Cost to income	0.5103**	−0.0014	0.0340***	0.0112
	(0.201)	(0.014)	(0.009)	(0.008)
NSMP*Cost to income	−0.0242**	0.0075	0.0080***	0.0213
	(0.010)	(0.005)	(0.003)	(0.014)
Income diversification	−0.1901	−0.0402***	−0.0590***	−0.0426***
	(0.222)	(0.013)	(0.010)	(0.007)
NSMP*Income diversification	0.0074	−0.0011	−0.0069**	0.0054
	(0.011)	(0.005)	(0.003)	(0.013)
Market concentration	−0.0688	−0.0616	−0.0526	−0.0705
	(0.053)	(0.047)	(0.052)	(0.046)
CISS	0.0084*	0.0126***	0.0064	0.0131***
	(0.005)	(0.005)	(0.005)	(0.004)
SIFIs	2.6906***	1.7096***	1.8036***	1.7072***
	(0.519)	(0.447)	(0.472)	(0.449)
Bank type dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes
N	1185	1185	1185	1185
Adjusted R^2	0.6395	0.7226	0.6604	0.7214
Sargan-Hansen test (*p*-value)	0.5724	0.7182	0.6229	0.8615
GMM distance endogeneity test (*p*-value)	0.0000	0.0001	0.0000	0.0001
Kleibergen-Paap Wald F-test statistic	11.5989	10.1796	11.6867	14.9464
First stage F-test (*p*-value)	0.0000	0.0000	0.0000	0.0000

This Table reports the IV-GMM estimation results for the entire sample, with interaction terms between NSMP and bank-level variables included. The dependent variable is the natural logarithm of SRISK. Column 1 shows results with NSMP as the natural logarithm of the sum of the total assets purchased and LTROs (AP). Column 2 shows results with the 10-year yields on synthetic sovereign bonds of Euro area countries. Column 3 shows results with the shadow rate (SR). Column 4 shows results with the SMCI. Bank-level variables are mean-centred. Explanatory variables are lagged one period, except for SIFIs which is a dummy variable for systemically important financial institutions. Variable definitions are as in Table 3. The Sargan-Hansen test is the test for overidentification. The null hypothesis tested under the GMM distance endogeneity test is that the specified endogenous regressors can actually be treated as exogenous. The Kleibergen-Paap Wald F-test statistic is a test for weak instruments and should have a value of at least 10 for weak identification not to be considered a problem (Staiger and Stock 1997). The First-stage F-test is another test of weak identification. First stage F-test *p*-value is the same for the endogenous variable and its

Table 6 (continued)

interaction with NSMP. The endogenous variable is market capitalisation. The instruments are the equity-to-assets ratio and GDP growth. Robust standard errors are in (), N is the number of observations, R^2 is R-squared. *,**, and *** denote significance at the 10%, 5%, and 1% levels, respectively

Table 7 The impact of NSMP on ΔCoVaR

Dependent variable: *ΔCoVaR*	1	2	3	4
	NSMP variables			
	AP	Yield	SR	SMCI
NSMP	0.2624***	−0.1153***	−0.0613***	−0.5664***
	(0.050)	(0.022)	(0.012)	(0.109)
Total assets	0.2288***	0.2288***	0.2288***	0.2288***
	(0.013)	(0.013)	(0.013)	(0.013)
Market capitalisation	0.0042***	0.0042***	0.0042***	0.0042***
	(0.001)	(0.001)	(0.001)	(0.001)
Cost to income	0.0006	0.0006	0.0006	0.0006
	(0.001)	(0.001)	(0.001)	(0.001)
Income diversification	0.0016*	0.0016*	0.0016*	0.0016*
	(0.001)	(0.001)	(0.001)	(0.001)
Market concentration	−0.001	−0.001	−0.001	−0.001
	(0.007)	(0.007)	(0.007)	(0.007)
CISS	−0.0001	−0.0001	−0.0001	−0.0001
	(0.001)	(0.001)	(0.001)	(0.001)
SIFIs	0.0571	0.0571	0.0571	0.0571
	(0.061)	(0.061)	(0.061)	(0.061)
Bank type dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes
N	1143	1143	1143	1143
Adjusted R^2	0.6682	0.6682	0.6682	0.6682
Sargan-Hansen test (*p*-value)	0.7273	0.7273	0.7273	0.7273
GMM distance endogeneity test (*p*-value)	0.0000	0.0000	0.0000	0.0000
Kleibergen-Paap Wald F-test statistic	22.2376	22.2376	22.2376	22.2376
First stage F-test (*p*-value)	0.0000	0.0000	0.0000	0.0000

This Table reports the IV-GMM estimation results for the entire sample. The dependent variable is ΔCoVaR (%). Column 1 shows results with NSMP as the natural logarithm of the sum of total assets purchased and LTROs (AP). Column 2 shows results with the 10-year yields on synthetic sovereign bonds of Euro area countries. Column 3 shows results with the shadow rate (SR). Column 4 shows results with the SMCI. Bank-level variables are mean-centred. Explanatory variables are lagged one period, except for SIFIs which is a dummy variable for systemically important financial institutions. Variable definitions are as in Table 3. The Sargan-Hansen test is the test for overidentification. The null hypothesis tested under the GMM distance endogeneity test is that the specified endogenous regressors can actually be treated as exogenous. The Kleibergen-Paap Wald F-test statistic is a test for weak instruments and should have a value of at least 10 for weak identification not to be considered a problem (Staiger and Stock 1997). The First-stage F-test is another test of weak identification. The endogenous variable is market capitalisation. The instruments are the equity-to-assets ratio and GDP growth. Robust standard errors are in (), N is the number of observations, R^2 is R-squared. *,**, and *** denote significance at the 10%, 5%, and 1% levels, respectively

Table 8 The impact of NSMP on ΔCoVaR—Regression with interactions

Dependent variable: *ΔCoVaR*	1	2	3	4
	NSMP variables			
	AP	Yield	SR	SMCI
NSMP	0.2202***	−0.0814***	−0.0478***	−0.5222***
	(0.050)	(0.025)	(0.012)	(0.113)
Total assets	0.6805***	0.2482***	0.2337***	0.2274***
	(0.230)	(0.022)	(0.014)	(0.013)
NSMP*Total assets	−0.0215**	−0.0058	0.002	0.0394***
	(0.011)	(0.006)	(0.003)	(0.014)
Market capitalisation	0.0680**	0.0038**	0.0078***	0.0045***
	(0.027)	(0.002)	(0.002)	(0.001)
NSMP*Market capitalisation	−0.0030**	0.0009	0.0008**	0.0038**
	(0.001)	(0.001)	0.000	(0.002)
Cost to income	0.024	−0.0001	0.0019*	0.0012*
	(0.020)	(0.001)	(0.001)	(0.001)
NSMP*Cost to income	−0.0011	0.0007	0.0003	0.0014
	(0.001)	(0.001)	0.000	(0.001)
Income diversification	0.032	0.0003	0.0022*	0.0013*
	(0.023)	(0.001)	(0.001)	(0.001)
NSMP*Income diversification	−0.0015	0.0005	0.0003	0.001
	(0.001)	(0.001)	0.000	(0.001)
Market concentration	−0.0077	−0.0069	−0.007	−0.0075
	(0.007)	(0.008)	(0.007)	(0.007)
CISS	−0.0002	0.0000	−0.0001	−0.0005
	(0.001)	(0.001)	(0.001)	(0.001)
SIFIs	0.0678	0.0485	0.0663	0.0507
	(0.061)	(0.065)	(0.061)	(0.061)
Bank type dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes
N	1143	1143	1143	1143
Adjusted R^2	0.6893	0.6545	0.6879	0.6757
Sargan-Hansen test (*p*-value)	0.2871	0.1912	0.2743	0.1294
GMM distance endogeneity test (*p*-value)	0.0000	0.0000	0.0000	0.0000
Kleibergen-Paap Wald F-test statistic	10.0609	12.1161	10.8568	11.6251
First stage F-test (*p*-value)	0.0000	0.0000	0.0000	0.0000

This Table reports the IV-GMM estimation results for the entire sample, with interaction terms between NSMP and bank-level variables included. The dependent variable is ΔCoVaR (%). Column 1 shows results with NSMP as the natural logarithm of the sum of total assets purchased and LTROs (AP). Column 2 shows results with the 10-year yields on synthetic sovereign bonds of Euro area countries. Column 3 shows results with the shadow rate (SR). Column 4 shows results with the SMCI. Bank-level variables are mean-centred. Explanatory variables are lagged one period, except for SIFIs which is a dummy variable for systemically important financial institutions. Variable definitions are as in Table 3. The Sargan-Hansen test is the test for overidentification. The null hypothesis tested under the GMM distance endogeneity test is that the specified endogenous regressors can actually be treated as exogenous. The Kleibergen-Paap Wald F-test statistic is a test for weak instruments and should have a value of at least 10 for weak identification not to be considered a problem (Staiger and Stock 1997). The First-stage F-test is another test of weak identification. First stage F-test *p*-value is the same for the endogenous variable and its interaction with NSMP. The endogenous vari-

Table 8 (continued)

able is market capitalisation. The instruments are the equity-to-assets ratio and GDP growth. Robust standard errors are in (), N is the number of observations, R^2 is R-squared. *,**, and *** denote significance at the 10%, 5%, and 1% levels, respectively

Table 9 The impact of NSMP on MES

Dependent variable: *MES*	1	2	3	4
	NSMP variables			
	AP	Yield	SR	SMCI
NSMP	0.7901***	−0.3471***	−0.1845***	−1.7051***
	(0.218)	(0.096)	(0.051)	(0.469)
Total assets	0.4605***	0.4605***	0.4605***	0.4605***
	(0.058)	(0.058)	(0.058)	(0.058)
Market capitalisation	0.0033	0.0033	0.0033	0.0033
	(0.003)	(0.003)	(0.003)	(0.003)
Cost to income	0.0412***	0.0412***	0.0412***	0.0412***
	(0.011)	(0.011)	(0.011)	(0.011)
Income diversification	−0.0056	−0.0056	−0.0056	−0.0056
	(0.005)	(0.005)	(0.005)	(0.005)
Market concentration	−0.073	−0.073	−0.073	−0.073
	(0.046)	(0.046)	(0.046)	(0.046)
CISS	−0.0051	−0.0051	−0.0051	−0.0051
	(0.003)	(0.003)	(0.003)	(0.003)
SIFIs	2.0379***	2.0379***	2.0379***	2.0379***
	(0.297)	(0.297)	(0.297)	(0.297)
Bank type dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes
N	1107	1107	1107	1107
Adjusted R^2	0.5717	0.5717	0.5717	0.5717
Sargan-Hansen test (*p*-value)	0.5269	0.5269	0.5269	0.5269
GMM distance endogeneity test (*p*-value)	0.008	0.008	0.008	0.008
Kleibergen-Paap Wald F-test statistic	87.2434	87.2434	87.2434	87.2434
First stage F-test (*p*-value)	0.0000	0.0000	0.0000	0.0000

This Table reports the IV-GMM estimation results for the entire sample. The dependent variable is the Marginal Expected Shortfall (MES) (%). Column 1 shows results with NSMP as the natural logarithm of the sum of total assets purchased and LTROs (AP). Column 2 shows results with the 10-year yields on synthetic sovereign bonds of Euro area countries. Column 3 shows results with the shadow rate (SR). Column 4 shows results with the SMCI. Bank-level variables are mean-centred. Explanatory variables are lagged one period, except for SIFIs which is a dummy variable for systemically important financial institutions. Variable definitions are as in Table 3. The Sargan-Hansen test is the test for overidentification. The null hypothesis tested under the GMM distance endogeneity test is that the specified endogenous regressors can actually be treated as exogenous. The Kleibergen-Paap Wald F-test statistic is a test for weak instruments and should have a value of at least 10 for weak identification not to be considered a problem (Staiger and Stock 1997). The First-stage F-test is another test of weak identification. The endogenous variable is market capitalisation. The instruments are the equity-to-assets ratio and GDP growth. Robust standard errors are in (), N is the number of observations, R^2 is R-squared. *,**, and *** denote significance at the 10%, 5%, and 1% levels, respectively

Table 10 The impact of NSMP on MES—Regression with interactions

Dependent variable: *MES*	1	2	3	4
	NSMP variables			
	AP	Yield	SR	SMCI
NSMP	1.1684***	−0.4631***	−0.2339***	−2.8160***
	(0.259)	(0.125)	(0.063)	(0.502)
Total assets	2.3404**	0.3652***	0.5535***	0.4434***
	(1.093)	(0.084)	(0.058)	(0.055)
NSMP*Total assets	−0.0881*	0.0674**	0.0218	0.2499***
	(0.053)	(0.028)	(0.015)	(0.067)
Market capitalisation	0.1493***	−0.0045	0.0141***	0.0014
	(0.054)	(0.003)	(0.004)	(0.002)
NSMP*Market capitalisation	−0.0068***	0.0063***	0.0024***	0.0027
	(0.003)	(0.002)	(0.001)	(0.003)
Cost to income	−0.3689*	0.0438***	0.0322***	0.0289***
	(0.224)	(0.017)	(0.007)	(0.006)
NSMP*Cost to income	0.0191*	−0.005	−0.0023	−0.0404***
	(0.011)	(0.005)	(0.003)	(0.013)
Income diversification	−0.1268	0.0028	−0.0127***	−0.0024
	(0.116)	(0.008)	(0.005)	(0.004)
NSMP*Income diversification	0.0058	−0.0036	−0.0026	−0.0009
	(0.006)	(0.003)	(0.002)	(0.007)
Market concentration	−0.0534	−0.0539	−0.0436	−0.0491
	(0.037)	(0.039)	(0.037)	(0.038)
CISS	−0.0066**	−0.0067**	−0.0066**	−0.0067**
	(0.003)	(0.003)	(0.003)	(0.003)
SIFIs	1.9830***	1.9406***	1.9422***	1.9994***
	(0.271)	(0.273)	(0.271)	(0.267)
Bank type dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes
N	1107	1107	1107	1107
Adjusted R^2	0.5804	0.5782	0.5755	0.6013
Sargan-Hansen test (*p*-value)	0.614	0.4091	0.5332	0.3696
GMM distance endogeneity test (*p*-value)	0.014	0.0303	0.0265	0.0057
Kleibergen-Paap Wald F-test statistic	43.7288	43.744	47.7024	28.0213
First stage F-test (*p*-value)	0.0000	0.0000	0.0000	0.0000

This Table reports the IV-GMM estimation results for the entire sample, with interaction terms between NSMP and bank-level variables included. The dependent variable is the Marginal Expected Shortfall (MES) (%). Column 1 shows results with NSMP as the natural logarithm of the sum of total assets purchased and LTROs (AP). Column 2 shows results with the 10-year yields on synthetic sovereign bonds of Euro area countries. Column 3 shows results with the shadow rate (SR). Column 4 shows results with the SMCI. Bank-level variables are mean-centred. Explanatory variables are lagged one period, except for SIFIs which is a dummy variable for systemically important financial institutions. Variable definitions are as in Table 3. The Sargan-Hansen test is the test for overidentification. The null hypothesis tested under the GMM distance endogeneity test is that the specified endogenous regressors can actually be treated as exogenous. The Kleibergen-Paap Wald F-test statistic is a test for weak instruments and should have a value of at least 10 for weak identification not to be considered a problem (Staiger and Stock 1997). The First-stage F-test is another test of weak identification. First stage F-test *p*-value is the same for the endogenous variable and its

Table 10 (continued)

interaction with NSMP. The endogenous variable is market capitalisation. The instruments are the equity-to-assets ratio and GDP growth. Robust standard errors are in (), N is the number of observations, R^2 is R-squared. *,**, and *** denote significance at the 10%, 5%, and 1% levels, respectively

Table 11 The impact of NSMP on SRISK—Sub-sample analysis

Dependent variable: *SRISK (ln)*	1	2	3	4
	NSMP variables			
	AP	Yield	SR	SMCI
NSMP	0.8375***	−0.3679***	−0.1955***	−1.8073***
	(0.315)	(0.138)	(0.073)	(0.679)
Total assets	0.8513***	0.8513***	0.8513***	0.8513***
	(0.105)	(0.105)	(0.105)	(0.105)
Market capitalisation	−0.0616***	−0.0616***	−0.0616***	−0.0616***
	(0.011)	(0.011)	(0.011)	(0.011)
Cost to income	−0.0147**	−0.0147**	−0.0147**	−0.0147**
	(0.007)	(0.007)	(0.007)	(0.007)
Income diversification	−0.0215**	−0.0215**	−0.0215**	−0.0215**
	(0.010)	(0.010)	(0.010)	(0.010)
Market concentration	0.02	0.02	0.02	0.02
	(0.035)	(0.035)	(0.035)	(0.035)
CISS	0.0071*	0.0071*	0.0071*	0.0071*
	(0.004)	(0.004)	(0.004)	(0.004)
SIFIs	0.7736*	0.7736*	0.7736*	0.7736*
	(0.427)	(0.427)	(0.427)	(0.427)
Bank type dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes
N	799	799	799	799
Adjusted R^2	0.5726	0.5726	0.5726	0.5726
Sargan-Hansen test (*p*-value)	0.5415	0.5415	0.5415	0.5415
GMM distance endogeneity test (*p*-value)	0.0000	0.0000	0.0000	0.0000
Kleibergen-Paap Wald F-test statistic	19.8731	19.8731	19.8731	19.8731
First stage F-test (*p*-value)	0.0000	0.0000	0.0000	0.0000

This Table reports the IV-GMM estimation results for a sub-sample of commercial banks, bank holding companies, co-operative banks, and savings banks. The dependent variable is the natural logarithm of SRISK. Column 1 shows results with NSMP as the natural logarithm of the sum of total assets purchased and LTROs (AP). Column 2 shows results with the 10-year yields on synthetic sovereign bonds of Euro area countries. Column 3 shows results with the shadow rate (SR). Column 4 shows results with the SMCI. Bank-level variables are mean-centred. Explanatory variables are lagged one period, except for SIFIs which is a dummy variable for systemically important financial institutions. Variable definitions are as in Table 3. The Sargan-Hansen test is the test for overidentification. The null hypothesis tested under the GMM distance endogeneity test is that the specified endogenous regressors can actually be treated as exogenous. The Kleibergen-Paap Wald F-test statistic is a test for weak instruments and should have a value of at least 10 for weak identification not to be considered a problem (Staiger and Stock 1997). The First-stage F-test is another test of weak identification. The endogenous variable is market capitalisation. The instruments are the equity-to-assets ratio and GDP growth. Robust standard errors are in (), N is the number of observations, R^2 is R-squared. *,**, and *** denote significance at the 10%, 5%, and 1% levels, respectively

Table 12 The impact of NSMP on SRISK—Regression with interactions—Sub-sample analysis

Dependent variable: *SRISK (ln)*	1	2	3	4
	NSMP variables			
	AP	Yield	SR	SMCI
NSMP	0.5842**	−0.2960**	−0.1347**	−1.3800**
	(0.279)	(0.125)	(0.066)	(0.597)
Total assets	2.1110*	1.4130***	1.4682***	1.4570***
	(1.277)	(0.090)	(0.102)	(0.083)
NSMP*Total assets	−0.0316	0.0083	0.0098	0.0327
	(0.060)	(0.029)	(0.016)	(0.083)
Market capitalisation	−0.1249	0.0004	−0.0254**	−0.0171***
	(0.131)	(0.009)	(0.010)	(0.004)
NSMP*Market capitalisation	0.0051	−0.0146*	−0.0022	−0.0121
	(0.006)	(0.008)	(0.002)	(0.009)
Cost to income	0.3118*	−0.0044	0.0195*	0.0078
	(0.181)	(0.010)	(0.011)	(0.008)
NSMP*Cost to income	−0.0142*	0.0072	0.0032	0.0129
	(0.009)	(0.004)	(0.002)	(0.017)
Income diversification	−0.1362	−-0.0265*	−0.0377***	−0.0323***
	(0.268)	(0.015)	(0.014)	(0.009)
NSMP*Income diversification	0.0049	−0.0028	−0.0018	−0.0096
	(0.013)	(0.006)	(0.004)	(0.018)
Market concentration	0.0276	0.0188	0.0197	0.0379
	(0.045)	(0.045)	(0.045)	(0.046)
CISS	0.0083**	0.0079*	0.0082*	0.0088**
	(0.004)	(0.004)	(0.004)	(0.004)
SIFIs	−0.5881	−0.5496	−0.5571	−0.6426*
	(0.370)	(0.366)	(0.368)	(0.373)
Bank type dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes
N	781	781	781	781
Adjusted R^2	0.6561	0.6601	0.6563	0.655
Sargan-Hansen test (*p*-value)	0.2863	0.2572	0.1377	0.1284
GMM distance endogeneity test (*p*-value)	0.0217	0.0348	0.0167	0.0441
Kleibergen-Paap Wald F-test statistic	40.7523	67.4294	49.895	37.8579
First stage F-test (*p*-value)	0.0000	0.0000	0.0000	0.0000

This Table reports the IV-GMM estimation results for a sub-sample of commercial banks, bank holding companies, co-operative banks, and savings banks, with interaction terms between NSMP and bank-level variables included. The dependent variable is the natural logarithm of SRISK. Column 1 shows results with NSMP as the natural logarithm of the sum of the total assets purchased and LTROs (AP). Column 2 shows results with the 10-year yields on synthetic sovereign bonds of Euro area countries. Column 3 shows results with the shadow rate (SR). Column 4 shows results with the SMCI. Bank-level variables are mean-centred. Explanatory variables are lagged one period, except for SIFIs which is a dummy variable for systemically important financial institutions. Variable definitions are as in Table 3. The Sargan-Hansen test is the test for overidentification. The null hypothesis tested under the GMM distance endogeneity test is that the specified endogenous regressors can actually be treated as exogenous. The Kleibergen-Paap Wald F-test statistic is a test for weak instruments and should have a value of at least 10 for weak identification not to be considered a problem (Staiger and Stock 1997). The First-stage F-test is another test of weak identification. First stage

Table 12 (continued)

F-test *p*-value is the same for the endogenous variable and its interaction with NSMP. The endogenous variable is market capitalisation. The instruments are the equity-to-assets ratio and GDP growth. Robust standard errors are in (), N is the number of observations, R^2 is R-squared. *,**, and *** denote significance at the 10%, 5%, and 1% levels, respectively

Table 13 The impact of NSMP on ΔCoVaR—Sub-sample analysis

Dependent variable: *ΔCoVaR*	1	2	3	4
	NSMP variables			
	AP	Yield	SR	SMCI
NSMP	0.2790***	−0.1226***	−0.0651***	−0.6021***
	(0.053)	(0.023)	(0.012)	(0.114)
Total assets	0.3006***	0.3006***	0.3006***	0.3006***
	(0.019)	(0.019)	(0.019)	(0.019)
Market capitalisation	0.0069***	0.0069***	0.0069***	0.0069***
	(0.001)	(0.001)	(0.001)	(0.001)
Cost to income	0.0020**	0.0020**	0.0020**	0.0020**
	(0.001)	(0.001)	(0.001)	(0.001)
Income diversification	0.0011	0.0011	0.0011	0.0011
	(0.001)	(0.001)	(0.001)	(0.001)
Market concentration	−0.0063	−0.0063	−0.0063	−0.0063
	(0.007)	(0.007)	(0.007)	(0.007)
CISS	−0.0016*	−0.0016*	−0.0016*	−0.0016*
	(0.001)	(0.001)	(0.001)	(0.001)
SIFIs	−0.1158	−0.1158	−0.1158	−0.1158
	(0.075)	(0.075)	(0.075)	(0.075)
Bank type dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes
N	804	804	804	804
Adjusted R^2	0.7215	0.7215	0.7215	0.7215
Sargan-Hansen test (*p* value)	0.1532	0.1532	0.1532	0.1532
GMM distance endogeneity test (*p* value)	0.0000	0.0000	0.0000	0.0000
Kleibergen-Paap Wald F-test statistic	19.367	19.367	19.367	19.367
First stage F-test (*p*-value)	0.0000	0.0000	0.0000	0.0000

This Table reports the IV-GMM estimation results for a sub-sample of commercial banks, bank holding companies, co-operative banks, and savings banks. The dependent variable is ΔCoVaR (%). Column 1 shows results with NSMP as the natural logarithm of the sum of the total assets purchased and LTROs (AP). Column 2 shows results with the 10-year yields on synthetic sovereign bonds of Euro area countries. Column 3 shows results with the shadow rate (SR). Column 4 shows results with the SMCI. Bank-level variables are mean-centred. Explanatory variables are lagged one period, except for SIFIs which is a dummy variable for systemically important financial institutions. Variable definitions are as in Table 3. The Sargan-Hansen test is the test for overidentification. The null hypothesis tested under the GMM distance endogeneity test is that the specified endogenous regressors can actually be treated as exogenous. The Kleibergen-Paap Wald F-test statistic is a test for weak instruments and should have a value of at least 10 for weak identification not to be considered a problem (Staiger and Stock 1997). The First-stage F-test is another test of weak identification. The endogenous variable is market capitalisation. The instruments are the equity-to-assets ratio and GDP growth. Robust standard errors are in (), N is the number of observations, R^2 is R-squared. *,**, and *** denote significance at the 10%, 5%, and 1% levels, respectively

Table 14 The impact of NSMP on ΔCoVaR—Regression with interactions – Sub-sample analysis

Dependent variable: *ΔCoVaR*	1	2	3	4
	NSMP variables			
	AP	Yield	SR	SMCI
NSMP	0.2487***	−0.1040***	−0.0564***	−0.5597***
	(0.050)	(0.021)	(0.011)	(0.111)
Total assets	0.3541	0.3384***	0.2833***	0.3034***
	(0.368)	(0.023)	(0.019)	(0.020)
NSMP*Total assets	−0.0026	−0.0169***	−0.0067**	−0.0054
	(0.018)	(0.005)	(0.003)	(0.015)
Market capitalisation	0.2173**	0.0033*	0.0150***	0.0081***
	(0.098)	(0.002)	(0.004)	(0.002)
NSMP* Market capitalisation	−0.0097**	0.0032*	0.0015**	0.0048
	(0.005)	(0.002)	(0.001)	(0.004)
Cost to income	0.0431	0.0016	0.0035**	0.0023**
	(0.032)	(0.001)	(0.001)	(0.001)
NSMP*Cost to income	−0.0019	0.0006	0.0002	0.002
	(0.001)	(0.001)	0.000	(0.002)
Income diversification	0.0784	−0.0032	0.0043***	−0.0001
	(0.058)	(0.002)	(0.002)	(0.001)
NSMP*Income diversification	−0.0037	0.0018**	0.0015***	0.0059**
	(0.003)	(0.001)	(0.001)	(0.002)
Market concentration	−0.0148*	−0.0157**	−0.0190**	−0.0136*
	(0.009)	(0.008)	(0.008)	(0.008)
CISS	−0.0011	−0.0011	−0.0009	−0.0013
	(0.001)	(0.001)	(0.001)	(0.001)
SIFIs	−0.1091	−0.1217	−0.1213	−0.1273
	(0.077)	(0.078)	(0.077)	(0.080)
Bank type dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes
N	786	786	786	786
Adjusted R^2	0.655	0.733	0.7111	0.7205
Sargan-Hansen test (*p*-value)	0.1136	0.1978	0.1697	0.4619
GMM distance endogeneity test (*p*-value)	0.0000	0.0000	0.0000	0.0000
Kleibergen-Paap Wald F-test statistic	10.2823	12.5157	10.2472	11.3719
First stage F-test (*p*-value)	0.0000	0.0000	0.0000	0.0000

This Table reports the IV-GMM estimation results for a sub-sample of commercial banks, bank holding companies, co-operative banks, and savings banks, with interaction terms between NSMP and bank-level variables included. The dependent variable is ΔCoVaR (%). Column 1 shows results with NSMP as the natural logarithm of the sum of total assets purchased and LTROs (AP). Column 2 shows results with the 10-year yields on synthetic sovereign bonds of Euro area countries. Column 3 shows results with the shadow rate (SR). Column 4 shows results with the SMCI. Bank-level variables are mean-centred. Explanatory variables are lagged one period, except for SIFIs which is a dummy variable for systemically important financial institutions. Variable definitions are as in Table 3. The Sargan-Hansen test is the test for overidentification. The null hypothesis tested under the GMM distance endogeneity test is that the specified endogenous regressors can actually be treated as exogenous. The Kleibergen-Paap Wald F-test statistic is a test for weak instruments and should have a value of at least 10 for weak identification not to be considered a problem (Staiger and Stock 1997). The First-stage F-test is another test of weak identification. First stage F-test

Table 14 (continued)

p-value is the same for the endogenous variable and its interaction with NSMP. The endogenous variable is market capitalisation. The instruments are the equity-to-assets ratio and GDP growth. Robust standard errors are in (), N is the number of observations, R^2 is R-squared. *,**, and *** denote significance at the 10%, 5%, and 1% levels, respectively

the *p*-values of the Sargan-Hansen test for overidentifying restrictions imply that the null hypothesis that the instruments are valid cannot be rejected.

5.1 The impact of NSMP

5.1.1 SRISK

We report the results with SRISK as the dependent variable in Tables 5 and 6 (without and with interaction terms, respectively). We find that NSMP increase systemic risk, as denoted by a positive relationship between AP and SRISK, and a negative association of the 10-year bond yield, the shadow rate, and the SMCI with SRISK. Specifically, a one percent increase in the amount of assets purchased is associated with an increase in SRISK by 0.9% (column 1, Table 5). On the other hand, a one percentage point (pp) increase in the 10-year bond yield, the shadow rate, or the SMCI is associated with a decrease in SRISK by 32.5%, 18.9%, and 85.5%, respectively (columns 2–4, Table 5). Similar results are reported in Table 6.

We further find some evidence of significant interactions between NSMP and bank characteristics (Table 6). In detail, the impact of more relaxed unconventional monetary policies is more pronounced for smaller (columns 2 and 3, Table 6) and less cost-inefficient (columns 1 and 3, Table 6) banks. This also appears to be the case for banks with lower market capitalisation and those that are more prone to non-traditional sources of income (column 3, Table 6). Our results are supportive of the study of Buch et al. (2014), in which small banks are reported to increase their risk exposure following expansionary monetary policy shocks, as well as the study of Ioannidou et al. (2015), which shows that when interest rates are low, banks with a lower capital ratio have stronger risk-taking.

5.1.2 ΔCoVaR

Tables 7 and 8 report the results with ΔCoVaR as the dependent variable. As with SRISK, we find consistent evidence for the negative effect of NSMP on systemic risk. A one percent increase in the amount of assets purchased is associated with an increase in ΔCoVaR by 0.26 basis points (bps) (column 1, Table 7). A one pp increase in the 10-year bond yield, the shadow rate, or the SMCI is associated with a decrease in ΔCoVaR by 11.53 bps, 6.13 bps, and 56.64 bps, respectively (columns 2–4, Table 7). In Table 8, where interactions between NSMP and bank-specific control variables are also included, we find similar overall economic impacts of NSMP. Furthermore, the relationship between NSMP and ΔCoVaR is stronger for smaller (columns 1 and 4, Table 8) and undercapitalised (columns 1, 3, and 4, Table 8) banks, similar to the case of SRISK discussed in sub-Sect. 5.1.1.

5.1.3 MES

Tables 9 and 10 report the results with the MES as the systemic risk measure. In particular, the MES would increase by 0.79 bps in response to a one percent increase in the amount of

Table 15 The impact of NSMP on MES – Sub-sample analysis

Dependent variable: *MES*	1	2	3	4
	NSMP variables			
	AP	Yield	SR	SMCI
NSMP	0.7785***	−0.3420***	−0.1818***	−1.6801***
	(0.219)	(0.096)	(0.051)	(0.473)
Total assets	1.1175***	1.1175***	1.1175***	1.1175***
	(0.099)	(0.099)	(0.099)	(0.099)
Market capitalisation	0.0302***	0.0302***	0.0302***	0.0302***
	(0.007)	(0.007)	(0.007)	(0.007)
Cost to income	0.0320***	0.0320***	0.0320***	0.0320***
	(0.007)	(0.007)	(0.007)	(0.007)
Income diversification	0.0043	0.0043	0.0043	0.0043
	(0.007)	(0.007)	(0.007)	(0.007)
Market concentration	−0.0678*	−0.0678*	−0.0678*	−0.0678*
	(0.038)	(0.038)	(0.038)	(0.038)
CISS	−0.0108**	−0.0108**	−0.0108**	−0.0108**
	(0.004)	(0.004)	(0.004)	(0.004)
SIFIs	0.25	0.25	0.25	0.25
	(0.304)	(0.304)	(0.304)	(0.304)
Bank type dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes
N	796	796	796	796
Adjusted R^2	0.6032	0.6032	0.6032	0.6032
Sargan-Hansen test (*p*-value)	0.1642	0.1642	0.1642	0.1642
GMM distance endogeneity test (*p*-value)	0.0000	0.0000	0.0000	0.0000
Kleibergen-Paap Wald F-test statistic	19.3386	19.3386	19.3386	19.3386
First stage F-test (*p*-value)	0.0000	0.0000	0.0000	0.0000

This Table reports the IV-GMM estimation results for a sub-sample of commercial banks, bank holding companies, co-operative banks, and savings banks. The dependent variable is the Marginal Expected Shortfall (MES) (%). Column 1 shows results with NSMP as the natural logarithm of the sum of total assets purchased and LTROs (AP). Column 2 shows results with the 10-year yields on synthetic sovereign bonds of Euro area countries. Column 3 shows results with the shadow rate (SR). Column 4 shows results with the SMCI. Bank-level variables are mean-centred. Explanatory variables are lagged one period, except for SIFIs which is a dummy variable for systemically important financial institutions. Variable definitions are as in Table 3. The Sargan-Hansen test is the test for overidentification. The null hypothesis tested under the GMM distance endogeneity test is that the specified endogenous regressors can actually be treated as exogenous. The Kleibergen-Paap Wald F-test statistic is a test for weak instruments and should have a value of at least 10 for weak identification not to be considered a problem (Staiger and Stock 1997). The First-stage F-test is another test of weak identification. First stage F-test *p*-value is the same for the endogenous variable and its interaction with NSMP. The endogenous variable is market capitalisation. The instruments are the equity-to-assets ratio and GDP growth. Robust standard errors are in (), N is the number of observations, R^2 is R-squared. *,**, and *** denote significance at the 10%, 5%, and 1% levels, respectively

assets purchased (column 1, Table 9). As for the other NSMP variables, a one pp increase in the bond yield, the shadow rate, or the SMCI is associated with a decrease in the MES by 34.7 bps, 18.5 bps, and 170.5 bps, respectively (columns 2–4, Table 9). These economic impacts are higher when we account for the interactions between NSMP and bank

Table 16 The impact of NSMP on MES—Regression with interactions – Sub-sample analysis

Dependent variable: *MES*	1	2	3	4
	NSMP variables			
	AP	Yield	SR	SMCI
NSMP	0.8720***	−0.3404***	−0.1868***	−1.7313***
	(0.209)	(0.095)	(0.049)	(0.478)
Total assets	1.6063	1.0553***	1.0669***	1.0491***
	(1.551)	(0.121)	(0.099)	(0.100)
NSMP*Total assets	−0.0276	0.0107	0.0036	0.1826**
	(0.074)	(0.030)	(0.017)	(0.081)
Market capitalisation	0.2472	0.0118	0.0539***	0.0304***
	(0.361)	(0.010)	(0.020)	(0.009)
NSMP* Market capitalisation	−0.0105	0.0122	0.0064*	0.0241
	(0.017)	(0.010)	(0.004)	(0.020)
Cost to income	0.3819***	0.0185**	0.0476***	0.0280***
	(0.141)	(0.009)	(0.008)	(0.007)
NSMP*Cost to income	−0.0166**	0.0067*	0.0047***	0.0115
	(0.007)	(0.004)	(0.002)	(0.013)
Income diversification	−0.0972	0.0048	0.0038	0.0049
	(0.259)	(0.013)	(0.008)	(0.008)
NSMP*Income diversification	0.0051	0.001	−0.0009	−0.0033
	(0.012)	(0.005)	(0.003)	(0.015)
Market concentration	−0.0912***	−0.0942***	−0.0898**	−0.0714*
	(0.035)	(0.036)	(0.035)	(0.037)
CISS	−0.0123***	−0.0126***	−0.0120***	−0.0118***
	(0.004)	(0.004)	(0.004)	(0.004)
SIFIs	0.5634*	0.4115	0.4528	0.3651
	(0.298)	(0.306)	(0.303)	(0.315)
Bank type dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes
N	778	778	778	778
Adjusted R^2	0.6251	0.6115	0.6124	0.617
Sargan-Hansen test (*p*-value)	0.1332	0.1412	0.1528	0.8744
GMM distance endogeneity test (*p*-value)	0.0013	0.0000	0.0005	0.0001
Kleibergen-Paap Wald F-test statistic	11.2669	12.6904	10.8188	11.3351
First stage F-test (*p*-value)	0.0000	0.0000	0.0000	0.0000

This Table reports the IV-GMM estimation results for a sub-sample of commercial banks, bank holding companies, co-operative banks, and savings banks, with interaction terms between NSMP and bank-level variables included. The dependent variable is the Marginal Expected Shortfall (MES) (%). Column 1 shows results with NSMP as the natural logarithm of the sum of total assets purchased and LTROs (AP). Column 2 shows results with the 10-year yields on synthetic sovereign bonds of Euro area countries. Column 3 shows results with the shadow rate (SR). Column 4 shows results with the SMCI. Bank-level variables are mean-centred. Explanatory variables are lagged one period, except for SIFIs which is a dummy variable for systemically important financial institutions. Variable definitions are as in Table 3. The Sargan-Hansen test is the test for overidentification. The null hypothesis tested under the GMM distance endogeneity test is that the specified endogenous regressors can actually be treated as exogenous. The Kleibergen-Paap Wald F-test statistic is a test for weak instruments and should have a value of at least 10 for weak identification not to be considered a problem (Staiger and Stock 1997). The First-stage F-test is another test of weak iden-

Table 16 (continued)

tification. First stage F-test p-value is the same for the endogenous variable and its interaction with NSMP. The endogenous variable is market capitalisation. The instruments are the equity-to-assets ratio and GDP growth. Robust standard errors are in (), N is the number of observations, R^2 is R-squared. *,**, and *** denote significance at the 10%, 5%, and 1% levels, respectively

characteristics (Table 10). Again, we find some evidence of a more pronounced negative effect of NSMP in increasing systemic risk in smaller (columns 1, 2, and 4, Table 10), undercapitalised (columns 1–3, Table 10), and less efficient (columns 1 and 4, Table 10) banks.

The above results reveal that further monetary easing poses a threat to financial stability, thus supporting hypothesis H_0, consistently across NSMP and systemic risk alternatives. Therefore, there is robust evidence suggesting that the systemic risk-taking channel of monetary policy is at play in the Eurozone. With expansionary monetary policies through unconventional tools, policymakers aim to stipulate growth, investment, spending, and, in turn, overall economic activity. In crisis times such as the Eurozone debt crisis and exceptional circumstances such as the COVID-19 pandemic, these measures aim to alleviate the adverse impacts of the distressed situations. However, financial stability can be at stake as it is impossible to eliminate the side effects of these unconventional monetary policy tools. This proved to be the case with bank systemic risk based on our results for the Euro area between 2008 and 2020. Further asset purchase programmes, coupled with too-low-for-too-long short-term interest rates, create an environment where banks are induced to take risks, adding to the network effect they inherit from the nature of their business by making other banks and the whole financial system more vulnerable to stressed market conditions. The mechanisms are explained by the "search for yield", the appreciation of asset prices, reduced returns volatility, and the implicit government safety net, as mentioned in sub-Sect. 3.1. As banks in our sample are listed, they are more likely to be exposed to market volatility, complex financial linkages, counterparty risk, and correlated risks.

To the best of our knowledge, with bank systemic risk as a centred focus, no direct comparison can be made between our study and earlier studies in the literature. Kabundi and De Simone (2020), Faia and Karau (2021), Kabundi and De Simone (2022) are a few recent, topic-related studies in the literature that we provide complementary findings to, as already discussed in sub-Sect. 3.2. These studies, in general, find a presence of systemic risk-taking corresponding to unconventional monetary policy easing. Using three different measures of systemic risk and four different proxies for unconventional monetary policies and offering micro-level evidence, our results highlight that bank systemic risk is monetary policy dependent. Further expansion of NSMP increases bank sensitivity to contagion and interconnectedness, and the overall impact is also susceptible to the strength of the bank's balance sheet. Bolstering key balance sheet characteristics can help banks reduce the unintended consequences of ultra-easy monetary conditions. Furthermore, monitoring bank systemic risk can be part of the tasks concerning policymakers when deciding on the next tools and implementation of monetary policy.

5.2 The impact of other determinants

With respect to the effect of bank-specific variables, size is found to be an important driver of systemic risk, in line with the literature (Basel 2013; Laeven et al. 2016; Varotto and Zhao 2018; Buch et al. 2019; Hedström et al. 2024), irrespective of systemic risk metrics used. Its effect is positive and statistically significant across all models, as previously found in the literature (De Jonghe et al. 2015; Borri and Di Giorgio 2022; Mies 2024). Large banks usually own a significant market share, with their financial products and services being harder to be replaced quickly and cheaply should they fail. They also tend to be more complex in business models, which can involve cross-jurisdictional activities, further amplifying the likelihood of distress at other financial institutions in the event of their failure. In another strand, they also benefit from the "too-big-to-fail" phenomenon, such that the supervisory authorities have no option but to make good on their obligations. As a result, larger banks are more prone to risk-taking, a typical type of moral hazard due to government subsidies.

On the effect of market capitalisation, there are mixed findings. Greater market capitalisation reduces SRISK, supporting Laeven et al. (2016), while the contrary is found for ΔCoVaR and the MES, in line with Apergis et al. (2022). The positive association between market capitalisation and systemic risk is not unusual. It could be due to the fact that under the low interest rate environment and expansionary unconventional monetary policies, bank market value will increase when rates are lower, which, in turn, could encourage more risk-taking. Contradictory but insightful results have been presented in the empirical literature about the effect of bank capital. One can argue that shareholders stand to lose more with more capital being put in the banks, should risk-taking activities do not pay off. Thus, moral hazard could be discouraged with higher capital requirements (Jiménez et al. 2014). Others can argue that ample capital secures greater loss-absorbing capacity and, therefore, banks find more leeway in lending and investment decisions (Gambacorta and Mistrulli 2004; Altunbas et al. 2014; Bonfim and Soares 2018). As discussed in sub-Sect. 4.3, although capital-abundant financial institutions could withstand more risk, the fact that they can stretch their risk tolerance could actually serve as a motive for them to engage in more risky positions, as a result, exposing them to higher systemic risk. As argued in Allahrakha et al. (2018) and Duffie (2018), the Basel III leverage ratio, once becoming binding, could incentivise banks to shift risk. Another potential explanation for this positive relationship is reported in Chen et al. (2021), who find that banks under greater initial capital stringency are exposed to higher systemic risk as it will be more difficult for them to raise capital during distress, in turn experiencing capital shortfall.

Regarding performance, financial institutions which are cost inefficient pose greater systemic risk. This is confirmed across systemic risk measures (Tables 6, 7, 8, 9, 10). This finding is somewhat related to the "*bad management*" hypothesis (Berger and DeYoung 1997), whereby managers' incompetence in controlling daily operational expenses is usually associated with greater credit risk due to inabilities in credit screening and loan monitoring. Cost efficiency can dictate bank survival, affecting overall bank soundness, as worst performing banks build up losses and have to exit the market. Our result lends support to similar findings in the literature. De Jonghe et al. (2015) provide evidence for greater systemic risk corresponding to higher cost-to-income ratio in publicly traded European banks between 2005 and 2013. Apergis et al. (2022) also report a positive relationship between cost inefficiency and SRISK in OECD listed banks.

As for income diversification, it is found to reduce SRISK (Tables 5 and 6), consistent with the results of Buch et al. (2019) and Apergis et al. (2022). We further find some evidence (statistically significant at the 10% level) that banks with higher proportion of non-interest income are associated with higher ΔCoVaR (Tables 7 and 8), whereas with the MES, the evidence is weak (Tables 9 and 10). Hence, just like what has been reported and explained in the literature (Nguyen et al. 2012; Buch et al. 2019) as discussed in Sect. 4.3, we find no clear-cut evidence for the impact of income diversification on systemic risk. However, according to the statistical significance of the coefficients, it appears that the negative relationship between income diversification and systemic risk dominates.

As expected, SIFIs are more systemically important than non-SIFIs, as denoted by the positive and highly significant coefficients of the SIFI dummy variable (Tables 5, 6 and 9, 10). In terms of macroeconomic variables, we find a positive association between the CISS and SRISK, suggesting that higher systemic stress at the country level is an important indicator of greater systemic risk at the bank level, as in Gehrig and Iannino (2021). On the other hand, market concentration is not found to be a driver of systemic risk.

5.3 Sub-sample analysis

One could argue that monetary policies are directly intended to apply to banks. Therefore, it is essential to conduct the analysis on a sub-sample of commercial banks, bank holding companies, co-operative banks, and savings banks. In the sub-sample analysis, bank type dummies and a dummy for SIFIs are also included to account for heterogeneity between bank types. Tables 11, 12, 13, 14, 15, 16 report the results for the sub-sample.

As shown in Tables 11, 12, the positive relationship between the amount of assets purchased and SRISK and the negative relationship between SRISK and the other NSMP proxies (yield, shadow rate, and SMCI) are confirmed for the sub-sample, further supporting hypothesis H_0. The economic impacts of NSMP on SRISK are slightly smaller in absolute terms for the sub-sample than those in the case of all banks reported in Table 5. Moreover, we find some evidence of a stronger effect of NSMP on SRISK in more capitalised (column 2, Table 12) and cost-efficient banks (column 1, Table 12), statistically significant at the 10% level. Dell'Ariccia et al. (2017) also find that a decrease in interest rates is associated with greater risk-taking, more markedly in strongly capitalised banks.

As far as ΔCoVaR is concerned (Tables 13, 14), we also find evidence in favour of hypothesis H_0 (Tables 13, 14). Compared to the results in Tables 7, 8, a relatively higher (in absolute terms) economic impact of NSMP on ΔCoVaR is reported for the sub-sample. This impact is more prominent on larger banks (columns 2 and 3, Table 13) but weaker on well-capitalised (columns 1–3, Table 13) and well-diversified banks (columns 2–4, Table 13).

With the MES as the systemic risk metric (Tables 15, 16), hypothesis H_0 is once again confirmed. The magnitudes of the impacts of NSMP on the MES are found to be marginally smaller in absolute terms for the sub-sample than those reported in Tables 9 and 10. Larger (column 4, Table 16), well-capitalised (column 3, Table 16), and more cost-inefficient (columns 1–3, Table 16) banks see a weaker impact of NSMP on their MES. As with the case of all banks reported in Table 9, a larger size, greater market capitalisation, and a higher expense ratio (Table 15) are associated with greater systemic risk (Bakkar and Nyola 2021).

Therefore, according to the above results, the negative impact of expansionary unconventional monetary policy on systemic risk is consistent for the sub-sample. The effects of the control variables on systemic risk are also similar to those reported for all banks and financial firms in the previous sub-section. Higher amounts of total assets entail greater systemic risk (De Jonghe et al. 2015; Borri and Di Giorgio 2022). Greater market capitalisation and income diversification are found to lower SRISK (Tables 11, 12), in line with Bakkar and Nyola (2021) and Buch et al. (2019). Mixed findings on the effect of cost efficiency on SRISK correspond to those reported in Bakkar and Nyola (2021). Higher ΔCoVaR and MES values are associated with greater market capitalisation and cost inefficiency (Tables 13, 14, 15, 16). Higher macroeconomic systemic stress also contributes to SRISK of individual banks in the sub-sample.

In terms of institutional settings, the higher the market concentration, the lower the MES (Tables 15–16) and ΔCoVaR (Table 14), implying that the "*competition-fragility*" hypothesis (Beck et al. 2006; Beck 2008; Liu and Wilson 2013; Mamatzakis and Vu 2018) may be at play for these banks. In a less consolidated market, banks would have to compete more aggressively to increase their market share and profit, and thus may be more inclined to take on more risk to compensate for the profits forgone in reduced lending opportunities. The rise in credit risk due to banks relaxing their lending standards to compete for customers could be a source of financial instability, in turn contributing to bank systemic risk. With respect to country-level systemic stress, interestingly, this group of banks and bank holding companies would exhibit a reduced level of MES following a sign of greater sovereign uncertainties. This finding could unveil the fact that these banks react promptly to changes in macroeconomic conditions, where rising domestic uncertainties push them to take precautionary measures to ensure viability.

5.4 Robustness checks

In this sub-section, we discuss the results when leverage is used as a source of endogeneity. The tables presenting these results are provided in Appendix 3 (Tables C1-C6 for all banks and Tables C7-C12 for the sub-sample of commercial banks, bank holding companies, co-operative banks, and savings banks). As mentioned at the beginning of Sect. 5, tests for endogeneity, overidentification, and weak instruments confirm that our models are appropriate.

The main results for all banks in the sample are consistent with those reported in Tables 5–10. Overly easy unconventional monetary policy is associated with greater systemic risk (Tables C1-C6). The same is true for the banks in the sub-sample (Tables C7–C12). The negative effect of easing NSMP on SRISK is more pronounced for smaller and highly leveraged banks (columns 1 and 3, Table C2). With ΔCoVaR, smaller and more cost-efficient banks witness a stronger impact of NSMP (Table C4). This is also true for more cost-efficient banks in the sub-sample (Table C10). As for the MES, its relationship with NSMP is also more significant in smaller, highly leveraged, and more cost-efficient and income-diversified banks (Table C6). This result also holds for smaller and more cost-efficient banks in the sub-sample (Table C12).

With regard to the effects of bank-specific variables, size remains an important driver of systemic risk (Tables C1–C12). Similar to market capitalisation, leverage has mixed effects. In general, we mostly find a positive relationship between leverage and SRISK (Tables C1, C2, C7, C8), in line with the negative relationship between market capitalisation and SRISK shown in Tables 5, 6 and 11, 12. On the other hand, more leverage reduces ΔCoVaR, although with a small magnitude (Tables C3, C4, C9, C10). Mixed effects are found for the MES, with the effect being negative when considering all banks (Table C6) but positive for the sub-sample (Tables C11, C12). Generally, income diversification lowers systemic risk, while cost inefficiency increases it. However, some variations are reported for ΔCoVaR with respect to the impacts of these two determinants. Again, SIFIs are found to pose greater systemic risk than their peers (Tables C1, C2, C5, C6, C11, C12). As for the effects of the macroeconomic variables, a higher degree of market concentration reduces systemic risk (Tables C3, C5, C10-C12), confirming the existence of the "*competition-fragility*" hypothesis discussed in sub-Sect. 5.3.

6 Conclusion

In this study, we explore the relationship between NSMP and bank systemic risk of listed financial institutions in the Eurozone between 2008 and 2020. We find consistent evidence for a positive relationship between NSMP and systemic risk, i.e. further expansionary unconventional monetary policies are associated with greater bank systemic risk, supporting the systemic risk-taking channel of monetary policy (Colletaz et al. 2018). The results are robust to different systemic risk metrics and NSMP proxies. The impact of NSMP on systemic risk is stronger for smaller, undercapitalised, and well-diversified banks. We also perform the analysis on a sub-sample of commercial banks, bank holding companies, co-operative banks, and savings banks. The main finding of NSMP increasing bank systemic risk holds in this sub-sample. However, there is mixed evidence with respect to the interaction of NSMP with bank characteristics, depending on the systemic risk measure. The results highlight that heterogeneity exists among financial institutions and could catalyse the transmission of monetary policy, as theorised in the literature.

Our study comes at a time when there seems to be a never-ending implementation of NSMP in major economies around the world. Japan has enforced an aggressive quantitative easing policy for a decade to battle sluggish growth and counter disinflationary pressures. The asset purchase programmes in the Euro area, although recently terminated, definitely did not end the era of non-standard monetary policy tools in the European Monetary Union. The TLTROs, reinstated in September 2019 with seven series, aimed at further incentivising bank lending to the real economy. They were followed by the Pandemic Emergency Purchase Programme launched in March 2020 in response to the COVID-19 pandemic. This programme could be the very much needed lifeline to avoid an economic crisis stemming from the prolonged consequences of the recent health crisis. However, the effectiveness of these programmes could be offset by heightened bank systemic risk, emphasising the trade-off between financial and price stability. Therefore, cautions should remain in place at the monetary union level when making inferences about the macroeconomic effects of these policies.

Policy implications of our study can be far-reaching. Bank systemic risk metrics should be actively monitored alongside other bank-characteristic variables that represent microprudential regulations. NSMP concerning the whole Euro area should be exercised in connection with the stance of systemically important financial institutions to lower the likelihood of financial spillovers across the monetary union. Macroprudential policy measures may need to be well-coordinated with microprudential policy tools to mitigate the potential adverse, unwanted consequences of expansionary monetary policy shocks on financial stability.

Appendix 1

See Tables 17

Table 17 Number of SIFIs, banks/FIs and observations per specialisation

Specialisation Description	Number of SIFIs	Number of banks/FIs	Number of observations
Bank Holding Companies	4	10	62
Co-operative Banks	2	20	210
Commercial Banks	31	66	573
Finance Companies	0	25	139
Investment Banks	0	11	95
Investment & Trust Corporations	0	3	25
Private Banking	0	7	62
Real Estate & Mortgage FIs	0	5	24
Savings Banks	1	5	37
Securities Firms	0	7	51
Total	38	159	1278

This Table reports the total number of systemically important financial institutions (SIFIs), banks/financial institutions (FIs), and observations per specialisation. The total number of banks/FIs also includes SIFIs

Appendix 2

See Table 18

Table 18 Number of SIFIs, banks/FIs and observations per country

Country	Number of SIFIs	Number of banks/FIs	Number of observa-tions
Austria	3	9	79
Belgium	1	5	37
Cyprus	2	5	33
Estonia	0	1	4
Finland	0	7	46
France	3	35	298
Germany	2	31	239
Greece	4	5	48
Ireland	2	4	18
Italy	4	27	222
Lithuania	1	1	12
Luxembourg	0	1	3
Malta	2	4	41
Netherlands	2	7	46
Portugal	3	3	26
Slovakia	2	3	35
Slovenia	3	3	9
Spain	4	8	82
Total	38	159	1278

This Table reports the total number of systemically important financial institutions (SIFIs), banks/financial institutions (FIs) and observations per country. The total number of banks/FIs also includes SIFIs

Appendix 3

See Tables 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30

Table 19 The impact of NSMP on SRISK—Robustness check

Dependent variable: *SRISK (ln)*	1	2	3	4
	NSMP variables			
	AP	Yield	SR	SMCI
NSMP	1.1136***	−0.4893***	−0.2600***	−2.4034***
	(0.339)	(0.149)	(0.079)	−0.732
Total assets	0.6944***	0.6944***	0.6944***	0.6944***
	(0.123)	(0.123)	(0.123)	(0.123)
Leverage	0.0021***	0.0021***	0.0021***	0.0021***
	(0.000)	(0.000)	(0.000)	(0.000)
Cost to income	0.0139*	0.0139*	0.0139*	0.0139*
	(0.008)	(0.008)	(0.008)	(0.008)
Income diversification	−0.0556***	−0.0556***	−0.0556***	−0.0556***
	(0.009)	(0.009)	(0.009)	(0.009)
Market concentration	0.0037	0.0037	0.0037	0.0037
	(0.055)	(0.055)	(0.055)	(0.055)
CISS	0.0243***	0.0243***	0.0243***	0.0243***
	(0.005)	(0.005)	(0.005)	(0.005)
SIFIs	1.3570***	1.3570***	1.3570***	1.3570***
	(0.401)	(0.401)	(0.401)	(0.401)
Bank type dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes
N	1202	1202	1202	1202
Adjusted R^2	0.6851	0.6851	0.6851	0.6851
Sargan-Hansen test (*p*value)	0.1079	0.1079	0.1079	0.1079
GMM distance endogeneity test (*p*value)	0.0001	0.0001	0.0001	0.0001
Kleibergen-Paap Wald F-test statistic	20.3786	20.3786	20.3786	20.3786
First stage F-test (*p*value)	0.0000	0.0000	0.0000	0.0000

This Table reports the IV-GMM estimation results for the entire sample. The dependent variable is the natural logarithm of SRISK. Column 1 shows results with NSMP as the natural logarithm of the sum of the total assets purchased and LTROs (AP). Column 2 shows results with the 10-year yields on synthetic sovereign bonds of Euro area countries. Column 3 shows results with the shadow rate (SR). Column 4 shows results with the SMCI. Bank-level variables are mean-centred. Explanatory variables are lagged one period, except for SIFIs which is a dummy variable for systemically important financial institutions. Variable definitions are as in Table 3. The Sargan-Hansen test is the test for overidentification. The null hypothesis tested under the GMM distance endogeneity test is that the specified endogenous regressors can actually be treated as exogenous. The Kleibergen-Paap Wald F-test statistic is a test for weak instruments and should have a value of at least 10 for weak identification not to be considered a problem (Staiger and Stock 1997). The First-stage F-test is another test of weak identification. The endogenous variable is leverage. The instruments are the equity-to-assets ratio and GDP growth. Robust standard errors are in (), N is the number of observations, R^2 is R-squared. *,**, and *** denote significance at the 10%, 5%, and 1% levels, respectively

Table 20 The impact of NSMP on SRISK—Regression with interactions—Robustness check

Dependent variable: *SRISK (ln)*	1	2	3	4
	NSMP variables			
	AP	Yield	SR	SMCI
NSMP	1.0534***	−0.4127**	−0.2769***	−2.2585***
	(0.344)	(0.166)	(0.085)	(0.755)
Total assets	5.8204***	0.5568***	0.9743***	0.6595***
	(2.050)	(0.152)	(0.162)	(0.123)
NSMP*Total assets	−0.2430**	0.0587	0.0809***	0.1042
	(0.097)	(0.059)	(0.029)	(0.152)
Leverage	−0.0239*	0.0024***	0.0011*	0.0022***
	(0.012)	(0.001)	(0.001)	0.000
NSMP*Leverage	0.0012**	−0.0001	−0.0004**	0.0001
	(0.001)	(0.000)	(0.000)	(0.001)
Cost to income	0.1408	0.006	0.0161	0.014
	(0.182)	(0.014)	(0.013)	(0.009)
NSMP*Cost to income	−0.006	0.004	0.0005	0.0066
	(0.009)	(0.005)	(0.003)	(0.014)
Income diversification	0.1094	−0.0681***	−0.0486***	−0.0563***
	(0.197)	(0.015)	(0.011)	(0.009)
NSMP*Income diversification	−0.0078	0.0066	0.0014	0.0227
	(0.009)	(0.005)	(0.003)	(0.014)
Market concentration	0.0278	−0.0106	0.0332	−0.0211
	(0.059)	(0.059)	(0.056)	(0.061)
CISS	0.0234***	0.0240***	0.0213***	0.0243***
	(0.005)	(0.005)	(0.005)	(0.005)
SIFIs	1.2575***	1.3920***	1.2001***	1.4183***
	(0.397)	(0.411)	(0.410)	(0.409)
Bank type dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes
N	1202	1202	1202	1202
Adjusted R^2	0.6875	0.678	0.69	0.6807
Sargan-Hansen test (*p*value)	0.3073	0.1397	0.1139	0.1143
GMM distance endogeneity test (*p*value)	0.0001	0.0001	0.0006	0.0002
Kleibergen-Paap Wald F-test statistic	11.6714	13.5731	10.1141	12.8386
First stage F-test (*p*value)	0.0000	0.0000	0.0000	0.0000

This Table reports the IV-GMM estimation results for the entire sample, with interaction terms between NSMP and bank-level variables included. The dependent variable is the natural logarithm of SRISK. Column 1 shows results with NSMP as the natural logarithm of the sum of the total assets purchased and LTROs (AP). Column 2 shows results with the 10-year yields on synthetic sovereign bonds of Euro area countries. Column 3 shows results with the shadow rate (SR). Column 4 shows results with the SMCI. Bank-level variables are mean-centred. Explanatory variables are lagged one period, except for SIFIs which is a dummy variable for systemically important financial institutions. Variable definitions are as in Table 3. The Sargan-Hansen test is the test for overidentification. The null hypothesis tested under the GMM distance endogeneity test is that the specified endogenous regressors can actually be treated as exogenous. The Kleibergen-Paap Wald F-test statistic is a test for weak instruments and should have a value of at least 10 for weak identification not to be considered a problem (Staiger and Stock 1997). The First-stage F-test is another test of weak identification. First stage F-test *p*-value is the same for the endogenous variable and its

Table 20 (continued)

interaction with NSMP. The endogenous variable is leverage. The instruments are the equity-to-assets ratio and GDP growth. Robust standard errors are in (), N is the number of observations, R^2 is R-squared. *,**, and *** denote significance at the 10%, 5%, and 1% levels, respectively

Table 21 The impact of NSMP on ΔCoVaR—Robustness check

Dependent variable: *ΔCoVaR*	1	2	3	4
	NSMP variables			
	AP	Yield	SR	SMCI
NSMP	0.2380***	−0.1046***	−0.0556***	−0.5137***
	(0.047)	(0.021)	(0.011)	(0.102)
Total assets	0.2490***	0.2490***	0.2490***	0.2490***
	(0.018)	(0.018)	(0.018)	(0.018)
Leverage	−0.0003***	−0.0003***	−0.0003***	−0.0003***
	(0.000)	(0.000)	(0.000)	(0.000)
Cost to income	0.0014**	0.0014**	0.0014**	0.0014**
	(0.001)	(0.001)	(0.001)	(0.001)
Income diversification	0.0029**	0.0029**	0.0029**	0.0029**
	(0.001)	(0.001)	(0.001)	(0.001)
Market concentration	−0.0158**	−0.0158**	−0.0158**	−0.0158**
	(0.008)	(0.008)	(0.008)	(0.008)
CISS	−0.0019**	−0.0019**	−0.0019**	−0.0019**
	(0.001)	(0.001)	(0.001)	(0.001)
SIFIs	0.0732	0.0732	0.0732	0.0732
	(0.065)	(0.065)	(0.065)	(0.065)
Bank type dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes
N	1159	1159	1159	1159
Adjusted R^2	0.6019	0.6019	0.6019	0.6019
Sargan-Hansen test (*p*value)	0.1055	0.1055	0.1055	0.1055
GMM distance endogeneity test (*p*value)	0.0000	0.0000	0.0000	0.0000
Kleibergen-Paap Wald F-test statistic	13.1516	13.1516	13.1516	13.1516
First stage F-test (*p*value)	0.0000	0.0000	0.0000	0.0000

This Table reports the IV-GMM estimation results for the entire sample. The dependent variable is ΔCoVaR (%). Column 1 shows results with NSMP as the natural logarithm of the sum of total assets purchased and LTROs (AP). Column 2 shows results with the 10-year yields on synthetic sovereign bonds of Euro area countries. Column 3 shows results with the shadow rate (SR). Column 4 shows results with the SMCI. Bank-level variables are mean-centred. Explanatory variables are lagged one period, except for SIFIs which is a dummy variable for systemically important financial institutions. Variable definitions are as in Table 3. The Sargan-Hansen test is the test for overidentification. The null hypothesis tested under the GMM distance endogeneity test is that the specified endogenous regressors can actually be treated as exogenous. The Kleibergen-Paap Wald F-test statistic is a test for weak instruments and should have a value of at least 10 for weak identification not to be considered a problem (Staiger and Stock 1997). The First-stage F-test is another test of weak identification. The endogenous variable is leverage. The instruments are the equity-to-assets ratio and GDP growth. Robust standard errors are in (), N is the number of observations, R^2 is R-squared. *,**, and *** denote significance at the 10%, 5%, and 1% levels, respectively

Table 22 The impact of NSMP on ΔCoVaR—Regression with interactions—Robustness check

Dependent variable: *ΔCoVaR*	1	2	3	4
	NSMP variables			
	AP	Yield	SR	SMCI
NSMP	0.2030***	−0.0930***	−0.0465***	−0.5170***
	(0.050)	(0.022)	(0.012)	(0.104)
Total assets	0.9074***	0.2418***	0.2799***	0.2487***
	(0.340)	(0.023)	(0.025)	(0.017)
NSMP*Total assets	−0.0310*	0.0092	0.0064	0.0554***
	(0.016)	(0.009)	(0.004)	(0.020)
Leverage	−0.0022	−0.0003***	−0.0004***	−0.0003***
	(0.002)	(0.000)	(0.000)	(0.000)
NSMP*Leverage	0.0001	0.0000	0.0000	−0.0001
	(0.000)	(0.000)	(0.000)	(0.000)
Cost to income	0.0602**	−0.0003	0.0047***	0.0017**
	(0.027)	(0.001)	(0.002)	(0.001)
NSMP*Cost to income	−0.0027**	0.0012**	0.0008**	0.0021*
	(0.001)	(0.001)	(0.000)	(0.001)
Income diversification	−0.0039	0.0037*	0.0018	0.0027**
	(0.025)	(0.002)	(0.002)	(0.001)
NSMP*Income diversification	0.0003	−0.0007	−0.0003	−0.0005
	(0.001)	(0.001)	(0.000)	(0.002)
Market concentration	−0.0118	−0.0134	−0.0137	−0.0116
	(0.009)	(0.009)	(0.009)	(0.008)
CISS	−0.0020**	−0.0021***	−0.0021***	−0.0020***
	(0.001)	(0.001)	(0.001)	(0.001)
SIFIs	0.0543	0.0488	0.0418	0.0574
	(0.065)	(0.068)	(0.067)	(0.063)
Bank type dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes
N	1159	1159	1159	1159
Adjusted R^2	0.5768	0.5748	0.5614	0.61
Sargan-Hansen test (*p*value)	0.1735	0.2261	0.289	0.3089
GMM distance endogeneity test (*p*value)	0.000	0.000	0.000	0.000
Kleibergen-Paap Wald F-test statistic	10.4713	10.4248	12.1586	11.5957
First stage F-test (*p*value)	0.0000	0.0000	0.0000	0.0000

This Table reports the IV-GMM estimation results for the entire sample, with interaction terms between NSMP and bank-level variables included. The dependent variable is ΔCoVaR (%). Column 1 shows results with NSMP as the natural logarithm of the sum of total assets purchased and LTROs (AP). Column 2 shows results with the 10-year yields on synthetic sovereign bonds of Euro area countries. Column 3 shows results with the shadow rate (SR). Column 4 shows results with the SMCI. Bank-level variables are mean-centred. Explanatory variables are lagged one period, except for SIFIs which is a dummy variable for systemically important financial institutions. Variable definitions are as in Table 3. The Sargan-Hansen test is the test for overidentification. The null hypothesis tested under the GMM distance endogeneity test is that the specified endogenous regressors can actually be treated as exogenous. The Kleibergen-Paap Wald F-test statistic is a test for weak instruments and should have a value of at least 10 for weak identification not to be considered a problem (Staiger and Stock 1997). The First-stage F-test is another test of weak identification. The endogenous variable is leverage. The instruments are the equity-to-assets ratio and GDP growth. Robust standard

Table 22 (continued)

errors are in (), N is the number of observations, R^2 is R-squared. *,**, and *** denote significance at the 10%, 5%, and 1% levels, respectively

Table 23 The impact of NSMP on MES—Robustness check

Dependent variable: *MES*	1	2	3	4
	NSMP variables			
	AP	Yield	SR	SMCI
NSMP	0.7540***	−0.3312***	−0.1760***	−1.6271***
	(0.269)	(0.118)	(0.063)	(0.580)
Total assets	0.5850***	0.5850***	0.5850***	0.5850***
	(0.121)	(0.121)	(0.121)	(0.121)
Leverage	−0.0007	−0.0007	−0.0007	−0.0007
	(0.000)	(0.000)	(0.000)	(0.000)
Cost to income	0.0435***	0.0435***	0.0435***	0.0435***
	(0.017)	(0.017)	(0.017)	(0.017)
Income diversification	−0.0057	−0.0057	−0.0057	−0.0057
	(0.006)	(0.006)	(0.006)	(0.006)
Market concentration	−0.1157**	−0.1157**	−0.1157**	−0.1157**
	(0.048)	(0.048)	(0.048)	(0.048)
CISS	−0.0083**	−0.0083**	−0.0083**	−0.0083**
	(0.004)	(0.004)	(0.004)	(0.004)
SIFIs	1.6631***	1.6631***	1.6631***	1.6631***
	(0.367)	(0.367)	(0.367)	(0.367)
Bank type dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes
N	1139	1139	1139	1139
Adjusted R^2	0.5116	0.5116	0.5116	0.5116
Sargan-Hansen test (*p*value)	0.721	0.721	0.721	0.721
GMM distance endogeneity test (*p*value)	0.0522	0.0522	0.0522	0.0522
Kleibergen-Paap Wald F-test statistic	15.6765	15.6765	15.6765	15.6765
First stage F-test (*p*value)	0.0000	0.0000	0.0000	0.0000

This Table reports the IV-GMM estimation results for the entire sample. The dependent variable is the Marginal Expected Shortfall (MES) (%). Column 1 shows results with NSMP as the natural logarithm of the sum of total assets purchased and LTROs (AP). Column 2 shows results with the 10-year yields on synthetic sovereign bonds of Euro area countries. Column 3 shows results with the shadow rate (SR). Column 4 shows results with the SMCI. Bank-level variables are mean-centred. Explanatory variables are lagged one period, except for SIFIs which is a dummy variable for systemically important financial institutions. Variable definitions are as in Table 3. The Sargan-Hansen test is the test for overidentification. The null hypothesis tested under the GMM distance endogeneity test is that the specified endogenous regressors can actually be treated as exogenous. The Kleibergen-Paap Wald F-test statistic is a test for weak instruments and should have a value of at least 10 for weak identification not to be considered a problem (Staiger and Stock 1997). The First-stage F-test is another test of weak identification. The endogenous variable is leverage. The instruments are the equity-to-assets ratio and GDP growth. Robust standard errors are in (), N is the number of observations, R^2 is R-squared. *,**, and *** denote significance at the 10%, 5%, and 1% levels, respectively

Table 24 The impact of NSMP on MES—Regression with interactions Robustness check

Dependent variable: *MES*	1	2	3	4
	NSMP variables			
	AP	Yield	SR	SMCI
NSMP	1.1561***	−0.5502***	−0.2376***	−2.2302***
	(0.297)	(0.154)	(0.073)	(0.506)
Total assets	4.2359**	0.3844***	0.7755***	0.3835***
	(1.658)	(0.124)	(0.131)	−0.057
NSMP*Total assets	−0.1728**	0.1169***	0.0539**	0.4826***
	(0.079)	(0.044)	(0.023)	(0.091)
Leverage	−0.0147*	−0.0001	−0.0013***	0.0003
	(0.009)	(0.001)	(0.000)	(0.000)
NSMP*Leverage	0.0007	−0.0003	−0.0002*	−0.0015***
	(0.000)	(0.000)	(0.000)	(0.000)
Cost to income	−0.2636	0.0519**	0.0394***	0.0123***
	(0.306)	(0.026)	(0.011)	(0.004)
NSMP*Cost to income	0.0142	−0.0067	−0.0009	0.0212**
	(0.015)	(0.008)	(0.004)	(0.010)
Income diversification	−0.1409	−0.0016	−0.0137**	−0.0013
	(0.140)	(0.010)	(0.007)	(0.004)
NSMP*Income diversification	0.0065	−0.0028	−0.0028	−0.0168**
	(0.007)	(0.004)	(0.002)	(0.008)
Market concentration	−0.0739	−0.0736	−0.0721	−0.0266
	(0.049)	(0.048)	(0.050)	(0.043)
CISS	−0.0094**	−0.0093**	−0.0101***	−0.0061*
	(0.004)	(0.004)	(0.004)	(0.003)
SIFIs	1.5578***	1.4661***	1.5037***	1.8538***
	(0.337)	(0.355)	(0.356)	(0.257)
Bank type dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes
N	1139	1139	1139	1139
Adjusted R^2	0.5223	0.5212	0.4985	0.5519
Sargan-Hansen test (*p*value)	0.9678	0.4439	0.7688	0.2224
GMM distance endogeneity test (*p*value)	0.0023	0.0125	0.0035	0.0062
Kleibergen-Paap Wald F-test statistic	11.4122	12.1738	11.42	17.3257
First stage F-test (*p*value)	0.0000	0.0000	0.0000	0.0000

This Table reports the IV-GMM estimation results for the entire sample, with interaction terms between NSMP and bank-level variables included. The dependent variable is the Marginal Expected Shortfall (MES) (%). Column 1 shows results with NSMP as the natural logarithm of the sum of total assets purchased and LTROs (AP). Column 2 shows results with the 10-year yields on synthetic sovereign bonds of Euro area countries. Column 3 shows results with the shadow rate (SR). Column 4 shows results with the SMCI. Bank-level variables are mean-centred. Explanatory variables are lagged one period, except for SIFIs which is a dummy variable for systemically important financial institutions. Variable definitions are as in Table 3. The Sargan-Hansen test is the test for overidentification. The null hypothesis tested under the GMM distance endogeneity test is that the specified endogenous regressors can actually be treated as exogenous. The Kleibergen-Paap Wald F-test statistic is a test for weak instruments and should have a value of at least 10 for weak identification not to be considered a problem (Staiger and Stock 1997). The First-stage F-test is another test of weak identification. First stage F-test *p*-value is the same for the endogenous variable and its

Table 24 (continued)

interaction with NSMP. The endogenous variable is leverage. The instruments are the equity-to-assets ratio and GDP growth. Robust standard errors are in (), N is the number of observations, R^2 is R-squared. *,**, and *** denote significance at the 10%, 5%, and 1% levels, respectively

Table 25 The impact of NSMP on SRISK – Sub-sample analysis—Robustness check

Dependent variable: *SRISK (ln)*	1	2	3	4
	NSMP variables			
	AP	Yield	SR	SMCI
NSMP	1.1753***	−0.5551***	−0.2435***	−1.2099***
	(0.347)	(0.164)	(0.072)	(0.357)
Total assets	1.3382***	1.3382***	1.3382***	1.3382***
	(0.109)	(0.109)	(0.109)	(0.109)
Leverage	0.0012***	0.0012***	0.0012***	0.0012***
	(0.000)	(0.000)	(0.000)	(0.000)
Cost to income	−0.0076	−0.0076	−0.0076	−0.0076
	(0.006)	(0.006)	(0.006)	(0.006)
Income diversification	−0.0577***	−0.0577***	−0.0577***	−0.0577***
	(0.008)	(0.008)	(0.008)	(0.008)
Market concentration	0.0623	0.0623	0.0623	0.0623
	(0.045)	(0.045)	(0.045)	(0.045)
CISS	0.0082*	0.0082*	0.0082*	0.0082*
	(0.004)	(0.004)	(0.004)	(0.004)
SIFIs	−0.6849	−0.6849	−0.6849	−0.6849
	(0.428)	(0.428)	(0.428)	(0.428)
Bank type dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes
N	890	890	890	890
Adjusted R^2	0.5958	0.5958	0.5958	0.5958
Sargan-Hansen test (*p*value)	0.2821	0.2821	0.2821	0.2821
GMM distance endogeneity test (*p*value)	0.0000	0.0000	0.0000	0.0000
Kleibergen-Paap Wald F-test statistic	12.2728	12.2728	12.2728	12.2728
First stage F-test (*p*value)	0.0000	0.0000	0.0000	0.0000

This Table reports the IV-GMM estimation results for a sub-sample of commercial banks, bank holding companies, co-operative banks, and savings banks. The dependent variable is the natural logarithm of SRISK. Column 1 shows results with NSMP as the natural logarithm of the sum of the total assets purchased and LTROs (AP). Column 2 shows results with the 10-year yields on synthetic sovereign bonds of Euro area countries. Column 3 shows results with the shadow rate (SR). Column 4 shows results with the SMCI. Bank-level variables are mean-centred. Explanatory variables are lagged one period, except for SIFIs which is a dummy variable for systemically important financial institutions. Variable definitions are as in Table 3. The Sargan-Hansen test is the test for overidentification. The null hypothesis tested under the GMM distance endogeneity test is that the specified endogenous regressors can actually be treated as exogenous. The Kleibergen-Paap Wald F-test statistic is a test for weak instruments and should have a value of at least 10 for weak identification not to be considered a problem (Staiger and Stock 1997). The First-stage F-test is another test of weak identification. The endogenous variable is leverage. The instruments are the equity-to-assets ratio and GDP growth. Robust standard errors are in (), N is the number of observations, R^2 is R-squared. *,**, and *** denote significance at the 10%, 5%, and 1% levels, respectively

Table 26 The impact of NSMP on SRISK – Regression with interactions – Sub-sample analysis—Robustness check

Dependent variable: *SRISK (ln)*	1	2	3	4
	NSMP variables			
	AP	Yield	SR	SMCI
NSMP	1.1332***	−0.5178***	−0.2386***	−0.7377**
	(0.327)	(0.183)	(0.080)	(0.323)
Total assets	2.0664	1.4404***	1.2619***	1.2761***
	(3.353)	(0.117)	(0.162)	(0.109)
NSMP*Total assets	−0.0355	−0.0781	−0.0181	−0.0844
	(0.156)	(0.056)	(0.030)	(0.111)
Leverage	−0.0022	0.0008*	0.0014***	0.0014***
	(0.015)	(0.000)	(0.001)	(0.000)
NSMP*Leverage	0.0002	0.0003	0.0001	−0.0001
	(0.001)	(0.000)	(0.000)	(0.000)
Cost to income	−0.3063	0.0067	−0.0219	−0.0054
	(0.294)	(0.009)	(0.016)	(0.007)
NSMP*Cost to income	0.014	−0.0065	−0.0041	−0.0183
	(0.014)	(0.006)	(0.003)	(0.017)
Income diversification	0.0557	−0.0683***	−0.0490***	−0.0477***
	(0.239)	(0.012)	(0.011)	(0.007)
NSMP*Income diversification	−0.0054	0.0082	0.0031	0.0121
	(0.011)	(0.005)	(0.002)	(0.011)
Market concentration	0.0768	0.0426	0.0457	0.0568
	(0.061)	(0.055)	(0.055)	(0.050)
CISS	0.0090*	0.0092*	0.0103**	0.0099**
	(0.005)	(0.005)	(0.005)	(0.004)
SIFIs	−0.6491	−0.5279	−0.5916	−0.4977
	(0.454)	(0.448)	(0.427)	(0.381)
Bank type dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes
N	890	890	890	890
Adjusted R^2	0.5899	0.5705	0.5844	0.5856
Sargan-Hansen test (*p*-value)	0.3994	0.2183	0.2219	0.1279
GMM distance endogeneity test (*p*-value)	0.0000	0.0000	0.0000	0.0000
Kleibergen-Paap Wald F-test statistic	11.4598	10.0039	10.091	11.7886
First stage F-test (*p*-value)	0.0000	0.0001	0.0000	0.0000

This Table reports the IV-GMM estimation results for a sub-sample of commercial banks, bank holding companies, co-operative banks, and savings banks, with interaction terms between NSMP and bank-level variables included. The dependent variable is the natural logarithm of SRISK. Column 1 shows results with NSMP as the natural logarithm of the sum of the total assets purchased and LTROs (AP). Column 2 shows results with the 10-year yields on synthetic sovereign bonds of Euro area countries. Column 3 shows results with the shadow rate (SR). Column 4 shows results with the SMCI. Bank-level variables are mean-centred. Explanatory variables are lagged one period, except for SIFIs which is a dummy variable for systemically important financial institutions. Variable definitions are as in Table 3. The Sargan-Hansen test is the test for overidentification. The null hypothesis tested under the GMM distance endogeneity test is that the specified endogenous regressors can actually be treated as exogenous. The Kleibergen-Paap Wald F-test statistic is a test for weak instruments and should have a value of at least 10 for weak identification not to be considered

Table 26 (continued)

a problem (Staiger and Stock 1997). The First-stage F-test is another test of weak identification. First stage F-test *p*-value is the same for the endogenous variable and its interaction with NSMP. The endogenous variable is leverage. The instruments are the equity-to-assets ratio and GDP growth. Robust standard errors are in (), N is the number of observations, R^2 is R-squared. *,**, and *** denote significance at the 10%, 5%, and 1% levels, respectively

Table 27 The impact of NSMP on ΔCoVaR—Sub-sample analysis—Robustness check

Dependent variable: *ΔCoVaR*	1	2	3	4
	NSMP variables			
	AP	Yield	SR	SMCI
NSMP	0.3347***	−0.1470***	−0.0782***	−0.7223***
	(0.053)	(0.023)	(0.012)	(0.114)
Total assets	0.2174***	0.2174***	0.2174***	0.2174***
	(0.017)	(0.017)	(0.017)	(0.017)
Leverage	−0.0001**	−0.0001**	−0.0001**	−0.0001**
	(0.000)	(0.000)	(0.000)	(0.000)
Cost to income	−0.0004	−0.0004	−0.0004	−0.0004
	(0.001)	(0.001)	(0.001)	(0.001)
Income diversification	0.0029**	0.0029**	0.0029**	0.0029**
	(0.001)	(0.001)	(0.001)	(0.001)
Market concentration	−0.0126	−0.0126	−0.0126	−0.0126
	(0.009)	(0.009)	(0.009)	(0.009)
CISS	−0.0014	−0.0014	−0.0014	−0.0014
	(0.001)	(0.001)	(0.001)	(0.001)
SIFIs	0.0977	0.0977	0.0977	0.0977
	(0.070)	(0.070)	(0.070)	(0.070)
Bank type dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes
N	792	792	792	792
Adjusted R^2	0.7412	0.7412	0.7412	0.7412
Sargan-Hansen test (*p*value)	0.3004	0.3004	0.3004	0.3004
GMM distance endogeneity test (*p*value)	0.0280	0.0280	0.0280	0.0280
Kleibergen-Paap Wald F-test statistic	11.1963	11.1963	11.1963	11.1963
First stage F-test (*p*value)	0.0000	0.0000	0.0000	0.0000

This Table reports the IV-GMM estimation results for a sub-sample of commercial banks, bank holding companies, co-operative banks, and savings banks. The dependent variable is ΔCoVaR (%). Column 1 shows results with NSMP as the natural logarithm of the sum of total assets purchased and LTROs (AP). Column 2 shows results with the 10-year yields on synthetic sovereign bonds of Euro area countries. Column 3 shows results with the shadow rate (SR). Column 4 shows results with the SMCI. Bank-level variables are mean-centred. Explanatory variables are lagged one period, except for SIFIs which is a dummy variable for systemically important financial institutions. Variable definitions are as in Table 3. The Sargan-Hansen test is the test for overidentification. The null hypothesis tested under the GMM distance endogeneity test is that the specified endogenous regressors can actually be treated as exogenous. The Kleibergen-Paap Wald F-test statistic is a test for weak instruments and should have a value of at least 10 for weak identification not to be considered a problem (Staiger and Stock 1997). The First-stage F-test is another test of weak identification. The endogenous variable is leverage. The instruments are the equity-to-assets ratio and GDP growth. Robust standard errors are in (), N is the number of observations, R^2 is R-squared. *,**, and *** denote significance at the 10%, 5%, and 1% levels, respectively

Table 28 The impact of NSMP on ΔCoVaR—Regression with interactions—Sub-sample analysis—Robustness check

Dependent variable: *ΔCoVaR*	1	2	3	4
	NSMP variables			
	AP	Yield	SR	SMCI
NSMP	0.3143***	−0.1340***	−0.0685***	−0.7115***
	(0.052)	(0.022)	(0.012)	(0.114)
Total assets	0.085	0.2326***	0.2035***	0.2242***
	(0.322)	(0.021)	(0.019)	(0.019)
NSMP*total assets	0.0064	−0.003	−0.0047	0.0027
	(0.015)	(0.007)	(0.004)	(0.023)
Leverage	0.0019	0.0000	0.0000	−0.0001**
	(0.002)	(0.000)	(0.000)	(0.000)
NSMP*leverage	−0.0001	0.0000	0.0000	0.0001
	(0.000)	(0.000)	(0.000)	(0.000)
Cost to income	0.0629*	−0.0032**	0.0021	−0.0002
	(0.033)	(0.001)	(0.001)	(0.001)
NSMP*cost to income	−0.0030*	0.0019***	0.0007**	0.0046
	(0.002)	(0.001)	(0.000)	(0.003)
Income diversification	0.0555*	0.0027	0.0044***	0.0026*
	(0.032)	(0.002)	(0.002)	(0.001)
NSMP*income diversification	−0.0025	0.0002	0.0005	0.0023
	(0.002)	(0.001)	(0.000)	(0.002)
Market concentration	−0.0213**	−0.0219**	−0.0219**	−0.0189*
	(0.009)	(0.009)	(0.009)	(0.010)
CISS	−0.0015*	−0.0018**	−0.0017*	−0.0018*
	(0.001)	(0.001)	(0.001)	(0.001)
SIFIs	0.1027	0.0697	0.0918	0.0838
	(0.071)	(0.072)	(0.071)	(0.074)
Bank type dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes
N	792	792	792	792
Adjusted R^2	0.7428	0.7401	0.7411	0.7194
Sargan-Hansen test (*p*-value)	0.4394	0.2099	0.1220	0.1904
GMM distance endogeneity test (*p*-value)	0.0604	0.0275	0.0273	0.0289
Kleibergen-paap wald F-test statistic	10.9423	11.2482	12.0644	10.7749
First stage F-test (*p-value*)	0.0000	0.0000	0.0000	0.0000

This Table reports the IV-GMM estimation results for a sub-sample of commercial banks, bank holding companies, co-operative banks, and savings banks, with interaction terms between NSMP and bank-level variables included. The dependent variable is ΔCoVaR (%). Column 1 shows results with NSMP as the natural logarithm of the sum of total assets purchased and LTROs (AP). Column 2 shows results with the 10-year yields on synthetic sovereign bonds of Euro area countries. Column 3 shows results with the shadow rate (SR). Column 4 shows results with the SMCI. Bank-level variables are mean-centred. Explanatory variables are lagged one period, except for SIFIs which is a dummy variable for systemically important financial institutions. Variable definitions are as in Table 3. The Sargan-Hansen test is the test for overidentification. The null hypothesis tested under the GMM distance endogeneity test is that the specified endogenous regressors can actually be treated as exogenous. The Kleibergen-Paap Wald F-test statistic is a test for weak instruments and should have a value of at least 10 for weak identification not to be considered a prob-

Table 28 (continued)

lem (Staiger and Stock 1997). The First-stage F-test is another test of weak identification. First stage F-test *p-value* is the same for the endogenous variable and its interaction with NSMP. The endogenous variable is leverage. The instruments are the equity-to-assets ratio and GDP growth. Robust standard errors are in (), N is the number of observations, R^2 is R-squared. *,**, and *** denote significance at the 10%, 5%, and 1% levels, respectively

Table 29 The impact of NSMP on MES—Sub-sample analysis—Robustness check

Dependent variable: *MES*	1	2	3	4
	NSMP variables			
	AP	Yield	SR	SMCI
NSMP	1.2368***	−0.5434***	−0.2888***	−2.6691***
	(0.228)	(0.100)	(0.053)	(0.492)
Total assets	0.6018***	0.6018***	0.6018***	0.6018***
	(0.075)	(0.075)	(0.075)	(0.075)
Leverage	0.0005***	0.0005***	0.0005***	0.0005***
	(0.000)	(0.000)	(0.000)	(0.000)
Cost to income	0.0104**	0.0104**	0.0104**	0.0104**
	(0.005)	(0.005)	(0.005)	(0.005)
Income diversification	0.0074	0.0074	0.0074	0.0074
	(0.006)	(0.006)	(0.006)	(0.006)
Market concentration	−0.0838**	−0.0838**	−0.0838**	−0.0838**
	(0.041)	(0.041)	(0.041)	(0.041)
CISS	−0.0083*	−0.0083*	−0.0083*	−0.0083*
	(0.005)	(0.005)	(0.005)	(0.005)
SIFIs	1.1475***	1.1475***	1.1475***	1.1475***
	(0.272)	(0.272)	(0.272)	(0.272)
Bank type dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes
N	793	793	793	793
Adjusted R^2	0.602	0.602	0.602	0.602
Sargan-Hansen test (*p* -value)	0.1249	0.1249	0.1249	0.1249
GMM distance endogeneity test (*p* -value)	0.0195	0.0195	0.0195	0.0195
Kleibergen-Paap Wald F-test statistic	13.9798	13.9798	13.9798	13.9798
First stage F-test (*p* -value)	0.0000	0.0000	0.0000	0.0000

This Table reports the IV-GMM estimation results for a sub-sample of commercial banks, bank holding companies, co-operative banks, and savings banks. The dependent variable is the Marginal Expected Shortfall (MES) (%). Column 1 shows results with NSMP as the natural logarithm of the sum of total assets purchased and LTROs (AP). Column 2 shows results with the 10-year yields on synthetic sovereign bonds of Euro area countries. Column 3 shows results with the shadow rate (SR). Column 4 shows results with the SMCI. Bank-level variables are mean-centred. Explanatory variables are lagged one period, except for SIFIs which is a dummy variable for systemically important financial institutions. Variable definitions are as in Table 3. The Sargan-Hansen test is the test for overidentification. The null hypothesis tested under the GMM distance endogeneity test is that the specified endogenous regressors can actually be treated as exogenous. The Kleibergen-Paap Wald F-test statistic is a test for weak instruments and should have a value of at least 10 for weak identification not to be considered a problem (Staiger and Stock 1997). The First-stage F-test is another test of weak identification. First stage F-test *p-value* is the same for the endogenous variable and its interaction with NSMP.The endogenous variable is leverage. The instruments are the equity-to-assets ratio and GDP growth. Robust standard errors are in (), N is the number of observations, R^2 is R-squared. *,**, and *** denote significance at the 10%, 5%, and 1% levels, respectively

Table 30 The impact of NSMP on MES—Regression with interactions—Sub-sample analysis—Robustness check

Dependent variable: *MES*	1	2	3	4
	NSMP variables			
	AP	Yield	SR	SMCI
NSMP	1.2127***	−0.5035***	−0.2723***	−2.6271***
	(0.233)	(0.104)	(0.052)	(0.520)
Total assets	2.7317**	0.6566***	0.6495***	0.5830***
	(1.320)	(0.111)	(0.084)	(0.074)
NSMP*Total assets	−0.0996	0.0423	0.0113	0.2748***
	(0.064)	(0.035)	(0.021)	(0.092)
Leverage	0.0003	−0.0002	0.0005**	0.0004**
	(0.005)	(0.000)	(0.000)	(0.000)
NSMP*Leverage	0.0000	0.0001	0.0001	−0.0002
	(0.000)	(0.000)	(0.000)	(0.000)
Cost to income	0.2836**	0.0049	0.0223***	0.0106**
	(0.141)	(0.008)	(0.007)	(0.004)
NSMP*Cost to income	−0.0128*	0.0071*	0.0031**	0.0301**
	(0.007)	(0.004)	(0.002)	(0.014)
Income diversification	−0.1198	0.0162	0.0093	0.0094
	(0.164)	(0.012)	(0.007)	(0.007)
NSMP*Income diversification	0.0061	−0.0019	0.0004	−0.0100
	(0.008)	(0.004)	(0.002)	(0.010)
Market concentration	−0.0888**	−0.1300***	−0.1087***	−0.0847**
	(0.041)	(0.037)	(0.038)	(0.042)
CISS	−0.0106**	−0.0151***	−0.0113***	−0.0103**
	(0.004)	(0.004)	(0.004)	(0.004)
SIFIs	1.1454***	1.1104***	1.2409***	1.2082***
	(0.270)	(0.283)	(0.275)	(0.270)
Bank type dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes
N	793	793	793	793
Adjusted R^2	0.6043	0.5855	0.6002	0.5988
Sargan-Hansen test (*p*-value)	0.1113	0.1341	0.1395	0.1886
GMM distance endogeneity test (*p*-value)	0.049	0.0766	0.0331	0.0086
Kleibergen-Paap Wald F-test statistic	10.5917	18.8797	18.2689	14.4736
First stage F-test (*p*-value)	0.0000	0.0000	0.0000	0.0000

This Table reports the IV-GMM estimation results for a sub-sample of commercial banks, bank holding companies, co-operative banks, and savings banks, with interaction terms between NSMP and bank-level variables included. The dependent variable is the Marginal Expected Shortfall (MES) (%). Column 1 shows results with NSMP as the natural logarithm of the sum of total assets purchased and LTROs (AP). Column 2 shows results with the 10-year yields on synthetic sovereign bonds of Euro area countries. Column 3 shows results with the shadow rate (SR). Column 4 shows results with the SMCI. Bank-level variables are mean-centred. Explanatory variables are lagged one period, except for SIFIs which is a dummy variable for systemically important financial institutions. Variable definitions are as in Table 3. The Sargan-Hansen test is the test for overidentification. The null hypothesis tested under the GMM distance endogeneity test is that the specified endogenous regressors can actually be treated as exogenous. The Kleibergen-Paap Wald F-test statistic is a test for weak instruments and should have a value of at least 10 for weak identification not to

Table 30 (continued)

be considered a problem (Staiger and Stock 1997). The First-stage F-test is another test of weak identification. First stage F-test *p-value* is the same for the endogenous variable and its interaction with NSMP. The endogenous variable is leverage. The instruments are the equity-to-assets ratio and GDP growth. Robust standard errors are in (), N is the number of observations, R^2 is R-squared. *,**, and *** denote significance at the 10%, 5%, and 1% levels, respectively

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