Universität Hamburg
DER FORSCHUNG | DER LEHRE | DER BILDUNG

FAKULTÄT
FÜR WIRTSCHAFTS- UND
SOZIALWISSENSCHAFTEN

A leaky pipeline - Macroprudential policy shocks, non-bank financial intermediation and systemic risk in Europe

Johanna Krenz
Akhilesh K Verma

WiSo-HH Working Paper Series
Working Paper No. 79
December 2023

WiSo-HH Working Paper Series
Working Paper No. 79
December 2023

A leaky pipeline - Macroprudential policy shocks, non-bank financial intermediation and systemic risk in Europe

Johanna Krenz, University of Hamburg
Akhilesh K Verma, Economic and Social Research Institute & Trinity College, Dublin

ISSN 2196-8128

Font used: „TheSans UHH" / LucasFonts

Kontakt:
WiSo-Forschungslabor
Von-Melle-Park 5
20146 Hamburg
E-Mail: experiments@wiso.uni-hamburg.de
Web: http://www.wiso.uni-hamburg.de/forschung/forschungslabor/home/

A leaky pipeline - Macroprudential policy shocks, non-bank financial intermediation and systemic risk in Europe*

Johanna Krenz†

Akhilesh K Verma‡

Abstract

How does macroprudential regulation affect financial stability in the presence of non-bank financial intermediaries? We estimate the contributions of traditional banks vis-à-vis non-bank financial intermediaries to changes in systemic risk – measured as ΔCoVaR – after macroprudential policy shocks in European countries. We find that while tighter macroprudential regulation, generally, decreases systemic risk among traditional banks, it has the opposite effect on systemic risk in the non-bank financial intermediation sector. For some types of regulations, the latter effect is even stronger than the former, indicating that macroprudential tightening increases systemic risk in the entire financial system, through leakages between the traditional and the non-bank financial intermediation sectors.

Keywords: macroprudential policy, systemic risk, ΔCoVaR, non-bank financial intermediation, regulatory arbitrage, Europe

JEL classification: G18, G23, G28, G21, E58

*We thank Maria Kagkeli for her research support.

†University of Hamburg; Email: mail@johannakrenz.de

‡Economic and Social Research Institute & Trinity College, Dublin; Email: akhil089@gmail.com, Akhilesh.KumarVerma@esri.ie

1 Introduction

Since the Global Financial Crisis (GFC) many countries around the world have adopted a macroprudential approach to financial regulation (see, e.g., Hanson et al., 2011). This approach seeks to safeguard the financial system as a whole and entails a variety of measures which are aimed at curbing excessive credit growth, reducing financial market volatility caused by adverse price-credit spirals, and addressing vulnerabilities related to systemically important banks. So far, most existing macroprudential policies (MaP) are targeted at traditional banks. The European financial system has historically been dominated by such entities. However, at least since the GFC, a significant shift has occurred towards non-bank financing[1], also dubbed shadow banking[2]. For example, the share of non-bank financing in the provision of credit to non-financial corporations doubled from approximately 15% in 2008 to almost 30% in 2021 (ECB Committee on Financial Integration, 2022). Furthermore, interlinkages between the traditional banking sector and non-bank financial intermediaries are on the rise: In 2022, non-bank financial intermediaries' (NBFI) assets accounted for approximately 9% of significant institutions' total assets and the total share of NBFI funds in banks' liabilities amounted to approximately 14% (ECB, 2023).

This raises the question, whether macroprudential policy (MaP) is effective in safeguarding the financial system as a whole, when a growing part of this system remains unregulated and when interlinkages between regulated and unregulated actors are substantial? Our paper aims to answer this question. In particular, based on a panel of European countries ranging from 2004q1 to 2019q2, we estimate the effects of macroprudential policy shocks on systemic risk in European countries and, in particular, on the risk contributions by banks and non-banks, respectively.

Why should we worry that the effectiveness of macroprudential policy is undermined by the growth and interconnectedness of the shadow banking sector? NBFIs complement the traditional banking sector by offering further funding sources and diversified financing options. However, these benefits are counterbalanced by certain drawbacks, such as complex securitization processes, high leverage, and pro-cyclical risk-taking. Their reliance on volatile funding sources can heighten financial instability during stress periods (see also chapter 2.1). The ties of

[1] We define the non-bank financial intermediation (NBFI) sector as entities or activities involved in the process of credit intermediation, however, without or with significantly less stringent prudential oversight and without direct public enhancement (e.g., Resti et al., 2021). Section 2.1 provides a more detailed definition of the NBFI sector. In section 3.2 we elaborate on how we identify such entities in the Compustat database.

[2] The Financial Stability Board replaced the term "shadow banking" with "non-bank financial intermediation" in 2018. We use both terms interchangeably.

NBFIs to traditional banks make a way for “spillover risk”, i.e. the risk that stress in the NBFI sector may be transmitted quickly to the rest of the financial system through a flight to quality and fire sales during risky events (IMF, 2014). Furthermore, it has been documented that the rise of the NBFI sector is to a large extend driven by regulatory arbitrage, i.e., a the shift of intermediation activities from the regulated to the unregulated sector with the purpose of avoiding costs associated with supervision and regulation.[3] Such leakages can mute the effects of macroprudential policy, or, in the worst case, even create new sources of systemic risk. For instance, when traditional banks engage in so-called ”window-dressing” activities, securitizing their assets and selling them to shadow banks, information asymmetries are aggravated and interconnectedness between the two sectors increases. When regulation and supervision limit the profitability of traditional banks they may engage in more risk-taking themselves. Regulations related to liquidity requirements affect traditional banks’ ability to provide liquidity to other financial entities, including NBFIs, during periods of stress.

We measure systemic risk as ΔCoVaR, which is defined as the change in the value at risk of the financial system, conditional on financial institutions being under distress (Adrian and Brunnermeier, 2016). It captures the marginal contribution of a financial institution to the entire financial system’s risk. It is very well suited for our purpose, as it allows us to calculate systemic risk for the banking and the shadow banking separately, while taking into account that potential risk-spillovers between these closely interlinked institutions might affect the systemic risk of the entire financial system. Since the shadow banking sector is quite heterogeneous, comprising entities which are involved in very different aspects of the credit intermediation process, which itself might be differently affected by MaP, we also measure the systemic risk contribution of different types of NBFIs separately, in particular, of financial services (FS), investment banks and brokerages (IBB), asset management companies (AMCs) and insurance companies (INSR).

In order to be able to assess the effects of changes in macroprudential policy on systemic risk, without facing the issue of reverse causality, we resort to macroprudential policy shock identification as recently proposed by Chari et al. (2022) and Ahnert et al. (2021). Here, the policy shock is defined as the part of the macroprudential policy stance which is orthogonal to observables. A further challenge in the evaluation of macroprudential policies is the relatively limited use of macroprudential policies up to date. We face this challenge by relying on a panel study containing 20 European countries. As figure 4 in the appendix shows, across these countries,

[3]Many studies have provided evidence on bank regulations increasing the size of the shadow banking sector vis-à-vis the traditional banking sector. An overview of this literature is provided in section 2.2.

the number of interventions is substantial. Macroprudential policy measures are very heterogeneous. They are targeted at different parts of the financial intermediation process and not all parts might be equally prone to regulatory arbitrage or risk-shifting. For instance, measures meant to reduce the demand for credit, such as loan-to-value (LTV) ratios, might be easily circumvented by borrowers by turning to shadow banks. The same might be true for measures targeting the supply of loans, e.g., limits on credit growth. Liquidity-targeted measures, on the other hand, might lead to less direct leakage to the NBFI sector as they do not only affect credit provision but the entire credit intermediation process. Therefore, we also analyze whether the systemic risk implications of macroprudential policy shocks are different for different types of measures. In particular, we distinguish between loan-targeted demand measures, loan-targeted supply measures, capital-targeted supply measures and liquidity-targeted supply measures.[4] [5]

Our analysis begins with a baseline model that examines the relative importance of MaP demand and MaP supply shocks in influencing systemic risk for NBFIs and banks. The interaction between MaP shocks and a dummy variable distinguishing shadow banks from traditional banks serves as our key explanatory variable. Notably, we uncover statistically significant and positive coefficients for the interaction variable, indicating that both – positive MaP demand and MaP supply shocks (tightenings) – elevate systemic risk for NBFIs. On the other hand, MaP demand measures significantly reduce system risk among traditional banks, while the effects of supply measure are small and insignificant. In the aggregate, i.e. for the entire financial system, the effects of tightenings are negative for demand and positive for supply shocks, however, insignificant. Further disaggregation of MaP shocks and the NBFI sector reveals that positive loan-targeted supply shocks significantly increase systemic risk among shadow banks and that this effect is mainly driven by financial services (FS), asset management companies (AMC) and investment banks and brokerages (IBB). Capital-targeted measures induce an increase in systemic risk in the shadow banking system which is entirely driven by AMCs and IBBs. Liquidity-targeted measures, quite notably, induce a decrease in systemic risk in the shadow banking system which is entirely driven by AMCs. Capital-targeted measures induce a significant reduction in systemic risk among traditional banks which is apparently large enough to reduce systemic risk in the entire system. Loan-targeted measures on the other hand do not significantly reduce systemic risk in the banking sector and, notably, lead to a significant increase in systemic risk in the entire system. None of the MaPs has significant effects on systemic

[4] Araujo et al. (2020) show that quantity and price of credit are affected differently by different types of MaP. Apergis et al. (2022) find that different MaP measures have differential effects on market-based measures of systemic risk.

[5] In the related literature, *demand measures* are also dubbed *borrower-based measures*, while *supply measures* are also referred to as *lender-based measures*.

risk among insurance companies (INSR). Additionally we find that the effects of different MaP measures on systemic risk are different between core and peripheral European countries, which is, e.g., caused by different macroprudential stances and different sizes of the NBFI sectors in the two regions.

These results have important policy implications. First of all, we show that in Europe, most types of macroprudential policies are ineffective with respect to their main goal – reducing systemic risk. This is mainly driven by an increase in system risk among non-bank financial intermediaries, i.e. regulatory arbitrage. This shows a pressing need to find ways to broaden the regulations to also cover the NBFI sector, or, at least, certain parts of it. Our results also provide guidance with respect to the question of which types of NBFIs have the most urgent need for regulation. With respect to the insurance sector, which, due to its sheer size and growth, has lately become of great concern to regulators in Europe, our study provides some positive signs, showing that, in general, insurance companies do not contribute more to systemic risk that banks and are not prone to regulatory arbitrage.

Our study makes significant contributions to two strands of the existing literature. Firstly, a growing body of research analyzes and documents leakages of macroprudential policies. The latter take the form of shifts of activities from regulated to unregulated agents – where the latter can either be NBFIs in the same jurisdiction or financial intermediaries in other jurisdictions[6] – or shifts of activities from the banking sector to the corporate bond market. Closest to our analysis are those studies which document leakages from the traditional banking sector to the NBFI sector within the same jurisdiction. We provide a more detailed review of this literature in section 2.2, when we define hypotheses for our empirical analysis. However, neither of these studies measures the effects of such leakages on systemic risk nor uses macroprudential shocks in the analysis in order to avoid the issue of reverse causality. We fill these gaps.

Secondly, our work serves as an addition to a critical body of literature concentrating on the mitigating role of macroprudential regulations with respect to bank systemic risk and financial cycle management (Ely et al., 2021; Cerutti et al., 2017; Altunbas et al., 2018; Meuleman and Vander Vennet, 2020). In this context, our study extends the scope by demonstrating that macroprudential regulations can heighten the systemic risk contribution of the NBFI sector while simultaneously reducing systemic risk in the banking sector. Our paper aligns with recent studies exploring the systemic risk contribution of the shadow banking or NBFI sector. Pellegrini

[6]E.g., Ahnert et al. (2021) provide evidence that macroprudential tightenings induce leakage to foreign financial intermediaries.

et al. (2022), for instance, highlights how shadow banking entities, including financial services and money market mutual funds, contribute more substantial systemic risk compared to the traditional banking sector as they expand in size. Notably, they primarily focus on the role of balance sheet factors in understanding the relative systemic risk contributions of the banking and shadow banking sectors. Our work, on the other hand, sheds light on the role of regulatory policy shocks in managing partial risk within the banking sector and potentially redirecting it towards the NBFI sector.

This paper is organized as follows. In the next section, we provide a definition of the non-bank financial intermediation sector and review theoretical and empirical literature providing insights on potential effects of macroprudential policies on activities of NBFIs. Section 3 outlines our data sources and the construction of our systemic risk and macroprudential policy measures. Section 4 presents the empirical strategy and the hypotheses we are going to test and section 5 the results of the empirical analyses. Section 6 concludes.

2 Some priors on non-bank financial intermediation and macroprudential policy

In this chapter, we first define the non-bank financial intermediation sector and then review theoretical and empirical literature providing insights on potential effects of macroprudential policies on activities of NBFIs.

2.1 Definition of non-bank financial intermediation

The role of the traditional banking sector is to intermediate credit between borrowers and savers. This process involves credit, maturity and liquidity transformation. These conceptually different activities are usually performed under one roof. To reduce the inherent risks, the credit intermediation process is often enhanced through credit guarantees by the government (e.g., deposit insurance) and access to central bank liquidity (Pozsar et al., 2010). Such official enhancements, however, potentially foster excessive risk-taking, which, among others, motivated the establishment of many forms of supervision and regulation for the traditional banking system (e.g., Adrian, 2014).

The non-bank financial intermediation (NBFI) sector also performs credit, maturity and liquidity transformation. However, here, the credit intermediation process is sliced up into a granular set of steps with each step being performed by a specific type of entity and involving different funding techniques. The funds which flow into the shadow banking systems usually stem from large investors such as corporations and insurance companies while traditional banks are largely funded by retail deposits (e.g., Resti et al., 2021). Besides being specialized and serving a different group of savers, another defining feature of NBFIs is that they are not officially enhanced, i.e., do not have access to central bank liquidity of public sector guarantees. Furthermore, compared to traditional banks engaged in similar activities, regulatory standards and supervisory oversight are either absent or significantly less stringent for NBFIs.

The above considerations provide us with a definition of the NBFI sector as *entities or activities involved in the process of credit intermediation, however, without or with significantly less stringent prudential oversight and without direct public enhancement.* (e.g., Resti et al., 2021)

In practice, when identifying NBFIs in the data, we are restricted by the industry classification used by the data provider Compustat which is the Global Industry Classification Standard (GICS) (see chapter 3.2). Therefore, the sample of non-bank financial intermediaries we consider in our empirical analyses does not cover all entities in Europe which fall under the definition given above.

2.2 Effects of macroprudential regulations on the activities of non-bank financial intermediaries – insights from the literature

In recent years, a growing body of research has analyzed potential shifts of activities from banks to NBFIs in response to macroprudential tightenings and systemic risk implications of a growing shadow banking sector per se. In the following we will review some of this literature.

DSGE-model based analyses of leakages from the banking to NBFI sector in response to macroprudential tightenings are undertaken by Gebauer and Mazelis (2023), Begenau and Landvoigt (2022) and Fève et al. (2019). All three contributions consider *capital-targeted* measures. The model by Fève et al. (2019) is developed to analyze the main role of shadow banks in the US prior to the Great Financial Crisis and, hence, not suited to provide us with insights on the current situation in Europe. The model by Begenau and Landvoigt (2022) is also calibrated to the US, but might highlight channels which are also relevant in current European financial system. The authors show that capital regulations increase lending by shadow banks but may, nevertheless, reduce systemic risk as subsidies from deposit insurance schemes are eliminated which reduces competitive pressures on shadow banks to take risks. A similar channel is present in the model by Gebauer and Mazelis (2023) who tailor their analysis to Europe. They assume that commercial banks can exert some market power, while shadow banks are perfectly competitive. This assumption allows them to identify a novel leakage mechanism: Tighter capital regulations result in higher intermediation costs for traditional banks and, hence, less loan provision. Monopolistically competitive banks exploit their market power, which further raises the cost of credit. In the shadow banking sector, on the other hand, lending spreads decline, which leads to larger loan provision and an increase in leverage. However, the study does not quantify the overall risk implications of this shift in activities.

While the theoretical literature so far has confined itself to the analysis of capital regulations, empirical studies have scrutinized the effects of different kinds of macroprudential measures. The studies by Cizel et al. (2019) and Claessens et al. (2021) comprise a large set of countries and a variety of MaPs. They provide evidence that macroprudential policies encourage a substitution of bank credit by non-bank credit. Claessens et al. (2021) complement these results by showing that such substitution effects can be observed in all parts of the NBFI system, in particular, with respect to those economic functions which may pose risks to financial stability (Money Market Funds and Fixed Income Funds). Irani et al. (2021) focuses on the effects of capital regulations in the US market for syndicated corporate loans and also provides evidence of a shift of credit provision from banks to NBFIs. This effect is particularly pronounced for less-capitalized banks, among loans with higher capital requirements and at times when capital is scarce. Acharya et al. (2013) provide evidence that regulatory capital requirements in the US before the financial crisis motivated banks to securitize assets at a large scale which significantly contributed to the growth of the shadow banking system. However, it should be noted that the practice of securitization has decreased in the US and was never economically important in Europe. Karapetyan et al. (2023), Acharya et al. (2020) and Braggion et al. (2022) document leakages after an increase of the LTV ratio in Sweden, Ireland and China, respectively. Karapetyan et al. (2023) show that an increase in the LTV ratio in Sweden led to a 50% increase in unregulated debt within two years. Due to higher interest rates on this form of debt, total indebtedness increased. The results are driven by poorer households, which implies an increase in the riskiness of the debt. Furthermore, they show that in a sample of 13 European countries, one year after the introduction of an LTV ratio, the number of credit cards per 1000 citizens had increased by 84%. Acharya et al. (2020) find for Ireland, that in response to the introduction of an LTV ratio mortgage credit reallocated from poorer to richer households and from poorer to richer areas in the country, slowed down house price growth and led to portfolio rebalancing by banks, i.e., banks switched to riskier assets holdings in asset classes not directly affected by the regulation. Braggion et al. (2022) show that home buyers increase online borrowing at so-called marketplace credit firms to bypass tighter mortgage loan-to-value (LTV) caps in China.

Even though some of the leakages documented in these empirical studies allude to systemic risk implications, neither one measures the effects of such leakages on systemic risk.

The review articles by Adrian (2014) and Pozsar et al. (2010) outline various channels through which the growth in shadow banking could increase the risk in the entire financial system. First, without official enhancement, the NBFI system relies on uninsured funding and, hence, is much more prone to runs than the official banking system. This problem is aggravated through the fact that shadow banks heavily rely on funding from large well-informed investors who tend to react fast, creating high volatility in funding. Second, the complex securitization process may create or aggravate information asymmetries which create negative externalities. Third, in search for yields, NBFIs might pile up exposures to extreme risks which are usually underpriced. This can lead to a serious aggravation of systemic risks after bad shocks, i.e., when investors become fully aware of these risks. Fourth, commercial banks often provide informal support to NBFIs, e.g., in form of liquidity backstops. Thereby, NBFIs indirectly profit from official enhancement without being subject to official regulation or monitoring, which clearly distorts risk-taking incentives and leads to mispriced government guarantees. Fifth, such credit enhancements and liquidity lines, but also plain borrowing and lending lead to numerous and intricated connections between the two banking systems, which means that any stress in the large unregulated NBFI sector can easily be transmitted to the regulated banking system. Shadow banks are often highly leveraged which means that they can be a source of flights to quality and fire sales which will very likely also reach balance sheets of traditional banks.

3 Data

Our empirical analysis relies on a comprehensive dataset compiled from various sources to investigate the effects of different macroprudential policies on systemic risk of different types of financial institutions. In the following, we explain the compilation of the dataset, the classification of financial institutions, the calculation of the systemic risk measure, ΔCoVar, and the determination of the macroprudential policy stance. In section 3.5 we provide some descriptive statistics.

3.1 Data sources

The financial-intermediary-level data – daily market returns and annual balance sheet data – is sourced from Compustat Global, spanning the period from 2004q1 to 2019q2. Country-specific macroeconomic data at quarterly frequency stems from the International Financial Statistics database of the International Monetary Fund (IMF). The (mixed-frequency) macroeconomic and financial data used in the estimation of the macroprudential policy shocks was provided by Chari et al. (2022) and is described in the appendix of their article.

We chose to handle the mixed frequency of our data, by aggregating or, respectively, extrapolating the data to quarterly frequency and running our main estimation, described in section 4.3, at quarterly frequency. With this procedure, we keep the loss of information from data aggregation to a minimum.

In particular, to create the systemic risk measure ΔCoVaR (see section 3.3) we make use of daily intermediary-level market return data and daily European financial data. The resulting ΔCoVaR is then aggregated into quarterly frequency by taking the mean over all days of the quarter.

Further intermediary-level metrics such as size, represented by the logarithm of bank assets, leverage, quantified as the ratio between total assets and book value of equity, and market-to-book ratio variables, which we need for our main estimation (equation (5)), are annual. To obtain the quarterly frequency, we repeat the annual balance sheet information across consecutive quarters.

3.2 Classification of financial intermediaries

The Compustat dataset on which we rely for our analyses, classifies entities by the Global Industry Classification Standard (GICS). By this standard, the financial sector is divided into "Banks" (4010), "Diversified Financials" (4020) and "Insurance" (4030). "Banks" include "Diversified" (40101010) and "Regional banks" (40101015) and we include all these entities as traditional banks in our dataset. Of the industry group "Financial Services", we focus on the industries and sub-industries "Consumer Finance" (40202010), "Other Diversified Financial Services" (40201020), "Multi-Sector Holdings" (40201030) and "Specialized Finance" (40201040) and group them together as "Financial Services" (FS). These entities are predominantely engaged in providing loans, leases and mortgages to borrowers. Furthermore, we use the subindustry "Asset Management & Custody Banks" (40203010), short AMC. Entities in this group (e.g. Money Market Mutual funds) collect funds from savers and invest them into the liabilities of other financial intermediaries. Furthermore, we include entities of the subindustry "Investment Banking & Brokerage" (40203020), short IBB. The latter are mainly involved in the securitization and collateralization process (e.g. broker-dealers). Furthermore, we include insurance companies into our analysis, "Life Health Insurance" (40301020) and "Multi-line Insurance" (40301030) as those entities are considered as non-bank financial intermediaries by the ECB and closely monitored by the latter due to their large and increasing weight in the European financial system (see figure 4). Table 12 in the appendix provides an overview of the distribution across countries of theses entities and their total numbers.

3.3 Systemic risk (ΔCoVaR) calculation

Following Adrian and Brunnermeier (2016), we estimate systemic risk as a change in conditional value at risk (ΔCoVaR) that captures marginal contribution of a financial institution to the entire financial system's systemic risk. One of key advantage of the measures ΔCoVaR is that it accounts for risk spillovers across financial institutions within a financial network which quite relevant to our case of studying MaP shock spillovers from the banking to the non-banking sector.

The calculation of ΔCoVaR begins with the estimation of the Value at Risk (VaR). VaR quantifies the maximum expected loss of an individual financial institution (i) at a certain quantile (q). It is defined as the probability that the institution's risk variable (x^i) falls below the VaR threshold:

$$Pr\big(x^i \leq VaR^i_q\big) = q$$

Here, x^i represents the variable for which VaR is calculated. The next step involves evaluating $\Delta CoVaR^{j/x_i=VaR^i_q}$, which quantifies the risk of the entire financial system (j) given the distress of a specific bank (i). It represents the qth quantile of the conditional probability distribution of market returns under this scenario:

$$Pr\Big(x^j/(x_i = VaR^i_q) \leq CoVaR_q^{j/x_i=VaR^i_q}\Big) = q$$

In this equation, x^j signifies the market return of the financial sector.

To calculate the contribution of bank i to systemic risk ($\Delta CoVaR_q^i$), we take the difference between the risk of the total financial system conditioned on bank i being in distress and its risk when bank i is in a median (normal) state. Mathematically, this relationship is expressed as:

$$\Delta CoVaR_q^i = CoVaR_q^{j/x_i=VaR_q^i} - CoVaR_q^{j/x_i=VaR_{median}^i} \tag{1}$$

To estimate the contribution of a bank to the overall risk of the financial system ($\Delta CoVaR_q^i$), we employ quantile regression. This technique helps us estimate two components in the right-hand side of the equation 1: the CoVaR of the financial system under stressed conditions and the CoVaR under unstressed conditions for bank i. Formally, this estimation can be represented as:

$$\Delta CoVaR_q^i = \hat{\beta}_q^i (VaR_q^i - VaR_{median}^i) \tag{2}$$

Our calculation of VaR and CoVaR involves using daily losses in asset values (x) for individual banks for each sample country across the EU financial system following Adrian and Brunnermeier (2016). To capture temporal fluctuations in VaR and CoVaR, we incorporate several lagged state variables - market volatility as 22 days rolling standard deviation of market index (STOXX Europe 600); liquidity spread calculated as the difference between 3 month Euribor rate and 3 month Euro T-bill rate; change is the slope of the yield curve defined as the difference between 10 year Euro government bond rate and 3 month Euro T-bill rate; credit spread defined as the difference between BAA corporate bond yield and 10 year Euro government bond rate and change in Euro 3 month treasury bill rate. Notably, we reverse the sign of ΔCoVaR by multiplying it by -1, making it positive and more intuitive for interpretation. In this context, a positive ΔCoVaR indicates that an institution's systemic risk amplifies, underscoring its heightened systemic importance during adverse market conditions.

3.4 Macroprudential policies

For the estimation of macroprudential policy shocks (see section 4.2) is it necessary to first find an appropriate measure of country-specific macroprudential policies. In this regard, we also follow Chari et al. (2022) and use the Integrated Macroprudential Policy (iMaPP) database, compiled and described by Alam et al. (2019). The dataset combines information from several pre-existing databases and is the most comprehensive collection of macroprudential policies worldwide. The macroprudential tools are grouped into 17 different types of policies with subcategories. Tightenings and loosenings for all instruments are captured by dummy variables (+1 for a tightening, −1 for a loosening), except for the LTV ratio for which quantitative measures are provided. Furthermore, data on changes in the CCyB and corresponding buffer levels is collected from the BIS and the ESRB homepage.

Since we expect leakages of macroprudential policies to the NBFI sector to be quite heterogeneous, depending on the target of the measure and the type of NBFI, we are not interested in the effects of innovations to a general macroprudential policy stance, but to innovations in different types of measures. With respect to the classification of measures, we will follow the common practice and the same selection of measures into the groups as Chari et al. (2022). In particular, we group as follows -

- *Demand measures – loan targeted*: loan-to-value limits (LTV), debt-service-to-income ratios (DSTI),
- *Supply measures – loan targeted*: limits on credit growth, loan-loss provisions, loan restrictions,
- *Supply measures – capital targeted*: conservation buffers, capital surcharges for SIFIs, CCyBs, and,
- *Supply measures – liquidity targeted*: reserve and liquidity requirements.

Monthly measures for these categories are calculated by summing up the dummy variables for each of the instruments in the respective group.

3.5 Descriptive statistics

Table 1 presents the summary statistics of key financial and macroeconomic variables for the entire financial sector, i.e. the banking sector and NBFI sector. For the whole sample, mean ΔCoVaR stands at 0.73, indicating the average systemic risk contribution of a financial intermediary to the European financial system.

We notice that ΔCoVaR for banks has a higher mean (0.80) compared to NBFIs (0.71). One reason for this is that the average bank is substantially larger than the average NBFI (9.97 vs. 4.87). Additionally, the market to book (MB) ratio has a much higher mean (0.24) and standard deviation (9.26) in an average bank compared to an NBFI (mean of 0.05 and SD of 1.86), indicating greater variability and possibly higher financial leverage within banks. Similarly, mean leverage of banks (0.13) is higher than in NBFIs (0.05).

Table 1: Summary Statistics: Financial accounts and macroeconomic variables

	All		Banks		NBFIs	
	Mean	Std dev.	Mean	Std dev.	Mean	Std dev.
Bank level variables						
Δ CoVaR	0.56	0.73	0.64	0.72	0.52	0.73
MB ratio	0.10	5.01	0.24	9.26	0.05	1.86
Leverage	0.07	0.32	0.13	0.48	0.05	0.24
Size	6.21	3.58	9.97	1.98	4.87	3.03
Country level variables						
MaP demand	0.01	0.08	0.01	0.09	0.01	0.07
MaP supply	0.06	0.24	0.07	0.23	0.06	0.24
MaP supply (Loan)	0.01	0.06	0.01	0.07	0.01	0.05
MaP supply (Liquidity)	0.02	0.10	0.02	0.10	0.02	0.09
MaP supply (Capital)	0.04	0.17	0.04	0.15	0.04	0.18
GDP growth	0.01	0.03	0.01	0.03	0.02	0.03
Inflation	1.92	1.44	1.87	1.48	1.94	1.42
Observations	33519		8804		24715	

Notes: Size is measured as the logarithm of bank assets. Leverage is quantified as the ratio between total assets and the book value of equity.

Table 2 displays the same statistics for the different types of NBFIs we have in our sample. We see considerable variation between the different types of entities. Insurance companies (INSR) are by far the largest entities with mean log assets of 9.81. We conjecture that this is also the reason that these types of entities display the largest Δ CoVaR among all entities including banks.

Table 2: Summary Statistics for different types of NBFIs

	FS		AMC		IBB		INSR	
	Mean	Std dev	Mean	Std dev	Mean	Std dev	mean	Std dev
Delta CoVaR	0.60	0.71	0.46	0.70	0.57	0.82	0.77	0.80
MB ratio	0.02	0.13	0.03	1.59	0.26	3.95	0.02	0.14
Leverage	0.07	0.30	0.02	0.06	0.05	0.15	0.17	0.61
Size	5.50	2.68	4.02	2.43	4.44	2.40	9.81	2.92
Observations	4387		14973		3053		2289	

Overall, these comparisons highlight notable variations in systemic risk, financial ratios, and entity size between banks and non-banks but also between different types of non-banks, indicating potential distinctions in risk profiles and other characteristics which might provoke different reactions to macroprudential policy shocks.

4 Empirical strategy

In this chapter, we present hypotheses regarding the effects of macroprudential policy shocks on the systemic risk contribution of different parts of the financial intermediation sector, which we derive from the literature review in chapter 2.2 and our knowledge of the functioning for the financial intermediation sector. Then we present and discuss the empirical strategy which is divided into two parts. First, we identify macroprudential policy innovations following Chari et al. (2022) and, second, we use a two-way panel fixed effects model to analyze the risk response of banks and NBFIs following a macroprudential shock.

4.1 Definition of hypotheses

Various studies – empirical and theoretical – suggest that a tightening of *capital requirements*, generally, leads to a shift of activities from the traditional banking to the shadow banking sector, as banks have to reduce risk-taking. When credit becomes more expensive, it becomes more attractive for firms to issue bonds and for collective investment vehicles (CIVs) such as mutual funds etc. to purchase these. A tightening in capital requirements could also increase the demand for shares in mutual funds, that serve as a collateral for loans. This could, in particular, increase the activity of AMCs. Lower credit provision due to capital requirements in banks could induce FS to serve some of the credit demand previously served by banks. A tightening of capital requirements further means that banks have a reduced capacity for buying securities and reduced leverage capacity for M&A transactions, causing activities in the IBB sector to decrease.

Hence, in reaction to a tightening of *capital-targeted measures* we expect an increase in the systemic risk contribution of the NBFI sector. We expect this effect to be particularly pronounced in the AMC sector.

Loan-demand-targeted measures, such as LTV and DTI limits, could in general be designed as measures that apply to both, bank and non-bank credit. However, in most countries, including European countries, most LTV and DTI limits only apply to bank loans and not to loans offered by investment funds and other similar companies Cizel et al. (2019). Existing empirical studies document substantial leakages to unregulated forms of credit after a tightening of the LTV ratio. Since these measures are often targeted at households we expect the largest spillovers to the FS sector, which is – to a large part – made up of consumer finance.

Hence, in reaction to a tightening of *loan-demand-targeted measures* we expect an increase in the systemic risk contribution of the NBFI sector. We expect this effect to be particularly pronounced in the FS sector.

With respect to *loan-supply-targeted measures* we expect similar effects as for the demand-targeted measures. Additionally, as in the case of a tightening of capital requirements, in reaction to a tightening of loan-supply-targeted measures, firms might increase bond issuance which increases activities in the AMC sector.

Hence, in reaction to a tightening of *loan-supply-targeted measures* we expect an increase in the systemic risk contribution of the NBFI sector. We expect this effect to be particularly pronounced in the FS sector and the AMC sector.

Unfortunately, the literature does not provide us with guidance regarding the effects of macroprudential measures *targeted at liquidity provision*. We conjecture that the requirement that banks hold more liquidity leads to lower yields on liquid assets, which might have adverse effects on shadow banks which predominantly hold such assets. This could either lead to more risk-taking in the NBFI sector due to a search for yield in order to restore profitability or, to the contrary, to a reduction of shadow banking activity causing a reduction in their systemic risk contribution. Furthermore, if banks are required to hold more liquidity they might also be more willing to provide more liquidity to AMCs which increases the activities of the latter but also reduces their liquidity risk.

Hence, in reaction to a tightening of *liquidity-targeted measures* we mostly expect effects in the AMC sector, however, the direction of the effects is unclear.

4.2 Macroprudential policy shock identification

We aim to analyze the effects of macroprudential policy on systemic risk. However, as regulatory authorities often implement or adjust macroprudential measures in reaction to observed changes in systemic risk indicators, reverse causality becomes an issue. This is a common challenge in the empirical assessment of macroprudential policies and various ways to tackle this challenge have been proposed, such as simply including lags of the macroprudential measure, using propensity score matching or using instrumental-variable (IV) estimation. However, as Forbes (2021) points out, these approaches either cannot fully tackle the endogeneity problem or are not applicable to most macroprudential policy tools. In a study of the effects of macroprudential policy on systemic risk in the UK, Bluwstein and Patozi (2022) apply a technique which has become state-of-the art in the identification of monetary policy shocks: the identification of shocks via high-frequency movements in financial market variables within short time windows around policy announcements. This approach controls well for endogeneity, however, as it entails the construction of a day-by-day macroprudential policy dataset and further, a manual pre-selection of events, it is hardly feasible to use it for a large set of countries.

Therefore, we follow an approach which also builds upon a technique commonly used in the identification of other policy shocks, such as monetary (Auerbach and Gorodnichenko, 2012) or fiscal policy shocks (Furceri et al., 2018), and which has been recently applied to macroprudential policy shock identification by Chari et al. (2022) and Ahnert et al. (2021).[7] They identify a macroprudential policy shock as the part of the macroprudential policy stance, which is orthogonal to observables.

In particular, Chari et al. (2022) first estimate the macroprudential policy stance (described above) of country j at time t on a group of variables which potentially affect macroprudential policy decisions, i.e.

$$MaP_{jt} = \alpha_j + \beta_1 Crisis_{jt-1} + \beta_2 Credit_{jt-1} + \beta_3 Growth_{jt-1} + \beta_4 Controls_{jt-1} + \epsilon_{jt}, \qquad (3)$$

where α_j denotes country-fixed effects. We follow Chari et al. (2022) in first estimating equation (3) with 18 explanatory variables, all described in the Appendix of Chari et al. (2022), and then using backward and forward induction to reduce the set of variables to a combination of variables which meet a significance threshold.[8] Next, based on the set of significant variables and the estimated coefficients, the macroprudential stance is predicted ($\widehat{MaP_{jt}}$) and then subtracted from the actual macroprudential stance. The difference yields the macroprudential policy shock for country j at time t,

$$\widetilde{MaP_{jt}} = MaP_{jt} - \widehat{MaP_{jt}}. \qquad (4)$$

[7] Chari et al. (2022) provided us with their codes to identify macroprudential policy shocks, which we used for the analyses presented in this paper.

[8] For a more detailed description of this procedure, the reader is referred to Chari et al. (2022).

Table 11 in the appendix presents the results of the first-stage estimation of different macroprudential measures as given by equation 3. The choice of the explanatory variables is the result of the backward and forward induction procedure described above.

Among the different policies, different macroeconomic and financial indicators have explanatory power and sometimes the same explanatory variable has differential effects on different macroprudential measures. For example, higher house price growth predicts a tightening of loan demand measures, while simultaneously it also predicts a loosening of loan supply measures. The experience of a banking crisis throughout the last 12 months implies a tightening of liquidity measures, while it also implies a loosening of loan supply measures. An increase in the financial crises indicator (Romer & Romer intensity) over the last six month has the opposite effect. Only a lower policy rate corresponds to a tighter macroprudential stance with respect to all measures we consider.

We use the predicted values from these regressions to extract different MaP shocks, as given by equation 4.

4.3 Model estimation

The baseline model specification is

$$\begin{aligned}\Delta CoVaR_{ijt} = \alpha_i + \beta_0 + \beta_1 \widetilde{MaP_{jt-1}} + \beta_2 Shadow_{ijt} + \beta_3 \widetilde{MaP_{jt-1}} \cdot Shadow_{ijt} \\ + \beta_i X_{ijt-1} + \beta_j Z_{jt-1} + \gamma_t + \epsilon_{it},\end{aligned} \tag{5}$$

where $\Delta CoVaR_{ijt}$ denotes systemic risk for bank i and country j in time period t. $\widetilde{MaP_{jt}}$ is the MaP shock, varying at the country level[9]. $Shadow_{ijt}$ is a dummy variable which takes a value of 1 if the entity is a shadow bank and 0 otherwise. The key coefficient of interest is the term β_3 which captures the differential impact of MaPs on the systemic risk of shadow banks vis-a-vis traditional banks. In other words, if β_3 is statistically different from zero, this implies that the impact of MaP shocks on systemic risk varies depending on whether the institution is a shadow bank or a traditional bank. Hence, this term captures regulatory leakage from the traditional banking to the NBFI sector in terms of systemic risk. Moreover, X_{ijt} are bank level balance sheet control variables and Z_{jt} are country level macroeconomic variables to control the cross country variation in the business cycle. α_i and γ_t represent intermediary fixed effects

[9]Since $\widetilde{MaP_{jt}}$ is an estimated regressor, we use bootstrapping.

and time fixed effects, respectively. We consider the first lag of the MaP shock to account for implementation lags. With respect to the remaining explanatory variables, we take the first lag to address endogeneity concerns.

5 Empirical evidence

5.1 Baseline results

In the following sections we present the result of our baseline regressions, which estimates changes in systemic risk measured as ΔCoVaR in reaction to macroprudential policy shocks and the role of NBFIs therein. We first consider innovations in demand and supply measures, in general (5.1.1). In section 5.1.2 we further disaggregate the MaP supply shocks into loan-, liquidity and capital-targeted MaP shocks.

5.1.1 MaP demand and supply shocks

Table 3 presents the result of the baseline regression, which examines the impact of macroprudential shocks, entity types, and further control variables on systemic risk (ΔCoVaR). We provide the results for regressions including MaP demand shocks in columns (1) to (3), followed by the results for regressions including MaP supply shocks in columns (4) to (6). Recall that MaP demand shocks are innovations in regulations addressing the demand for loans, and MaP supply shocks are a composite of innovations in loan-, capital- and liquidity-targeted measures applied to banks (see section 3.4). The fourth row (Shadow bank x L.MaP-shock) shows the change in the systemic risk contribution of the NBFI sector in reaction to the respective MaP shock, while the third row (L.MaP-shock) reflects the change in systemic risk in the banking sector in reaction to the respective MaP shock.

Note first, that the coefficient on the shadow bank dummy (second row) is insignificant, indicating that the presence of NBFIs is, on average, not associated with an increase in systemic risk. However, as will become clear later, this is not true for all types of NBFIs.

Table 3: Macroprudential shocks, shadow banks and systemic risks

	MaP Demand shock			MaP Supply shock		
	(1)	(2)	(3)	(4)	(5)	(6)
L.Δ CoVaR	0.649***	0.648***	0.647***	0.658***	0.657***	0.656***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Shadow bank	0.090	0.050	0.049	0.086	0.050	0.049
	(0.061)	(0.061)	(0.062)	(0.062)	(0.063)	(0.064)
L.Map-shock	-0.084***	-0.083***	-0.073***	0.002	0.002	-0.002
	(0.024)	(0.024)	(0.024)	(0.009)	(0.009)	(0.009)
Shadow bank x L.MaP-shock	0.131***	0.131***	0.127***	0.019**	0.019**	0.020**
	(0.030)	(0.030)	(0.030)	(0.009)	(0.009)	(0.009)
L.MB ratio		0.001**	0.001**		-0.000*	-0.000**
		(0.000)	(0.000)		(0.000)	(0.000)
L.Leverage		0.003	0.002		0.002	0.002
		(0.003)	(0.003)		(0.003)	(0.003)
L.Size		-0.005***	-0.005***		-0.005***	-0.005***
		(0.001)	(0.001)		(0.001)	(0.001)
L.GDP growth			0.144*			0.158**
			(0.081)			(0.072)
L.Inflation			0.005***			0.006***
			(0.002)			(0.001)
Firm fixed effect	yes	yes	yes	yes	yes	yes
Time fixed effect	yes	yes	yes	yes	yes	yes
R-squared	0.943	0.943	0.944	0.946	0.946	0.946
No of obs.	31708.000	31639.000	31639.000	32945.000	32876.000	32876.000

Notes: Dependent variable is our systemic risk measure ΔCoVaR of the entire European financial system. The MaP demand shock measures innovations in macroprudential policies focusing on loan demand, i.e. DSTI and LTV regulations. The MaP supply shock measures innovations in macroprudential policies focused on the supply of credit. It covers a broad spectrum of policies including liquidity measures, capital measures and loan provision measures. Standard errors in parentheses. *, **, and *** indicate significance levels at 10%, 5%, and 1%, respectively

The MaP demand shock (columns (1)-(3), third row) is negatively associated with systemic risk, which implies that an exogenous increase in macroprudential regulation leads to a reduction in systemic risk for the banking sector. The coefficient is highly significant across all three specifications (columns (1)-(3)). The effects of the MaP supply shock, on the other hand, are not statistically significant (columns (4)-(6), third row), which might be driven by the fact that the MaP supply shock is a conglomerate of quite heterogeneous regulations.

With respect to the systemic risk contribution of NBFIs in response to MaP shocks, we obtain very different results. It is captured by the coefficient on the interaction between the shadow banking dummy and the MaP shock (Shadow bank x L.MaP-shock). This coefficient reflects the systemic risk spillover to the NBFI sector in response to innovations in macroprudential policies targeted at the banking sector. The positive and statistically significant (at 1-5%) coefficient of the interaction variable in every column indicates that tighter MaP regulation raises systemic risk of NBFIs. This effect is much larger and more significant for MaP shocks which target the demand for loans (columns (1)-(3)) than for MaP shocks targeted directly at banks (columns (4)-(6)). However, it should be noted again, that the latter shock measure captures much more heterogeneous policy innovations than the former, which might have very different implications for potential leakages to the NBFI sector. Therefore, we turn to an analysis of the implications of disaggregated MaP supply measures in the next section.

Traditional banks and NBFIs are highly interconnected and these interconnections might be further intensified in response to macroprudential tightenings. Therefore, the finding that macroprudential policy shocks, have opposite effects on banks and NBFIs – at least for MaP demand shocks – raises the questions how systemic risk in the entire financial system is affected. To answer this question we also run a regression, in which we consider the systemic risk implications for all types of financial intermediaries jointly, i.e., we exlude the shadow bank dummy and the interaction term. The results are shown in table 13 in the appendix. It can be observed that the coefficient on the MaP shock is negative for MaP demand shocks and positive for MaP supply shocks, however the coefficients are insignificant in both cases. This suggests, that unexpected macroprudential tightenings are not successfull in lowering systemic risk in the entire financial system.

5.1.2 Disaggregated MaP supply shocks

Macroprudential regulation for banks, i.e., MaP supply measures, target very diverse aspects of the financial market and, hence, might have very different implications for systemic risk and, in particular, the systemic risk contributions of different financial intermediaries. Therefore, we reestimate the baseline estimation considering each of the three MaP supply shocks – loan-targeted, liquidity-targeted and capital-targeted – separately and present the findings in table 4. Column (1) presents the effects on ΔCoVaR in reaction to loan-targeted MaP shocks, column (2) presents the effects on ΔCoVaR in reaction to liquidity-targeted MaP shocks and column (3) presents the effects on ΔCoVaR in reaction to capital-targeted MaP shocks.

Table 4: Disaggregated supply shocks, shadow banks and systemic risks

	MaP Supply shock (Loan)	MaP Supply shock (Liquidity)	MaP Supply shock (Capital)
L.Δ CoVaR	0.647***	0.655***	0.655***
	(0.010)	(0.010)	(0.010)
Shadow bank	0.046	0.052	0.051
	(0.061)	(0.063)	(0.064)
L.Map-shock	-0.011	0.028	-0.026**
	(0.021)	(0.019)	(0.010)
Shadow bank x L.Map-shock	0.078***	-0.037*	0.029***
	(0.025)	(0.021)	(0.011)
L.MB ratio	0.001**	-0.000**	-0.000**
	(0.000)	(0.000)	(0.000)
L.Leverage	0.003	0.002	0.002
	(0.003)	(0.003)	(0.003)
L.Size	-0.005***	-0.005***	-0.005***
	(0.001)	(0.001)	(0.001)
L.GDP growth	0.150*	0.151**	0.157**
	(0.081)	(0.072)	(0.072)
L.Inflation	0.005***	0.006***	0.006***
	(0.002)	(0.001)	(0.001)
Firm fixed effect	yes	yes	yes
Time fixed effect	yes	yes	yes
R-squared	0.943	0.946	0.946
No of obs.	31639.000	32876.000	32876.000

Notes: Dependent variable is our systemic risk measure ΔCoVaR of the entire European financial system. The MaP supply shock - loan captures innovations in limits on credit growth, loan-loss provisions and loan restrictions. The MaP supply shock - liquidity captures innovations in reserve and liquidity requirements. The MaP supply shock - capital captures innovations in conservation buffers, capital surcharges for SIFIs and CCyBs. Standard errors in parentheses. *, **, and *** indicate significance levels at 10%, 5%, and 1%, respectively

Some noteworthy findings emerge: in the specification with MaP loan supply shocks we find the largest coefficient (0.078) on the interaction term (Shadow bank x L.Map-shock), i.e. MaP loan supply shocks are associated with the largest increase in ΔCoVaR of NBFIs. As the negative coefficient on the MaP shock itself suggests, at the same time, systemic risk in the banking sector decreases. However, this effect is not statistically significant. These results raise the question, how loan-targeted MaPs change ΔCoVaR of the entire financial system. Table 14 in the appendix provides an answer. The positive coefficient on the MaP shock in the first columns indicates that loan-targeted MaPs aimed at banks increase systemic risk in the entire financial system due to an increase of systemic risk in the NBFI sector. The coefficient is significant at a 5% level.

Capital-targeted measures aimed at banks (last column) also raise systemic risk in the NBFI sector (0.029), however, significantly reduce risk in the banking sector (-0.026). As table 14 in the appendix shows, the net effect on the entire financial system is negative (-0.012) but barely significant, suggesting that capital-targeted measures are somewhat successfull in lowering systemic risk in the entire system.

In the case of innovations in liquidity-targeted regulations (middle column), on the other hand, the coefficient on the interaction term (Shadow bank x L.Map-shock) is negative (-0.037) and slightly significant, suggesting that liquidity regulations for banks decrease systemic risk in the NBFI sector. This in line with our conjecture that an increase of liquidity in the banking sector might also profit NBFIs by reducing their liquidity risk. The coefficient on the shock itself, indicating the effect of this shock on the banking sector, is positive but insignificant. Consulting table 14 in the appendix again, we find that liquidity-targeted regulations (middle column) have a negative (0.017) but insignificant effect on systemic risk in the entire system.

5.2 MaP shocks and disaggregated NBFIs

Table 5 shows the results of our analyses for four different types of NBFIs – Financial services (FS), investment banks and brokerages (IBB), asset management companies (AMC) and insurance companies (INSR). In particular, the coefficient on the interaction term of each type of NBFI with the respective MaP shock, reflects how this particular shock affects the ΔCoVaR of this particular type of intermediary. The coefficients on the entity dummies (FS, AMC, IBB, INSR) indicate whether this type of NBFI contributes more or less to systemic risk than a traditional bank.

Firstly, it should be noted, that financial services (FS) and investment banks and brokerages (IBB) contribute significantly more to systemic risk in the entire financial sector than banks, as indicated by the positive and (slightly) significant coefficients on FS and IBB. Insurance companies, on the other hand, contribute less to systemic risk than banks, as indicated by the negative coefficient, however, the latter is insignificant. The finding that among shadow entities, insurance companies feature the lowest systemic risk contribution could be driven the fact that they are the most regulated agents in the non-bank financial intermediation system.

Turning to the coefficients on the interaction terms, we observe that in response to loan-targeted measures – demand and supply side – systemic risk increases considerably among financial services (FS). In fact, in the specification with demand measures (first column), the coefficient on the interaction term is the largest among all specifications in table 5 (0.165). This result complements the empirical literature on the effects of LTV measures on shadow banking entities reviewed in section 2.2, which usually finds that LTV measures lead to large spillover effects to financial service companies. However, our study is the first to document that these spillovers are indeed accompanied by an increase of systemic risk in the financial service sector. Loan demand measures also trigger a significant increase in systemic risk in the investment banks and brokerages sector (IBB) (0.136) and slightly significant increase in systemic risk among insurance companies (INSR) (0.138). Systemic risk in the asset management companies (AMC) sector increases significantly in reaction to loan supply targeted measures (0.079). Overall, the effects on systemic risk in different sector of the NBFI sector we document with respect to loan-targeted measures – demand and supply side – are in line with our hypotheses.

In the case of liquidity-targeted measures, only the coefficient on the interaction term with AMCs is statistically significant (-0.056). However, notably, the sign of this coefficient is negative, i.e., innovations in liquidity-targeted measures cause a drop in the systemic risk contribution of AMCs. This results is noteworthy, as liquidity is the main source of risk in the AMC sector. The negative coefficient implies that liquidity requirements for banks are also effective in lowering liquidity risk among AMCs, i.e., that there are positive spillovers from regulated to unregulated agents.

Innovations in capital-targeted measures, on the other hand, imply a sizeable and significant increase in systemic risk in AMCs and IBBs (0.034 in both cases). This is also in line with our hypotheses.

Table 5: MaP shocks, different types of shadow banks and systemic risk

	Demand shock (Loan)	Supply shocks (Loan)	Supply shock (Liquidity)	Supply shock (Capital)
L.MaP-shock	-0.068**	-0.011	0.027	-0.026**
	(0.030)	(0.021)	(0.019)	(0.010)
FS	0.771***	0.740***	0.731***	0.733***
	(0.220)	(0.221)	(0.221)	(0.222)
FS x L.MaP-shock	0.165***	0.117***	-0.007	0.020
	(0.050)	(0.038)	(0.034)	(0.015)
AMC	0.051	0.046	0.053	0.051
	(0.063)	(0.061)	(0.064)	(0.064)
AMC x L.MaP-shock	0.053	0.079***	-0.056***	0.034***
	(0.044)	(0.027)	(0.022)	(0.011)
IBB	0.085*	0.079*	0.084*	0.083*
	(0.045)	(0.044)	(0.045)	(0.044)
IBB x L.MaP-shock	0.136***	0.058	-0.039	0.034**
	(0.052)	(0.037)	(0.033)	(0.013)
INSR	-0.046	-0.041	-0.035	-0.033
	(0.031)	(0.030)	(0.028)	(0.030)
INSR x L.MaP-shock	0.138*	0.013	0.035	-0.007
	(0.080)	(0.039)	(0.043)	(0.019)
L.MB ratio	0.001**	0.001**	-0.000**	-0.000**
	(0.000)	(0.000)	(0.000)	(0.000)
L.Leverage	0.003	0.003	0.002	0.002
	(0.003)	(0.003)	(0.003)	(0.003)
L.Size	-0.006***	-0.005***	-0.005***	-0.005***
	(0.001)	(0.001)	(0.001)	(0.001)
L.GDP growth	0.190*	0.150*	0.149**	0.158**
	(0.108)	(0.081)	(0.072)	(0.072)
L.Inflation	0.010***	0.005***	0.006***	0.006***
	(0.003)	(0.002)	(0.001)	(0.001)
Firm fixed effect	yes	yes	yes	yes
Time fixed effect	yes	yes	yes	yes
R-squared	yes	yes	yes	yes
No of obs.	0.925	0.943	0.946	0.946
N	31639.000	31639.000	32876.000	32876.000

Notes: Dependent variable is our systemic risk measure ΔCoVaR of the entire European financial system. The MaP supply shock - loan captures innovations in limits on credit growth, loan-loss provisions and loan restrictions. The MaP supply shock - liquidity captures innovations in reserve and liquidity requirements. The MaP supply shock - capital captures innovations in conservation buffers, capital surcharges for SIFIs and CCyBs. The MaP demand shock measures innovations in macroprudential policies focusing on loan demand, i.e. DSTI and LTV regulations.. Standard errors in parentheses. *, **, and *** indicate significance levels at 10%, 5%, and 1%, respectively

5.3 MaP shocks in core vs peripheral European countries

We next turn to examine the role of country level heterogeneity by dividing the EU into core and peripheral countries, following Campos and Macchiarelli (2021). Since core and periphery have shown differential impact of MaP shocks (e.g., Araujo et al., 2020), we intend to examine whether MaP shocks affect their NBFI sectors differently.

When comparing the results in table 6 to the results in table 7 various differences become evident. First, as the coefficients on the shadow bank dummy reflect, NBFIs contribute relatively more to systemic risk than banks in the core but relatively less in the periphery. However, this does not necessarily imply that shadow banks in the core are inherently more risky than shadow banks in the periphery, but is very likely an outcome of the fact that there are many more shadow banks per traditional bank in the core than in the periphery (see table 12 in the appendix).

MaPs targeting the demand side of credit (first column) reduce systemic risk in the banking sector (second row), however the effect is significant only in the periphery. Demand side MaPs raise systemic risk in the NBFI sector in both regions (third row) but, again, the effect is significant only in the periphery. As figure 2 in the appendix shows, this could be the result of DSTI an LTV ratios being much more commonly used in the periphery.

MaPs targeting the supply side of loan provision (second column) significantly increase ΔCoVaR in the shadow banking system (third row) in both regions but decrease ΔCoVaR in traditional banks in the core and increase it in the periphery (second row, both coefficients only slightly significant). Such MaP measures are also more commonly used in the periphery.

Liquidity measures (third column) are applied to a similar extend in the core and the periphery and also have similar effects on the symstemic risk contribution of banks and non-banks: a decrease of ΔCoVaR in NBFIs (third row) and an insignificant increase in banks (second row).

Lastly, capital-targeting MaP measures (fourth column) are effective in taming systemic risk in banks in the periphery (second row) while the coefficient on the interaction with shadow banks is insignificant. In the core, on the other hand, such measures increase systemic risk in the shadow banking system (third row) while not significantly changing it in the traditional banking sector. Recalling that the entities experiencing the largest spillovers from capital-targeting MaP measures where AMCs (see table 5), the fact that these intermediaries are much less common in the periphery than in the core could explain this result.

Table 6: Core countries: MaP shocks, shadow banks and systemic risk

	Demand shock (Loan)	Supply shock (Loan)	Supply shock (Liquidity)	Supply shock (Capital)
Shadow bank	0.617***	0.618***	0.621***	0.776***
	(0.107)	(0.107)	(0.107)	(0.114)
L.Map-shock	-0.028	-0.052*	0.007	-0.000
	(0.037)	(0.029)	(0.019)	(0.016)
Shadow bank x L.Map-shock	0.071	0.095***	-0.019	0.030**
	(0.043)	(0.033)	(0.021)	(0.013)
Controls	yes	yes	yes	yes
Firm fixed effect	yes	yes	yes	yes
Time fixed effect	yes	yes	yes	yes
R-squared	0.927	0.927	0.927	0.922
No of obs.	24478.000	24478.000	24490.000	24490.000

Notes: Dependent variable is our systemic risk measure ΔCoVaR in core European countries. The MaP supply shock - loan captures innovations in limits on credit growth, loan-loss provisions and loan restrictions. The MaP supply shock - liquidity captures innovations in reserve and liquidity requirements. The MaP supply shock - capital captures innovations in conservation buffers, capital surcharges for SIFIs and CCyBs. The MaP demand shock measures innovations in macroprudential policies focusing on loan demand, i.e. DSTI and LTV regulations.. Standard errors in parentheses. *, **, and *** indicate significance levels at 10%, 5%, and 1%, respectively

Table 7: Periphery countries: MaP shocks, shadow banks and systemic risk

	Demand shock (Loan)	Supply shock (Loan)	Supply shock (Liquidity)	Supply shock (Capital)
Shadow bank	-0.446***	-0.462***	-0.394***	-0.396***
	(-5.80)	(-6.12)	(-5.21)	(-5.28)
L.Map-shock	-0.093**	0.064*	0.035	-0.071***
	(-2.53)	(1.81)	(0.99)	(-3.70)
Shadow bank x L.Map-shock	0.171***	0.149***	-0.084*	0.036
	(3.91)	(3.21)	(-1.85)	(1.37)
Controls	yes	yes	yes	yes
Firm fixed effect	yes	yes	yes	yes
Time fixed effect	yes	yes	yes	yes
R-squared	0.959	0.959	0.959	0.959
No of obs.	7161.000	7161.000	8386.000	8386.000

Notes: Dependent variable is our systemic risk measure ΔCoVaR in peripheral European countries. The MaP supply shock - loan captures innovations in limits on credit growth, loan-loss provisions and loan restrictions. The MaP supply shock - liquidity captures innovations in reserve and liquidity requirements. The MaP supply shock - capital captures innovations in conservation buffers, capital surcharges for SIFIs and CCyBs. The MaP demand shock measures innovations in macroprudential policies focusing on loan demand, i.e. DSTI and LTV regulations.. Standard errors in parentheses. *, **, and *** indicate significance levels at 10%, 5%, and 1%, respectively

6 Conclusion

We analyze the effectiveness of macroprudential policy with respect to its main purpose – curbing systemic risk –, considering that a growing part of the financial intermediation sector is not or only indirectly subject to such regulations. According to our estimation results, in Europe, on average, positive innovations in macroprudential policies (tightenings) do not significantly reduce systemic risk – measured as $\Delta CoVaR$. Measures targeted at the supply of loans, are even associated with a significant increase in systemic risk in the entire financial system.

When considering the contributions of traditional banks vis-à-vis non-bank financial intermediaries to changes in systemic risk after macroprudential policy shocks in European countries, we find that, on average, macroprudential tightenings either reduce or do not change systemic risk in the traditional banking sector, but increase systemic risk in the non-bank financial intermediation sector. We deduce that the effectiveness of macroprudential policy is hampered by the presence of unregulated actors. In particular, regulatory arbitrage leads to a shift of risk from the balance sheets of traditional banks to the balance sheets of NBFIs. Since both types of intermediaries are highly interconnected, this hampers an overall reduction in systemic risk.

When considering the effects of different types of macroprudential policy shocks, we find that loan-targeted policies – demand as well as supply-side – lead to the largest increase of systemic risk in the non-bank financial intermediation sector, indicating that loan provision is particular prone to risk-shifting activities. Capital supply measures have similar effects, however, these are less strong. Interestingly, macroprudential policies targeted at liquidity, have a significant negative effect on systemic risk in the NBFI sector. Furthermore, we provide evidence that different types of non-bank financial intermediaries are differently affected by different types of macroprudential policy shocks.

Our results have important policy implications. Most importantly they stress the need to develop macroprudential tools targeted at different types of non-bank financial intermediaries. These measures may include stricter oversight, enhanced reporting requirements, or additional capital and loan requirements for NBFIs. The relationship between traditional banks and NBFIs can become more complex and interconnected as more credit flows between the two sectors. This complexity could amplify systemic risks if not properly managed and monitored.

References

Acharya, V.V., Bergant, K., Crosignani, M., Eisert, T., McCan, F., 2020. The Anatomy of the Transmission of Macroprudential Policies. Working Paper 20/58. IMF.

Acharya, V.V., Schnabl, P., Suarez, G., 2013. Securitization without risk transfer. Journal of Financial Economics 107, 515–536.

Adrian, T., 2014. Financial Stability Policies for Shadow Banking. Staff Report 664. Federal Reserve Bank of New York.

Adrian, T., Brunnermeier, M.K., 2016. CoVaR. The American Economic Review 106, 1705.

Ahnert, T., Forbes, K., Friedrich, C., Reinhardt, D., 2021. Macroprudential fx regulations: Shifting the snowbanks of fx vulnerability? Journal of Financial Economics 140, 145–174.

Alam, Z., Alter, M.A., Eiseman, J., Gelos, M.R., Kang, M.H., Narita, M.M., Nier, E., Wang, N., 2019. Digging deeper–evidence on the effects of macroprudential policies from a new database. IMF .

Altunbas, Y., Binici, M., Gambacorta, L., 2018. Macroprudential policy and bank risk. Journal of International Money and Finance 81, 203–220.

Apergis, N., Aysan, A.F., Bakkar, Y., 2022. Borrower- and lender-based macroprudential policies: What works best against bank systemic risk? Journal of International Financial Markets, Institutions and Money 80, 101648.

Araujo, J., Patnam, M., Popescu, A., Valencia, F., Yao, W., 2020. Effects of macroprudential policy: Evidence from over 6,000 estimates. IMF Working Papers 20.

Auerbach, A.J., Gorodnichenko, Y., 2012. Measuring the output responses to fiscal policy. American Economic Journal: Economic Policy 4, 1–27.

Begenau, J., Landvoigt, T., 2022. Financial Regulation in a Quantitative Model of the Modern Banking System. The Review of Economic Studies 89, 1748–1784.

Bluwstein, K., Patozi, A., 2022. The Effects of Macroprudential Policy Announcements on Systemic Risk. Conference Paper. EEA.

Braggion, F., Manconi, A., Zhu, H., 2022. Household credit and regulatory arbitrage: Evidence from online marketplace lending. Management Science 69, 6271–6292.

Campos, N.F., Macchiarelli, C., 2021. The dynamics of core and periphery in the European monetary union: A new approach. Journal of International Money and Finance 112, 102325.

Cerutti, E., Claessens, S., Laeven, L., 2017. The use and effectiveness of macroprudential policies: New evidence. Journal of financial stability 28, 203–224.

Chari, A., Dilts-Stedman, K., Forbes, K., 2022. Spillovers at the extremes: The macroprudential stance and vulnerability to the global financial cycle. Journal of International Economics 136, 1–37.

Cizel, J., Frost, J., Houben, A., Wierts, P., 2019. Effective macroprudential policy: cross-sector substitution from price and quantity measures. Journal of Money, Credit and Banking 51, 1209–1235.

Claessens, S., Cornelli, G., Gambacorta, L., Manaresi, F., Shiina, Y., 2021. Do macroprudential policies affect non-bank financial intermediation? .

ECB, 2023. Financial Stability Report. Policy Report 2023.

ECB Committee on Financial Integration, 2022. Financial Integration and Structure in the Euro Areas. Technical Report. European Central Bank. Frankfurt am Main, Germany.

Ely, R.A., Tabak, B.M., Teixeira, A.M., 2021. The transmission mechanisms of macroprudential policies on bank risk. Economic Modelling 94, 598–630.

Forbes, K.J., 2021. The international aspects of macroprudential policy. Annual Review of Economics 13, 203–228.

Furceri, D., Loungani, P., Zdzienicka, A., 2018. The effects of monetary policy shocks on inequality. Journal of International Money and Finance 85, 168–186.

Fève, P., Moura, A., Pierrard, O., 2019. Shadow banking and financial regulation: A small-scale DSGE perspective. Journal of Economic Dynamics and Control 101, 130–144.

Gebauer, S., Mazelis, F., 2023. Macroprudential regulation and leakage to the shadow banking sector. European Economic Review 154, 104404.

Hanson, S.G., Kashyap, A.K., Stein, J.C., 2011. A macroprudential approach to financial regulation. Journal of Economic Perspectives 25, 3–28.

IMF, 2014. Risk taking, liquidity, and shadow banking – Curbing excess while promoting growth. Global Financial Stability Report, October 2014, International Monetary Fund .

Irani, R.M., Iyer, R., Meisenzahl, R.R., Peydró, J.L., 2021. The rise of shadow banking: Evidence from capital regulation. The Review of Financial Studies 34, 2181–2235.

Karapetyan, A., Kvaerner, J.S., Rohrer, M., 2023. Inefficient regulation: Mortgages versus total credit. Review of Finance , 1–37.

Meuleman, E., Vander Vennet, R., 2020. Macroprudential policy and bank systemic risk. Journal of Financial Stability 47, 100724.

Pellegrini, C.B., Cincinelli, P., Meoli, M., Urga, G., 2022. The role of shadow banking in systemic risk in the European financial system. Journal of Banking & Finance 138, 106422.

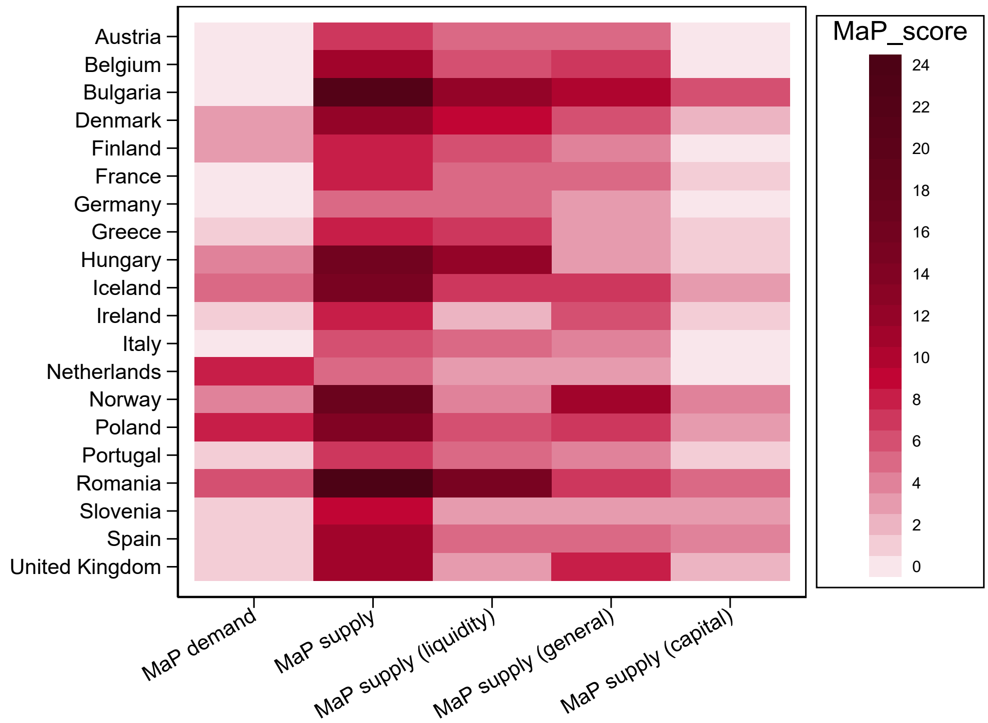
Pozsar, Z., Adrian, T., Ashcraft, A., Boesky, H., 2010. Shadow banking. Staff Report 458. Federal Reserve Bank of New York.

Resti, A., Onado, M., Quagliariello, M., Molyneux, P., 2021. Shadow Banking: What kind of Macroprudential Regulation Framework? Technical Report. European Parliament.

Appendix

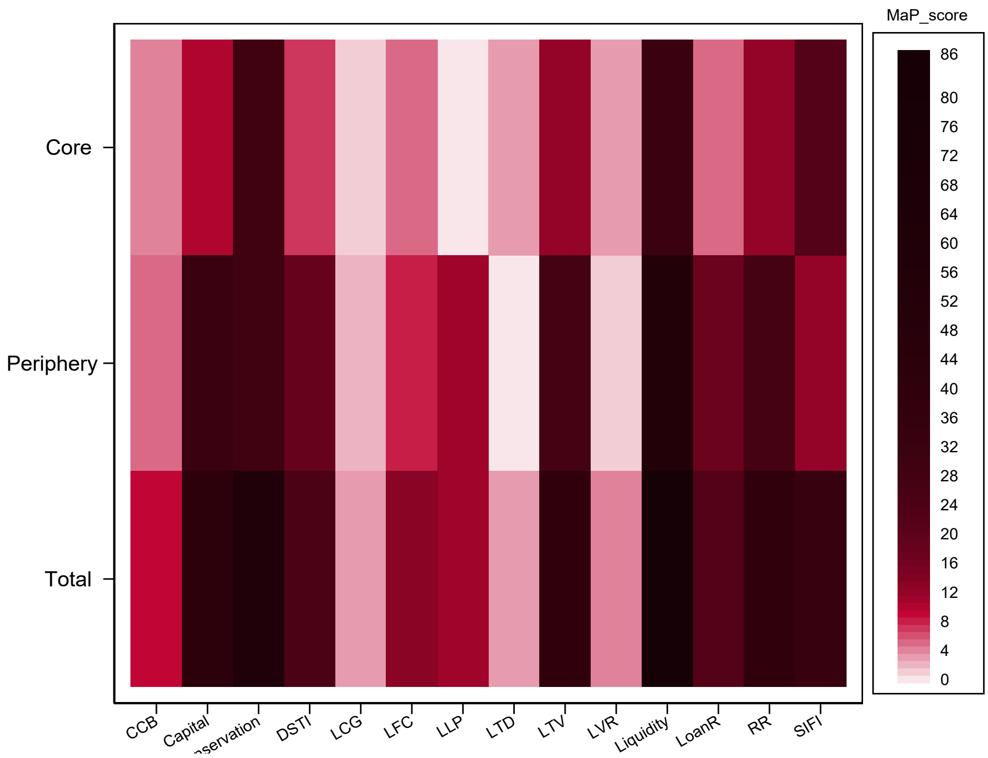
Additional tables and figures

Figure 1: Cross country variation in MaP intervention



Note: MaP supply (loan) captures innovations in limits on credit growth, loan-loss provisions and loan restrictions. MaP supply (liquidity) captures innovations in reserve and liquidity requirements. MaP supply (capital) captures innovations in conservation buffers, capital surcharges for SIFIs and CCyBs. MaP supply captures all three of the above categories. MaP demand (loan) captures LTV and DSTI ratios.

Figure 2: Cross country variation in MaP intervention



Note: MaP score for each instrument is based on the number of times each instrument is used by each country for the sample period 2005 - 2019. For additional information on each policy refer to table 9.

Table 8: Average systemic risk and size: Core and periphery European countries

	Core			Periphery		
	Bank	Shadow banks	Total	Bank	Shadow banks	Total
Delta CoVaR	0.55	0.43	0.45	0.76	0.87	0.82
Size	9.77	4.76	5.80	10.24	5.31	7.39
Observations	5176	19747	24923	3628	4968	8596

Notes: Size is measured as the logarithm of bank assets.

Table 9: Macroprudential Policies Examined

	Definition
Demand	
LTV	Restrictions on the loan-to-value ratios, mostly targeting housing loans. Additionally, includes restrictions targeting automobile loans and commercial real estate loans.
DSTI	Restrictions on the debt-service-to-income ratio for loans such as housing loans, commercial loans, etc.
Supply (loan)	
LCG	Restrictions on the expansion of aggregate credit, credit provided to households, or credit provided to the corporate sector.
LLP	Loan loss provision requirements.
LoanR	Restrictions for loans that are more customized than those included in LCG, such as loan limits and restrictions based on bank characteristics, loan characteristics, etc.
LTD	Restrictions on the loan-to-deposit ratio and penalties for high LTD ratios.
Supply (liquidity)	
RR	Reserve requirements (domestic or foreign currency).
Liquidity	Policies implemented to reduce systemic liquidity and funding risk, e.g. minimum requirements for liquidity coverage ratios, liquid asset ratios, etc.
Supply (capital)	
Capital	A broad spectrum of capital requirements, e.g. minimum capital requirements, systemic risk buffers, etc.
Conservation	A requirement for banks to maintain a capital conservation buffer.
SIFI	Policies implemented to decrease risks associated with globally and domestically significant financial institutions, including capital and liquidity surcharges.
CCyB	A requirement for banks to maintain a countercyclical capital buffer.
LVR	A limit on bank's leverage , calculated as dividing a measure of capital by the bank's non-risk-weighted exposures (Basel III)

Table 10: Overview of GICS Codes Used

Industry	**Sub-Industry**	**GICS Code**	**Classification**
Consumer Finance	Consumer Finance	40202010	FS
Diversified Financial Services	Other Diversified Financial Services	40201020	FS
	Multi-Sector Holdings	40201030	FS
	Specialized Finance	40201030	FS
Capital Markets	Asset Management Custody Banks	40203010	AMC
	Investment Banking Brokerage	40203020	IBB
Insurance	Life Health Insurance	40301020	INSR
	Multi-line Insurance	40301030	INSR

Table 11: First stage MaP policy estimation

	MaP Demand (Loan)	MaP Supply (Aggregate)	MaP Supply (Loan)	MaP Supply (Liquidity)	MaP Supply (Capital)
Inflation	0.003***	0.007**		0.005***	
	(0.001)	(0.003)		(0.002)	
REER growth	0.068**				
	(0.033)				
House prices	0.002**		-0.001*		
	(0.001)		(0.001)		
Real GDP growth	0.706***			0.185**	
	(0.170)			(0.092)	
Policy rate (t-1)	-0.004***	-0.030***	-0.003***	-0.005***	-0.017***
	(0.001)	(0.004)	(0.001)	(0.001)	(0.002)
Distance to default	-0.001*		0.001**	0.000	0.002*
	(0.001)		(0.001)	(0.001)	(0.001)
Growth forecast	-0.006***				
	(0.002)				
Currency crisis		0.004***		0.004***	0.002**
		(0.001)		(0.001)	(0.001)
$i - i^*$		0.022***			0.013***
		(0.004)			(0.002)
Banking crisis		0.005***	-0.003***	0.005***	
		(0.001)	(0.001)	(0.001)	
Romer & Romer intensity		-0.002***	0.001*	-0.002***	
		(0.000)	(0.000)	(0.001)	
Sovereign crisis			0.005***		
			(0.002)		
Romer & Romer count			-0.000	0.001**	-0.001***
			(0.000)	(0.001)	(0.000)
Domestic credit growth				-0.001**	
				(0.000)	
Constant	0.023**	0.171***	-0.006	0.045***	0.093***
	(0.010)	(0.021)	(0.009)	(0.016)	(0.017)
F-statistics	4.781	18.109	4.458	12.047	21.844
No of obs.	6891.000	11014.000	6891.000	10407.000	11309.000

Notes: Results of first-stage regressions predicting the MaP stance (MaP demand, MaP supply, MaP supply (liquidity), MaP supply (loan), MaP supply (capital)) as a function of the variables listed to the left side of the table. See Appendix A for details on the definitions and sources for the explanatory variables and information on the measures of the macroprudential stance. Bootstrapped standard errors clustered by country are in parentheses. Standard errors in parentheses. *, **, and *** indicate significance levels at 10%, 5%, and 1%, respectively.

Table 12: Country-wise financial institutions

Country	Banks (total)	Shadow banks (total)	Shadow Banks (FS)	Shadow Banks (IBB)	Shadow banks (AMC)	Shadow banks (INSR)
Austria	8	4	0	0	4	0
Belgium	3	17	7	1	8	1
Bulgaria	5	10	4	0	3	3
Denmark	46	15	2	0	12	1
Finland	3	13	3	2	7	1
France	20	32	7	3	20	2
Germany	16	121	14	20	77	10
Greece	10	11	3	2	4	2
Hungary	1	5	0	0	4	1
Iceland	2	5	2	1	1	1
Ireland	5	4	1	1	1	1
Italy	23	47	14	5	18	10
Netherlands	2	22	5	3	11	3
Norway	31	13	7	1	3	2
Poland	18	76	19	14	41	2
Portugal	5	1	0	1	0	0
Romania	3	6	0	1	5	0
Slovenia	2	4	1	0	2	1
Spain	18	10	1	2	4	3
Switzerland	15	49	5	5	35	4
United Kingdom	19	278	45	27	190	16
Total	255	743	140	89	450	64
Core	139	540	95	59	342	44
Periphery	116	203	45	30	108	20

Figure 3: Size of banks and shadow banks over time

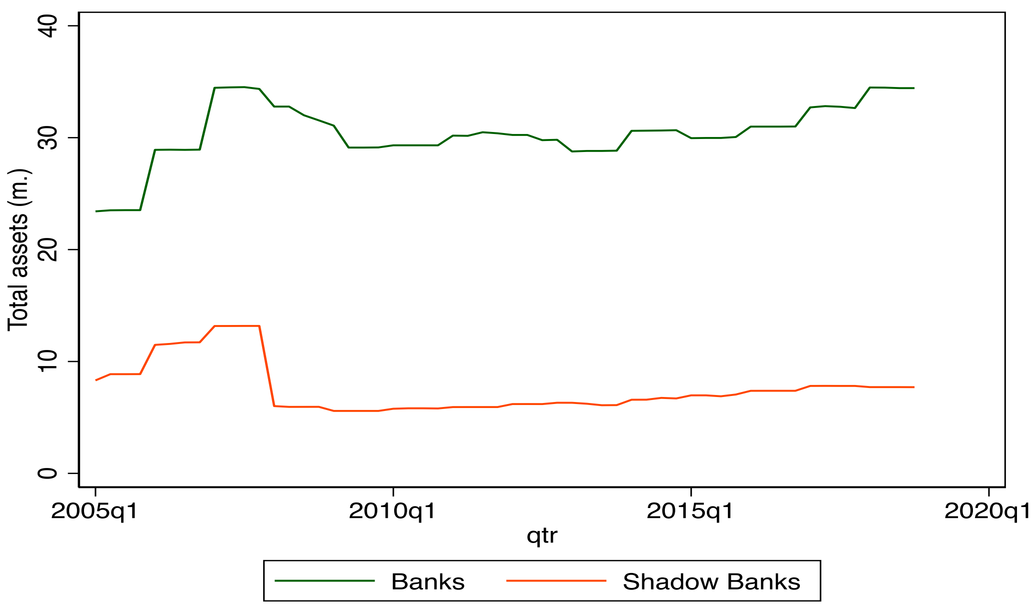
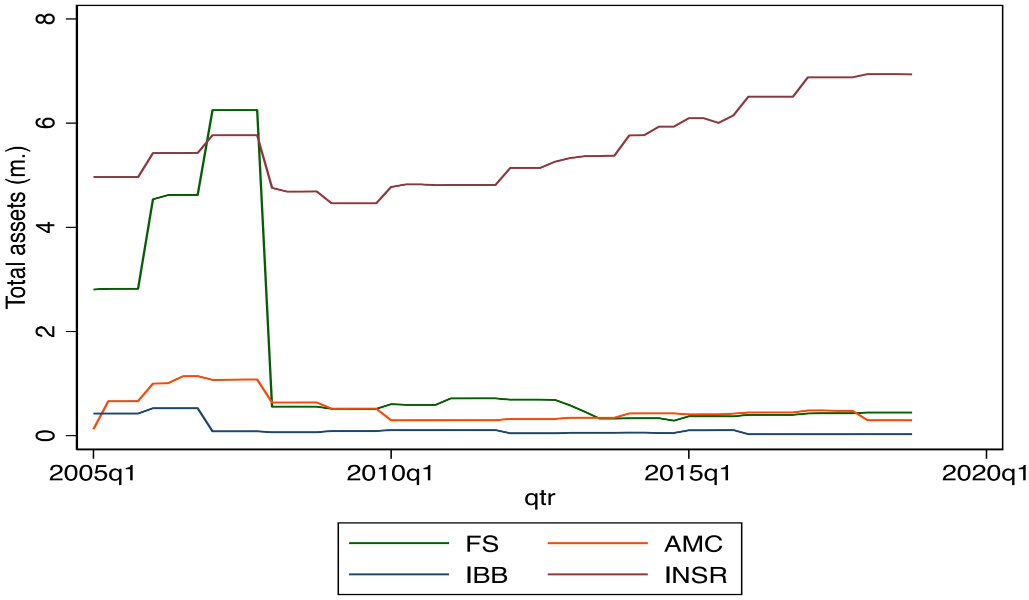


Figure 4: Size of different types of shadow banks over time



Additional results

Table 13: Macroprudential shocks and systemic risks for entire financial system

	MaP Demand shock			MaP Supply shock		
	(1)	(2)	(3)	(4)	(5)	(6)
L.Delta CoVaR	0.627***	0.625***	0.624***	0.635***	0.634***	0.630***
	(0.017)	(0.017)	(0.017)	(0.022)	(0.022)	(0.022)
L.map_shock	-0.022	-0.021	-0.013	0.013	0.013	0.012
	(0.017)	(0.017)	(0.016)	(0.014)	(0.014)	(0.014)
L.MB ratio		0.001**	0.001**		-0.000**	-0.001***
		(0.000)	(0.000)		(0.000)	(0.000)
L.Leverage		0.003	0.003		0.003	0.002
		(0.003)	(0.003)		(0.003)	(0.003)
L.Size		-0.007***	-0.007***		-0.008***	-0.007***
		(0.001)	(0.001)		(0.001)	(0.001)
L.GDP growth			0.207*			0.527***
			(0.109)			(0.181)
L.Inflation			0.010***			0.013***
			(0.003)			(0.002)
Firm fixed effect	yes	yes	yes	yes	yes	yes
Time fixed effect	yes	yes	yes	yes	yes	yes
R-squared	0.925	0.925	0.925	0.920	0.920	0.920
No of obs.	31149.000	31085.000	31085.000	32386.000	32322.000	32322.000

Notes: Dependent variable is our systemic risk measure ΔCoVaR of the entire European financial system. The MaP demand shock measures innovations in macroprudential policies focusing on loan demand, i.e., DSTI and LTV regulations. The MaP supply shock measures innovations in macroprudential policies focused on the supply of credit. It covers a broad spectrum of policies including liquidity measures, capital measures and loan provision measures. Standard errors in parentheses. *, **, and *** indicate significance levels at 10%, 5%, and 1%, respectively

Table 14: Disaggregated supply shocks and systemic risks for entire financial system

	MaP Supply shock (Loan)	MaP Supply shock (Liquidity)	MaP Supply shock (Capital)
L.Delta CoVaR	0.624***	0.630***	0.630***
	(0.017)	(0.022)	(0.022)
L.map_shock	0.068**	-0.017	-0.012*
	(0.030)	(0.038)	(0.007)
L.MB ratio	0.001**	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)
L.Leverage	0.003	0.002	0.002
	(0.003)	(0.003)	(0.003)
L.Size	-0.007***	-0.007***	-0.007***
	(0.001)	(0.001)	(0.001)
L.GDP growth	0.221**	0.526***	0.527***
	(0.109)	(0.181)	(0.181)
L.Inflation	0.010***	0.013***	0.013***
	(0.003)	(0.002)	(0.002)
Firm fixed effect	yes	yes	yes
Time fixed effect	yes	yes	yes
R-squared	0.925	0.920	0.920
No of obs.	31085.000	32322.000	32322.000

Notes: Dependent variable is our systemic risk measure ΔCoVaR of the entire European financial system. The MaP supply shock - loan captures innovations in limits on credit growth, loan-loss provisions and loan restrictions. The MaP supply shock - liquidity captures innovations in reserve and liquidity requirements. The MaP supply shock - capital captures innovations in conservation buffers, capital surcharges for SIFIs and CCyBs. Standard errors in parentheses. *, **, and *** indicate significance levels at 10%, 5%, and 1%, respectively