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344

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THE EFFECTIVENESS OF MACROPRUDENTIAL POLICIES IN CURBING OPERATIONAL RISK EXPOSURES

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ABSTRACT

Banks' focus nowadays shifts to non-financial risks, since credit and market risks are now well understood and under better control. We study whether macroprudential policy, designed to enhance financial system resilience, can mitigate or magnify losses stemming from such risks. To do so, we use a panel dataset on Eurozone countries between 2009-2018 and examine the dynamic path of operational risk exposures in response to tightening and loosening events of various macroprudential policies. Our results show that the tightening of specific measures, i.e., loan loss provisions, liquidity and loan to value, increases operational losses, whereas the loosening of measures, such as conservation buffers, loan loss provisions and debt service to income leads to a reduction in operational losses. Our results remain robust when we employ the inverse probability weighted estimator.

Keywords: macroprudential policies, non-financial risks, operational losses, banks, local projections

JEL classification: G21, G32, E44, E58

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1. Introduction

Since the onset of the Global Financial Crisis (GFC) in 2008, stringent regulations were imposed on financial institutions and banks, remaining in force till nowadays. In response to that, financial institutions have made substantial investments to upgrade their risk management practices and systems in order to comply with even more strict regulatory requirements. However, even though well-developed risk management frameworks are already set to address financial risks like credit, market and liquidity, there is question as of how effectively and at what level Non-Financial Risks (NFRs) are controlled by the current system.[1] This is an important topic since, besides traditional financial risks, many large risk events stem from NFRs as well.

The GFC gave prominence to severe deficiencies in risk management, which post-crisis regulation and supervision have sought to counteract aiming to prevent risk diffusion and enhance financial system's resilience. In light of promoting monetary and financial stability, the Basel Committee on Banking Supervision (BCBS), formed in 1974, has published a series of guidelines on capital adequacy and capital requirements known as Basel I, Basel II, and Basel III.[2]

What is more is that financial crises are associated with asset market collapses and profound declines in output and employment, *via* a slower credit growth (Ghosh and Kumar, 2022). In response to that, a macroprudential toolkit has been created to complement microprudential supervision in view of addressing systemic risk.[3] Macroprudential policy (MAP) is necessary to monitor and prevent the build-up of excessive risk in the system while securing its future resilience (Borio, 2003; ESRB, 2014; Tucker, 2016).

On the other hand, non-financial risks have not been studied yet so extensively as the traditional, most cited financial risks. However, they can threaten financial stability

[1] Non-Financial Risks include Operational, Conduct, Cybersecurity, Third-party, Compliance, Reputational, IT, Legal, Model, and Strategic risk.

[2] The Basel Committee on Banking Supervision (BCBS) is the primary global standard setter for the prudential regulation of banks and provides a forum for regular cooperation on banking supervisory matters. BCBS developed the Basel Accords, a series of three sequential banking regulation agreements (Basel I, II, and III). The Committee provides recommendations on banking and financial regulations, specifically, concerning capital risk, market risk, and operational risk.

[3] Systemic is defined as the risk of interruption of the provision of financial services caused by the impairment of all or part of the value of the assets of credit institutions. This interruption may have a significant negative impact on the real economy as it deprives the funds needed to finance investment. See also Perotti and Suarez, 2009; Borio and Drehmann, 2009; and Hanson *et al*., 2010 for a detailed discussion.

and have systemic implications (Berger *et al*., 2022). This was something that partly resolved in Basel II with first pillar development on minimum capital requirements for credit, market, and operational risk. This means that the new Accord requires the banking industry to incorporate operational risk into overall risk analysis for the purpose of setting capital requirements (Netter and Poulsen, 2003). Operational risk has received the most attention of the NFRs and it is simply defined, by most banks and regulators, as any risk not categorized as market or credit risk (BCBS, 1999).

Operational risk management involves managing financial losses associated with fraud, human errors, technical failures and other breakdowns in normal business processes and operations (Table 1). More precisely, EU legislation requires that institutions manage and mitigate operational risk effectively since it is embedded in all banking products and activities. Therefore, studying whether an extensively used tool like MAPs can mitigate or magnify operational losses can add significant knowledge to the existing literature and provide important policy implications. Effective macroprudential policies contribute to the reduction of systemic risk associated with operational losses. By adopting a macro-level perspective, regulators can address interconnectedness and contagion risks, thus fostering a more stable financial environment. Furthermore, given the increased complexity and globalization of the financial system, operational risk management is nowadays more relevant than ever.

*****Insert Table 1 here*****

Since significant operational risk events are able to disrupt the provision of credit and the functioning of markets, threatening financial stability, it is imperative these risks to be regulated to avoid any negative externalities. Consequently, capital requirements are necessary to incentivize banks to internalize and mitigate any costs associated with these risks. However, even though operational risk capital requirements were introduced in Basel II framework, consisting one of the fundamental components of the denominator of a bank's risk-based capital ratio (eq.1), representing 15.6% of the Risk Weighted Assets (RWA) of the 30 Globally Systemically Important Banks ("GSIBs") (Table A.1), it receives much less management, regulatory, investor or academic attention than the other two components, credit, and market RWA (Sands *et al.*, 2016).

$$\frac{Adjusted\ Common\ Equity}{(Credit\ RWA + Market\ RWA + Operational\ RWA)} = Common\ Equity\ Tier\ 1 \qquad (1)$$

Capital requirements act as absorption mechanism to any potential losses from credit, market, and operational risks (see, e.g., Mayordomo and Rodriguez-Moreno, 2021).[4] However, without effective loss absorbency, banks are very likely to react to operational losses by cutting lending and shrinking assets (Kashyap *et al*., 2008; Hanson *et al*., 2011). This could cause significant disruptions in the provision of financial services and the transactions between financial institutions. Therefore, transmission of such shocks is inevitable, especially in country groups that are characterized by a high degree of financial integration (e.g., the Eurozone). Cross-border activities of financial institutions are then an obvious and direct channel for creating negative externalities and risk spillovers (Buch *et al*., 2021).

The aim of this study is to examine the dynamic behavior of operational losses and whether these losses are mitigated or magnified with the use of MAPs. To do so, we employ the local projection method (Jorda, 2005) to investigate the dynamic response of operational losses to the implementation of tightening and loosening episodes of macroprudential policies. To assess the robustness of our baseline model results, we subsequently employ the inverse probability-weighted estimator (IPW), which has been employed before in the literature (e.g. Jorda and Taylor, 2016). The main findings of our study indicate that stricter loan loss provisions, liquidity measures, and loan-to-value ratios lead to higher operational losses, whereas loosening conservation buffers, loan loss provisions, and debt-service-to-income measures appear to mitigate such losses. These findings have significant policy implications, highlighting the need for a balanced, integrated approach that addresses operational risks while considering other policy objectives.

Our main contribution is that, to the best of our knowledge, this is the first study that investigates the dynamic impact of macroprudential policies on realized losses from non-financial risks. Furthermore, we restrict our attention to Eurozone, which is characterized by high financial integration but also heterogeneity across its members in the structure of the real economy and the financial sector, which can significantly raise

[4] The capital conservation buffer (CCoB) is a capital buffer of 2.5% of a bank's capital total exposures that needs to be met with an additional amount of Common Equity Tier 1 capital. The buffer sits on top of the 4.5% minimum requirement for Common Equity Tier 1 capital (ESRB).

financial stability risks. Thus, a monetary union constitutes an ideal laboratory to examine the effectiveness of MAPs in mitigating operational risk exposures.

The rest of this paper is structured as follows. Section 2 presents the theoretical background. Section 3 summarizes our data and empirical strategy. In section 4, we discuss our results. In section 5, we provide a robustness check given by the IPW estimator. Section 6 provides a discussion of the main policy implications. The last section (7) concludes.

2. Theoretical background

Financial stability is key to sustained growth and economic prosperity. Thus, the main objective of policymakers is to eliminate any potential risks that would expose the financial system's resilience into threat. However, literature has been devoted mainly to the study of financial risks and how they are effectively managed to avoid systemic banking distress.

A large strand of literature (Ayyagari *et al*., 2017; Cerutti *et al*., 2017; Akinci and Olmstead-Rumsey, 2018; Kuttner and Shim, 2016, Lim *et al*., 2011; Andries *et al*., 2021) has been devoted to the effects of MAPs on credit growth. Credit developments are highly associated with credit risk since besides the positive impact on the duration of expansions through credit availability, rapid credit growth tends to be followed by deeper recessions (Gadea Rivas M.A. *et al*., 2020).

Another part of research examines the association of macroprudential policies with bank risk (Altunbas, 2018; Andrieș, 2017; Meuleman, 2020). The responses of bank risk to changes in macroprudential tools vary depending on bank-specific characteristics such as size, capitalization, and funding structure, while macroprudential policies are more effective during the tightening phases compared to easing phases (Altunbas, 2018). However, in our case, we choose to focus on macro level data and examine the effects of MAPs on realized losses from non-financial risk. Specific macroprudential tools, such as capital requirements and countercyclical capital buffers, have been shown to reduce systemic risk and individual risk-taking (Andrieș, 2017). Similarly, we find that conservation buffers can reduce operational losses, indicating that operational risk is effectively addressed in this context. Meuleman (2020) finds that macroprudential policy actions have a positive impact on reducing bank systemic risk and more precisely that borrower-oriented tools and exposure limits are effective in decreasing the individual

risk component of banks, while liquidity tools and measures to enhance bank resilience are successful in reducing the systemic linkage component of bank risk. Similarly, Matos *et al*. (2024), find that capital macroprudential policies reduce banks' risk and enhance bank stability if banks are forced to hold subordinated debt. Chavleishvili *et al*. (2021) provide a risk-management framework for policymakers by developing a macro-financial stress test to monitor downside risks to the economy and a macroprudential stance metric to quantify when interventions may be beneficial.

Nevertheless, non-financial risks per se are not examined to the extent required by current events. Today, banks are exposed to non-financial risks like IT systems risk, human resources risk, reputational risk, etc. De Fontnouvelle *et al*. (2003) highlight the fact that financial organizations should manage operational risk effectively because it can exert significant costs. As pointed out by Alexander (2003), operational risk is considered as important as market or credit risks by about 70% of banks, with nearly a quarter of banks admitting to operation-related losses exceeding $1.6 billion. Dardac *et al*. (2010) argue that operational risk has become an important source of loss for credit institutions highlighting the need for effective risk management techniques.

Therefore, bank regulation constitutes an essential part in the study of risks in financial institutions. MAPs reduce the volatility of the bank's net worth and the leverage ratio and, thus, may reduce diffusion of risk in the real economy (Goyal and Verma, 2023). Especially since the onset of the 2008 GFC, many economies have been facing high regulatory standards, while international developments such as Basel make the structure of regulation even more complex than before. Ezer (2017) find that stricter regulation tends to decrease banks' risk levels. Anginer *et al*. (2021) investigate the evolution in bank capital regulations and bank risk after 2008, showing that regulatory capital increased and that quality of capital matters in reducing bank risk. The relationship between bank capital and risk management has been studied extensively after the capital regulation enforcement, with studies finding contradicting results (a positive correlation between risk and capital regulation, e.g., Siddika and Haron, 2019; Lundtofte and Nielsen, 2018; Diamond and Rajan, 2002, or a negative one in Maji and Kumar, 2015; Hsieh *et al*., 2013; and Agoraki *et al*., 2011). Lotto (2018) investigates the relationship between capital requirements regulation and bank operating efficiency and finds that stringent regulations make banks more operationally efficient.

3. Data and methodology

To assess the overall effectiveness of tightening and loosening events of MAPs on curbing operational risk exposures, we use the local projections (LP) method (Jorda, 2005). The LP framework is flexible enough and fits well within a panel structure of data while it is less sensitive to misspecification as the shape of the impulse response is not constrained. Moreover, as our key *shock* is measure of MAP that capture either tightening or loosening of the respective MAP measure in the spirit of the shocks identified in Romer and Romer (2010), incorporating such "shocks" which are of a discrete nature in VAR models would be challenging. We are interested in studying the dynamic behavior of operational losses in response to changes in macroprudential measures, as this will provide significant insights, especially for policymakers, who will be able to assess the effectiveness of the measures they have taken over time. Rojas *et al*. (2022), De Schryder and Opitz (2021), and Richter *et al.* (2019) also rely on the LP method when analyzing macroprudential policy.

The main advantage is that this method estimates local projections one equation at a time rather than extrapolating into increasingly distant horizons from a given model, as in the vector autoregressions (VAR). Moreover, local projections are less sensitive to misspecification compared to VAR models, while they can incorporate highly flexible specifications that may be unfeasible in a VAR context, although VAR models and LP methods estimate the same impulse responses (Jorda, 2005; Plagborg-Møller and Wolf, 2021). The LP method is more flexible in that it allows the estimation of the effect of shocks identified "outside the system" at each time horizon independently. Especially in the context of macroprudential policies, LP is expected to be more appropriate since macroprudential policies tend to vary over time, both in their intensity (tightening vs. loosening) and their effects on the economy.

Therefore, our baseline empirical specification takes the following forms:

$$y_{i,t+h} - y_{i,t-1} = c_i^h + \tau_t^h + \beta_{MPT}^h MPT_{i,t} + \sum_{n=1}^{N} \boldsymbol{\varphi}_n^h \boldsymbol{X}_{i,t-n} + \varepsilon_{i,t}^h \qquad (5)$$

$$y_{i,t+h} - y_{i,t-1} = c_i^h + \tau_t^h + \beta_{MPL}^h MPL_{i,t} + \sum_{n=1}^{N} \boldsymbol{\varphi}_n^h \boldsymbol{X}_{i,t-n} + \varepsilon_{i,t}^h \qquad (6)$$

where i denotes country, t denotes time, $h = 0,1,2,3$ denotes the projection horizon, N denotes the number of lags, y denotes operational risk exposures, $MPT_{i,t}$ and

$MPL_{i,t}$ include tightening and loosening events of MAPs enforced by country i in period t, X is a matrix of lagged dependent and control variables. We take one to two lags for our regressors, except for macroprudential measures, for which, we also include their current level.

Our attention is mainly drawn to the effect of macroprudential policies on operational losses; however, we include other potential explanatory variables (Table 2) For instance, GDP growth rate is an important determinant of operational losses as there is evidence that operational losses are more frequent and more severe during economic downturns (Chernobai *et al*., 2011). Moreover, control of corruption and government effectiveness are strongly related to banking stability, as found in Alshubiri *et al*. (2023), who provide evidence of an enhancement in banking stability under high control of corruption and increased levels of governments effectiveness.[5] Disruptions in banking stability could jeopardize banks' operations leading to potential losses. Bank regulatory capital to risk-weighted assets links the minimum amount of capital that banks must retain according to the risk profile of the bank's lending activities and other assets. As a result, and as mentioned in the introduction, operational risk capital requirements consist one of the fundamental components of the denominator of a bank's risk-based capital ratio representing 15.6% of the Risk Weighted Assets (RWA) of the 30 Globally Systemically Important Banks ("GSIBs"). Finally, regressions include country fixed effects c_i to control for country-specific unobserved heterogeneity and time fixed effects τ_t to control for time events and common shocks affecting all countries simultaneously, while ε is the $i.i.d.$ error term.

*****Insert Table 2 here*****

Data on MAPs come from the iMaPP database by Alam *et al.* (2019), including dummy-type indexes of tightening and loosening episodes over several instruments (see Table A.3 for a description). Operational risk exposure data are available from the European Central Bank's supervisory and prudential statistics database. Our dataset covers the period 2009-2018. This gives us the opportunity to study the period right after

[5] According to the World Bank's Worldwide Governance Indicators, government effectiveness captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies, while control of corruption captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests.

the GFC till the most recent available year data. Descriptive statistics of our variables are provided in Table 3.[6]

*****Insert Table 3 here*****

4. Baseline results

Results on local projections of both tightening and loosening macroprudential measures are provided in figures 1 and 2.

Loan loss provision requirements, which include dynamic provisioning and sectoral provisions, are captured in the *LLP* instrument. Imposing stricter restrictions on loan loss provision increase operational losses at years 2 and 3 (3.06% and 4.28% respectively, statistically significant at 1% significance level). Similarly, tightening of measures taken to mitigate systemic liquidity and funding risks (*Liquidity*) raise operational losses between years 1 and 2 (0.70% and 1.05% respectively, statistically significant at 10% significance level). Turning to borrower-targeted MAPs, we find that stricter restrictions on Loan to Value ratios result also in higher realized losses at years 2 and 3 (0.60% and 0.74% respectively, significant at 5% significance level). Thus, it appears that *LLP* restrictions have the greatest impact, in terms of magnitude, on operational exposures. Consequently, the aforementioned MAPs are not sufficient to mitigate operational losses and thus, they cannot address operational risk effectively. For instance, Siddika and Haron (2019) find that capital regulation enables banks to take excessive risks through allowing them to increase riskier investments. The positive association between risk and capital regulations is also found in other studies (Lundtofte and Nielsen, 2018; Diamond and Rajan, 2002). Lundtofte and Nielsen (2018) suggesting that banks may respond to stricter regulation by increasing the share of high risk-assets and this is evident through their empirical analysis on US banks. Increasing risky assets may affect event-type categories like execution, delivery and process management or clients, products, and business practices, rising operating risks and losses.

A possible channel could also be attributed to the fact that stricter regulations may increase compliance costs for banks as they must allocate significant resources to meet new regulatory standards, which can substantially raise operational losses (Basel III,

[6] Our sample covers 19 Eurozone countries for the period 2009-2018, so we end up with 190 observations in our panel dataset.

2011). Tightening measures require more complex reporting systems, which can lead to higher chances of errors and operational costs. Another explanation of the above results can be attributed also to the capital and liquidity adjustments that need to be done in response to tightened measures of capital and liquidity ratios. These actions can be costly, putting a lot of pressure on operational budgets, and thus, resulting in higher operational losses. For instance, banks may need to raise more funds or keep more cash on hand in order to meet stricter capital and liquidity regulations. These adjustments strain their budgets, making operations more costly leading to higher losses.

On the contrary, loosening episodes of *Conservation, LLP*, and *DSTI* reduce operational risk exposures. *Conservation* includes requirements for banks to maintain a capital conservation buffer, including the one established under Basel III. Loosening events of this MAP decrease operational losses during the first year of the projection horizon (-0.73%, significant at 1% significance level). Similarly, *LLP* loosening causes a -0.58% (significant at 1% significance level) reduction in operational losses. Finally, loosening events of *DSTI* are found to reduce operational exposures as well (-1.84% in the third year, significant at 5% significance level). Thus, loosening episodes lead to operational losses reduction, with *DSTI* exhibiting the largest impact in terms of magnitude. The reasons behind these results are exactly the opposite to the ones discussed above for the effect of tightening measures. Only one exemption arises regarding *SIFI*. *SIFI* includes measures taken to mitigate risk from global and domestic systemically important financial institutions, containing capital and liquidity surcharges. Implementation of loosening *SIFI* measures results in an increase in operational losses of 2.05% in the third year (significant at 10% significance level). Looser capital requirements for SIFIs increase operational losses as the operational risk component for the 30 Globally Systemically Important Banks ("GSIBs") is considerable, representing a significant fraction of the denominator in Tier 1 Capital (see section 1).

Table 4 presents a summary of the main findings of the baseline local projection model.

*****Insert Table 4 here*****

5. Inverse Probability Weighted Estimator (IPW) – The Macroprudential Policy treatment is not randomly allocated.

5.1 Empirical strategy (IPW)

In this section, we provide insights into the effects of MAPs on operational losses considering the treatment effect to be non-random. For this exercise, we employ an inverse probability weighted (IPW) estimator. The IPW estimator gives more weight to those treatments that are difficult to predict based on observables and less weight to those observables that are non-random due to other factors, and this way, we can re-randomize the treatment. Jorda *et al.* (2016) use the IPW estimator for the probability of observing a financial crisis driven recession rather than a normal recession.[7]

The first step includes the specification of a logit model to estimate the probability (p_{it}) that macroprudential policy instruments are implemented by country i in period t. The estimate of this probability is called the propensity score. In the second step, we estimate the baseline local projections model using regression weights given by the inverse of p_{it}. Weighting by the inverse of the propensity score allows to put more weight on those macroprudential instruments that were difficult to predict based on observables and put less weights on those instruments that could be predicted. We apply the same procedure for our model given in eq. 2.

More precisely, we denote by $d_{i,t}$ a dummy that takes the value one and zero if the specific macroprudential policy tightening or loosening instrument is implemented or not respectively. As mentioned above, the estimation proceeds in two stages. In the first stage, we use a logit model to estimate the probability that macroprudential measures are implemented:

$$\log\left(\frac{P\left[d_{i,t}=1|Z_{i,t-1}\right]}{P\left[d_{i,t}=0|Z_{i,t-1}\right]}\right)=a_i+\beta Z_{i,t-1}+\varepsilon_{i,t}$$

, where $Z_{i,t-1}$ is a vector that contains our control variables. We also include country-fixed effects to account for country-specific usage of macroprudential policies. The probability of the implementation of MAPs is called the propensity score and its

[7] Following Jorda *et al.* (2016), we are interested in characterizing the average treatment effect (ATE). Intuitively, the goal of reweighting in this framework is to focus the estimator on a rebalanced sample in each part of the treatment and control groups that closely resemble each other and so obtain an ATE estimate as if the allocation had been randomly assigned.

estimated value from the logit model is denoted by $\widehat{p_{i,t}}$. In the second stage, we estimate local projections using regression weights given by the inverse of $\widehat{p_{i,t}}$.[8] We apply the local projections method in our models in equations (2) and (3).

5.2. Empirical findings (IPW)

In this section, we discuss the empirical findings from the IPW estimation (Figures B.3 and B.4). In general, our results remain robust and do not deviate significantly from the baseline LP regressions results.

More precisely, statistically significant results are obtained with the implementation of tightening measures of *Liquidity*, *LLP* and *Other* macroprudential policies. Tightening measures to mitigate systemic liquidity and funding risks lead to a rise in operational losses in years 3 and 4 (1.31% and 1.74% respectively), while restrictions on loan loss provisions result in a 2.3% increase in operational exposures at the end of the projection horizon. We also find a significant result with the implementation of *Other* measures, which include stress testing, restrictions on profit distribution, and structural measures (e.g., limits on exposures between financial institutions). *Other* measures increase operational losses during the whole projection period with a maximum increase materialized at year 2 (0.74%). If banks are required to conduct frequent and comprehensive stress tests, they need to develop complex models and hire specialized personnel, that could contribute to higher operational losses.

On the other hand, loosening events of *Capital* and *LLP* lead to increases in operational losses. Loosening restrictions on capital requirements for banks, which include risk weights, systemic risk buffers, and minimum capital requirements, result in a 3% reduction of operational losses at the end of the projection horizon. Similarly, relaxing loan loss provisions can reduce operational losses right after implementation, reaching a 1.3% reduction in the first two years. Only one contradicting result is found with the implementation of loosening *LTV*, which results in operational losses increase right after the implementation (0.74%).

Table 5 presents a summary of the main findings of the IPW model.

[8] The weights are defined by $w_{i,t} = \frac{d_{i,t}}{p_{i,t}} + \frac{1-d_{i,t}}{1-p_{i,t}}$, where we truncate $w_{i,t}$ at 10.

*****Insert Table 5 here*****

6. Policy implications

Our results provide valuable insights into the design and implementation of macroprudential policies (MAPs). We find that certain macroprudential measures, particularly those involving stricter regulations, increase operational losses. For instance, the increase of operational losses after *LLP*, *Liquidity* and *LTV* measures implementation highlights the need for a more balanced approach in policy design. While these macroprudential measures aim to mitigate credit risk, the associated compliance costs, budget pressures, and potential shifts toward riskier assets magnify operational costs. Policy authorities should consider complementary measures that also address operational risks when tightening macroprudential regulations.

Our findings emphasize that macroprudential policy tightening measures alone are not sufficient to mitigate operational losses. Policymakers should adopt a holistic risk management framework that integrates credit, liquidity and operational risk considerations. For example, improved operational risk management through regular training together with streamlined compliance mechanisms could mitigate operational losses stemming from tightened macroprudential measures. On the other hand, our findings regarding loosening measures suggest that policymakers could design a mix of measures that balance risk mitigation with operational cost efficiencies. Finally, the unique findings concerning loosening *SIFI* measures require the introduction of assurance to manage operational risks specific to the risk profiles of globally systemically important financial institutions during loosening episodes.

By considering these dynamics, macroprudential policy authorities can design more effective policies, adopting a balanced integrated approach that considers both operational risks together with other policy objectives.

7. Concluding remarks

Risk is an integral part of any financial institution and plays a vital role in banks' daily operations. Recently, especially after the GFC, banks are highly guided by regulations and supervised by monetary authorities. Regulators and risk managers define risk as any situation of uncertainty that has adverse effects on the bank's performance. Therefore, and foremost, the purpose of regulations is to secure the well-functioning of individual bank institutions (microprudential aspect) and to prevent any systemic risk that could destabilize the financial system and the real economy (macroprudential aspect). In light of promoting monetary and financial stability, the Basel Committee on Banking Supervision (BCBS) was formed in 1974, publishing a number of landmark guidelines on capital adequacy and capital requirements known as Basel I, Basel II, and Basel III.

However, although financial risks are now well understood, non-financial risks received less attention, and this was something partly resolved in Basel II with first pillar development on minimum capital requirements for credit, market, and operational risk. Operational risk is considered one of the most fundamental non-financial risks and it is at the core of the present study. This paper tries to put NFRs in the foreground by examining the dynamic path of realized operational risk exposures. Furthermore, it examines whether the extensive use of MAPs can mitigate or magnify operational losses.

Thus, we employ a panel dataset on Eurozone countries (Table A.2) for the period 2009-2018 and we use the local projection method (Jorda, 2005) to investigate the dynamic path of operational risk exposures over a two-time year horizon. To the best of our knowledge this is the first study that investigates the dynamic impact of MAPs on realized losses from non-financial risks.

Our empirical findings are summarized as follows: *LLP*, *Liquidity* and *LTV* tightening measures increase operational losses, with *LLP* restrictions having the greatest impact. The positive correlation between risk and capital regulations is also found in other studies (Siddika and Haron, 2019; Lundtofte and Nielsen, 2018; Diamond and Rajan, 2002) and is based on the fact that banks respond to stricter regulations by increasing the share of high-risk assets. Moreover, stricter regulations increase compliance costs, require more advanced and complex reporting systems and models, necessitate adjustments in assets and liabilities management, demand specialized personnel, all of which result in higher operational losses. On the other hand, loosening

episodes of *Conservation*, *LLP* and *DSTI* are capable of reducing losses, with *DSTI* having the largest effect. Furthermore, employing the IPW estimator, we find similar results, i.e., tightening measures of *LLP*, *Liquidity* and *Other* measures result in operational losses increases, while loosening episodes on *Capital* and *LLP* can reduce operational losses.

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Table 1: Basel Loss Event Type Classification			
Event-Type Category (Level 1)	**Definition**	**Categories (Level2)**	**Activity Examples (Level 3)**
Internal Fraud	Losses due to acts of a type intended to defraud, misappropriate property, or circumvent regulations, the law or company policy, excluding diversity/ discrimination events, which involve at least one internal party	• Unauthorized Activity • Theft and Fraud	Transactions not reported (intentional) Transaction type unauthorized (w/monetary loss) Mismarking of position (intentional) Fraud / credit fraud / worthless deposits Theft / extortion / embezzlement / robbery Misappropriation of assets Malicious destruction of assets Forgery Check kiting Smuggling Account take-over / impersonation / etc. Tax non-compliance / evasion (willful) Bribes / kickbacks Insider trading (not on firm's account)
External Fraud	Losses due to acts of a type intended to defraud, misappropriate property, or circumvent the law, by a third party	• Theft and Fraud	Theft/Robbery Forgery Check kiting

		• Systems Security	Hacking damage Theft of information (w/monetary loss)
Employment Practices and Workplace Safety	Losses arising from acts inconsistent with employment, health or safety laws or agreements, from payment of personal injury claims, or from diversity / discrimination events	• Employee Relations • Safe Environment • Diversity & Discrimination	Compensation, benefit, termination issues Organized labor activity General liability (slip and fall, etc.) Employee health & safety rules events Workers' compensation All discrimination types
Clients, Products & Business Practices	Losses arising from an unintentional or negligent failure to meet a professional obligation to specific clients (including fiduciary and suitability requirements), or from the nature or design of a product.	• Suitability, Disclosure & Fiduciary • Improper Business or Market Practices	Fiduciary breaches / guideline violations Suitability / disclosure issues (KYC, etc.) Retail customer disclosure violations Breach of privacy Aggressive sales Account churning Misuse of confidential information Lender liability Antitrust Improper trade / market practices Market manipulation Insider trading (on firm's account)

			Unlicensed activity Money laundering
		• Product Flaws	Product defects (unauthorized, etc.) Model errors
		• Selection, Sponsorship & Exposure	Failure to investigate client per guidelines Exceeding client exposure limits
		• Advisory Activities	Disputes over performance of advisory activities
Damage to Physical Assets	Losses arising from loss or damage to physical assets from natural disaster or other events.	• Disasters and other events	Natural disaster losses Human losses from external sources (terrorism, vandalism)
Business disruption and system failures	Losses arising from disruption of business or system failures	• Systems	Hardware Software Telecommunications Utility outage / disruptions
Execution, Delivery & Process Management	Losses from failed transaction processing or process management, from relations with trade counterparties and vendors	• Transaction Capture, Execution & Maintenance	Miscommunication Data entry, maintenance or loading error Missed deadline or responsibility Model / system misoperation Accounting error / entity attribution error Other task misperformance Delivery failure Collateral management failure

			Reference Data Maintenance
		• Monitoring and Reporting	Failed mandatory reporting obligation Inaccurate external report (loss incurred)
		• Customer Intake and Documentation	Client permissions / disclaimers missing Legal documents missing / incomplete
		• Customer/Client Account Management	Unapproved access given to accounts Incorrect client records (loss incurred) Negligent loss or damage of client assets
		• Trade Counterparties	Non-client counterparty misperformance Misc. non-client counterparty disputes
		• Vendors & Suppliers	Outsourcing Vendor disputes

Source: Basel Committee on Banking Supervision (BCBS), 2004

Table 2: List of Variables and Sources

Variable	Description	Source
Operational Losses	Total risk exposure amount for operational risks (%)	Supervisory and prudential statistics, ECB
Macroprudential policies	Tightening and loosening episodes of macroprudential instruments	Alam *et al*. (2019)
GDP growth rate	Real GDP growth rate (%)	World Bank Development Indicators
Government effectiveness	Government Effectiveness captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.	World Bank Worldwide Governance Indicators
Control of Corruption	Control of Corruption captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests.	World Bank Worldwide Governance Indicators
Bank Regulatory Capital to Risk Weighted Assets (%)	The capital adequacy of deposit takers. It is a ratio of total regulatory capital to its assets held, weighted according to risk of those assets.	Global Financial Development Database, World Bank (2019)

Table 3: Descriptive Statistics

VARIABLES	N	mean	sd	min	max
Operational losses	190	9.830	2.132	5.249	17.78
GDP growth rate	190	1.260	4.153	-14.84	24.37
Government effectiveness	190	1.204	0.456	0.125	2.235
Control of corruption	190	1.080	0.681	-0.190	2.241
Regulatory capital	190	17.04	4.233	7.343	35.65
CCB (Tight)	190	0.0211	0.144	0	1
CCB (Loos)	190	0	0	0	0
Conservation (Tight)	190	0.226	0.420	0	1
Conservation (Loos)	190	0.0105	0.102	0	1
Capital (Tight)	190	0.0789	0.270	0	1
Capital (Loos)	190	0.0158	0.125	0	1
SIFI (Tight)	190	0.189	0.393	0	1
SIFI (Loos)	190	0.00526	0.0725	0	1
DSTI (Tight)	190	0.0789	0.270	0	1
DSTI (Loos)	190	0.0105	0.102	0	1
LTV (Tight)	190	0.111	0.314	0	1
LTV (Loos)	190	0.0105	0.102	0	1
Other (Tight)	190	0.100	0.301	0	1
Other (Loos)	190	0.0263	0.160	0	1
Liquidity (Tight)	190	0.274	0.447	0	1
Liquidity (Loos)	190	0.0263	0.160	0	1
LLP (Tight)	190	0.105	0.308	0	1
LLP (Loos)	190	0.00526	0.0725	0	1

Table 4: Local Projections

Measure	Tightening/Loosening (T/L)	Result	Years	Percentage
LLP	T	Increase	2 and 3	3.06% and 4.28%
Liquidity	T	Increase	1 and 2	0.70% and 1.05%
LTV	T	Increase	2 and 3	0.60% and 0.74%
Conservation	L	Decrease	1	0.73%
LLP	L	Decrease	1	0.58%
DSTI	L	Decrease	3	1.84%
SIFI	L	Increase	3	2.05%

Note: Table 4 summarizes the main findings of the baseline local projections method.

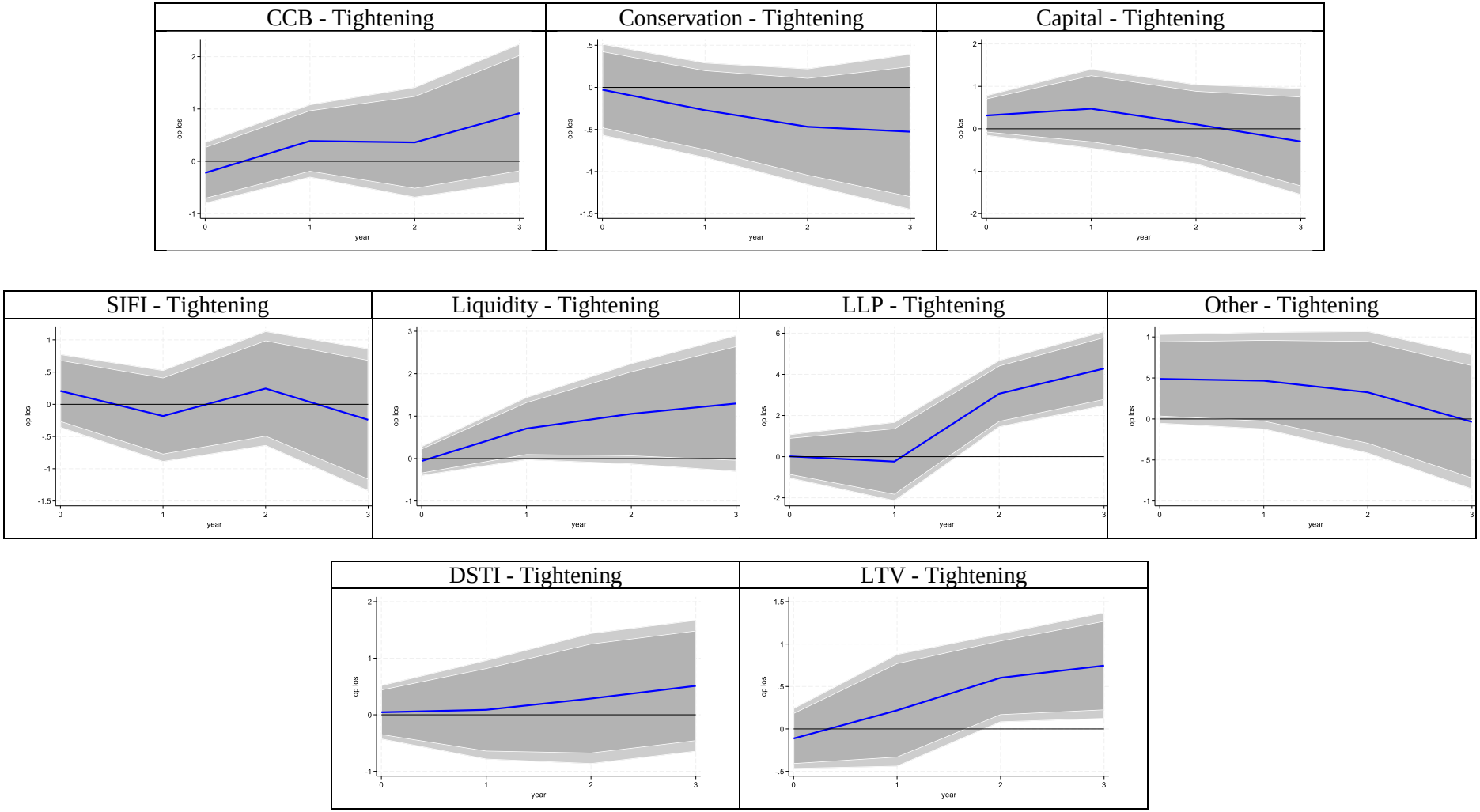
Table 5: IPW

Measure	Tightening/Loosening (T/L)	Result	Years	Percentage
LLP	T	Increase	3	2.29%
Liquidity	T	Increase	2 and 3	1.31% and 1.74%
Other	T	Increase	whole horizon	0.74% (max, year 2)
Capital	L	Decrease	3	3.05%
LLP	L	Decrease	1 and 2	1.31% and 1.32%
LTV	L	Increase	Right after implementation	0.74%

Note: Table 5 summarizes the main findings of the IPW estimator.

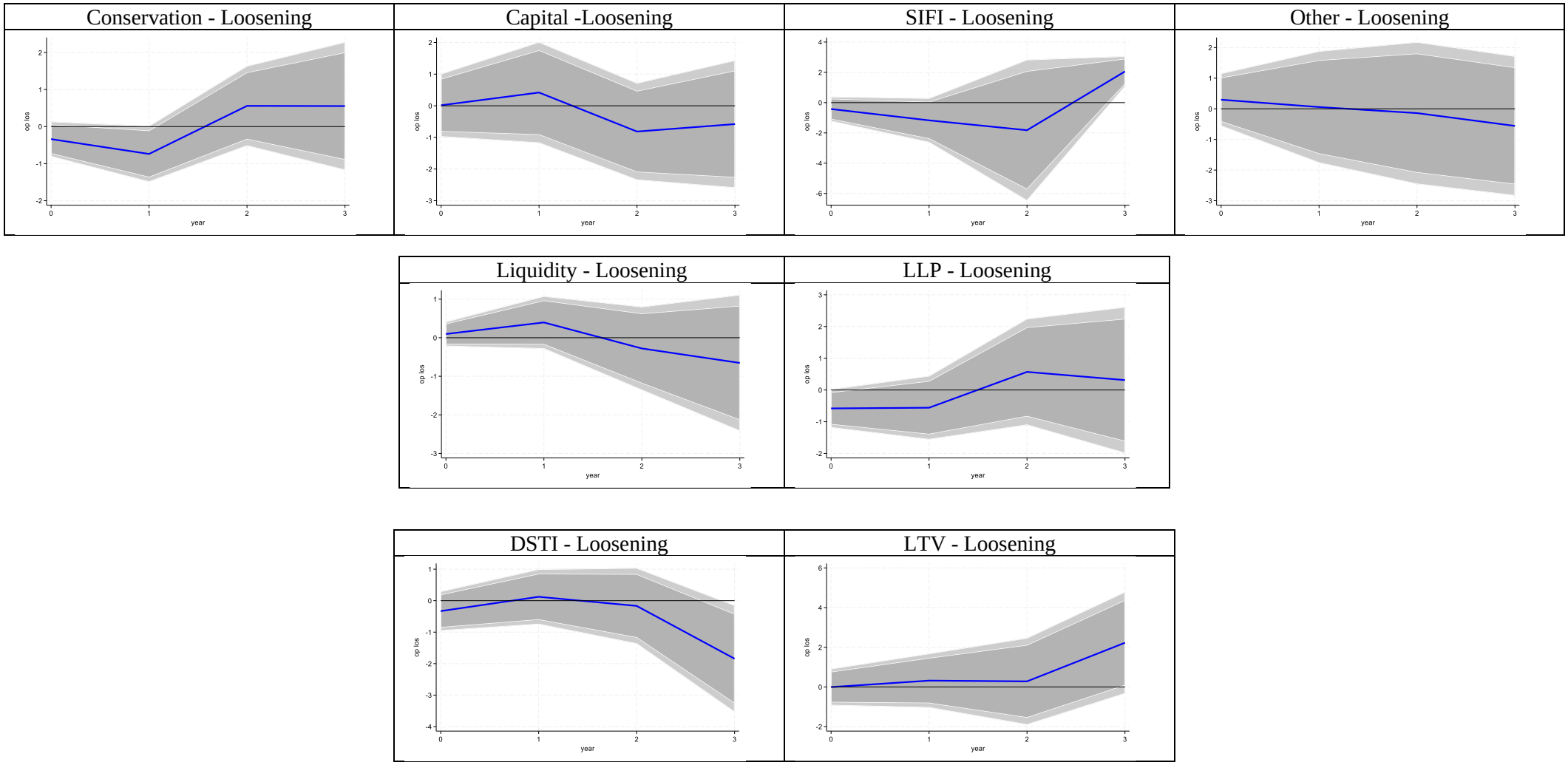
Figures

Figure 1 Impulse response graphs – Baseline specification (Tightening Episodes)



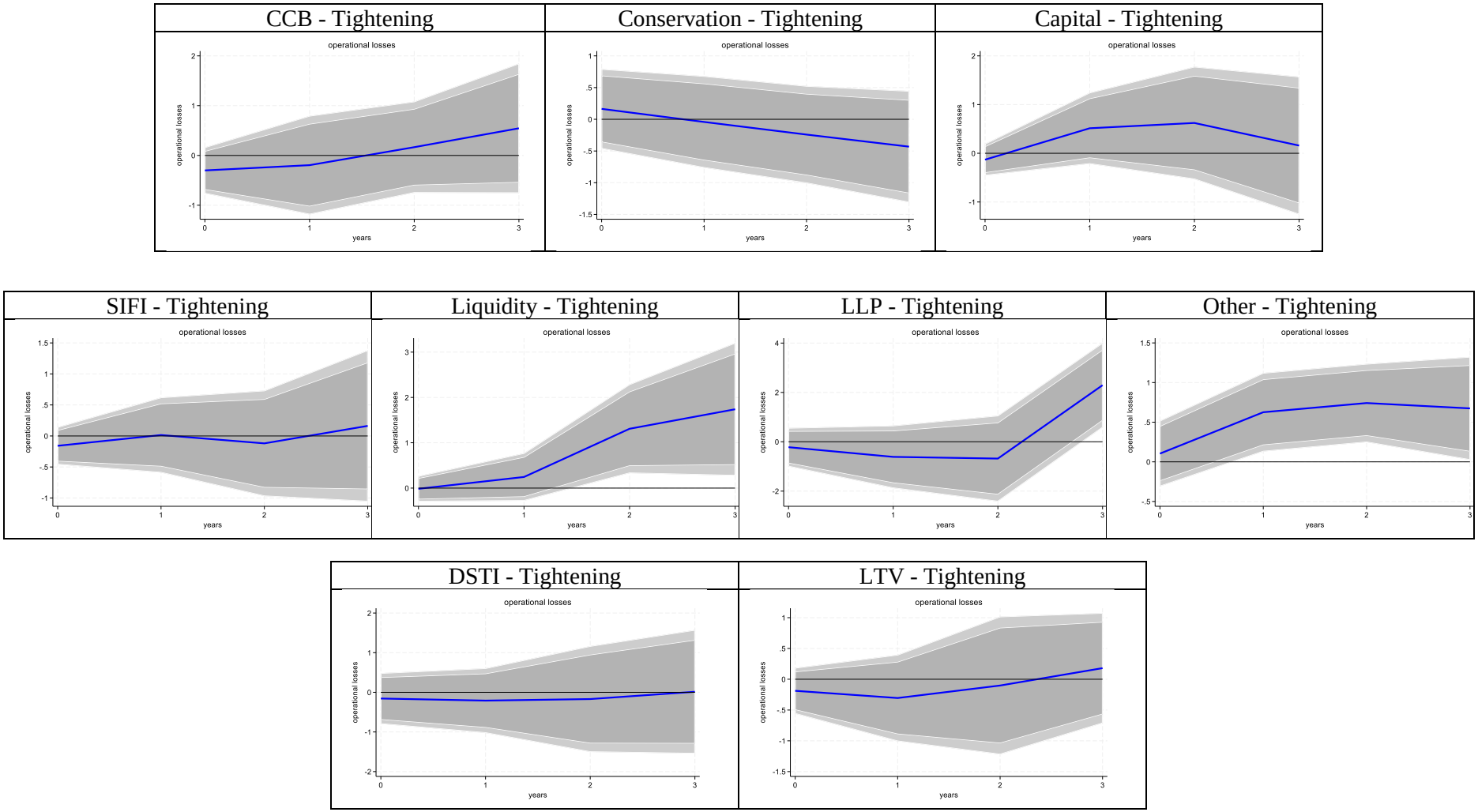
Notes Figure 1: Local projection: Responses of operational losses to the implementation of Macroprudential Policy Measures (Tightening Episodes). The blue lines display the coefficients of cumulative responses of operational losses over the next three years following the implementation of tightening events of specific MAPs. Shaded areas refer to 90% (dark grey) and 95% confidence intervals (light grey). Baseline specification as in Equations 2 and 3, including additional control variables described in the text.

Figure 2 Impulse response graphs – Baseline specification (Loosening Episodes)



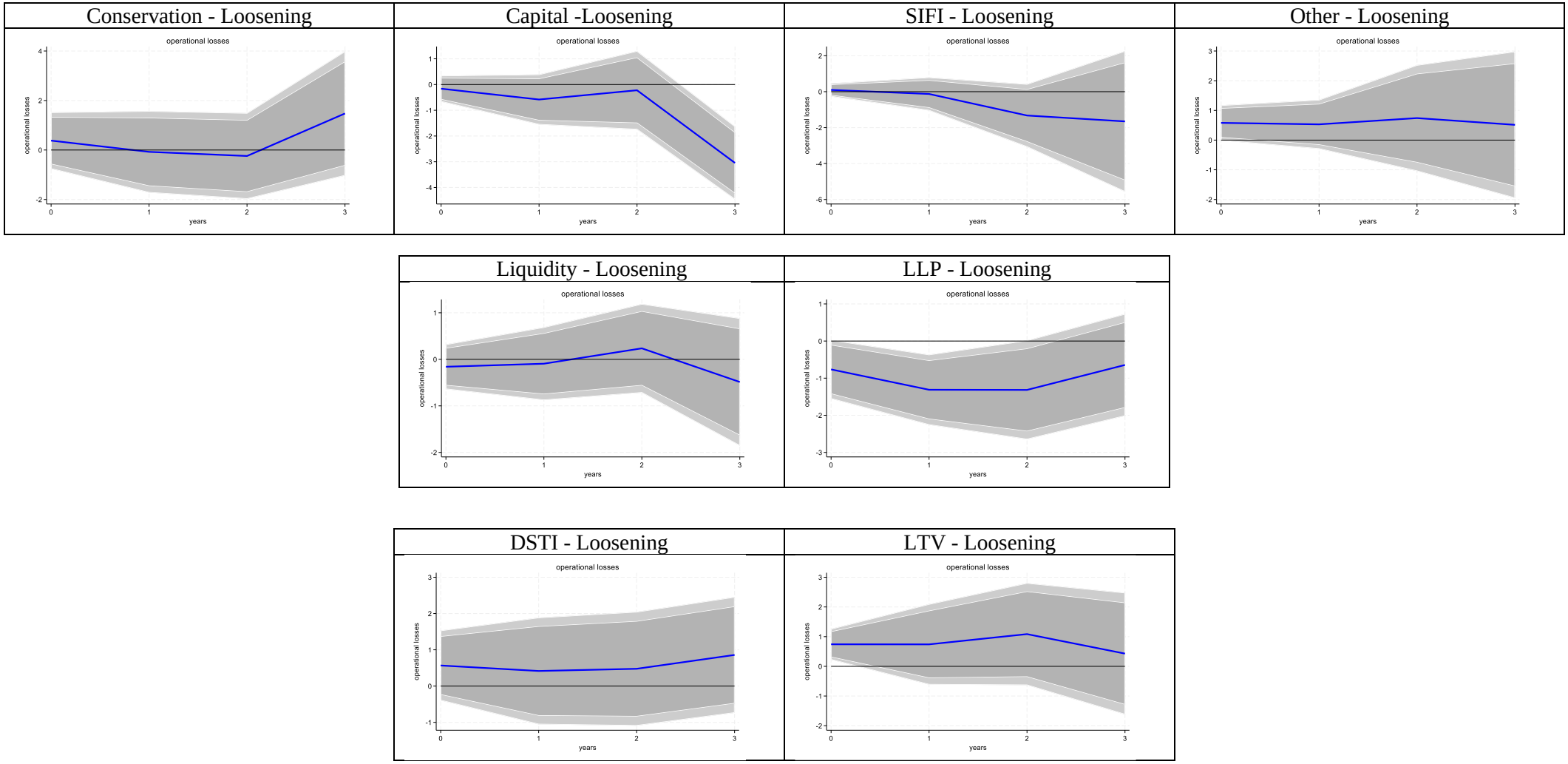
Notes Figure 2: Local projection: Responses of operational losses to the implementation of Macroprudential Policy Measures (Loosening Episodes). The blue lines display the coefficients of cumulative responses of operational losses over the next three years following the implementation of loosening events of specific MAPs. Shaded areas refer to 90% (dark grey) and 95% confidence intervals (light grey). Baseline specification as in Equations 2 and 3, including additional control variables described in the text. **CCB is not reported in this figure, as loosening events of CCB do not exist.*

Figure 3 Impulse response graphs – Inverse Probability Weighted Estimator (IPW) (Tightening Episodes)



Notes Figure 3: Inverse propensity weighted local projection: Responses of operational losses to the implementation of Macroprudential Policy Measures (Tightening Episodes). The blue lines display the coefficients of cumulative responses of operational losses over the next three years following the implementation of tightening events of specific MAPs. Shaded areas refer to 90% (dark grey) and 95% confidence intervals (light grey). Baseline specification as in Equations 2 and 3, including additional control variables described in the text.

Figure 4 Impulse response graphs – Inverse Probability Weighted Estimator (IPW) (Loosening Episodes)



Notes Figure 4: Inverse propensity weighted local projection: Responses of operational losses to the implementation of Macroprudential Policy Measures (Loosening Episodes). The blue lines display the coefficients of cumulative responses of operational losses over the next three years following the implementation of loosening events of specific MAPs. Shaded areas refer to 90% (dark grey) and 95% confidence intervals (light grey). Baseline specification as in Equations 2 and 3, including additional control variables described in the text. **CCB is not reported in this figure, as loosening events of CCB do not exist.*

Appendix

A.1 List of the 30 globally systemically important banks (GSIBs) (as mentioned in Sands *et al*., 2016)

Table A.1: List of the 30 GSIBs

Agricultural Bank	ING
BofA	JPM Chase
Bank of China	Mitsubishi UFJ FG
NY Mellon	Mizuho FG
Nanque Populaire	MS
Barclays	Nordea
BNP Paribas	RBS
China	Santander
Citigroup	Societe Generale
Credit Agricole	Standard
CS	Satet Street
DB	Sumitomo Mitsui
GS	UBS
HSBC	Unicredit Group
ICBC	Wells Fargo

A.2 List of countries

Table A.2: List of countries (Eurozone)

Austria	Latvia
Belgium	Lithuania
Cyprus	Luxembourg
Estonia	Malta
Finland	Netherlands
France	Portugal
Germany	Slovakia
Greece	Slovenia
Ireland	Spain
Italy	

Table A.3 – List of macroprudential policy measures	
Macroprudential Policy Instrument	**Description**
CCB	A requirement for banks to maintain a countercyclical capital buffer. Implementations at 0% are not considered as a tightening in dummy-type indicators.
Conservation	Requirements for banks to maintain a capital conservation buffer, including the one established under Basel III.
Capital	Capital requirements for banks, which include risk weights, systemic risk buffers, and minimum capital requirements. Countercyclical capital buffers and capital conservation buffers are captured in their sheets respectively and thus not included here.
LLP	Loan loss provision requirements for macroprudential purposes, which include dynamic provisioning and sectoral provisions (e.g., housing loans).
LTV	Limits to the loan-to-value ratios, including those mostly targeted at housing loans, but also includes those targeted at automobile loans, and commercial real estate loans.
DSTI	Limits to the debt-service-to-income ratio and the loan-to-income ratio, which restrict the size of debt services or debt relative to income. They include those targeted at housing loans, consumer loans, and commercial real estate loans.
Liquidity	Measures taken to mitigate systemic liquidity and funding risks, including minimum requirements for liquidity coverage ratios, liquid asset ratios, net stable funding ratios, core funding ratios and external debt restrictions that do not distinguish currencies.
SIFI	Measures taken to mitigate risks from global and domestic systemically important financial institutions (SIFIs), which includes capital and liquidity surcharges.
Other	Macroprudential measures not captured in the above categories - e.g., stress testing, restrictions on profit distribution, and structural measures (e.g., limits on exposures between financial institutions).

Source: Alam *et al.* (2019)

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