The Impact of Capital-Based Macroprudential Policy on Banks' Balance Sheet Composition *

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Abstract

This paper aims to assess the effects of capital-based macroprudential policy on the composition of banks' balance sheets. By employing a bank-level panel vector autoregressive model incorporating 188 macroprudential actions across 30 European countries, I analyze the impact of regulatory changes on banking variables while accounting for endogeneity. The results indicate that macroprudential policy shocks positively affect the common equity tier 1 ratio, prompting banks to adjust their asset allocations from higher-risk loans to safer, more liquid assets, thereby reducing risk-weighted assets and increasing the capital ratio. Additionally, regulators demonstrate proactive behavior by raising capital requirements in response to heightened bank lending and profitability. Policymakers should be cautious, as additional capital requirements may lead banks to strengthen their capital positions by reducing risk-weighted assets, potentially diminishing lending and adversely affecting banking profitability.

KEYWORDS: macroprudential policy; panel vector autoregression model; capital regulation; bank balance sheet adjustment;

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1 Introduction

The economic downturn of 2008 prompted both the economic professionals and authorities to question the effectiveness of current institutional arrangements in ensuring financial stability. A major concern was the absence of a macroprudential policy framework equipped with the necessary mandates, analytical tools, and instruments to sustain financial stability. Subsequently, significant global efforts have been made to address these shortcomings, especially with the introduction of the new Basel regulation in 2010 (Bank for International Settlements 2010).

Within the European Union, national macroprudential authorities have been established with the responsibility to employ a a set of macroprudential instruments to mitigate systemic risk in the banking sector. Capital-based macroprudential tools, like the Countercyclical Capital Buffer (CCyB), are designed to enhance financial stability by requiring banks to accumulate extra capital to absorb losses and reduce systemic risks associated with large and interconnected banks.

The transmission and the effects of capital-based regulation to both banks' strategies and to the real economy is still under investigation and further theoretical and empirical research is called for.

There exists a significant body of literature which investigates the influence of capital on lending, focusing on the dynamic and general equilibrium effects resulting from an exogenous change in bank capital ratios (Berrospide & Edge 2010, Francis & Osborne 2012, Mésonnier & Stevanovic 2017, Baros et al. 2023). However, this research omits the explicit inclusion of capital requirements in its empirical investigations.

Due to the relatively recent implementation of capital-based regulatory tools, many empirical investigations rely on quasi-experimental methodologies to analyze how banks react to the announcement and introduction of new capital regulations. (Mésonnier & Monks 2014, Jiménez et al. 2017, Gropp et al. 2019, Auer et al. 2022, Behncke 2023, Mathur et al. 2023, Couaillier et al. 2024).

Other studies in this field adopt a narrative methodology to identify instances when regulatory capital requirements were changed, thereby estimating the exogenous regulatory shocks to these requirements (Eickmeier et al. 2018, Conti et al. 2023). Additionally, the time-varying regulatory capital requirements imposed on UK banks during the 90s provide an ideal setting for estimating the effects of changes in microprudential capital requirements on banks' behavior (Francis & Osborne 2012, Aiyar et al. 2014, Bridges et al. 2014, Noss & Toffano 2016, Meeks 2017).

The empirical literature generally agrees that in the short term, tighter capital requirements are likely to lead to a reduction in lending (Favara et al. 2021, Couaillier et al. 2024, Berrospide & Edge 2024). However, additional research is required to gain a more comprehensive understanding of how banks adjust the risk structure of their assets and to specifically identify the regulatory impact.

Given that bank capital is highly endogenous and subject to various influences, isolating and identifying the effects of regulatory changes on bank capital from other drivers is crucial for assessing policy decisions (Eickmeier et al. 2018). In a broader model, the adjustments of assets' risk composition may impact the capital ratio and may also have consequences on banks' profitability (Farag et al. 2013).

The inherent endogeneity of capital leads researchers to employ a Vector Autoregression (VAR) approach for estimating exogenous changes in macroprudential capital requirements and assessing their dynamic impact on the real economy (Meeks 2017, Eickmeier et al. 2018, Conti et al. 2023).

However, to the best of my knowledge, no studies have yet applied a VAR model to bank-specific data which directly incorporate a measure of capital-based macroprudential policy to assess the dynamic interrelationships among the time-varying macroprudential capital requirements and factors such as capital ratio, liquidity, bank lending, and profitability.

This study contributes to the literature by integrating a macroprudential measure within a bank-level Panel Vector Autoregressive (PVAR) model, capturing 188 macroprudential actions (comprising 139 tightenings and 49 loosening) implemented by national authorities across 30 European countries. The inclusion of this macroprudential variable permits to isolate the regulatory impacts on banking operations within a framework that accounts for the endogenous nature and the interactions among banking variables. Importantly, it sheds new light on the impact of macroprudential policies not only on lending, but also on asset allocation and profitability, offering a comprehensive understanding of regulatory effects. Additionally, this approach is particularly suitable for examining several macroprudential policies applied across various countries, rather than focusing on a single national context.

The findings reveal that macroprudential policy shocks positively impact the Common Equity Tier 1 (CET1) ratio as banks adjust their asset allocations from higher-risk loans to more liquid, lower-risk assets to decrease risk-weighted assets and increase the CET1 ratio. This strategic shift to safer assets in response to tighter capital requirements adversely affects banks' profitability, as evidenced by a decline in the Return on Average Assets (ROAA). Additionally, regulators are observed to increase capital requirements following surges in bank lending and profitability, aiming to enhance financial stability. The significant role of macroprudential measures is also demonstrated by their contribution to the variability in forecast errors for critical banking metrics, highlighting their impact on banking operations.

The results of this study present new empirical evidence concerning the effects of capital-oriented macroprudential measures on banking capitalization, asset reallocation, and profitability. Policymakers, in their efforts to reinforce financial stability through increased capital requirements, should exercise caution regarding unintended domestic consequences. Specifically, they need to be mindful that heightened capital requirements may lead banks to increase their capital positions by reducing their risk-weighted assets (RWA). If banks opt to achieve this by reducing lending, it could adversely impact banking profitability and potentially result in a more substantial decline in credit expansion to the economy than initially intended.

The paper proceeds as follow. Section 2 reviews the relevant academic literature. Section 3 introduces the data and 4 the methodology. Section 5 presents the results and 6 discusses the policy implications and concludes.

2 Literature Review

Following the Great Financial Crisis, one crucial measure was the establishment of the European Systemic Risk Board (ESRB), tasked with macroprudential oversight of the EU financial system. Since its foundation in 2010, the ESRB has actively fostered the development of macroprudential policy frameworks, particularly with the enforcement of the Capital Requirements Directive (CRD) and Capital Requirements Regulation (CRR) on 2014. These regulations enhance Member States' capacity to conduct macroprudential policy within a unified legal framework, offering a set of macroprudential instruments to mitigate systemic risk in the banking sector.

Guidance on setting the appropriate CCyB rate should focus on safeguarding the banking system from potential losses stemming from excessive credit expansion or other cyclical systemic risks (European Systemic Risk Board 2014). Additionally, for Global Systemically Important Institutions (G-SIIs) and Other Systemically Important Institutions (O-SIIs), national authorities may impose supplementary requirements they must maintain in the form of Common Equity Tier 1 capital as a buffer. As outlined in European Systemic Risk Board (2014), these buffers serve to address the potential adverse impacts that such institutions might pose to the global or domestic financial system in the event of their failure. They also aim to mitigate the externalities stemming from the systemic risks associated with their interconnectedness within the financial system.

While capital-based macroprudential policy are intended to enhance the banking sector resilience in the long run (Claessens 2015, De Nicolò 2015), existing empirical literature has examined the constraining impact of increase in bank capital requirements on the extension of bank credit in the short run (Cappelletti et al. 2022). The resulting reduction in credit volumes may influence the real economy, impacting output, investment and employment (Meeks 2017, Fraisse et al. 2020).

In general, when faced with increased additional capital requirements, banks have multiple response options. They can utilize their capital surplus to address the additional capital requirements. If the overall capital surplus is insufficient or if banks aim to maintain an additional voluntary capital buffer above the requirements, they may opt to slow down the growth or reduce the absolute size of their balance sheets/loan portfolios. Alternatively, they can modify the risk composition of their assets, raise equity or increase their retained earnings by adjusting dividend payout or postponing planned reinvestment activities. These strategies can also be combined to align with the new capital regime (Cappelletti et al. 2022, Malovaná & Ehrenbergerová 2022).

Given the scarcity of experience with capital-based instruments, a majority of empirical studies employ quasi-experimental designs, such as Difference-in-differences, to exploit banks' responses around the announcement of the introduction of new capital requirements (Behncke 2023, Mathur et al. 2023, Couaillier et al. 2024). For example, examining the recapitalization exercise of 2011-12 by the European Banking Authority (EBA), during which the EBA announced the implementation of higher capital requirements, some empirical analyses confirm that an increase in the requirements has a negative short-run impact on bank lending which might also have repercussions on real economy (Mésonnier & Monks 2014, Gropp et al. 2019). Moreover, Auer et al. (2022) investigate the compositional changes in the supply of credit by Swiss banks, exploiting their differential exposure to the activation in 2013 of the CCyB. Jiménez et al. (2017) conduct a difference-in-difference analysis, where they assess the lending behavior of the same bank both before and after each shock resulting from the introduction of dynamic provisioning in Spain in 2000.

A pertinent body of literature investigating the influence of capital on lending does not explicitly include the capital requirements in the empirical analysis. Instead, it first estimates deviations of capital levels relative to an estimated target at the bank level. Subsequently, it incorporates the aggregate estimated measure of deviations from the target capital into a VAR model alongside macroeconomic variables to explore the dynamic and general equilibrium effects resulting from an exogenous change in bank capital ratios

(Berrospide & Edge 2010, Francis & Osborne 2012, Mésonnier & Stevanovic 2017, Baros et al. 2023).

Another stream of research employs a narrative approach to identify the events in which regulatory capital requirements were changed and estimate the regulatory exogenous shocks to bank capital requirements. Particularly, Eickmeier et al. (2018) create a narrative index of permanent tightenings in US capital requirements in a sample from 1979 to 2008, based on detailed readings of legislative documents. Conti et al. (2023) impose narrative restrictions to identify the structural capital required shocks based on the EBA 2011 Stress Test and the ECB 2014 Comprehensive Assessment. According to these studies, in response to a tightening in capital requirements, banks temporarily reduce business and real estate lending, which lowers investment, consumption, housing activity and production. On the other hand, a decline in financial and macroeconomic risk contributes to sustain spending in the medium run.

None of the previously mentioned literature directly integrates a dynamic measure of regulatory capital requirements. This absence complicates the identification and isolation of the effects of regulatory changes on both banks and the real economy. Certain studies utilized databases including dummy-type indicators representing tightening and loosening actions for various macroprudential policy instruments, compiled by monetary authorities such as the International Monetary Fund or the European Central Bank (Cerutti et al. 2017, Meuleman & Vander Vennet 2020). However, a drawback of this approach is its neglect of the diverse scope of macroprudential policy instruments and the varying intensity levels of their implementations.

In light of this, the time-varying microprudential Pillar 2 regulatory capital requirements imposed on UK banks during the 90s provide an ideal setting for estimating the effects of changes in microprudential capital requirements on banks' behavior (Francis & Osborne 2012, Aiyar et al. 2014, Bridges et al. 2014, Noss & Toffano 2016, Meeks 2017). Two main findings emerge from the studies examining UK regulation. Firstly, regulatory requirements have an impact on bank capital ratios, as banks usually rebuild the buffer in their capital ratios above the regulatory minimum after an increase in that minimum requirement (Bridges et al. 2014). Secondly, the tightening of capital requirements leads to a contraction in lending supply (Aiyar et al. 2014, Bridges et al. 2014, Meeks 2017).

The empirical literature presented in this study generally agrees that the short-run consequences of increased capital requirements are expected to result in a decrease in overall lending. However, additional research is required to gain a more comprehensive understanding of how banks adjust the risk structure of their assets and to specifically identify the regulatory impact.

Bank capital is highly endogenous and fluctuates due to multiple causes. To identify the effects of bank capital regulation in a way that is useful for policy one needs to separate movements in bank capital due to regulatory changes from its other potential drivers (Eickmeier et al. 2018). Bank capital matters in the propagation of different types of shocks to lending, owing to the existence of regulatory capital constraints and imperfections in the market for bank fund-raising shocks (Mésonnier & Stevanovic 2017). The adjustments of assets' risk composition impacts the capital ratio and may also have consequences on the profitability (Farag et al. 2013).

Given the endogeneity of capital, some studies employ a Vector Autoregression (VAR) approach to estimate exogenous changes in macroprudential capital requirements and evaluate their dynamic effects on the real economy. Within this framework, the VAR approach has exclusively been utilized for macroeconomic variables (Meeks 2017, Eickmeier et al. 2018, Conti et al. 2023). Meanwhile, it is feasible to construct a macroprudential measure at the bank level by summing the capital buffers mandated by national macroprudential authorities for each institution. This provides a favorable setting to adopt a VAR approach with individual bank level data to estimate exogenous macroprudential shock and investigate their propagation to the asset risk composition, regulatory capital ratio, and bank profitability. A Panel VAR approach offers the flexibility to examine both temporal and cross-sectional dimensions and leverage information from various macroprudential policy implementations by pooling data across multiple cross-sectional units (Sigmund & Ferstl 2021). This is particularly valuable in this scenario where there are limitations in time-series observations and experiences with macroprudential actions.

Of central interest in this study is the examination of the dynamic interrelationships among the time-varying macroprudential capital requirements and the capital ratio, liquidity, loan supply, and bank profitability.

The paper aims to explore various aspects concerning the implications of recent capital requirements. Specifically, it examines how changes in capital requirements influence a bank's risk asset allocation and subsequently affect its profit generation capabilities. Insights into these inquiries could carry significant policy implications concerning the stability and reliability of the banking system.

3 Data

To analyze how banks react to additional capital surcharges, I compile a dataset that integrates individual bank data with macroeconomic variables and publicly accessible information on capital buffers. The capital requirements for European banks are sourced from notifications provided by national authorities to the European Systemic Risk Board, which consistently publishes this information on its website. These details include the specified capital buffer, notification date, and the publication and implementation of the policy.

The data pertaining to individual banks are sourced from the Fitch Connect database. I assemble an unbalanced annual panel dataset encompassing all banks from all member states of the European Systemic Risk Board (ESRB) between 2014 and 2023, for which a Global Systemically Important Institution (G-SII), Other Systemically Important Institution (O-SII), or Systemic Risk Buffer has been applied. Market and Macroeconomic information are collected from the Statistical Data Warehouse (SDW) maintained by the ECB, the Bank for International Settlements (BIS), and the World Bank (WB) databases. Table 3.0.1 defines each variable and its corresponding source of data.

3.1 The Combined Buffer Requirements

The Combined Buffer Requirements (CBR) variable is formulated to capture the sum of capital buffers mandated by national macroprudential authorities at the time of implementation. This aggregate measure considers the Countercyclical Capital Buffer (CCyB), buffers for Other Systemically Important Institutions (O-SII) and Global Systemically Important Institutions (G-SII), the Systemic Risk Buffer (SRB) and the domestic Systemic Risk Buffer (SRB_{DOM}).

The CBR is calculated as follows:

$$CBR = CCyB + SRB_{\text{DOM}} + \max(O\text{-}SII, G\text{-}SII, SRB) \quad (1)$$

Variable	Acronym	Definition	Source
Combined Buffer Requirements	CBR	Sum of the active capital-based measures (CCyB, O-SII, G-SII and SRB capital buffers) imposed by national macroprudential authorities at the time is implemented	ESRB Notifications
Common Equity Tier 1 ratio	CET1	Common Tier-1 capital divided by total risk-weighted assets	FITCH Connect
Liquid to Total Assets	LIQ	Total liquid assets, such as cash and cash equivalents, short-term investments, and other highly liquid assets, divided by total assets	FITCH Connect
Return on Average Assets	ROAA	Net income divided by average total assets	FITCH Connect
Net Loans to Total Assets	LOANS	Total net loans divided by total assets	FITCH Connect
Real GDP annual growth	RGDP	Annual rate of growth of the real gross domestic product	SDW, WB
CPI annual growth	CPI	Annual rate of growth of the consumer price index	SDW, BIS
Country Level Index of Financial Stress	CLIFS	Economic indicator that reflects the level of financial stress at country level	SDW

Table 3.0.1: Variable Sources and Definitions

The variable is constructed on an institution-by-institution basis and is expressed in terms of the percentage of risk-weighted assets, as is standard for regulatory capital ratios. Notably, if an institution is simultaneously subject to G-SII, O-SII, and SRB, and the sum of these is not feasible due to regulatory constraints, only the highest buffer is applied, as reflected in the equation 1.

The Table 3.1.1 and Figure 3.1.1 provide a comprehensive overview of macroprudential policy activity and a comparative visualization of the temporal evolution of the additional macroprudential capital buffers across European countries from 2014 to 2023. It reveals a heterogeneous approach to macroprudential regulation across Europe, with some countries imposing higher and more volatile capital requirements (e.g., Sweden and Norway), while others maintain a lower or more stable buffer profile (e.g., Italy, Spain and Portugal). This heterogeneity may reflect the individual economic and financial conditions, systemic risk assessments, and regulatory approaches prevalent in each country.

Variable	Obs.	Mean	Std dev	Min	Max
CBR	2,190	1.30	1.43	0.00	7.00
CET1 Ratio	1,449	18.71	9.49	8.18	92.14
Liquidity	1,831	22.38	15.62	1.47	83.79
ROAA	1,827	0.55	1.03	-5.77	3.16
Loans	1,831	54.04	17.82	0.62	94.63
RGDP	2,177	2.52	3.59	-10.36	22.29
CPI	2,146	2.72	3.68	-2.10	19.71
CLIFS	2,190	0.10	0.07	0.02	0.44

Table 3.0.2: Variables Descriptive Statistics

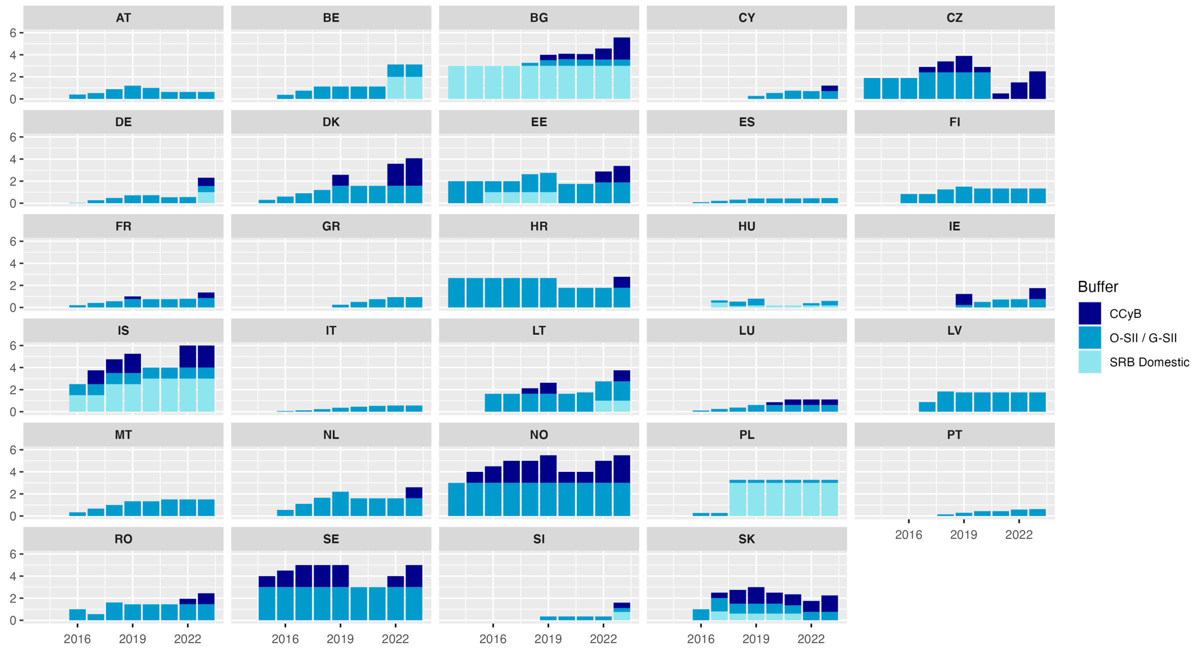

Figure 3.1.1: Combined Buffer Requirements (CBR) by Country and Measure Type: Each subplot represents a unique country as denoted by its two-letter international code. The subplots detail the annual CBR levels, calculated as the simple average across individual banks. The composition of these requirements includes the Countercyclical Capital Buffer (CCyB) in dark blue, the highest buffer between Other Systemically Important Institutions (O-SII) and Global Systemically Important Institutions (G-SII) in sky blue, and the domestic Systemic Risk Buffer (SRB_DOM) in light blue.

Country	N. Banks	CCyB		O-SII		SRB_{DOM}		Total	
		+	-	+	-	+	-	+	-
AT	15	0	0	3	2	0	0	**3**	**2**
BE	8	2	1	1	0	1	0	**4**	**1**
BG	11	4	1	2	3	0	0	**6**	**4**
CY	6	2	0	3	3	0	0	**5**	**3**
CZ	5	6	1	1	1	0	0	**7**	**2**
DE	17	2	1	3	3	1	0	**6**	**4**
DK	7	4	1	1	0	0	0	**5**	**1**
EE	4	2	0	3	1	1	1	**6**	**2**
ES	7	0	0	4	0	0	0	**4**	**0**
FI	6	0	0	3	1	0	0	**3**	**1**
FR	7	4	1	3	1	0	0	**7**	**2**
GB	5	5	1	2	3	0	0	**7**	**4**
GR	4	0	0	1	1	0	0	**1**	**1**
HR	9	2	0	0	1	0	0	**2**	**1**
HU	8	1	0	1	0	2	1	**4**	**1**
IE	9	3	1	5	0	0	0	**8**	**1**
IS	6	5	1	1	0	3	0	**9**	**1**
IT	4	0	0	4	0	0	0	**4**	**0**
LT	4	3	1	2	0	1	0	**6**	**1**
LU	9	2	0	2	0	0	0	**4**	**0**
LV	6	1	0	1	2	0	0	**2**	**2**
MT	3	0	0	2	0	0	0	**2**	**0**
NL	5	2	0	2	1	0	0	**4**	**1**
NO	2	5	1	0	0	0	0	**5**	**1**
PL	11	0	0	1	0	1	0	**2**	**0**
PT	6	0	0	2	1	0	0	**2**	**1**
RO	18	2	0	2	2	0	0	**4**	**2**
SE	4	4	1	0	0	0	0	**4**	**1**
SI	8	2	0	2	2	1	0	**5**	**2**
SK	5	5	1	1	3	2	3	**8**	**7**
	219	**68**	**13**	**58**	**31**	**13**	**5**	**139**	**49**

Table 3.1.1: Number of Macroprudential Policy Actions by National Authorities: The actions are categorized by type - Countercyclical Capital Buffer (CCyB), Other Systemically Important Institutions (O-SII), and Domestic Systemic Risk Buffer (SRB_{DOM}) — and are further differentiated by whether they represent an increase (+) or decrease (-) in regulatory requirements. The 'Total' columns aggregate the counts of increases and decreases across all types of measures for each country.

4 Methodology

The limited experience in implementing macroprudential policies presents challenges for conducting time series analysis and identifying and isolating exogenous macroprudential policy shocks. These policies are evaluated and adjusted by macroprudential authorities based on various factors such as bank size, importance in the national financial system, and complexity (European Banking Authority 2014). The interrelationships among lending, liquidity, capital, macroprudential policies and bank profitability pose potential issues of endogeneity in dynamic panel models.

Based on this background, this study employs a Panel Vector Autoregression (PVAR) approach at the bank level, integrating a dynamic measure of macroprudential policy to isolate the effects of regulatory changes on banks. This model can capture the dynamic interdependencies between the variables, treating each of them as endogenous to its own past values, as well as to the other variables under consideration. In the context of a VAR model, exogeneity implies that the shock is independent of the variables within the model and is, instead, presumed to be influenced by external factors such as macroprudential authorities' decisions. This exogeneity of the shock allows us to isolate the impact of changes in macroprudential policy on the banks' variables, such as capital, lending, and profitability.

The PVAR model extends standard VARs by incorporating a cross-sectional dimension. VARs are commonly used in monetary and fiscal policy research to analyze policy impacts (Sims 1980). In banking literature, the PVAR model is extensively applied to study intertemporal relationships (Koutsomanoli-Filippaki & Mamatzakis 2009, Fiordelisi & Molyneux 2010, Fiordelisi et al. 2011, Tran et al. 2016, Jouida 2018).

Considering the specific characteristics of the dataset, which includes a limited time series alongside a substantial cross-sectional dataset of banks subjected to various macroprudential policy interventions, this study adopts the PVAR model outlined by Sigmund & Ferstl (2021). This model extends the two-step system GMM estimation method proposed by Arellano & Bover (1995) and Blundell & Bond (1998) to PVAR models. Notably, this approach remains robust even with limited time periods and large cross-sections, as demonstrated by previous studies (Love & Zicchino 2006, Abrigo & Love 2016, Lin et al. 2019). To address potential downward bias in the two-step estimator, I employ the robust standard error method developed by Windmeijer (2005).

4.1 The model

The following equation defines the stationary PVAR with fixed effects:

$$y_{i,t} = \alpha_i + \sum_{l=1}^{p} \beta_l y_{i,t-l} + B x_{i,t} + C s_{i,t} + \varepsilon_{i,t} \tag{2}$$

where $y_{i,t} \in \mathbb{R}^m$ is an $m \times 1$ vector of endogenous variables for the ith cross-sectional unit at time t. These endogenous variables include the combined buffer requirements (CBR), the return on average assets (ROAA), the loans to total asset ratio (LOAN), the liquid to total asset ratio (LIQ), and the common equity tier 1 ratio (CET1). Let $y_{i,t-l} \in \mathbb{R}^m$ be an $m \times 1$ vector of lagged endogenous variables.

$x_{i,t} \in \mathbb{R}^k$ is a $k \times 1$ vector of predetermined variables that are potentially correlated with past errors. $s_{i,t} \in \mathbb{R}^n$ is an $n \times 1$ vector of strictly exogenous variables that neither depend on t nor on $t - s$ for $s = 1, \ldots, T$. These exogenous variables include the macro variables such as Gross Domestic Product annual rate of growth (GDP), consumer price index annual rate of growth (CPI), and a country financial stress index (CLIFS).

Moreover, the disturbances i, t are independently and identically distributed (i.i.d.) for all i and t with $E[i, t] = 0$ and $Var[i, t] = \Sigma$, where Σ is a positive semidefinite matrix.

We assume that all unit roots of A in Eq. (1) fall inside the unit circle to assure covariance stationarity.

The cross section i and the time section t are defined as follows: $i = 1, 2, \ldots, N$ and $t = 1, 2, \ldots, T$.

In this specification, we assume parameter homogeneity for A $(m \times m)$, B $(m \times k)$, and C $(m \times n)$ for all i.

4.2 Generalized impulse response function

Following the estimation of the PVAR model, the study examines the dynamic effects of macroprudential policy shocks on bank behaviour through impulse response functions. These functions trace the response of each variable in the system to an exogenous shock to the policy index, allowing for an assessment of the temporal evolution of regulatory impacts.

The Generalized Impulse Response Analysis (GIRF) provides a framework for analyzing the dynamic response of variables in a system to shocks, without the need for orthogonalization of these shocks.

The responses are computed following the methodology outlined by Sigmund & Ferstl (2021), which is based on Pesaran & Shin (1998) as follows:

$$\text{GIRF}(\epsilon_t) = E[y_{t+h}|\epsilon_t] - E[y_{t+h}] \tag{3}$$

where $E[y_{t+h}|\epsilon_t]$ is the expected value of the response variable y at time $t + h$ given the shock at time t, and $E[y_{t+h}]$ is the expected value of y at time $t + h$ in the absence of the shock [1].

5 Results

Prior to examining the empirical findings, assessing the model's stability is essential. Figure 5.0.1 illustrates the roots of the companion matrix derived from the Panel VAR model. The fact that all roots lie within the unit circle confirms the model's stability, indicating that variables will revert to their long-run path following any shocks.

The Table 5.0.1 presents the results from the panel VAR model estimation.

The positive impact of the lagged CBR on Liquidity (1.6342^{**}) suggests that previous increments in CBR may lead to increased liquidity positions within banks, potentially as a precautionary measure against capital requirement adjustments. Conversely, the negative effect on Loans (-2.0229^{***}) highlights the potential contraction in credit provision following heightened capital requirements. The positive relationship with CET1 ratio (0.8977^{**}) further suggests that previous CBR adjustments are positively correlated with stronger common equity Tier 1 ratios, affirming the role of macroprudential policies in enhancing banking sector capitalization.

[1] Please refer to :Sigmund & Ferstl (2021) for more details on the computation of Impulse Response Functions (IRFs) and the Forecast Error Variance Decomposition (FEVD).

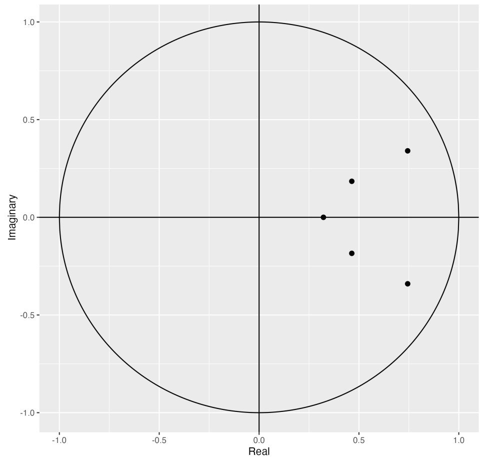

Figure 5.0.1: Graph of eigenvalue in the unit circle

Furthermore, CBR's positive relationship with Real GDP and CPI growth suggests that macroprudential authorities may be more inclined to implement stricter capital requirements during favorable economic conditions.

Figure 5.0.2 shows impulse response functions derived from the Panel VAR model. It exhibits the dynamic effects of one standard deviation shocks to each variable on itself and on the other variables over a horizon of ten years. In the first row of Figure 5.0.2, which assesses the effect of macroprudential policy shock, we observe that an increase in additional capital requirements determines an increase of the common equity Tier 1 equity (CET1) ratio. Specifically, a shock of 0.75% in the combined buffer requirements leads the CET1 ratio to increase by about 0.7%. This indicates that banks are proactive in adjusting their capital reserves to align with tighter regulatory requirements. Furthermore, the effects of macroprudential policy shocks suggest that banks increase their liquid assets by as much as 1.8% of total assets, while simultaneously decreasing loan allocations by a similar proportion. This behavior likely reflects a strategic shift in asset allocation from higher-risk loans to lower-risk, more liquid assets, with the objective of reducing risk-weighted assets and increasing the CET1 ratio. The decline in ROAA by 0.073% following a macroprudential policy shock illustrates how banks' shifting from riskier to safer assets, in response to capital requirements, could potentially impact their profitability.

Moreover, it is significant to note that macroprudential regulators tend to tighten capital requirements in response to shocks in bank lending and profitability. This result suggests that authorities, upon observing a rise in bank lending and profitability, aim to mitigate the bank's risk exposure and encourage banks to accumulate capital buffers. Such reserves are intended to strengthen their resilience during potential upcoming periods of stress.

Figure 5.0.3 presents the Forecast Error Variance Decomposition (FEVD) for each variable within the model to assess the impact of the shocks on the variance of forecast errors over time.

A critical observation from this figure is the extent to which bank lending impacts the variance in forecast errors related to the capital-based macroprudential stance. Furthermore, the impact of macroprudential measures is evident in the variability of the forecast error for the key banking indicators within the model. Notably, macroprudential actions contribute up to 10% of the variance in the CET1 ratio forecasts, around 13% in the

Table 5.0.1: Dynamic Panel VAR estimation, two-step GMM

	ROAA	**Liquidity**	**Loans**	**CET1**	**CBR**
lag1_ROAA	0.3159*	-0.1603	-0.0686	0.2842	0.0960
	(0.1447)	(0.4495)	(0.4802)	(0.2913)	(0.1013)
lag1_Liquidity	-0.0010	0.3669*	0.2026	-0.1739	0.0123
	(0.0128)	(0.1627)	(0.1581)	(0.1106)	(0.0175)
lag1_Loans	0.0018	-0.2353	0.9809***	-0.2544*	0.0678**
	(0.0195)	(0.1618)	(0.1992)	(0.1017)	(0.0224)
lag1_CET1	-0.0168	0.3315	-0.0327	0.3934*	-0.0112
	(0.0236)	(0.1769)	(0.2431)	(0.1723)	(0.0189)
lag1_CBR	-0.0824	1.6342**	-2.0229***	0.8977**	0.6816***
	(0.0480)	(0.5265)	(0.5191)	(0.2925)	(0.0744)
RGDP	0.0262**	0.0698	0.1259*	-0.0501	0.0243**
	(0.0082)	(0.0556)	(0.0641)	(0.0268)	(0.0080)
CPI	0.0414**	-0.0534	0.1379	-0.0432	0.0556***
	(0.0128)	(0.0845)	(0.0889)	(0.0449)	(0.0129)
CLIFS	-0.7701	-4.4220	0.6389	-0.2970	0.4071
	(0.5829)	(3.5042)	(3.7570)	(1.7983)	(0.6051)

Additional Information:

Transformation: First-differences
Number of observations = 1,025
Number of banks = 178
Obs per bank: min = 1, avg = 5.758, max = 8

Note: $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$. Standard errors in parentheses.

forecasts of liquidity assets, and over 15% in the forecast variance of bank lending.

This analytical insight highlights the substantial role that macroprudential policy plays in shaping the dynamics of banking variables. It underscores the interconnectedness of regulatory actions and bank operations, revealing the significant effect of macroprudential policy shocks on the banking behaviour.

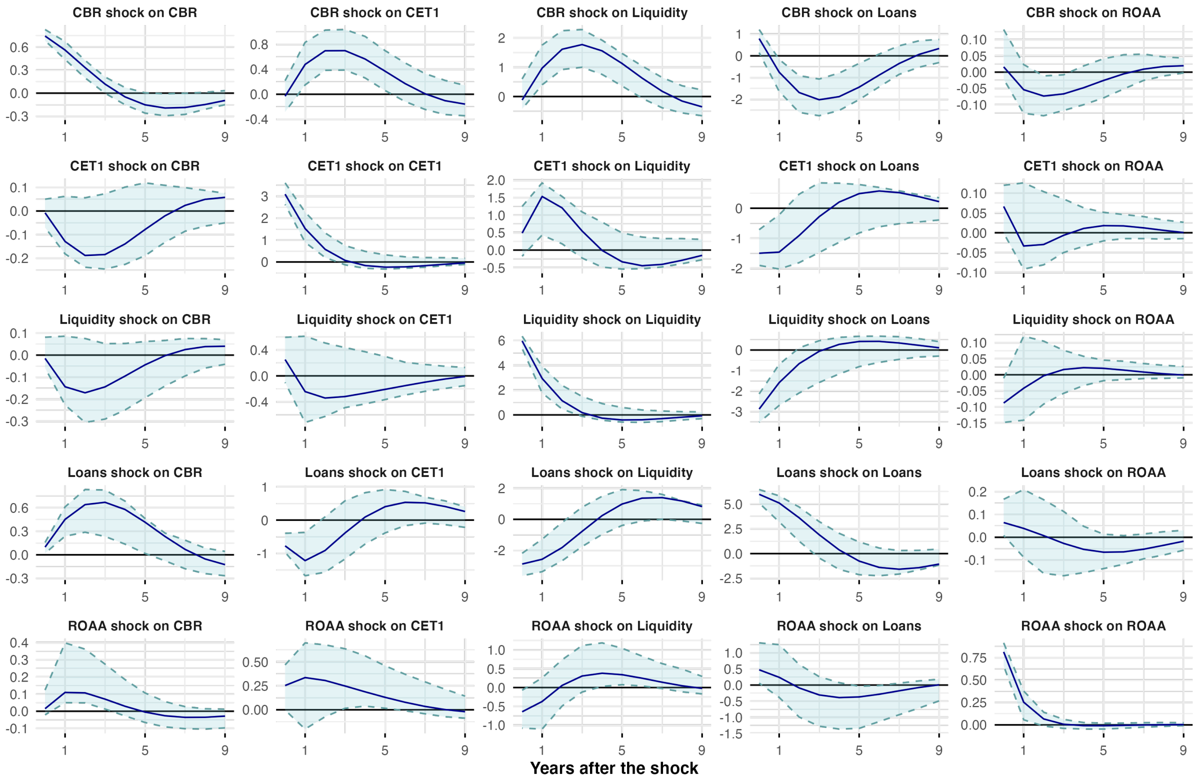

Figure 5.0.2: Impulse Response Functions. Blue lines are the mean of the generalized impulse response functions. Light blue shaded areas denote 80% bootstrapped confidence interval of the mean response.

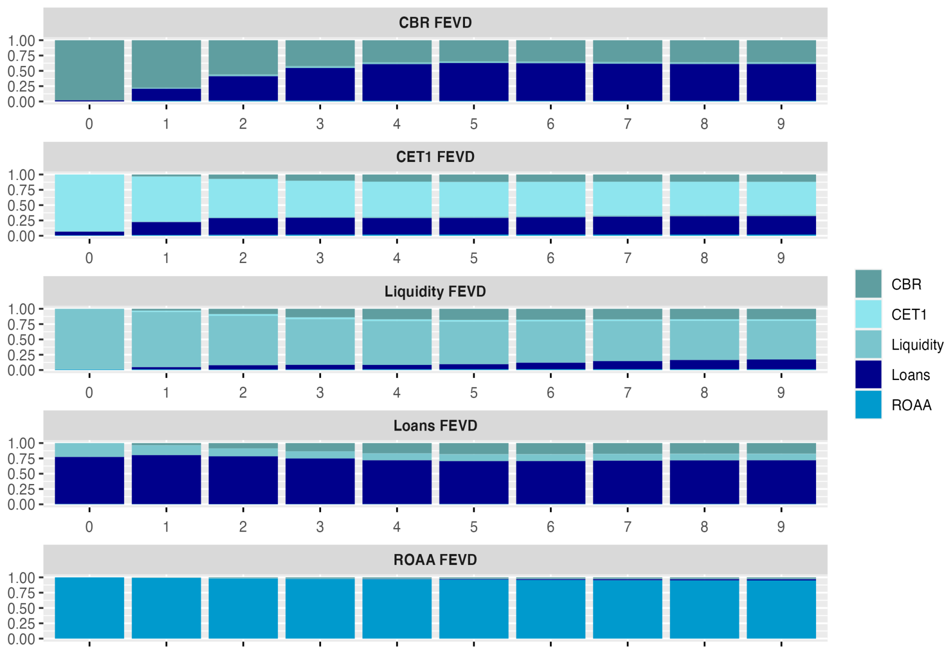

Figure 5.0.3: Forecast Error Variance Decomposition

6 Conclusions

This study contributes valuable insights into the effects of capital-based macroprudential policies on the composition of banks' balance sheets. Through the utilization of a bank-level Panel Vector Autoregressive (PVAR) model incorporating 188 macroprudential actions across 30 European countries, I isolate the impacts of regulatory changes on banking variables within a framework that accounts for endogeneity. The findings shed light on how banks adjust their capital and assets in response to changes in these requirements. Comparable results from previous studies support the notion that banks tend to reduce lending and decrease their exposure to riskier assets following an increase in capital requirements, consistent with existing literature (Francis & Osborne 2012, Eickmeier et al. 2018, Kanngiesser et al. 2020, Conti et al. 2023).

However, it is worth noting that these results focus uniquely on the potential effects on individual banks' operations and do not capture feedback effects from the real economy back onto bank balance sheets stemming from increased capital requirements.

Research by various scholars suggests that capital surcharges on global systemically important banks (GSIBs) lead to decreased lending, with firms seeking alternative credit sources to offset the reduction in loans from banks subject to higher capital requirements Favara et al. (2021), Degryse et al. (2023), Berrospide & Edge (2024). However, there are instances where firms struggle to reallocate their credit needs to less constrained banks, indicating unintended consequences of the capital framework that may incentivize pro-cyclical behavior by banks during economic downturns (Couaillier et al. 2024).

The observed decline in Return on Average Assets (ROAA) following changes in combined buffer requirements underscores how banks' shift from riskier to safer assets can impact their profitability. Furthermore, regulators exhibit a proactive stance, increasing capital requirements in response to periods of heightened bank lending and profitability, aiming to mitigate risk exposure and encourage the accumulation of capital buffers to enhance resilience during periods of financial stress.

In summary, this study underscores the significance of capital-oriented macroprudential measures in shaping banking dynamics and provides policymakers with a comprehensive understanding of how banks respond to macroprudential policy shocks and the resulting effects on asset composition and profitability. It is crucial for policymakers to exercise caution, as unintended consequences such as reduced lending and decreased profitability may arise from heightened capital requirements. This underscores the need for a nuanced approach to macroprudential policy formulation and implementation, considering the potential trade-offs between stability objectives and adverse effects. Policymakers should remain vigilant and adaptive, continuously assessing the efficacy and unintended consequences of regulatory interventions to foster a resilient and stable financial system.

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