ANALYSIS OF CYCLICAL SYSTEMIC RISKS IN SPAIN AND OF THEIR MITIGATION THROUGH COUNTERCYCLICAL BANK CAPITAL REQUIREMENTS

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Abstract

This paper first identifies the level of cyclical systemic risks in Spain, also calibrating their impact on the solvency of the banking system, and, second, assesses the costs and benefits of the countercyclical use of capital requirements. The first part of the paper is based on an integrated analysis of indicators and other quantitative and qualitative information, while impacts are calibrated using a combination of macroeconomic projection models and stress tests. The second part of the analysis is undertaken using quantile regression models, applied to European data, Bayesian time series models, applied to data for Spain, and a general equilibrium model. The integrated analysis to identify cyclical systemic risks shows the importance of a holistic approach monitoring the different dimensions of these risks, while the impact calibration shows that slight or intermediate materialisation of such risks also involves material capital consumption for the banking sector. The different methodologies applied for cost-benefit analysis find favourable results, in terms of GDP and credit growth, for the activation of releasable capital requirements in situations where cyclical systemic risks are intermediate and high and, notably, for their release in adverse cyclical phases.

Keywords: cyclical systemic risk, bank capital requirements, countercyclical capital buffer, GDP, credit, indicator, stress tests, growth at risk, Bayesian analysis, general equilibrium.

JEL classification: E17, E58, G10, G21, G28, G32.

Resumen

Este documento presenta un conjunto amplio de análisis para, en primer lugar, identificar el nivel de los riesgos sistémicos cíclicos en España y calibrar su impacto sobre la solvencia del sistema bancario y, adicionalmente, valorar los costes y beneficios del uso contracíclico de los requerimientos de capital bancario. La primera parte del análisis se sustenta en una utilización integrada de indicadores, junto con otra información cuantitativa y cualitativa, y en la combinación de modelos de proyección macroeconómica y pruebas de resistencia para calibrar impactos. La segunda parte del análisis se aborda con modelos de regresiones cuantílicas aplicados a datos europeos, modelos de serie temporal bajo enfoque bayesiano aplicados a datos de España, y con un modelo teórico de equilibrio general. El análisis integrado para el seguimiento de riesgos sistémicos cíclicos muestra la importancia de un enfoque holístico que monitorice las distintas dimensiones de estos riesgos, mientras que la calibración de impactos muestra que la materialización leve o intermedia de los mismos también implica un consumo de capital relevante para el sector bancario. Las distintas metodologías aplicadas para el análisis de coste-beneficio encuentran resultados favorables, en términos de crecimiento del PIB y del crédito, de la activación de requerimientos de capital liberables en situaciones en las que los riesgos sistémicos cíclicos son intermedios y elevados y, de forma destacada, de su liberación en fases cíclicas adversas.

Palabras clave: riesgo sistémico cíclico, requerimientos de capital bancario, colchón de capital anticíclico, PIB, crédito, indicador, pruebas de resistencia, crecimiento en riesgo, análisis Bayesiano, equilibrio general.

Códigos JEL: E17, E58, G10, G21, G28, G32.

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1 Introduction

Systemic risk is that of instability hindering the functioning of the financial system to such an extent that economic growth and the well-being of the population are negatively affected at the aggregate level. The scope and severity with which it manifested itself during the global financial crisis led to a profound reform of the prudential regulatory framework to which banks are subject,[1] standing out the development of a new toolkit for authorities, which uses traditional microprudential measures (such as capital requirements), but with an aggregate perspective. Hence, it is denominated macroprudential policy.

In fact, prior to the global financial crisis, it was considered that in order to achieve the objective of having a stable financial system, it was sufficient to ensure the solvency and liquidity of each financial institution (including infrastructure) on an individual basis. That is, a microprudential approach to banking regulation and supervision prevailed. The magnitude of this episode of systemic crisis highlighted how optimal management decisions from the individual perspective of each financial institution can generate risks to financial stability. This is due to the fact that individual institutions do not take into account the implications of their actions on the entire financial system through either the multiple interconnections within it, or the systemic importance that a single one of them may have.

The objective of macroprudential policy is, on the one hand, to strengthen the resilience of financial institutions, and in particular the solvency of the banking sector, against the materialisation of systemic risk and, on the other hand, to mitigate this type of risk, reducing its intensity. To do this, it has different tools, since systemic risks are complex and multidimensional. On the one hand, they evolve throughout the macro-financial cycle (cyclical-time dimension) and, on the other hand, in some cases they derive from the size, complexity, interconnection and other characteristics of financial institutions that are stable over time (transversal-structural dimension). In addition, both dimensions often interact with each other.

Taking into account this nature of systemic risks, reforms in the banking sector to establish macroprudential regulation and supervision have developed, inter alia, capital buffers to address cyclical and structural systemic risks.[2] The Countercyclical Capital Buffer (CCyB) is the main macroprudential tool available in the regulations in force in the European Union (EU) and in Spain to address the cyclical/time dimension of systemic risks.[3] This buffer is designed to be activated when cyclical systemic risks accumulate and released by the authorities when they materialise. Its release allows banks to use capital resources

1 See for example Mencía and Saurina (2016).

2 These were initially driven by the G20, the Financial Stability Board and the Basel Committee on Banking Supervision between 2008 and 2014. The resulting framework was called Basel III and has subsequently been transposed into European and Spanish regulations, which also contain additional rules to establish other macroprudential policy instruments (e.g. the systemic risk capital buffer at European level or limits on lending standards in Spanish national regulations) with this common objective of addressing the different dimensions of systemic risk.

3 This requirement was designed by the Basel Committee on Banking Supervision (2010). The Banco de España can require it from banks since 2016.

to absorb losses without incurring regulatory breaches. This reinforces the incentives to maintain the flow of financing to the real economy during crisis, reducing the volatility of the macro-financial cycle.

In the period since the global financial crisis, there has been progress in the empirical and theoretical knowledge about systemic risks and the implementation of optimal macroprudential policies to address them.[4] This document contributes to this progress, with the development of a new methodological framework to identify cyclical systemic risks and gauge their impact on the solvency of the banking system in Spain. In addition, it presents different studies, both empirical and theoretical, of the costs and benefits, mainly in terms of GDP growth, but also of other macrofinancial variables, of the countercyclical activation and release of bank capital requirements.

These studies gather evidence both for the EU as a whole and specifically for Spain, and examine whether it is optimal to activate this type of requirements when cyclical systemic risks are at a standard level, that is, intermediate between a low and a high level. This analysis is of particular relevance for the review of the adequacy of the Banco de España framework for the setting of the CCyB, which must be regularly reexamined in line with the recommendations of the European Systemic Risk Board (ESRB).[5]

The analysis of the rest of the document is organized as follows. Section 2 presents different methodologies for monitoring cyclical systemic risks and identifying their level. Section 3 brings together the results of different simulation exercises using the MTBE (macroeconomic projection) and FLESB (top-down bank stress test framework) models to estimate the impacts of different intensity degrees of materialisation of cyclical risk. Section 4 includes the analysis using GaR (Growth-at-Risk) methodologies applied to euro area-wide data of the costs and benefits of activating and releasing bank capital requirements. The same issue is examined with time series Bayesian methodologies applied to data specific to Spain under section 5. The cost-benefit analysis is completed in section 6 with the application of a DSGE *(Dynamic Stochastic General Equilibrium)* theoretical model calibrated to replicate key characteristics of the Spanish economy and banking system. Section 7 presents the conclusions of the study.

4 See for example Biljanovska, Chen, Gelos, Igan, Martínez Peria, Nier and Valencia (2023).

5 See recitals 7 and 8 and Recommendation A, principles 2 and 3 of Recommendation ESRB 2014/1.

2 Identification and monitoring of the level of cyclical systemic risks through indicators

2.1 Summary

Despite significant research advances in the macro-financial area in the aftermath of the global financial crisis (GFC), there is still no agreed framework for the identification of cyclical systemic risks.[6] This shortcoming is part of a more general context where macroprudential policy, which aims to mitigate these risks, is still at an early stage of development (Estrada and Mencía, 2021). In addition, the broad and diffuse nature of the objective of maintaining financial stability may justify the heterogeneity of frameworks in jurisdictions with different structural and cyclical characteristics of their macro-financial environment. Additional to these considerations is the fact that, as mentioned in the introduction, cyclical systemic risks are complex and multidimensional in nature. These risks can arise both from the accumulation of vulnerabilities in the real economy and in the financial sector, and can manifest themselves in different quantity and price variables.

The identification of cyclical risk can be addressed by methodologies of varying complexity.[7] In this section, an approach based on the computation of synthetic indicators from different sources of macrofinancial information is presented, as well as other empirical methodologies that can facilitate the interpretation and qualification of these indicators. This approach is intended to be holistic, taking into account the different dimensions of cyclical systemic risks. It also seeks to avoid a mechanic monitoring of these risks, which can produce equivocal signals when complementary information, such as that also discussed in this section, is not incorporated into the process. Taking into account the multidimensional nature of cyclical systemic risks and the uncertainty associated with this identification process, a comprehensive approach is used, which includes a two-stage analysis.

In the first stage, of a quantitative nature, a framework for monitoring cyclical systemic risks has been developed, through a set of 16 main indicators, grouped into four blocks, representing the four dimensions of risk analysis considered relevant:

i Macroeconomic situation[8];

ii Macro-financial situation[9];

6 See, for example, Banco de España (2021).

7 The simplest methodologies for the identification of cyclical systemic risk are those that are data-driven such as heatmaps – for example, as proposed in Mencía and Saurina (2016) for the Spanish banking system or regularly updated by the IMF in its Global *Financial Stability Report* (Adrian et al., 2019b) – or synthetic indices summarising data information such as the CISS (composite indicator of financial stress) proposed by Hollò et al. (2012). The most complex methodologies for identifying cyclical systemic risk are model-based, such as those that estimate the capital shortfall, i.e. the capital that an institution would need under stressed conditions (Bisias et al. 2012). See Banco de España (2021) for details.

8 Economic activity and labour market indicators.

9 Financial indicators, such as bank credit, and their interaction with variables related to the macroeconomic situation.

iii Financial market situation[10];

iv Financial situation of the banking system[11].

In a second stage of the assessment of the position of cyclical systemic risks, additional available information, including that of a qualitative nature, which is described in subsequent sections, is analysed to ratify or rectify the result obtained in the first stage. Additional information includes banking sector variables, in addition to those covered by the set of indicators described above, the level of which does not provide a clear signal on the position of cyclical systemic risks, but which are useful for assessing the potential systemic impact of the risks identified. Likewise, this section describes how to use different complementary metrics on the stance of macroprudential policy for the analysis, the components of credit supply and demand, and other indicators of credit dynamics.

The approach based on the aggregation of indicators (section 2.2), the macroprudential policy stance indicator (section 2.3) and the additional indicators on credit dynamics (section 2.4) are described in more detail below.

2.2 Synthetic indicators for monitoring cyclical systemic risks

To comprehensively assess the potential build-up of cyclical systemic risks and assess whether they are at an intermediate level, a set of 16 main indicators is monitored. As noted in the summary, this set of indicators is classified into four relevant analytical dimensions: 1) macroeconomic situation, 2) macro-financial situation, 3) financial market situation, and 4) financial situation of the banking system. Table 2.1 lists these indicators (see their definitions in Annex 1) and, by way of illustration, reports information on the current situation of each of them in relation to their historical distribution, to assess the level of cyclical risk derived from it. Indicators can provide information from one or two tails of their distribution.

For two-tailed indicators that show a positive correlation with the macro-financial cycle,[12] a high upward (above the 75th percentile) or downward (below the 25th percentile) deviation from its historical central value (50th percentile) will determine whether they are in a high-risk or a risk materialisation situation, with risks being then at a low level in this latter case. Conversely, an indicator position between the 25th and 75th percentiles will be associated with an intermediate or standard situation, where risks are neither particularly high nor low. For two-tailed indicators that have a negative correlation with the macro-financial cycle,[13] the positioning of extreme situations would be the opposite. Two of the indicators[14] are single-

10 This financial indicator is disaggregated from the rest of this nature by its particular usefulness to measure the materialisation of risks in the financial markets in a contemporary way.

11 In Spain, the banking system corresponds to all credit institutions.

12 Output gap, GDP growth, credit-to-GDP gap, credit intensity, rate of change in credit to households and non-financial corporations, econometric models of credit imbalance, rate of change in house prices and indicators of price imbalance in the residential real estate sector.

13 Unemployment rate and systemic risk indicator.

14 Debt service ratio and NPL ratio of the banking sector in business in Spain.

tailed and only present an extreme situation when they are above the 75th percentile (the existence of high risks in the case of the debt service ratio and low capital generation capacity in the case of the non-performing loans – NPL – ratio).

In summary, to represent the position of the indicators in their historical distribution, they are classified into a maximum of three possible phases:

— Risk materialisation (typically associated with a low level of the probability that they may materialise again in the short term).

— Cyclical risk at standard level. Risks at intermediate level, not excessively high, but also not low.

— High risk.

Table 2.1 includes four additional complementary indicators, which make it possible to assess the solvency, liquidity, efficiency and financing costs of banks. These are not taken into account when calculating the aggregate indicator, as their usefulness derives not so much from the signalling of cyclical systemic risks, as from their relevance for assessing the impact of these risks on the banking sector. For example, both solvency and liquidity ratios provide very valuable information on the resilience of the banking sector to risk materialisation. However, both high and low levels of these ratios have been consistent in the past with high or low cyclical systemic risk situations. These banking sector indicators are used in the second phase of the assessment of the position of cyclical systemic risks, together with other available supplementary information, described in subsequent sections.

The information contained in the set of 16 main indicators is summarised in a single composite indicator to facilitate its interpretation. Two alternative procedures are used for this purpose. In both procedures, there is a first phase of standardisation of the individual indicators, followed by a second phase of aggregation of the standardised indicators.

The **first procedure** begins with the standardisation of individual variables from their empirical cumulative distributions (ECDFs) in line with the literature on financial stress indices (Holló et al., 2012). The ECDF calculation is relatively immediate. First, the observed values of each indicator x_t are ordered where t denotes each date of available information, from 1 to T (sample size). Thus, for each original series of the indicator $x_t = (x_1, x_2, ..., x_T)$ a new series is obtained with its ordered values $x_{[t]} = (x_{[1]}, x_{[2]}, ..., x_{[T]})$. In this transformed series $x_{[1]}$ represents the lowest value of the indicator and $x_{[T]}$ the highest value. Subsequently, to obtain the transformed indicator z_t, the numerical *ranking* is assigned to each value of x_t (r) and this result is divided by the sample size T

$$z_t = \frac{r}{T} \quad \text{for } x_{[r]} \leq x_t < x_{[r+1]}, \quad r = 1, 2, ..., T$$

Table 2.1

Key indicators for monitoring cyclical systemic risk

		Latest data observed	Previous observation	1-year projection
Macroeconomic indicators	**Output gap**	0.20	-0.02	0.27
	Annual change in real GDP	2.02	1.93	1.74
	Unemployment rate	11.76	11.84	
Macro-financial indicators	**Adjusted credit-to-GDP gap**	-9.13	-8.82	-3.62
	Credit intensity	-4.41	-5.96	2.02
	Debt service ratio	18.16	18.26	16.59
	Rate of change, credit to households and firms	-3.32	-4.34	1.65
	Econometric models of credit imbalance	[-9.7 -2.8]	[-8.7 -2.3]	[-10.9 -4.1]
	Rate of change, house prices	4.14	4.36	2.68
	Indicators of price imbalances, real estate sector	3.77	3.53	0.19
Market indicators	**Systemic risk indicator (SRI)**	0.04	0.11	
Banking system indicators	ROE	12.44	12.59	
	NPL ratio	3.54	3.56	
	Net interest income to total assets	2.33	2.32	
	Price-to-book value	0.71	0.69	
	ROE Spain	11.30	11.39	
Memorandum items	CET1 ratio	13.21	13.07	
	LCR	186.28	179.19	
	Cost-to-income ratio	0.43	0.44	
	Cost of bank liabilities	2.07	1.83	

COLOUR CODES

One-tail risk indicators

Standard level	High risk
Value < 75th percentile	Value > 75th percentile

Two-tail risk indicators

Materialisation of risks	Standard level	High risk
Value < 25th percentile	25th percentile < Value < 75th percentile	Value > 75th percentile

BANKING SYSTEM COLOUR CODES

One-tail risk indicators

Standard capacity to generate capital	Low capacity to generate capital
Value < 75th percentile	Value > 75th percentile

Two-tail risk indicators

Low capacity to generate capital	Standard capacity to generate capital	High capacity to generate capital
Value < 25th percentile	25th percentile < Value < 75th percentile	Value > 75th percentile

SOURCES: INE and Banco de España.
NOTE: The "latest data observed" column refers to December 2023, and the "previous observation" column to September 2023. For the indicators that are negatively correlated with the macro-financial cycle (the unemployment rate and the systemic risk indicator (SRI)), the position of the high and low risk levels would be the opposite of that described in the colour codes. The one-tail indicators are the debt service ratio and the non-performing loans (NPL) ratio. In the second column, the indicators that were already included in the cyclical systemic risk monitoring framework previously in force are highlighted in bold.

where r indicates the position assigned to each ordered value of the variable. The new standardised variables are bounded between 1/T and 1, values that represent respectively the minimum and maximum of the distribution of the original indicator. That is, a value close to zero would indicate that these data would be close to the minimum of the variable, while a value close to one is near the maximum.

Second, aggregated indicators for the categories of macroeconomic, macro-financial and banking system indicators are obtained using the simple average of standardised variables. This aggregation procedure has been chosen for its simplicity, and to have a reference indicator in which the weights given to the different variables are uniform, so that it can be compared with more sophisticated ones that give different weights to the different indicators. Since the SRI, the only indicator in the market category, is itself a synthetic indicator, with its own aggregation methodology,[15] it is not necessary to apply a simple average of variables on it. Finally, a simple average of the four indicators aggregated by category is made to obtain the overall synthetic indicator. This gives each of the four risk categories a weight of 25%.

The **second procedure** is based on the use of principal components (PCAs) to derive the weights used in the aggregation of indicators (both individual and category aggregates). This mathematical method exploits the relationships between a broad set of variables to find a smaller number of transformed variables with informational content similar to the original set. Specifically, this procedure begins with the standardisation of variables, subtracting their mean and dividing by their standard deviation. Once standardised in this way, its principal components are calculated. For this purpose, we calculate each standardised indicator z_1, z_2, ..., z_N, where N = 16 denotes the total number of indicators, and a new set of variables y_1, y_2, ..., y_N orthogonal to each other, whose variances are progressively decreasing. Each y_j (where j=1, ..., N) is a linear combination of the original variables z_1, z_2,..., z_N. In other words:

$$y_j = a_{j1}z_1 + a_{j2}z_2 + \dots + a_{jN}z_N$$

where a_1, a_2, ..., a_N are the weights corresponding to the transformed indicators z_t. Given the high degree of correlation between indicators within each category, one principal component is sufficient to explain most of the variability in individual indicators. The first principal component is chosen, as it accumulates the most informative content, to obtain the weights to calculate the aggregate indicator of three categories – as in the first procedure, it is not necessary to aggregate to obtain the market category. Finally, the process is repeated to obtain the global composite indicator from the first principal component of the four standardised aggregate indicators.

Both procedures have different technical advantages and disadvantages, which makes the combined use of both advisable to provide greater robustness to the analysis. First, with the first methodology, in which the standardisation of the data is based on the calculation of the ECDF as in Holló et al. (2012), greater sensitivity to turning points in the cycle can be obtained. This is because, by construction, the distance between two consecutive observations in the transformed indicators is always the same (1/T). Therefore, the variations in the variables transformed at the central points of the distribution, where the

15 For a detailed explanation of the SRI indicator, see Box 1.1 of the May 2013 FSR.

beginning of expansions/contractions is located, are amplified with respect to the original series by means of this transformation. In contrast, with the methodology of Holló et al. (2012), the variations in the variables transformed near the extremes, where the peak and lowest moments of the cycle are located, are reduced with respect to the original series. This happens despite the fact that in the original series the data have a greater variability at the tails than in the central part of its distribution. This characteristic of the transformation can mean some loss of information in the analysis of extreme values in relation to the second methodology.

The principal component-based method, whose standardisation approach is not affected by the homogenisation in Holló et al. (2012), would be more useful to compare the intensity of the high risk signals in the proximity of the peaks of the upswings, or the extent of the deteriorations in the regions close to the lowest points of the downturns. Instead, it would be less sensitive to cycle changes in the central region of distribution.

Second, the principal component-based methodology has the advantage of considering different weights of individual indicators and subcategory aggregates, depending on their ability to explain the variability of the data set, in contrast to the imposition of a uniform a priori with the use of the simple average in the ECDF-based aggregation method. However, these weights do not take into account the ability of individual indicators to anticipate the materialisation of cyclical systemic risks.

With respect to the Banco de España's previous monitoring framework for cyclical systemic risk,[16] these new approaches provide an integrated quantitative indicator of macro-financial indicators previously monitored by the Banco de España (credit-to-GDP gap, output gap, credit intensity, credit imbalance and house price indicators, debt service ratio) with additional ones. Among these, the indicators of the capacity of the banking sector to generate capital stand out, and basic macro-financial metrics (growth of GDP and house prices) are also added to provide additional robustness to the analysis against the statistical assumptions of more complex indicators such as gaps.

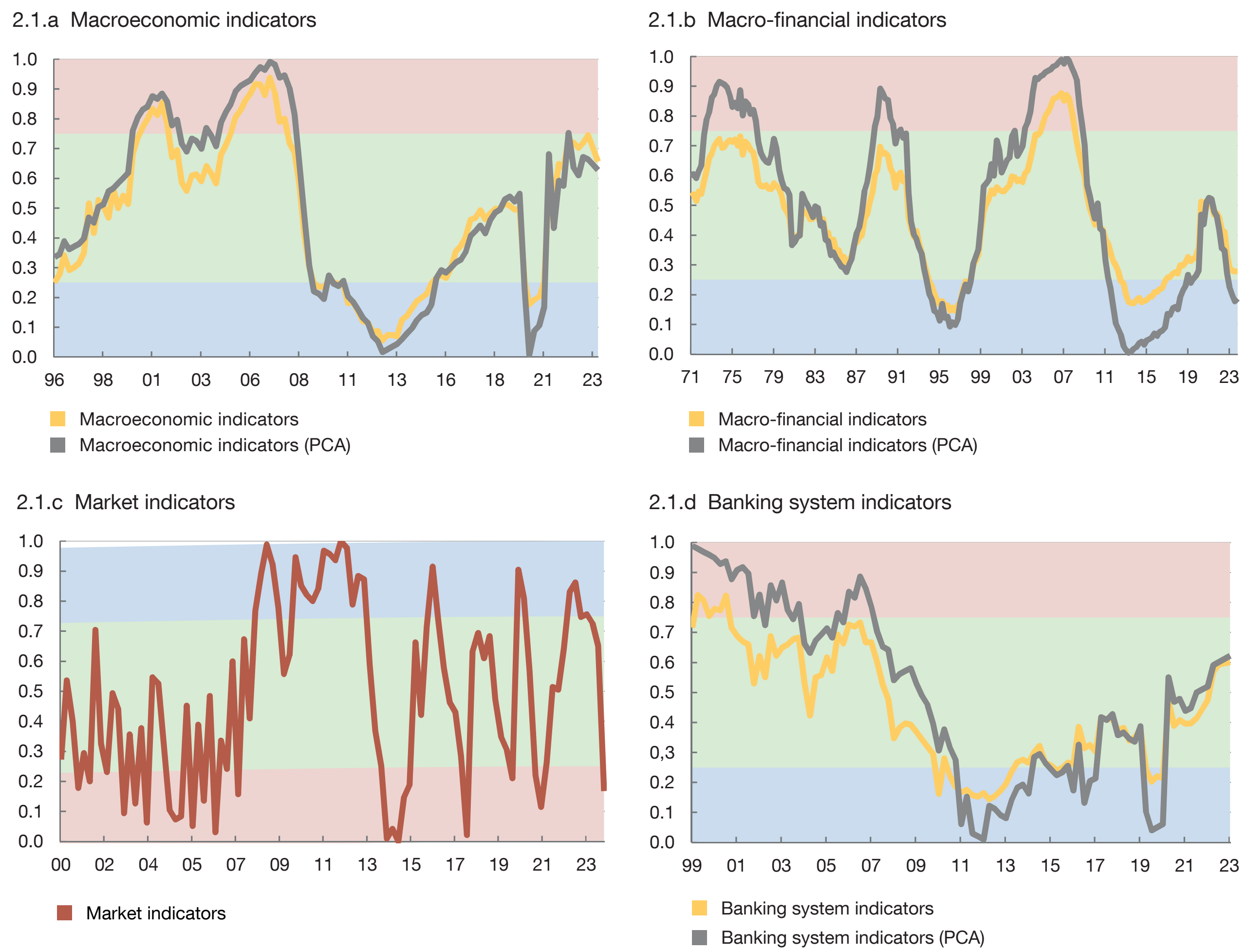
Charts 2.1 and 2.2 show that the results obtained with both procedures are relatively similar, both for the main risk categories and for the total synthetic indicator.

With data as at December 2023, macroeconomic and banking sector indicators are at a standard level of cyclical systemic risks, albeit approaching a high risk range (see Chart 2.1).

The market indicator is more volatile and trends in it are more difficult to detect (see Chart 2.1). In any case, the fact that it has been at a relatively low level for some time could alert us to a higher level of cyclical systemic risks.

16 See Mencía and Saurina (2016).

Chart 2.1
Composite indicators by risk bucket (a)



SOURCES: Datastream, INE, Banco de España and own calculations.

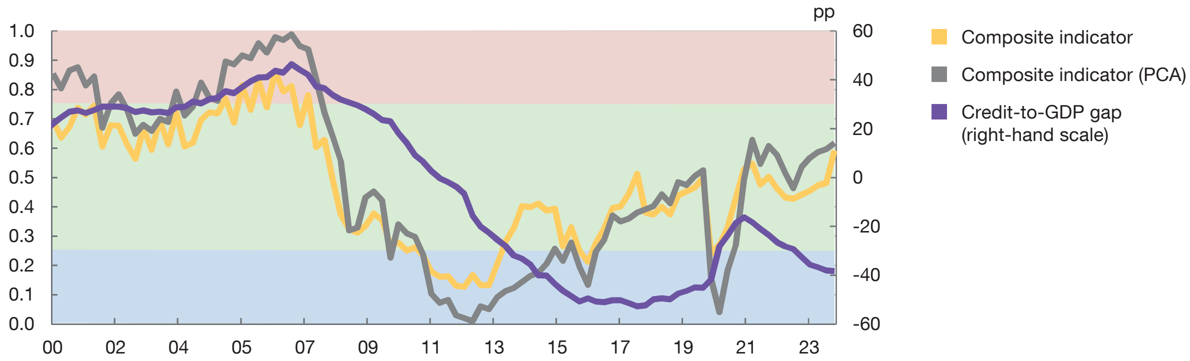
a Data updated at December 2023. The yellow lines show aggregation using simple averages and the grey lines aggregation using principal components (PCA). The SRI aggregates 12 financial market variables in accordance with the methodology described in Box 1.1 of the May 2013 FSR. Each indicator is defined on a scale of 0 to 1 according to the percentile vis-à-vis its historical distribution. The colours depict low (blue), standard (green) and high (red) levels of cyclical systemic risk, and in the case of the banking system indicators, capital generation capacity.

Finally, the indicator for the macro-financial category is within a range of values compatible with a low level of risk, very close to the standard risk threshold, even though some of its sub-components, such as those related to house prices, are at a standard level (see Chart 2.1).

For the aggregate synthetic indicator, it is remarkable that its values under either methodological approach were at a high level long before the global financial crisis materialised. Subsequently, there has been a slow and gradual recovery, temporarily interrupted by the outbreak of the pandemic, reaching the 60th percentile in the most recent period (see Chart 2.2). This contrasts with the credit-to-GDP gap under the Basel standard definition, which has remained persistently negative in the aftermath of the global financial crisis.

Chart 2.2

Overall composite indicator (a)



SOURCES: Datastream, INE, Banco de España and own calculations.

a Data updated at December 2023. The yellow line shows aggregation using simple averages and the grey line aggregation using principal components (PCA). The indicator is defined on a scale of 0 to 1 according to the percentile vis-à-vis its historical distribution. The colours depict low (blue), standard (green) and high (red) levels of cyclical systemic risk.The credit-to-GDP gap is calculated as the percentage point difference between the observed ratio and its long-term trend calculated by applying a one-sided statistical Hodrick-Prescott filter with a smoothing parameter of 400,000.

2.3 Indicator of the macroprudential policy stance

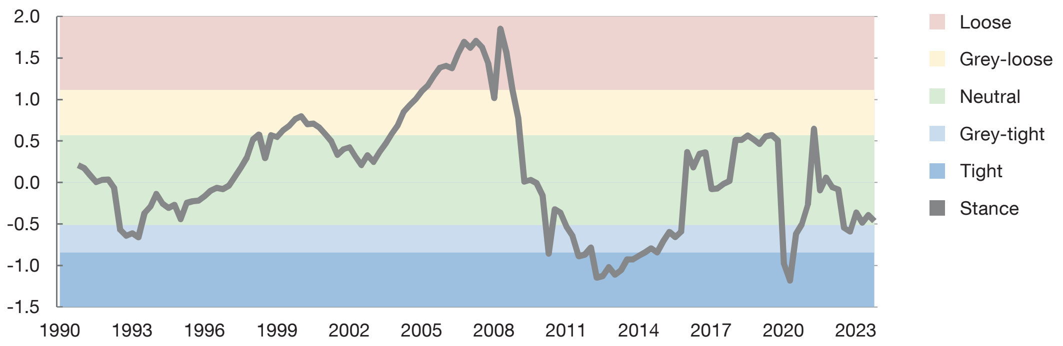
It is also very relevant to relate the identification of systemic vulnerabilities and the position of the economic and financial cycle to the position of macroprudential policy. In this sense, the Banco de España has participated very actively in the work carried out by the European Systemic Risk Board to develop a methodology that allows estimating the macroprudential stance, as a complementary tool to guide macroprudential policy decisions (ESRB, 2021). The methodology is based on the growth-at-risk analytical framework, used to estimate the probability distribution of future GDP growth under different scenarios (see Adrian, 2019a). In particular, growth at risk is the rate of GDP growth below which lower rates would be observed only with a very small probability (normally 5% or 10%, as defined), which would occur in the event of very severe adverse events with very adverse economic consequences.

Specifically, the macroprudential policy stance is approximated by the difference between median GDP growth (50th percentile) and growth at risk for the lower percentiles. This metric reflects the magnitude of the systemic risks that are accumulating, being greater that distance when the risks are greater.[17] This difference is computed with the 8-quarter projections, the horizon around which the greatest impacts of both cyclical vulnerabilities and macroprudential policy are found with this methodology. This horizon is also consistent with the time frame around which the literature has found the greatest predictive capacity of cyclical risk indicators on future systemic crises.[18]

17 See Suarez (2022) for the microeconomic rationale for this metric.

18 See Galán (2020), Lang et al., (2019).

Chart 2.3
Macroprudential policy stance in Spain (a)



SOURCES: ECB, ESRB, Banco de España.

a The bands are delimited by the 10th, 25th, 75th and 90th percentiles of the distribution of the distance between the median and growth-at-risk (5th percentile) of the distribution of GDP growth in Spain estimated over an 8-quarter horizon using a growth-at-risk model. Latest observation 2023 Q4.

As for the effects of macroprudential policy on this metric, Galán (2020) finds that its implementation has positive impacts on growth at risk and negative effects on the median. In addition, in absolute value, the effect on the median is much smaller than the effect on growth at risk. Consequently, the activation of macroprudential measures not only reduces this difference, but does so by improving above all the growth that would occur in a situation of materialisation of risks. In this way, the metric proposed by the ESRB incorporates both risk and macroprudential policy variables, which allows estimating a measure of the macroprudential policy stance in relation to risks.

Consequently, if the difference between median and at-risk GDP growth is very large, macroprudential policy would be too loose, and its tightening would reduce the impact on GDP of the materialisation of adverse risks to a much greater extent than the reduction in expected median growth. On the other hand, if this difference is very small, macroprudential policy would be too strict, and its release would allow to improve the more likely median growth to a greater extent than the deterioration of growth at risk.

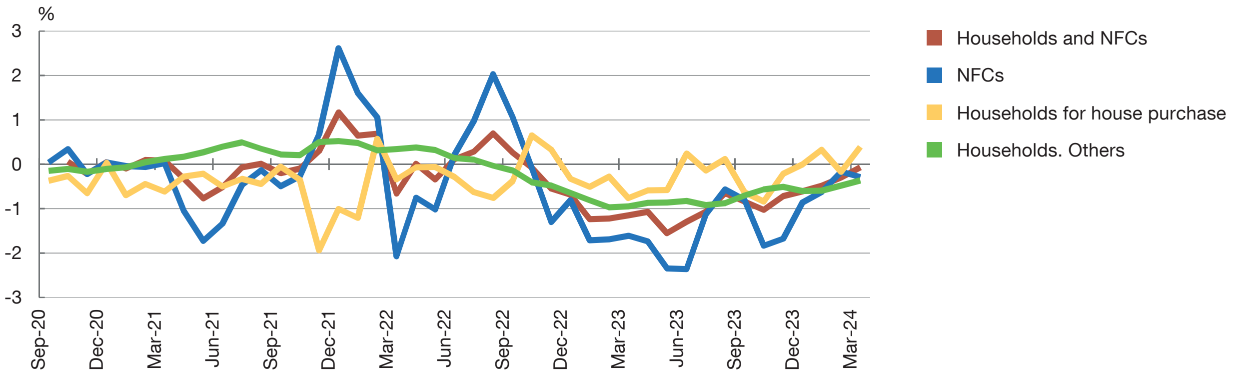
The methodology developed jointly with the ESRB proposes to define thresholds based on the percentiles of the historical distribution of the distance between median and growth at risk in each country (ESRB, 2024). Chart 2.3 presents the estimates made for Spain based on the proposed metric. It is observed that at present the macroprudential stance is in a neutral zone.

2.4 Complementary analysis of bank credit developments

2.4.1 Study of short-term growth of credit balances

The evolution of the balance of bank credit to households and non-financial companies (NFCs) is also analysed to quickly detect significant changes in its trend. To do this, and

Chart 2.4
Quarterly seasonally adjusted credit growth rate



SOURCE: Banco de España.

in order to have an up-to-date view of its evolution, its quarterly variations are studied, corrected for the seasonal effects that these variables may contain. Seasonal effects are recurring patterns that occur within the year. The series are seasonally adjusted using standard statistical programmes.[19]

On the basis of the most recent data available, as at March 2024, the seasonally adjusted quarter-on-quarter rate of credit to households and NFCs was close to zero, although it remained negative (-0.1 %) (see Chart 2.4). In the analysis by portfolio, this rate is already positive in the case of credit to households for house purchase (0.4%) and has improved by 0.1 pp in the rest of credit to households, although it is still in negative territory (-0.4%). On the other hand, credit to NFCs remains negative (-0.3%), although again much higher than a few months earlier.

The macro-financial indicators defined in section 2.2 have a relatively lower update frequency, so it is useful to complement them with this information on short-term developments and with their forecasts. In both cases, at the current juncture, both sources of supplementary information qualify the negative signal on the cyclical position of credit obtained in the main indicator.

2.4.2 Supply and demand factors in credit developments

The analysis of whether fluctuations in the volume of bank loans are a consequence of changes in the demand for or supply of credit is of great importance for understanding their

19 The statistical software used for this process is JDemetra+, which is based on the TRAMO-SEATS method developed by Gómez and Maravall (1996). In summary, the original series is first preset with the TRAMO procedure (Time series Regression with ARIMA noise, *Missing values and Outliers)* to eliminate outliers and calendar effects. In the next step, the SEATS (Signal Extraction in ARIMA Time Series) procedure performs the seasonal adjustment by decomposing the pre-adjusted series into different orthogonal components not directly observable (trend, cycle, seasonal and irregular) according to a flexible ARIMA (Autoregressive Intergrated Moving Average) model, selected automatically. Finally, the seasonal components are filtered to obtain the new seasonally adjusted series.

evolution, in particular in the face of changes in their trend or for assessing the impact of new policy measures. In addition, the implications for the macrofinancial environment, in variables such as economic growth or the general level of prices, differ depending on which of these factors predominates, as well as the optimal response that macroprudential policy could adopt to these fluctuations.

Supply and demand shocks for credit to households and non-financial corporations can be analysed using a structural autoregressive vector model (S-VAR).[20] This framework allows for the simultaneous modelling of the relationships between (i) the change in new credit and (ii) the change in the spread between interest rates on loans and bank deposits.[21] Under this framework, it is possible to estimate the potential contemporary effects on both variables of shocks associated with supply and demand factors.

The identification of credit supply and demand shocks is carried out taking into account the differential effects they have on credit and the interest rate differential. Thus, a positive demand shock should have a positive effect on the variation of the interest rate differential, i.e. it should increase it. Similarly, it should have a positive effect on credit variation. On the other hand, a positive supply shock should have a negative effect on the change in the interest rate differential (lowering it), and a positive effect on the change in credit.

The above description can be condensed into the following general formulation:

$$y_t = c + M^1 y_{t-1} + \dots + M^k y_{t-K} + Qu_t$$

where t is the time period (quarters); y_t is the vector containing the two variables studied (new credit flow variation and loan and deposit rate differential variation) in period t; c is a vector of constants; M^i, i = 1, ... , K, is a set of matrices of coefficients for the lags of the vector of variables studied (K being usually equal to 4); u_t is the vector of shocks (supply shock and demand shock, independent of each other) in period t, and Q is the matrix of coefficients for the shocks, on which the sign restrictions discussed above are imposed.

The model is estimated by Bayesian inference using a Gibbs sampling algorithm and Minnesota priors. As it is a statistical model, it must be interpreted as an approximation to the dynamics of the studied variables, with the consequent bands of uncertainty in the inferences made from them.

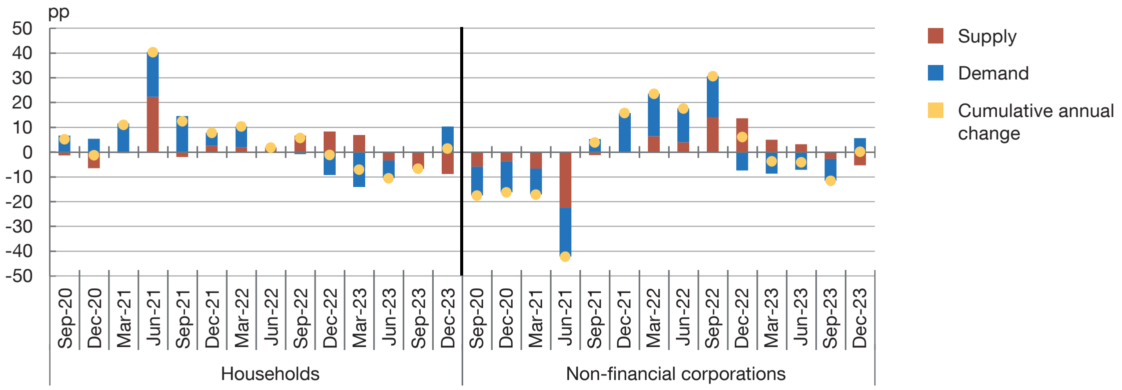
Finally, once the model is estimated, it is possible to extract, for each time period, the estimated value of the supply and demand shocks for each of the two variables studied, in particular for the variation of new credit flow.

20 See the following references for more information on this method and its recent application. Box 1. Analysis of supply and demand factors in the evolution of credit to households and businesses in Spain. Analytical Articles Banco de España 1/2021 and Box 3.1. Decomposition into supply and demand factors of recent developments in bank lending to households and firms in Spain. *Financial Stability Report*, Autumn 2023.

21 Both changes correspond to year-on-year rates applied to the amount and rate differential values associated with the new credit flow in the quarter.

Chart 2.5

Macroeconomic decomposition of new lending to households and non-financial corporations, by supply and demand factors (a)



SOURCES: European Central Bank and Banco de España.

a Cumulative year-on-year change. Supply and demand effects estimated with an S-VAR model, using data on volumes and loan-deposit interest rate spreads for new lending in euro area countries. The model is estimated by means of Bayesian inference, using a Gibbs sampling algorithm and Minnesota priors, drawing on 5,000 MCMC (Monte Carlo Markov Chain) samples out of a total of 50,000 iterations.

Illustratively, Chart 2.5 shows, for the change in credit to households and non-financial corporations, the decomposition in terms of supply and demand for the period 2020-2023. It is noted that positive supply factors contributed to the stabilisation of the growth of new credit to households and non-financial corporations in the last quarter of 2023, leaving behind the negative trend observed during the first three quarters of the year. This is consistent with the decline in spreads between interest rates on loans and deposits in recent quarters. On the other hand, demand factors have continued to contribute negatively, owing to the high level of interest rates.

3 Application of the FLESB stress test framework for measuring the impact of cyclical systemic shocks on the banking sector

3.1 Summary

This section details the results and methodology of multiple simulations of the Spanish economy's response to various adverse cyclical shocks and the associated capital consumption of the Spanish banking system, estimated through stress tests. The model used to simulate the effect of adverse cyclical shocks on the Spanish economy was the MTBE. Additionally, the estimation of capital consumption derived from these shocks has been carried out using the Banco de España's stress testing framework, known as FLESB *(Forward Looking Exercise on Spanish Banks).*

The shocks have been classified into three groups: i) external origin, and ii) internal nature. The latter can be either real or financial. This set of shocks is motivated by the available evidence, which shows that the nature of cyclical systemic risk is broad and that shocks of not only financial but also real origin can impact the solvency of the banking system.

The severity of the shocks has been calibrated according to historical experience, and classified as mild, medium, and severe. Regarding their effects on the Spanish economy, they are calibrated by simulating the isolated impact of each shock, as well as the impact of their joint materialization. Each of these combinations of shocks consumes a certain amount of CET1 ratio, providing a measure of the intensity of shocks that could be absorbed by the release of an additional capital requirement.

The analysis shows that a combination of mild shocks (both internal and external) would generate a CET1 ratio consumption absorbable with an additional buffer of 0.5 pp, which could also absorb more severe internal or external shocks if they materialize individually rather than in combination. Overall, the analysis highlights the systemic importance of these shocks for the banking sector due to their materiality, as well as the feasibility of enhancing resilience through greater accumulation of solvency resources.

The remainder of this section is subdivided as follows: (3.2) explanation of the use of the MTBE model to generate scenarios based on different types of cyclical shocks, (3.3) main characteristics of the Banco de España's stress testing framework, and (3.4) estimated capital consumption using the methodology presented in (3.3) under the different shocks calibrated in (3.2).

3.2 Calibration of cyclical macro-financial shocks

Starting from a baseline scenario aligned with the central forecast expectations, a range of adverse scenarios is generated by simulating the effects of a series of negative shocks of different magnitudes using the Quarterly Model of Banco de España (MTBE).[22] This is a large-

22 See Arencibia, Hurtado, de Luis and Ortega (2017).

scale macroeconometric model estimated with data from the Spanish economy, specified as a large set of error correction mechanism equations, and its behavior, especially in the short term, is primarily determined by demand channels.

The sources of external shocks include declines in foreign trade of goods and services, as well as increases in international prices of oil and natural gas. Internal financial shocks arise from increases in interest rates, credit declines, and drops in stock market and house prices. Real domestic shocks are defined based on increased pessimism among consumers and businesses, leading to worse behaviour in consumption, housing investment and, equipment investment than what would be implied by the evolution of their explanatory variables.

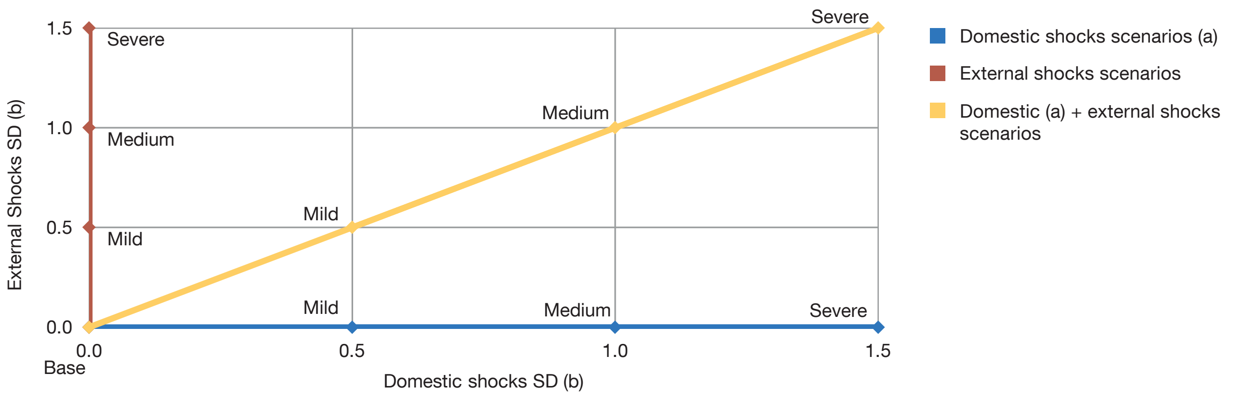
The calibration of the magnitudes of the shocks relies on the historical volatility of the different variables over various horizons. For instance, for the euro area export markets of goods, the standard deviation of their accumulated variation over one, two, and three years during the period 1999-2019 is calculated, resulting in values of 4.9 pp, 6.8 pp, and 7.7 pp, respectively. The same calculation is performed for the cumulative growth of non-euro area export markets of goods, for service markets, for oil prices, and for natural gas prices. Similarly, considering the standard deviation of their accumulated variations over one, two, and three years, the relative size of the different components that make up the simulation of internal financial shocks is defined.

In the case of real domestic shocks, the same type of direct calculation is not carried out, as they are based on variables (consumption and investment) that are determined within the model itself. The quantification of historical volatility in this case is performed using the standard deviation of the variation over four consecutive quarters of the residuals from each corresponding equation (consumption, housing investment, equipment investment).

When multiple independently calibrated negative shocks are considered together, some of them affecting variables having low correlation with each other, it is necessary to adequately consider the criteria for their combination to avoid generating scenarios with implausibly low probabilities of occurrence. This is particularly relevant for real domestic shocks since they are derived from the residuals of estimated equations, which by construction exhibit low correlation in the time series. Thus, the correlations between the three series of these residuals during the historical analysis period are very low (0.04, 0.07, and 0.33, for each of the three possible pairs of variables, with the correlation between consumption and equipment investment residuals being the highest). To avoid an implausibly severe result, shocks with a horizon of up to only one year are defined for them, compared to the broader horizons for directly observed variables[23]. Relatedly, calculating the aggregate probability of each scenario, even relative to the observed

23 The persistence of the shocks on the residuals of the consumption and investment equations, along with the inertia generated by the model when considering the interdependencies between these variables and others, propagates the initial shock, causing the simulation to generate negative effects over the entire twelve-quarter horizon, even though the original shocks only span four quarters.

Figure 3.1
Intensity of the scenarios under consideration



SOURCE: Banco de España.

a Scenarios of domestic shocks consider disturbances of real and financial nature.
b Scenario intensity is measured in standar deviations (SD) of historical variations of the variables that define each shock.

historical period, is not straightforward , although it is feasible to assess an order of magnitude[24].

Finally, the considered scenarios are generated by combining, in each case, groups of shocks of different intensities within a feasible range according to the considerations of the previous paragraph. Mild shocks reach a size of 0.5 standard deviations (of the directly affected variable) at each considered horizon, while medium and severe shocks have a size of 1 and 1.5 standard deviations, respectively. These intensities of individual shocks are maintained when combined with other shocks, leading to joint effects on the economy that amplify the impacts. Figure 3.1 summarizes the scenarios where the two types of shock are combined.

Regarding the estimated average impacts, the severe external cyclical shock (severe external scenario) would reduce real GDP growth by 0.7 standard deviations, with an approximate probability of occurrence (assuming a normal distribution of this variable) slightly below 25%. Meanwhile, the combination of severe domestic real and financial shocks (severe domestic scenario) would generate an average GDP growth slowdown of about 1.5 standard deviations, with an approximate probability of occurrence of 6%. In the most extreme case, the combination of both severe internal and external shocks would lead to an average real GDP slowdown of 2.1 standard deviations, with an approximate probability of occurrence of 2%, according to historical experience and the assumption of a normal distribution. As shown in Table 3.1, the mild shocks considered would lead to smaller impacts on GDP but would have a higher probability of occurrence.

24 As a guide, the accumulated variations in the level of GDP over one, two, and three years have standard deviations of 2.5 pp, 4.5 pp, and 6.3 pp. A simulation of a non-extreme scenario, in which external shocks and financial domestic shocks have a size of one standard deviation, while real domestic shocks have a size of half a standard deviation, generates an impact on GDP of approximately one standard deviation, albeit with some front-loading.

Table 3.1

Scenario impacts in terms of GDP standard deviations (a)

		Scenarios: GDP standard deviations				
		t+1	t+2	t+3	3 year average	Probability of occurrence (a)
External shocks scenarios	Mild	-0.2	-0.3	-0.2	-0.2	41%
	Medium	-0.5	-0.5	-0.4	-0.4	32%
	Severe	-0.7	-0.7	-0.6	-0.7	25%
Domestic shocks scenarios	Mild	-0.7	-0.6	-0.4	-0.6	28%
	Medium	-1.3	-1.1	-0.7	-1.1	14%
	Severe	-1.9	-1.6	-1.1	-1.5	6%
External + domestic shocks scenarios	Mild	-0.9	-0.8	-0.6	-0.8	21%
	Medium	-1.8	-1.6	-1.1	-1.5	7%
	Severe	-2.6	-2.3	-1.6	-2.1	2%

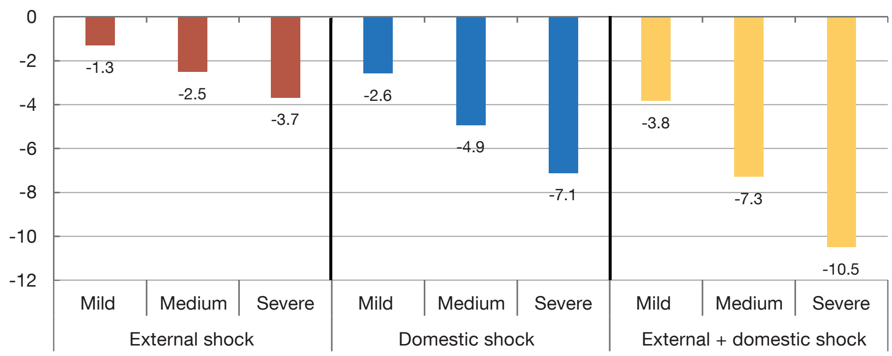
SOURCE: Banco de España.

a The probabilities of occurrence are approximated under the assumption of a normal distribution of the time series of real GDP variation.

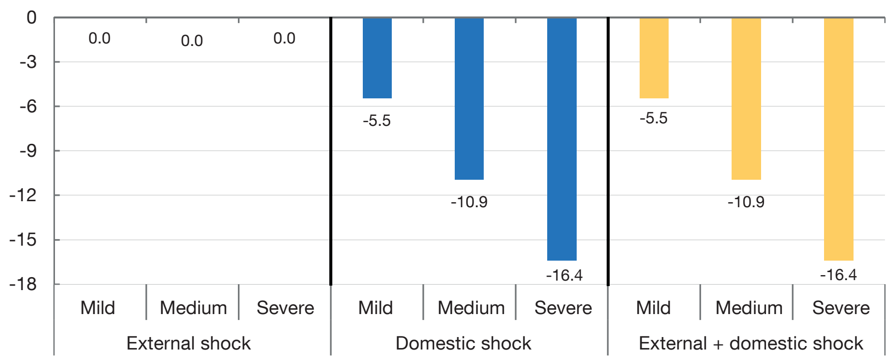
Chart 3.1

Impact on macrofinancial variables (a)

3.1.a GDP growth



3.1.b House price growth



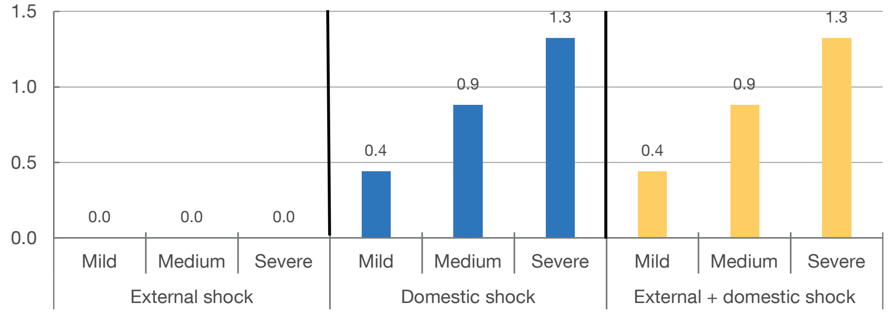
SOURCE: Banco de España.

a Baseline-adverse differences of cumulative growth in the three years of the exercise.

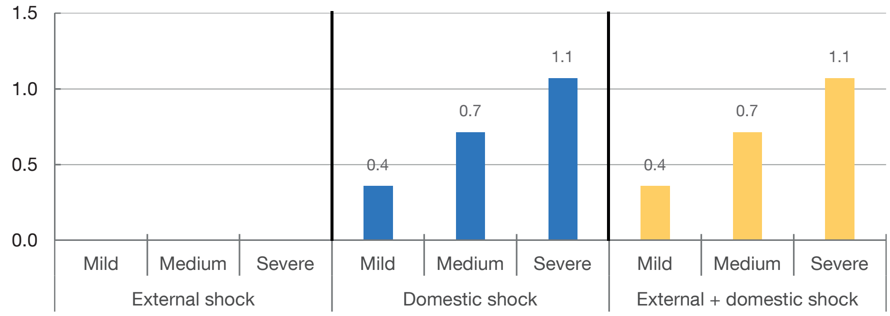
Chart 3.1

Impact on macrofinancial variables (cont'd) (a)

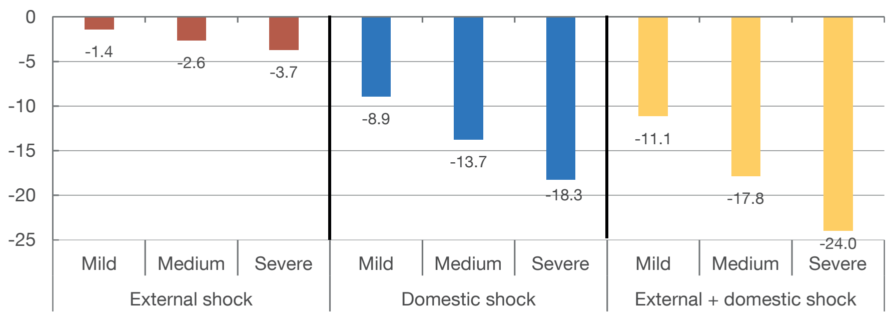
3.1.c Euribor 12 month (b)



3.1.d 10 year bond yield (b)



3.1.e Credit growth (b)



SOURCE: Banco de España.

a Baseline-adverse differences of cumulative growth in the three years of the exercise.
b Impacts on interest rates are shown as the baseline-adverse differences of the average levels over the three years of the exercise, whereas the impact on credit is shown in terms of baseline-adverse differences of cumulative growth in the three years of the exercise.

The first panel of Chart 3.1 shows the slowdown in GDP growth relative to the central projection scenario for the different scenarios, whose intensity increases with the severity of the applied shocks. The order of magnitude of the negative effects on GDP growth in the most severe scenarios, resulting from combining the realization of various macro-financial risks, closely aligns with that applied in the regular stress test exercises.[25]

25 In the European stress test conducted under the EBA methodology in 2023, the adverse scenario assumed a cumulative decline in real GDP of 5.4% over 2023-2025, while the baseline scenario assumed a growth of 6.2%, leading to a negative effect applied in the adverse scenario of 11.5 pp.

Domestic scenarios also consider a lower house price growth, whereas this effect does not occur in response to an external shock (Chart 3.1, second panel).

The scenarios imply a slowdown in credit growth since they all dampen economic activity and, consequently, the demand for this resource. However, the domestic shocks considered, by incorporating a financial component, exert additional pressure on credit, in environments where both short and long-term rates are tightened upwards (see Chart 3.1).

3.3 FLESB Methodology

Due to its forward-looking nature and flexibility to incorporate different scenarios, the FLESB tool has been used to estimate the consumption of bank capital arising from the shocks described in the previous section. The FLESB tool is a methodological framework developed by the Banco de España to assess the resilience, in terms of solvency,[26] of Spanish deposit institutions to the materialisation of macroeconomic scenarios that reflect different hypotheses on the evolution of the economy for a three-year horizon. It is a top-down tool, since its methodological framework is defined by the supervisory body, including the econometric projection models, and is applied consistently for all the banks analyzed.

In general terms, this tool uses the information available through the regulatory and supervisory reporting, including granular data from the credit register, and applies statistical models and technical assumptions to the initial situation of institutions to project the evolution of their balance sheet and income statement according to the scenarios (see Figure 3.2). [27]

The starting point for the analysis of a given scenario is established in December of the last year with available data, observing:

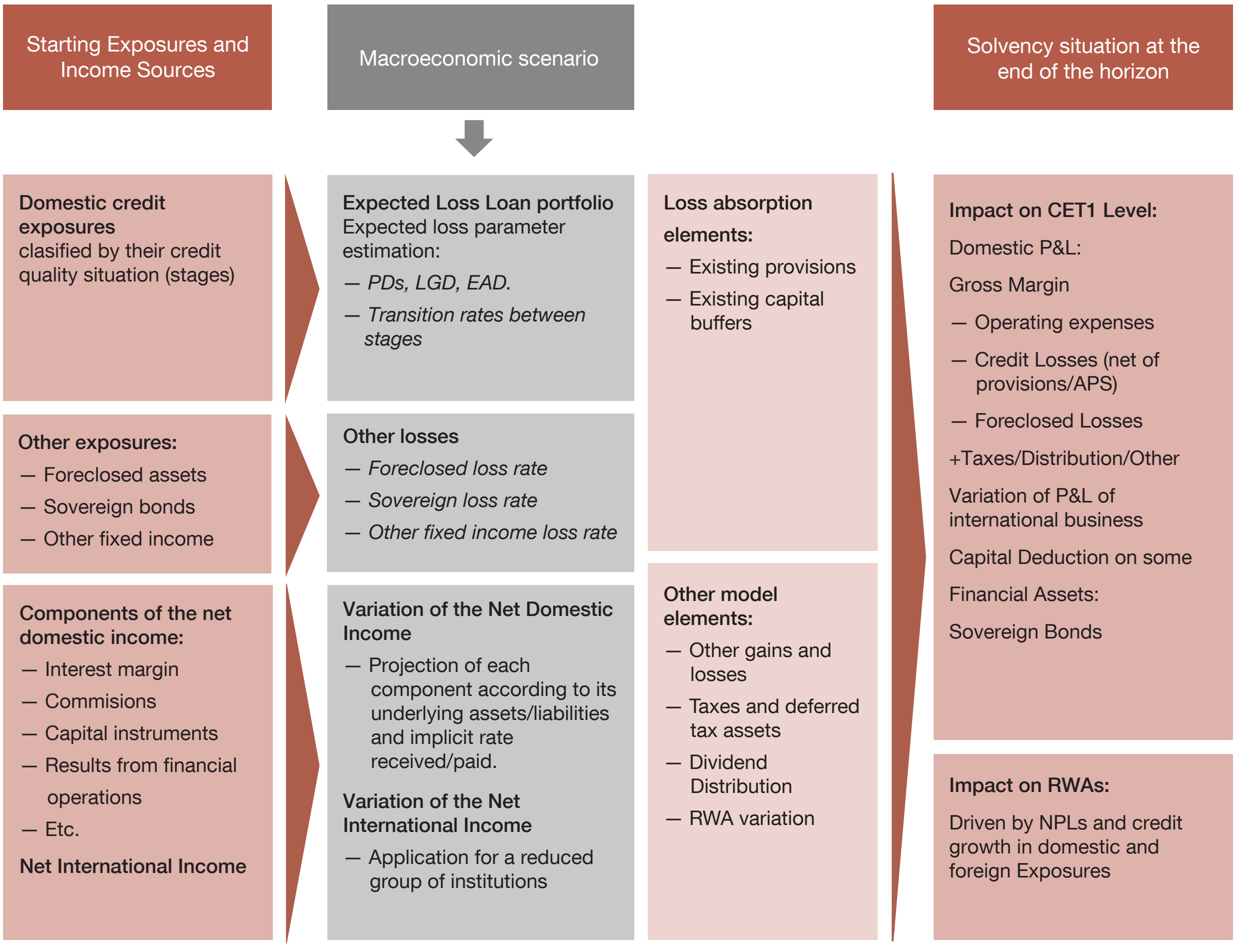
1 Domestic exposures in the credit portfolio, classified according to their situation in terms of credit impairment or default *(stages).* [28]

26 The assessment of the solvency of institutions through stress tests contributes to the macroprudential and micro-supervisory work of the Banco de España. As for its macroprudential work, the Banco de España tests the entire Spanish banking system, and its results inform the analysis of financial stability. These results and analyses are published in aggregate form in the autumn *Financial Stability Reports*. The results of the latest stress test can be found in Box 2.2 on the forward-looking assessment of the resilience of the Spanish banking system in the *Autumn 2023 Financial Stability Report*. Regarding the micro-supervisory function, stress tests are part of the requirements of the Banco de España's supervisory programme to the LSIs, and aim to facilitate the supervisory review and evaluation process (SREP). In addition, the Banco de España also analyses the resilience of deposit institutions in terms of liquidity.

27 A first introduction to the FLESB methodology was published in the section *Development of a tool to perform prospective analyses of Spanish banks on a regular basis. Methodology and first aggregated results* of the November 2013 *Financial Stability Report*. However, since then, new developments and methodological improvements have been included and have been presented in successive years in the *Financial Stability Report*.

28 Specifically, the stages of credit deterioration or default are: normal status with no significant deterioration in credit quality since the time of granting (Stage 1 or S1), status with significant deterioration in credit quality since the time of granting, but without reaching a non-performing status (Stage 2 or S2) and non-performing status, where either a default has occurred for a period exceeding 90 days, or there are sufficient indications to qualify the exposure as non-performing (Stage 3 or S3). To determine the S2 situation, a relevant indicator is the presence of defaults, but without reaching the a period of 90 days or more.

Figure 3.2
Main elements of the solvency exercise



SOURCE: Banco de España

2 Other exposures in the institution's portfolio, such as foreclosed assets, sovereign bonds or other debt instruments.

3 The components of the domestic income statement (net interest income, net commissions, operating expenses, etc.) and the international net profit[29].

In a simplified way, the CET 1 capital (ratio numerator) at the end of the year is obtained as the capital at the beginning of the year, minus impairment losses on assets, mitigated by the usage of the provisions existing at the beginning of the year and by

29 The information of the business abroad is less granular than that considered for Spain, and is only examined for entities with a more significant presence in other countries.

the results generated during the forecast horizon. To estimate risk-weighted assets (denominator), it is necessary to project the evolution of the average risk weight and also the size and composition of the assets of the institutions. These estimates are made with the FLESB tool and are determined by the behavior of the macroeconomic variables that are included in each scenario. In particular, the main elements estimated using the FLESB tool to gauge the impact of the materialisation of macroeconomic scenarios on the projection horizon are:

1 Projections of paths of credit risk parameters, to obtain the estimated loss on the loan portfolio in Spain. The applied methodology models the evolution of the credit quality of the portfolio in Spain under the different scenarios, considering seven main portfolios: (i) real estate development; (ii) public works; (iii) corporates; (iv) SMEs; (v) self-employed entrepreneurs; (vi) retail mortgage credit to natural persons; and (vii) other retail credit to natural persons.

2 Projections of other losses, such as those related to foreclosed assets, sovereign bonds and other fixed income on banks' balance sheets. For foreclosed assets, the calculation uses estimations of their present value by projecting it according to the different macroeconomic scenarios. For sovereign bond exposures, expected losses are estimated through aggregate financial models that apply certain scenario variables.

3 Projections of loss absorbing elements. The first recourse available to face the expected losses is the provisions for insolvencies existing at the starting point of the exercise. These provisions are compared with the estimated expected losses and, if additional provisions are required, the additional amount would be obtained from the net income results, via new provisions. The second element to absorb the expected losses is the profit generated during the exercise (before provisioning), whose projection is made using technical assumptions and statistical models that link the items that are part of the P&L with the macroeconomic variables of the scenarios.

4 Other elements of the calculation include the evolution of risk-weighted assets or, for institutions with significant international activity, the projection of net international income.

In addition, it should be noted that, in the present application, the analysis has been carried out considering that the balance sheet of the institutions is dynamic. In particular, it is assumed that banks' lending varies over the projection horizon depending on the evolution of the demand for credit from firms and households, which is consistent with the scenarios considered. Additionally, due to the objective of analyzing the impact on bank solvency of cyclical systemic risks in Spain, and their possible mitigation, impacts have been considered exclusively through the domestic business of Spanish banks.

3.4 Estimated impacts on the CET 1 ratio

The results in terms of impact on the CET1 ratio from the simulations using the Banco de España's FLESB stress testing tool are shown in Chart 3.2[30]. The impact of an external cyclical shock on the Spanish economy generates an estimated capital consumption for banks ranging from 0.1 to 0.4 pp, depending on its intensity. On the other hand, the impact of domestic cyclical shocks within the Spanish economy, combining financial and real elements, is associated with higher capital consumption, between 0.3 and 1.1 pp. If both external and domestic cyclical shocks were to materialize simultaneously, the estimated capital consumption would range from 0.4 (combination of mild-intensity shocks) to 2 pp (combination of severe-intensity shocks).

The estimated impact on bank capital from the combined materialization of domestic and external shocks with mild intensity could be absorbed by a capital buffer of approximately 0.5 pp of CET 1 ratio. According to the estimates reported in Chart 3.2, this buffer level would also absorb the impact of medium- and high-intensity external shocks on the Spanish economy if they occurred in the absence of domestic shocks. Likewise, it would absorb isolated domestic shocks of mild to medium intensity.

The estimated impacts on the CET1 ratio differ significantly between banks with a more significant foreign business presence[31] and the rest, as they are obtained by design as the effect on the domestic business of cyclical shocks materialized in Spain[32]. In particular, the combined materialization of domestic and external shocks would generate impacts of 0.4 pp, 0.8 pp, and 1.5 pp (for mild, medium, and severe intensity, respectively) for banks with a more significant foreign business presence. In contrast, these impacts would rise to 0.6 pp, 1.6 pp, and 3.2 pp for the rest of the banks.

The set of available macroprudential tools allows adjusting the available resources for each group of banks to the estimated impact of the risks. In particular, the CCyB requirement set by the Banco de España applies exclusively to exposures located in Spain, and its activation at a certain level translates into a different consolidated CCyB requirement depending on the relative weights of domestic and foreign business. For example, banks with a more significant presence in this segment would face an additional consolidated CCyB requirement of 0.3% when activated at 1% for exposures located in Spain, while the rest of banks would face a higher average requirement of 0.8%.

Chart 3.3 presents information on the channels through which the scenarios impact the solvency of banks. The greatest sensitivity is observed through asset impairment, which is the main explanatory factor driving capital consumption. The reduction in economic

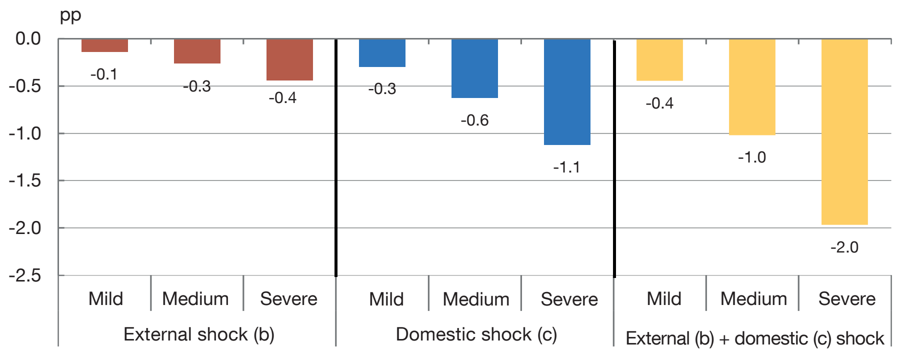
30 The sample of banks included in the analysis consists of 10 SIs and 43 LSIs, covering 94% of the total consolidated assets of the banking system.

31 This group includes the three banks with the most significant and long-standing foreign business operations.

32 The materialization of cyclical shocks in Spain could also be correlated with those in other geographies. These potential shocks to foreign business are not considered in this estimation exercise.

Chart 3.2

Aggregate impact of the simulated scenarios on the CET1 ratio of the banking system (a)

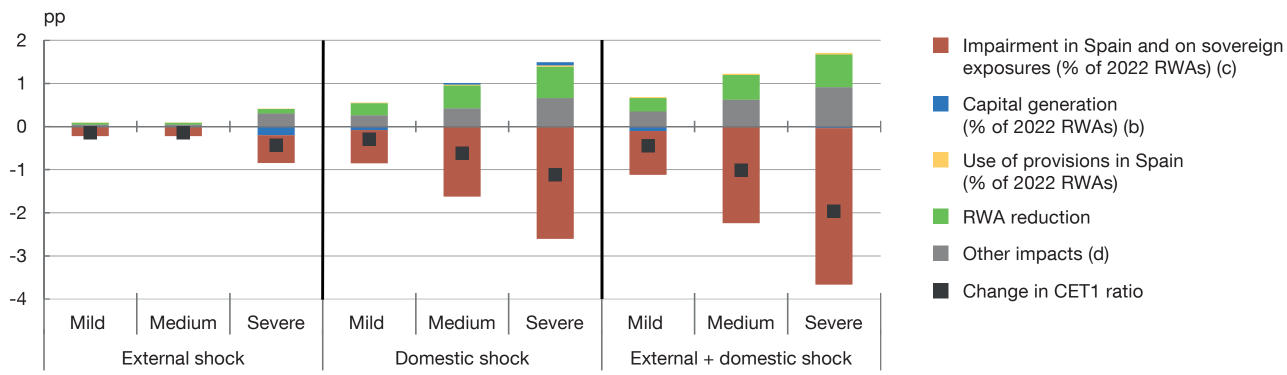


SOURCE: Banco de España.

a Impacts are defined as the differences in the banking system's expected CET1 ratio at the end of the projection horizon (2023-2025) between each scenario and the baseline scenario.
b External shock stemming from falling global markets and rising international oil and natural gas prices.
c Domestic shock, combining (1) financial elements: interest rate rises (in short-term reference rates, long-term government debt and bank rates), and declines in credit, stock prices and house prices; and (2) real elements: negative consumption, housing investment and capital investment shocks.

Chart 3.3

Breakdown of the different CET1 ratio impact channels of the simulated scenarios (a)



SOURCE: Banco de España.

a The impacts are defined as the expected changes in the CET1 ratio in 2025 and in different financial flows (e.g. capital generation) stemming from the materialisation of the adverse changes in macro-financial conditions envisaged in the scenarios.
b The generation of loss-absorbing capital is determined by net operating income in Spain, and also the net profit/loss generated abroad for banks with significant international activity.
c Impairment losses on loans and foreclosed assets in operations in Spain, and the impact on capital of the potential impairment on sovereign exposures at consolidated level.
d Other consolidated gains and losses, tax effects, exchange differences, profit distribution, coverage of losses linked to ICO-backed loans with Government guarantee.

activity associated with the various analyzed cyclical macro-financial shocks also translates into a lower generation of operating results in the Spanish business, although this effect is of a smaller order of magnitude. In the case of domestic shocks, which include a certain rise in benchmark interest rates, the negative effect on result generation is partly mitigated by a positive effect of these higher rates on the net interest income.

4 Use of growth and credit at-risk methodologies for the analysis of the countercyclical use of bank capital requirements

4.1 Summary

Most empirical studies that have analysed the impact of macroprudential policy identify positive effects on reducing the likelihood of systemic crises or smoothing the credit growth and house price cycles.[33] However, a negative impact on GDP growth in the short- to medium-term is commonly identified.[34] This is attributed to the moderation of financial variables, which also dampens the pace of economic growth. Nonetheless, if there is a positive effect on the reduction of systemic risk, it should also be reflected in a reduction in the risk of very low economic growth or severe downturns in the future. Consequently, it becomes essential to estimate the impact of changes in bank capital requirements across the entire distribution of GDP and specifically on its left tail, which represents the concept of growth at risk. That is, the rate of GDP growth that would be observed in the face of the materialization of adverse events that may trigger systemic financial crises, even if their probability of occurrence is relatively low.

The identification of these effects is carried out through quantile regressions (Koenker and Basset, 1978), where the impact of increases and decreases in the combined bank capital buffer requirement (CBR) on the 10th percentile of the GDP distribution is estimated. These changes in the CBR would be linked throughout the cycle to changes in the CCyB. This is mainly evident for CBR decreases during episodes of macro-financial crisis, when it is only possible to release certain requirements, primarily the CCyB. In particular, the specification proposed by Galán (2020) for estimating the impact of macroprudential policy on growth at risk is used as the basis for the analysis.[35] This work extends the study by Adrian et al. (2019a), who use quantile regressions for the identification of impacts of financial conditions on growth at risk, by adding macro-financial variables with an early warning capability for systemic crises, such as credit and house price growth, as well as variables identifying the implementation of macro-prudential measures.[36]

In line with Galan (2020), the current study highlights the importance for analysing the impact of macroprudential measures of considering both the effects at different time horizons and the variation across different stages of the economic and financial cycle. In particular, the paper identifies that an increase in bank capital requirements during

33 See Dell'Ariccia et al. (2016) for evidence on positive effects in decreasing the probability of occurrence of systemic crises and Claessens et al. (2013) or Cerutti et al. (2017) for effects on credit and house prices.

34 See e.g. Noss and Toffano (2016), Kim and Mehrotra (2018), Richter, Schularik and Shim (2019).

35 For other methodological applications of growth at risk for estimating macroprudential measures, see Duprey and Ueberfeldt (2020), Brandao-Marques et al. (2020) or Franta and Gambacorta (2020).

36 On the one hand, this study finds that both the accumulation of cyclical risk and the materialization of episodes of financial stress lead to lower growth at risk and increase the asymmetry of the GDP growth distribution to the left (more negative or less positive values). On the other hand, it identifies positive and significant effects of macroprudential policy on growth at risk, which mitigate these negative effects and reduce the asymmetry of the distribution towards the left tail. However, the temporal structure of these impacts differs. While financial stress has short-term effects (i.e. horizons of around one year), cyclical financial imbalances affect growth at risk in the medium term (i.e. horizons of around three years).

expansionary phases of the cycle takes around eight quarters to yield positive effects on growth at risk. Conversely, releasing capital during contractionary phases or financial stress events has nearly immediate positive effects. These results suggest the need to implement capital measures well in advance of financial cycle expansions, and confirm the benefits of maintaining sufficient macroprudential space to address financial stress shocks.

The analysis is complemented by a study at European level of the decisions to activate and release the CCyB in the periods before and after the outbreak of the COVID-19 pandemic. This analysis reinforces the evidence of the presence of substantial benefits of having releasable capital buffers to sustain the provision of credit to the economy in adverse cyclical phases, such as those in which cyclical systemic risks materialise.

4.2 Methodology and data

Galán (2020) finds positive and significant benefits from the use of macroprudential measures and, in particular, from bank capital requirements, on growth at risk. However, the use in this study of categorical variables for the identification of the use of these measures[37] does not allow estimating specific effects of the activation and release of different percentages of capital buffers. To address this limitation, the specification proposed in Galan (2020) is extended here by introducing the CBR as a metric. The estimated specification is as follows:

$$\hat{Q}_{y_{i,t+h}|x_{i,t},\alpha_i}(\tau|X_{i,t},\alpha_i) = \hat{\alpha}_{i\tau} + \hat{\beta}_{1\tau} y_{it} + \hat{\beta}_{2\tau} CLIFS_{it} + \hat{\beta}_{3\tau} SRI_{it} + \hat{\beta}_{4\tau} CBR_{it}$$
$$+ \hat{\beta}_{5\tau} SRI_{it} \times CBR_{it} + \hat{\beta}_{6\tau} CLIFS_{it} \times CBR_{it} + \hat{\beta}_{7\tau} y_{it} \times CBR_{it};$$
$$\tau = 10{,}50; \quad h = 1, \dots, 16, \tag{4.1}$$

where $y_{i,t+h}$ is the annualised GDP growth between period t and period t+h in country i; α_i represents the unobserved fixed country effects, $y_{i,t}$ is the annual GDP growth observed in period t; SRI is a composite cyclical risk index proposed by Lang et al. (2019) which aggregates financial variables by optimising their weights based on their predictive capacity of systemic crises[38]; CLIFS is the financial stress index proposed by Duprey et al. (2017), which aggregates variables that measure volatility and tail risk in equity, sovereign and foreign exchange markets; and CBR is the combined capital buffer requirement that includes the capital conservation buffer, the systemic risk buffer, the significant systemic institution buffers and the CCyB.[39] The inclusion of CBR interactions with macro-financial variables makes it possible to differentiate the effects of capital buffers at different stages of the real and financial cycles. Finally, τ represents the percentiles for which the quantile estimate is made, which in this case are the 10th percentile, used as an approximation to growth at risk, and the 50th percentile, which represents the median of the distribution. This makes it

37 In particular, the MPI (Macroprudential Policy Index) index is used, which includes the number of measures tightened or softened in each country within a broad catalogue of macroprudential actions.

38 The variables included in this index are: (i) biannual change in the credit-to-GDP ratio, (ii) biannual change in house prices, (iii) biannual change in the debt service ratio, (iv) biannual change in the stock market index and (v) the current account balance as a percentage of GDP.

39 The level of CCyB included in this analysis is this buffer requirement in each country, and not a weighted average of the effective CCyB requirements taking into account the exposures of the entities of a country in different geographies.

Table 4.1
Summary Statistics

Variable	Minimum	Median	Mean	Standard deviation	Maximum
GDP (annual growth rate, %)	-3.24	2.64	3.02	2.50	11.66
SRI	-3.11	-0.29	-0.34	0.47	0.51
CLIFS	0.01	0.07	0.08	0.05	0.56
CBR (% of CET1/RWA)	0.00	2.25	2.16	1.77	6.50

SOURCES: ECB, ESRB, Banco de España..

possible to identify asymmetric effects of the increase in the CBR at different points in the GDP distribution.

The sample comprises quarterly data from 2013 to 2019 for the 27 EU countries plus the UK. The sources of data are the European Central Bank and the European Systemic Risk Board. A summary statistics of the variables included in the sample is presented in Table 4.1.

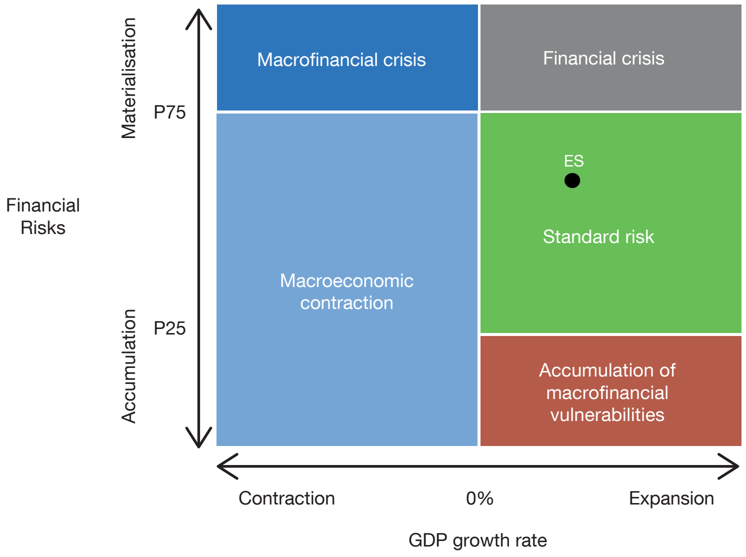
The inclusion of the CBR in this analysis limits the time dimension of the data because the implementation of macroprudential capital buffers emerged only after the global financial crisis. Consequently, the analysis is performed by using the method of moments introduced by Machado and Santos Silva (2019). This estimation method, designed for quantile regressions, yields consistent and unbiased estimators even in situations where conventional fixed effects panel estimation techniques can generate problems related to incidental parameters and statistical significance, which arise when the temporal dimension is insufficient with respect to the cross sectional dimension[40].

Separate models are estimated for all horizons ranging from 1 to 16 quarters following a change in the CBR, considering both the 10th and 50th percentiles. The results are presented for specific scenarios that intersect GDP growth with a combination of the cyclical risk index (SRI) and the financial stress index (CLIFS). These scenarios capture different positions throughout economic and financial cycles. To facilitate the representation of these interactions, the SRI and the CLIFS are aggregated into a single measure of financial risks. This composite measure takes high values during episodes of risk materialization and low values during periods of accumulation of cyclical vulnerabilities. Chart 4.1 illustrates these scenarios.

The marginal impact of a 1 pp variation in the CBR is calculated for different scenarios. This corresponds to the derivative with respect to the CBR in the estimated specification represented by $\hat{\beta}_{4\tau} + \hat{\beta}_{5\tau} SRI_{it} \times CBR_{it} + \hat{\beta}_{6\tau} CLIFS_{it} \times CBR_{it} + \hat{\beta}_{7\tau} y_{it}$, where the

40 For more details on the sufficiency of temporal and cross-sectional observations in panel quantile regressions see Kato et al. (2012).

Chart 4.1
Scenarios of interaction between the economic and financial cycles (a)



SOURCES: ECB, Banco de España.

a The scenarios assume different values based on the historical distributions of the GDP growth rate and of a function of the financial stress index (CLIFS) and the cyclical risk indicator (SRI), which is defined as a subtraction of the two indices. For instance, the standard risk scenario can be defined as periods of positive economic growth where financial risk is between the percentiles 25 y 75 of its historical distribution. The point represents the position of Spain in 2023Q4.

variables SRI, CLIFS and GDP growth (y) are assigned typical values observed for Spain within the scenarios depicted in Chart 4.1, based on their historical distribution[41].

4.3 Estimating the effects on GDP growth

Chart 4.2 presents the impact of a 1 pp accumulation in the CBR within an environment characterized by increasing macro-financial imbalances and elevated levels of cyclical systemic risks, such as that observed before the global financial crisis. This environment aligns with the original conception of the CCyB, before accumulating sufficient evidence and experience regarding its effectiveness against standard levels of cyclical systemic risks. This analysis examines the effects on annualised GDP growth over different time horizons (ranging from 1 to 16 quarters) following the accumulation of the CBR. The results show that the positive impact on growth at risk (Panel A) clearly exceeds the moderation of growth around the median (Panel B).

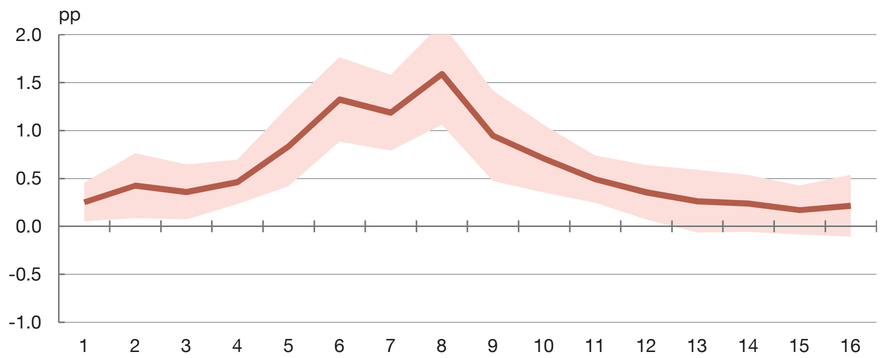
Chart 4.3 presents the impact of a 1 pp accumulation in the CBR achieved, for example, through a higher CCyB requirement, within a standard risk scenario, on the 10th and 50th percentiles of the annualised GDP growth distribution over different time

41 The values of the three variables observed during the period 1990-2019 are considered, covering a complete financial cycle in Spain and two systemic events.

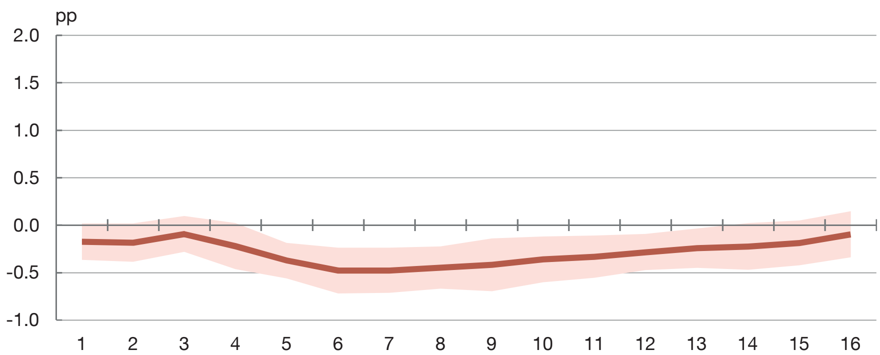
Chart 4.2

Impact of a 1 pp increase in the CCyB on growth-at-risk (P10) and the median (P50) of the GDP growth distribution - Scenario of accumulation of macrofinancial vulnerabilities (a)

4.2.a Impact on growth-at-risk



4.2.b Impact on the median



SOURCE: Banco de España.

a The lines represent the impact in percentage points (pp) of a 1 pp increase in the CBR on the percentiles 10 and 50 of the annualized GDP growth distribution between the period when the CBR is reduced and different horizons (ranging from 1 to 16 quarters). The shadowed areas represent 95% confidence bands of the estimates. The horizontal axis represents the quarters elapsed since the increase in the capital requirement. At time 0, values for GDP growth and financial risk are those corresponding with the percentiles 95 and 5 of their historical distributions in Spain from 1999 to 2019, respectively. These are representative values from the scenario of accumulation of macrofinancial vulnerabilities following the representation in Chart 4.1. For methodological details, see Galán, J.E. (2020).

horizons (ranging from 1 to 16 quarters) following the CBR accumulation. It is observed that the accumulation of a higher CBR yields positive effects on growth in the 10th percentile (the risk scenario), extending for up to 12 quarters and peaking around 5 quarters after the requirement increase (Panel A). While it is also noted that the measure would have negative effects on the median GDP growth, these effects are relatively smaller (Panel B).[42]

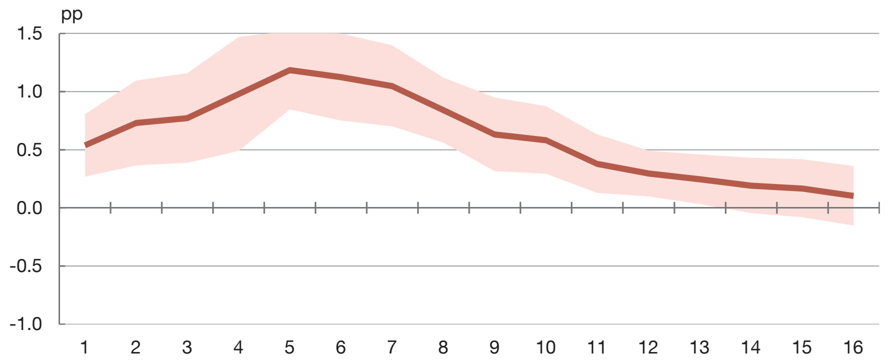
These results show that the benefits of increasing CBR to enhance growth within the risk scenario far outweigh costs in terms of a central trend measure of GDP growth. This holds true both in an environment characterized by high cyclical systemic risks (where more previous evidence was available), and in an environment where these risks are at a standard

42 These results are consistent with those found by Galán (2020) using macroprudential policy indices and with other similar studies (see, for example, Franta and Gambacorta, 2020).

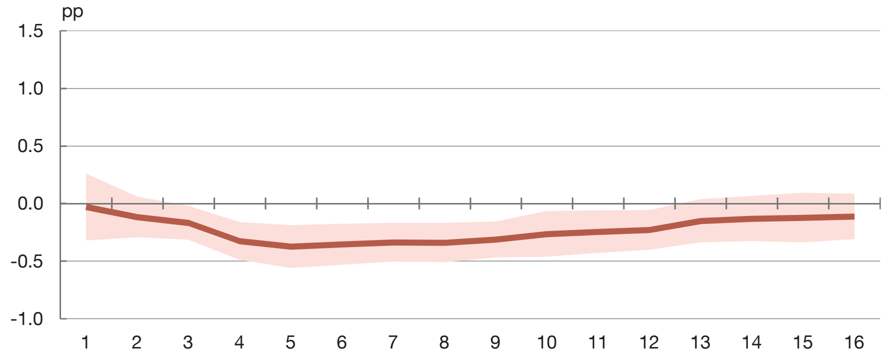
Chart 4.3

Impact of a 1 pp increase in the CCyB on growth-at-risk (P10) and the median (P50) of the GDP growth distribution - Standard risk scenario (a)

4.3.a Impact on growth-at-risk



4.3.b Impact on the median



SOURCE: Banco de España.

a The lines represent the impact in percentage points (pp) of a 1 pp increase in the CBR on the percentiles 10 and 50 of the annualized GDP growth distribution between the period when the CBR is reduced and different horizons (ranging from 1 to 16 quarters). The shadowed areas represent 95% confidence bands of the estimates. The horizontal axis represents the quarters elapsed since the increase in the capital requirement. At time 0, values for GDP growth and financial risk are those corresponding with the percentile 50 of their historical distributions in Spain from 1999 to 2019. These are representative values from the standard risk scenario following the representation in Chart 4.1. For methodological details, see Galán, J.E. (2020).

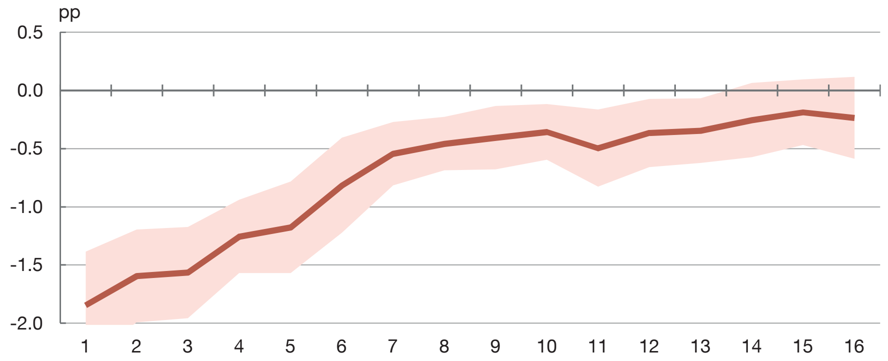
level (as identified more recently in this study). This would have a positive effect in terms of reducing the dispersion of the distribution of GDP growth. In particular, by mitigating its left asymmetry, an effect previously identified as the main negative consequence of heightened financial risks (Adrian et al., 2019a).

Chart 4.4 presents the impacts on median GDP growth and GDP growth at risk of an increase in CBR when the economy is already in a crisis situation, where systemic risks have materialised, resulting in generally low cyclical systemic risks. In this context, the cost-benefit balance strongly discourages increasing the CBR, as it leads to significantly negative effects on both median growth and growth at risk. In a stressed macro-financial environment, the contraction in the supply of credit due to additional capital requirements exacerbates that caused by the crisis itself, worsening the contraction in GDP. From a resilience perspective,

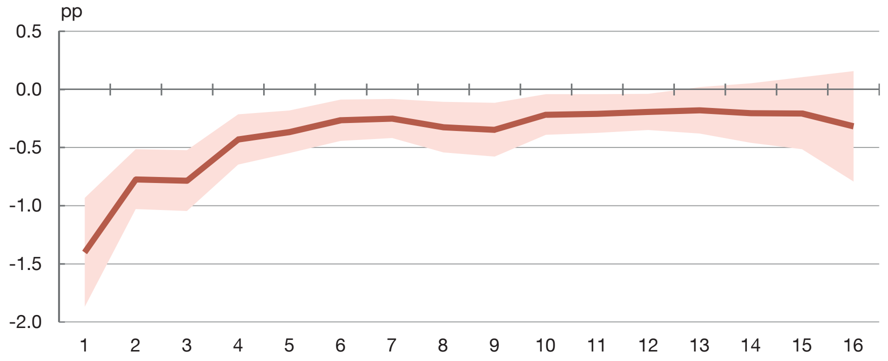
Chart 4.4

Impact of a 1 pp increase in the CCyB on growth-at-risk (P10) and the median (P50) of the GDP growth distribution - Macrofinancial crisis scenario (a)

4.4.a Impact on growth-at-risk



4.4.b Impact on the median



SOURCE: Banco de España.

a The lines represent the impact in percentage points (pp) of a 1 pp increase in the CBR on the percentiles 10 and 50 of the annualized GDP growth distribution between the period when the CBR is reduced and different horizons (ranging from 1 to 16 quarters). The shadowed areas represent 95% confidence bands of the estimates. The horizontal axis represents the quarters elapsed since the increase in the capital requirement. At time 0, values for GDP growth and financial risk are those corresponding with the percentiles 5 and 95 of their historical distributions in Spain from 1999 to 2019, respectively. These are representative values from the macrofinancial crisis scenario following the representation in Chart 4.1. For methodological details, see Galán, J.E. (2020).

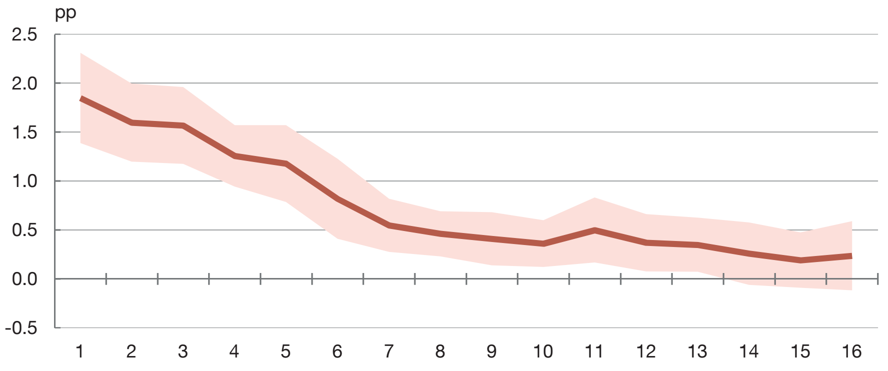
such an increase in the CBR is clearly procyclical and inadvisable, considering the broader objective of macroeconomic stabilisation.

Lastly, Chart 4.5 presents the effects of releasing of 1 pp of the CBR during the materialisation of a macro-financial crisis. It is important to note that this release can only occur through the reduction of its releasable components, notably the CCyB. Overall, it is noted that this release has very significant positive effects on both growth-at-risk and median GDP growth. These effects manifest rapidly, peaking only just 1 quarter after the CCyB release, and the corresponding reduction of the CBR. Additionally, the positive impact is more pronounced in the 10th percentile (associated with the risk scenario), suggesting important benefits in reducing the likelihood of a severe economic contraction and decreasing the left asymmetry of the GDP growth distribution.

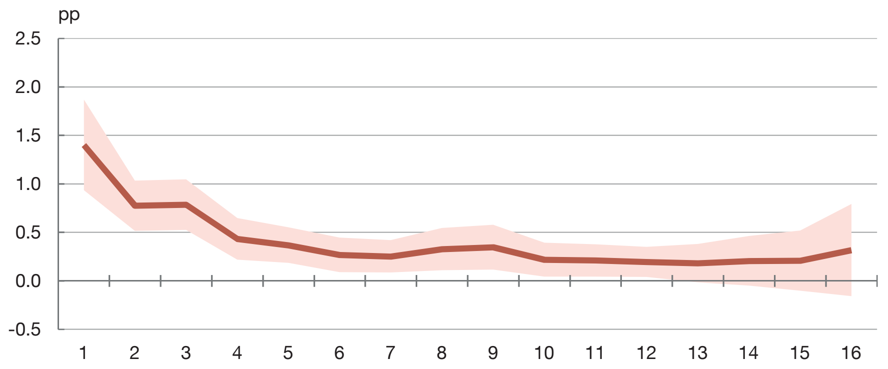
Chart 4.5

Impact of a 1 pp release of the CCyB on growth-at-risk (P10) and the median (P50) of the GDP growth distribution - Macrofinancial crisis scenario (a)

4.5.a Impact on growth-at-risk



4.5.b Impact on the median



SOURCE: Banco de España.

a The lines represent the impact in percentage points (pp) of a 1 pp decrease in the CBR on the percentiles 10 and 50 of the annualized GDP growth distribution between the period when the CBR is reduced and different horizons (ranging from 1 to 16 quarters). The shadowed areas represent 95% confidence bands of the estimates. The horizontal axis represents the quarters elapsed since the decrease in the capital requirement. At time 0, values for GDP growth and financial risk are those corresponding with the percentiles 5 and 95 of their historical distributions in Spain from 1999 to 2019, respectively. These are representative values from the macrofinancial crisis scenario following the representation in Chart 4.1. For methodological details, see Galán, J.E. (2020).

Overall, these results suggest that establishing macroprudential space through releasable capital buffers yields substantial benefits for mitigating the adverse impact of macrofinancial crises on economic growth.

4.4 Estimating the effects on credit growth

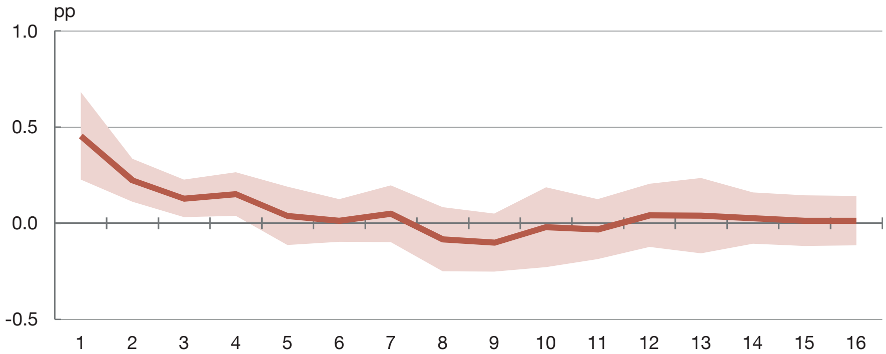
While assessing the impact of changes in bank capital requirements on GDP growth makes it possible to identify the effects on the ultimate objective of macroprudential policy, namely the prevention and mitigation of systemic risks, a crucial transmission channel for these changes operates through credit provision. Consequently, the above analysis is extended to estimate the effects of varying the CBR on the distribution of bank credit growth.

To achieve this, quantile regressions are estimated based on the specification outlined in Equation (4.1), replacing the dependent variable with the annualized growth rate of bank credit between period t and period t + h in country i. This modification implies replacing the cyclical risk index previously used. Since credit growth contributes to this indicator, its inclusion would introduce an endogeneity problem, by creating a correlation between explanatory variables and the unobserved portion of the dependent variable. In particular, this variable is substituted by annualised house price growth over the past two years and the same estimation procedure presented earlier is carried out.[43]

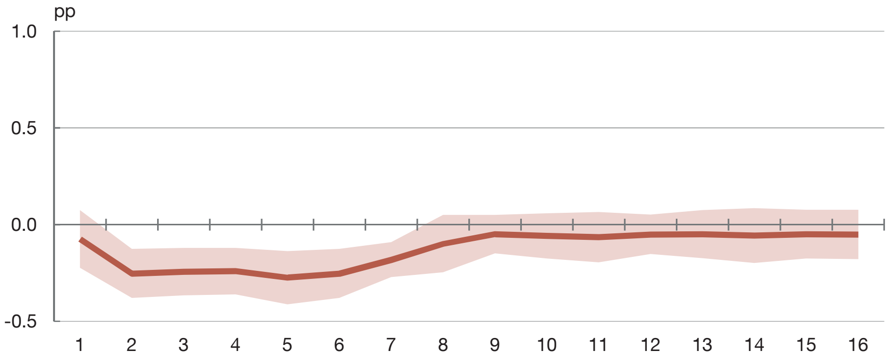
Chart 4.6

Impact of a 1 pp increase in the CCyB on credit-at-risk (P10) and the median (P50) of the credit growth distribution - Standard risk scenario (a)

4.6.a Impact on credit-at-risk



4.6.b Impact on the median



SOURCE: Banco de España.

a he lines represent the impact in percentage points (pp) of a 1 pp increase in the CBR on the percentiles 10 and 50 of the annualized credit growth distribution between the period when the CBR is increased and different horizons (ranging from 1 to 16 quarters). The shadowed areas represent 95% confidence bands of the estimates. The horizontal axis represents the quarters elapsed since the increase in the capital requirement. At time 0, values for GDP growth and financial risk are those corresponding with the percentile 50 of their historical distributions in Spain from 1999 to 2019. These are representative values from the standard risk scenario following the representation in Chart 4.1. For methodological details, see Galán, J.E. (2020).

43 The inclusion of house prices has been identified in studies of growth at risk as a highly relevant variable for capturing cyclical imbalances (see, for example, Aikman et al., 2019; Galán, 2020). As indicated in the previous section, house price growth is one of the factors integrated into the NIS.

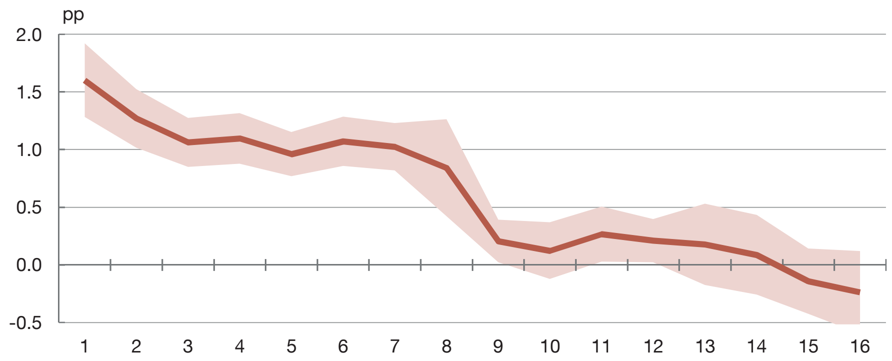
Estimates of the effects resulting from an increase in the CBR achieved through the accumulation of CCyB, on the 10th percentile (credit at risk) and the 50th percentile (median) of the distribution of bank credit within a standard risk scenario are presented in Chart 4.6. In general, the observed direction of the effects on both the left tail and the median mirrors that obtained for GDP growth. However, in comparison to the results for GDP growth, the positive impact on the 10th percentile of credit growth during standard risk periods is notably smaller. Additionally, this positive effect is somewhat lower than the negative impact identified on median growth at horizons spanning 4 to 8 quarters after the introduction of the measure.

Turning to scenarios characterized by high cyclical systemic risks (associated with the accumulation of macro-financial imbalances) and scenarios where systemic risks have materialized, the effects of increasing the CBR (for instance, through a higher CCyB) follow a

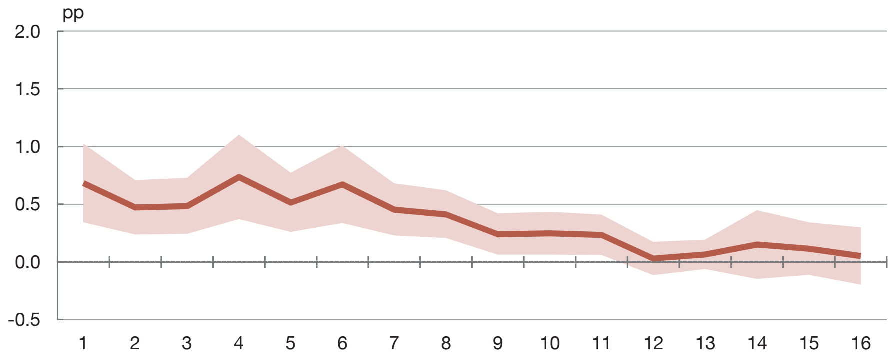
Chart 4.7

Impact of a 1 pp release in the CCyB on credit-at-risk (P10) and the median (P50) of the credit growth distribution - Macrofinancial crisis scenario (a)

4.7.a Impact on credit-at-risk



4.7.b Impact on the median



SOURCE: Banco de España.

a The lines represent the impact in percentage points (pp) of a 1 pp decrease in the CBR on the percentiles 10 and 50 of the annualized credit growth distribution between the period when the CBR is reduced and different horizons (ranging from 1 to 16 quarters). The shadowed areas represent 95% confidence bands of the estimates. The horizontal axis represents the quarters elapsed since the decrease in the capital requirement. At time 0, values for GDP growth and financial risk are those corresponding with the percentiles 5 and 95 of their historical distributions in Spain from 1999 to 2019, respectively. These values are representative from the macrofinancial crisis scenario following the representation in Chart 4.1. For methodological details, see Galán, J.E. (2020).

consistent pattern with those observed for GDP growth. However, we refrain from presenting these results here to avoid overextending the discussion. In both types of scenarios, the increase in CBR translates into significant negative effects on both median growth and growth at risk. While this containment of imbalances aligns with the countercyclical role of macroprudential policy in high-risk environments, it has the opposite effect when systemic risks have already materialized, exacerbating the negative swing in the credit cycle.

Conversely, the benefits of releasing the CCyB, during macro-financial crisis, resulting in a lower CBR, are very substantial in terms of improving the distribution of credit growth (Chart 4.7). These benefits are observed both in the left tail and in the median of this distribution, suggesting a very relevant role of the release of CCyB in supporting credit provision to the economy and reducing the risk of severe credit contractions during crisis events. The positive impact on the 10th percentile of credit growth and its median values becomes evident just 1 quarter after release and can be sustained for up to 8 quarters. Overall, the benefits of having a macroprudential buffer that can be released during a crisis far outweigh any initial implementation costs, particularly concerning average credit growth in standard risk scenarios.

4.5 Analysis of the impact of the use of the CCyB on bank credit during the pandemic

The previous analysis of the effects resulting from changes in the CBR, primarily driven by changes in the CCyB sheds light on very positive outcomes on the distribution of credit at the aggregate level, and, in particular, in terms of the effect on credit-at-risk of a CCyB release in a scenario of macrofinancial crisis. Nonetheless, it is equally important to study the impact at the individual bank level arising from variations in regulatory capital requirements. For this purpose, CCyB increases and releases observed across European countries during different periods before and after the outbreak of the pandemic are used.

This complementary analysis is applied to a comprehensive sample of 170 banks spanning 25 European countries with quarterly data from the third quarter of 2013 to the fourth quarter of 2022. In particular, the effects on bank credit of the CCyB accumulation announcements observed in European countries prior to the COVID-19 pandemic are estimated, as well as the effects of the CCyB releases made in response to COVID-19 in virtually all countries with positive CCyB rates. Given the recent empirical evidence on the differential impact that the pandemic had on credit provision between banks with higher and lower capital headroom over requirements[44] (the banks' voluntary solvency buffer), this analysis differentiates banks by their capital position. This differentiation relies on the distance between the observed CET1 ratio and the required regulatory capital (minimum regulatory capital plus CBR) at the time of the release. The median of this distance distribution within the sample is used as the criterion for this differentiation.

44 See Berrospide et al. (2021) and Couaillier et al. (2024) for evidence of these differential effects in the United States and Europe, respectively.

The estimation of the effects of the CCyB accumulation decisions is made by means of a panel model with fixed effects. In particular, *local projections* (Jordá, 2005) are used to identify the impact of these decisions over 8 quarters. The estimated specification is as follows:

$$\ln\left(\frac{Cred_{i,t+h}}{Cred_{i,t-1}}\right) = \beta^h CCA_{Acum_{c,t}} + \sum_{k+1}^{4} \theta_k^h \ln\left(\frac{Cred_{i,t-k}}{Cred_{i,t-k-1}}\right) + \gamma^h X_{i,t-1} + \varphi_c^h + \delta_i^h + \varepsilon_{i,t+h} \quad (4.2)$$

$Cred_{i,t}$ represents the gross credit granted by institution i in period t+h, where h is 1 to 8 quarters after the announcement of the increase in the CCyB; $CCA_{Acum_{c,t}}$ represents the announcement of the accumulation of enhanced CCyB in country c in period t; X represents a vector of banking variables including institution size as measured by total assets, profitability as measured by ROA, bank capital and efficiency ratio as measured by cost-to-income ratio; φ represents country fixed effects and δ represents bank fixed effects. The impact is analysed over 8 quarters, so the coefficient of interest is β^h.

Chart 4.8 presents these coefficients for the two types of institutions. The results show that the impact of the accumulation of CCyB is only significant for the most constrained institutions in terms of capital headroom over requirements and only in the very short term. However, this effect becomes rapidly non-significant. On the other hand, the effect on banks with more capital headroom over requirements is not significant. These results suggest that the impact of the activation of the CCyB on bank credit was limited, affecting only those most capital-constrained banks at the moment of the announcement.

The identified effect can be related to the institutions' response to increases in the CCyB in terms of capital. Chart 4.9 presents the results from a similar estimation to the one previously discussed, but using the distance to capital requirements as dependent variable. The results suggest that banks with higher headroom over requirements tend to adjust to the new capital requirement by initially reducing their voluntary capital buffer upon announcement of these requirements. Subsequently, they rebuild their voluntary buffer by increasing capital (the numerator of the solvency ratio), rather than reducing credit (a key determinant of the denominator of the solvency ratio). Conversely, banks with low headroom over requirements opt to reduce credit initially, thereby maintaining their distance from the requirements unchanged. Subsequently, they swiftly increase their capital before the typical 1-year deadline granted for CCyB compliance, allowing them to restore credit supply levels to those existing prior to the announcement.

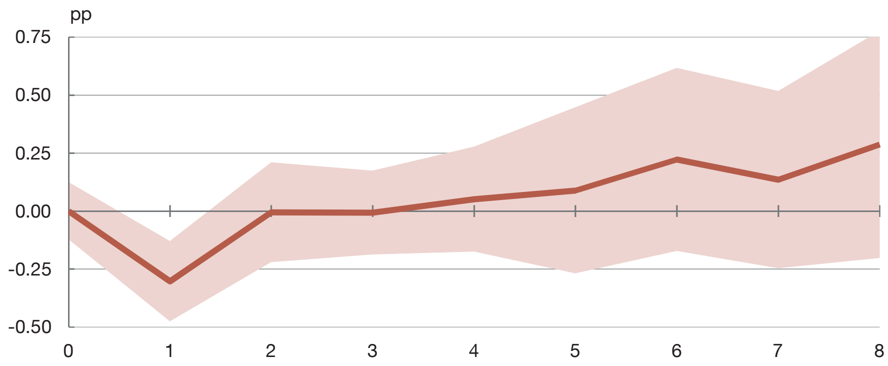
Furthermore, the CCyB releases observed in response to the pandemic, provide insights into its impact when adverse events with important economic consequences materialize. For this purpose, the following specification is estimated:

$$\ln\left(\frac{Cred_{i,t+h}}{Cred_{i,t-1}}\right) = \beta^h CCA_{Liber_{c,t}} + \sum_{k=1}^{4} \theta_k^h \ln\left(\frac{Cred_{i,t-k}}{Cred_{i,t-k-1}}\right) + \gamma^h X_{i,t-1} + Fiscal_{c,2020} + Dividendos_{c,2020} + \varphi_c^h + \delta_i^h + \varepsilon_{i,t+h} \quad (4.3)$$

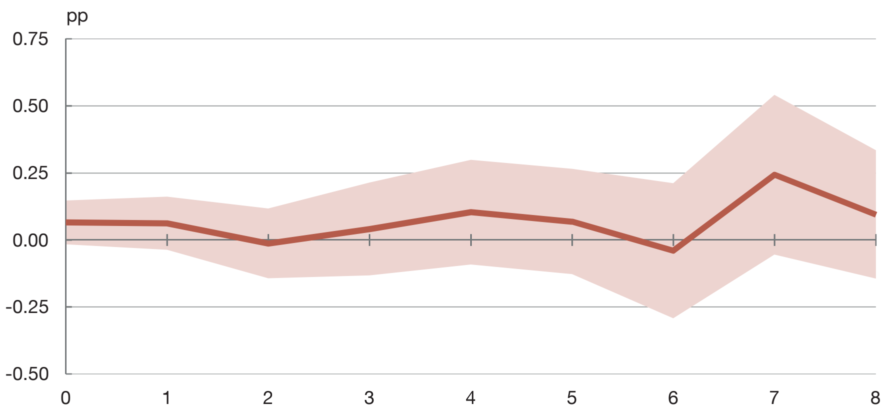
Chart 4.8

Impact on bank credit growth of a 1 pp increase in the CCyB by banks with low and high capital headroom over requirements (a)

4.8.a Low headroom



4.8.b High headroom



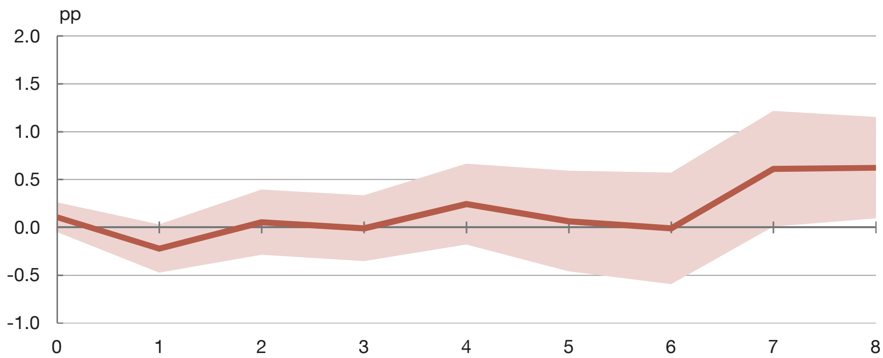
SOURCE: Bedayo y Galán (2024).

a The lines represent the impact in percentage points (pp) of CCyB increase announcements on credit growth over an 8 quarters horizon. The effects for banks with low and high distance from the total CET1 ratio to the sum of capital requirements and the CBR are displayed, using the median of that distance in the sample as a reference. The shadowed areas represent 95% confidence bands of the estimates.

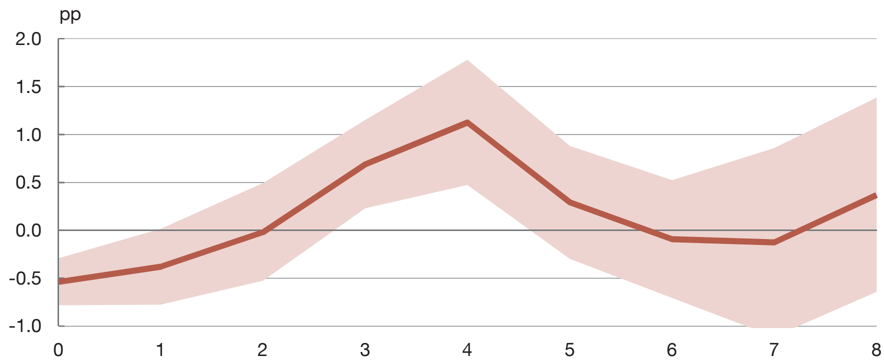
where the above definitions are maintained, with the exception that the CCyB variable ($CCA_{Liber_{c,t}}$) now represents the announcement of the release of CCyB made in country c in period t. This specification includes two additional variables designed to capture the effect of crucial measures adopted in response to the pandemic. These are fiscal support measures and restrictions on the payment of dividends by financial institutions. These measures potentially impacted credit during the same period as the CCyB release, and their exclusion could introduce biases in the estimation of the coefficient of interest (β^h). Regarding fiscal support measures, the variable $Fiscal_{c,2020}$ represents the magnitude of the fiscal aid implemented in each country as a response to the pandemic during 2020. The variable includes guarantee schemes and secured credit programs, capital injections, asset purchases and debt assumptions, expressed as a proportion of GDP, according to

Chart 4.9
Impact on capital headroom of a 1 pp increase in the CCyB by banks with low and high capital headroom over requirements (a)

4.9.a Low headroom



4.9.b High headroom



SOURCE: Bedayo and Galán (2024).

a The lines represent the impact in percentage points (pp) of CCyB increase announcements on the capital headroom over requirements, over an 8 quarters horizon. The effects for banks with low and high distance from the total CET1 ratio to the sum of capital requirements and the CBR are displayed, using the median of that distance in the sample as a reference. The shadowed areas represent 95% confidence bands of the estimates.

information from the International Monetary Fund. This variable is of particular importance since the size of this aid reached up to 35% of GDP and recent studies have found significant effects on credit.[45] Accounting for this fiscal support is essential to disentangle its impact from that of the CCyB release. Moreover, following the outbreak of the pandemic, the ECB issued a recommendation restricting dividend payments and share buybacks by financial institutions (Recommendation ECB/2020/19 of 27 March 2020). This measure prompted financial institutions to limit profit distributions, allowing them to strengthen their loss-absorbing capacity. Some recent empirical evidence suggests that this restriction supported credit provision to the economy.[46] This measure is captured with the variable

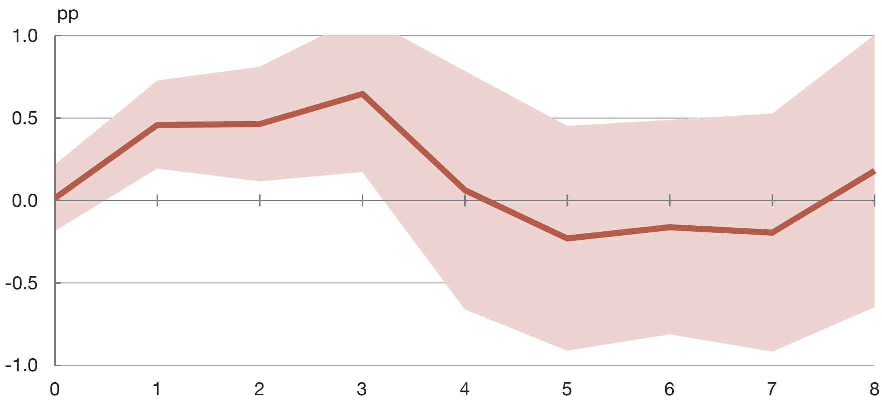
45 Jiménez et al. (2023) find that tax aid programs in Spain had a positive impact on bank credit during the pandemic.

46 Martínez-Miera and Vegas (2021) find a positive impact on the supply of credit in Spain by the entities affected by the recommendation not to distribute dividends.

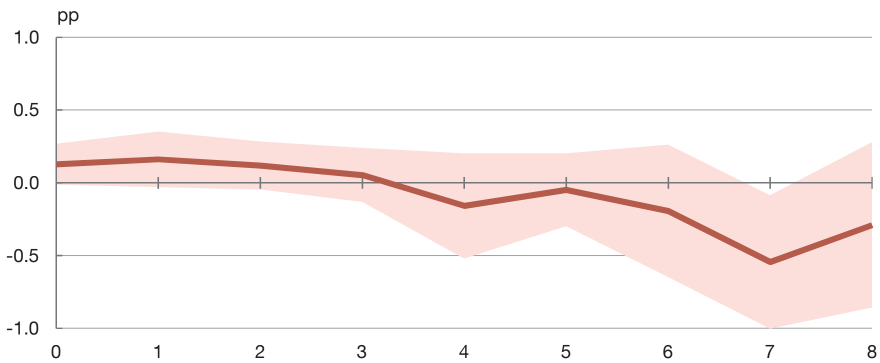
Chart 4.10

Impact on bank credit growth of a 1 pp release of the CCyB by banks with low and high capital headroom over requirements (a)

4.10.a Low headroom



4.10.b High headroom



SOURCE: Bedayo and Galán (2024).

a The lines represent the impact in percentage points (pp) of CCyB release announcements on credit growth over an 8 quarters horizon. The effects for banks with low and high distance from the total CET1 ratio to the sum of capital requirements and the CBR are displayed, using the median of that distance in the sample as a reference. The shadowed areas represent 95% confidence bands of the estimates.

$Dividendos_{i,2020}$, which identifies institutions subject to dividend payment restrictions due to the ECB's recommendation. It's important to note that not all banks were affected by the measure, as some had already announced dividend payments before the recommendation was published, and were legally bound to fulfill those commitments.

Chart 4.10 presents the estimated impact of the CCyB release in response to the pandemic on credit growth rates over the subsequent 8 quarters. As in the previous year, the analysis has been segmented by entities according to their level of capital in excess of regulatory requirements. The results show that the release of CCyB in those countries where this buffer was in place positively affected credit, and that this was mainly relevant for the most capital–constrained banks. In particular, for these banks, the impact translated to credit growth of up to 0.6 pp compared to pre-pandemic levels, extending for around

3 quarters after the CCyB release. Remarkably, this positive effect is more than twice the reduction observed during its previous accumulation.

These findings underscore the benefits of the CCyB, mainly when released in response to adverse events. Moreover, they suggest that the banks that most benefited from these measures are precisely those facing greater challenges in meeting regulatory requirements when such events materialize.

5 An econometric analysis for the Spanish economy of the impact on GDP growth of changes in bank capital requirements

5.1 Summary

This section presents the methodology and results of an econometric analysis of the effects of changes in bank capital requirements on economic growth in Spain. The results of this study are applied to assess an increase of 1 percentage point (pp) of the CCyB and the possible benefits of releasing it in the adverse phases of the macro-financial cycle, and thus promote the stability of the business cycle (see, for example, Ampudia et al., 2021).

It is impossible to directly assess the effect of a CCyB activation in Spain because there are no data from previous macroprudential policy actions of this type. On the other hand, an assessment that used the increase in the capital ratios of the banking system as an approximation to an activation of this buffer would also not be informative for the purpose of assessing the impact of macroprudential policy decisions. These capital increases could be the result of private decisions by banks to deal, for example, with an expansion of their activity that was anticipated with a higher voluntary buffer on requirements and not necessarily the result of an increase in perceived risks. Similarly, declines in capital ratios would not be analogous to deactivations, as the former could involve, for example, reductions in voluntary buffers for reasons other than the materialisation of risks.

Thus, the approach used infers an objective or equilibrium level of bank solvency based on its temporal dynamics, the requirements of micro and macro-prudential authorities and different macro-financial and banking variables. The analysis is carried out in aggregate terms for all Spanish banks and is based on multivariate time series analysis techniques with Bayesian methods. The available regulatory and financial information makes it possible to establish a broad period of analysis, covering the years 1995-2023, with quarterly data.

The results obtained show that the capital holdings and requirements of banks are associated with the evolution of the macrofinancial cycle in Spain. In addition, it is estimated that the activation of capital requirements in periods of expansion has associated costs (in terms of GDP growth) of a magnitude significantly lower than that of the benefits of releasing these same requirements in recessionary phases or, more generally, adverse cyclical phases. A financial position of the banking sector consistent with a standard level of cyclical systemic risks is also associated with a lower cost (in the form of a slowdown on GDP growth) of increasing capital requirements.

5.2 Information on Requirements and Supervisory Capital Guidance

Required capital is defined as the minimum capital that banks must compulsorily hold by regulatory requirement, measured as a ratio of risk-weighted assets (RWAs).

Capital requirements have varied over time, both due to the evolution of the rules that regulate pre-existing requirements, as well as the incorporation of new regulatory measures to deal with specific risks of institutions or those of a systemic nature. The definition of elements eligible as capital has also evolved over the years due to the emergence of new instruments computable as some form of regulatory capital.

To calculate a time series of bank capital requirements for Spain, a key piece of the analysis, and to make it as comparable as possible over time in the face of the different regulatory schemes that have been in place since 1995, we chose to consider those requirements that could be considered similar to the current Tier 1 capital.[47] The elements integrated into this metric under the different regulatory frameworks in the period of analysis are briefly described below:

— For the period 1995-2008, under the Basel I regulatory framework,[48] the minimum regulatory capital requirement for credit institutions was set at 8% of their RWAs. Of this, at least 50 % (i.e. 4 % of RWAs) had to be met with basic capital resources,[49] comparable to the current Tier 1 capital. However, given that in practice the availability of instruments other than those eligible as basic capital was very low, we considered that the capital requirement of the highest quality was, for practical purposes, higher than that 4%. In this sense, we estimate the basic capital requirement in a given quarter as the maximum between the 4% requirement and the difference between the total capital requirement (8%) and the average in the previous 8 quarters of the percentage of non-basic (Tier 2) capital holdings[50] over RWAs.

— At the end of 2008, the Basel II regulatory framework's entry into force originally[51] maintained the regulatory capital requirement at 8% of RWAs, and at 4% in terms of basic capital, so for this period we maintain the definition of the capital requirement detailed in the previous point.

— After the outbreak of the global financial crisis, and with the aim of strengthening solvency and confidence in the Spanish banking sector, the Spanish government

47 In any event, it should be noted that an increase in the Common Equity Tier 1 capital (CET 1) requirement as a result, for example, of an increase in the combined buffer following the activation of the CCyB, would also result in an increase of the same amount in the Tier 1 capital requirement.

48 The agreements on capital requirements for banks approved by the Basel Committee in 1988 (Basel I) were transposed into European law by Council Directive 89/299/EEC of 17 April 1989 on the own funds of credit institutions, and Council Directive 89/647/EEC of 18 December 1989 on a solvency ratio of credit institutions; and incorporated into Spanish legislation by Law 13/1992 of 1 June 1992 on own funds and supervision on a consolidated basis of financial institutions and Banco de España's Circular 5/1993 of 26 March 1993 to credit institutions on the determining and monitoring of minimum capital,.

49 Basic capital generally included share capital, effective reserves, general risk funds, minority interests and preferred shares with some limitations.

50 Non-basic capital instruments included non-voting shares, regularisation reserves, generic provisions (since 2005) and subordinated debt limited to 50% of total basic capital.

51 The agreements adopted by the Basel Committee in June 2004 with the aim of improving banks' credit risk management (Basel II) were transposed into European law by Directive 2006/48/EC of the European Parliament and of the Council of 14 June 2006 relating to the taking up and pursuit of the business of credit institutions; and transposed into Spanish law by Law 36/2007 of 16 November 2007 on investment ratios, own funds and reporting obligations of financial intermediaries and other rules of the financial system, by Royal Decree 216/2008 of 15 February 2008 on the own funds of financial institutions and Banco de España's Circular 3/2008 of 22 May 2008 to credit institutions on the determining and monitoring of minimum own funds.

increased the capital requirements on institutions, anticipating the new international standards under development, which would lead to Basel III.[52] Thus, the Tier 1-like capital requirement was set at 8 % (10 % for those institutions with less capacity to get wholesale market funding) since March 2011,[53] and increased to 9 % in 2013.[54]

— The entry into force in Spain of the Basel III regulatory framework in March 2014[55] resulted in new capital requirements beyond the Pillar 1 provisions[56] in force so far, in the form of Pillar 2 elements[57] (which, in fact, were already foreseen in the regulations since 2008, although they were not implemented before this date) and combined buffer requirements.[58] Within the Pillar 2 elements, established annually since March 2017, we consider both the Tier 1 capital requirements (P2R) and capital recommendations (P2G) applicable in each financial year as a result of the supervisory evaluation process. In the case of the buffers, given that a progressive but foreseeable entry into force was implemented, we consider these requirements in *fully-loaded* terms, that is, as the maximum value they would reach from the moment they were announced, without considering the reductions during transition periods (phase-in).

5.3 Data and methodology

Chart 5.1 shows the evolution of the capital requirement and the Tier 1 capital ratio in the analysed period. As shown in the graph, the global financial crisis set a turning point in the evolution of both variables, which went from a downward trend in the period 1993-2007 – resulting from a declining use of top-quality capital instruments in favour of Tier 2 funding sources[59] – to an increasing evolution after the outbreak of the crisis with the recapitalisation of the Spanish banking sector and the regulatory reforms brought about by Basel III. A first analysis reveals that in most quarters of the sample period there is a significant difference

52 In response to the global financial crisis, the Basel Committee on Banking Supervision adopted in December 2010 new measures aimed at strengthening the regulation, supervision and risk management of banks (Basel III) to be adopted by national jurisdictions within given deadlines.

53 In accordance with the provisions of Royal Decree-Law 2/2011 of 18 February on the strengthening of the financial system.

54 As established by Law 9/2012 of 14 November on the restructuring and resolution of credit institutions.

55 The Basel III agreements were transposed into European law by Directive 2013/36/EU of the European Parliament and of the Council of 26 June 2013 on access to the activity of credit institutions and the prudential supervision of credit institutions and investment firms and by Regulation (EU) No 575/2013 of the European Parliament and of the Council of 26 June 2013 on prudential requirements for credit institutions and investment firms, as subsequently amended by Directive (EU) 2019/878 and Regulation (EU) 2019/876. In turn, these rules were transposed into Spanish law through Law 10/2014 of 26 June 2014 on the regulation, supervision and solvency of credit institutions, Royal Decree 84/2015 implementing this Law, and Banco de España's Circulars 2/2014 and 2/2016.

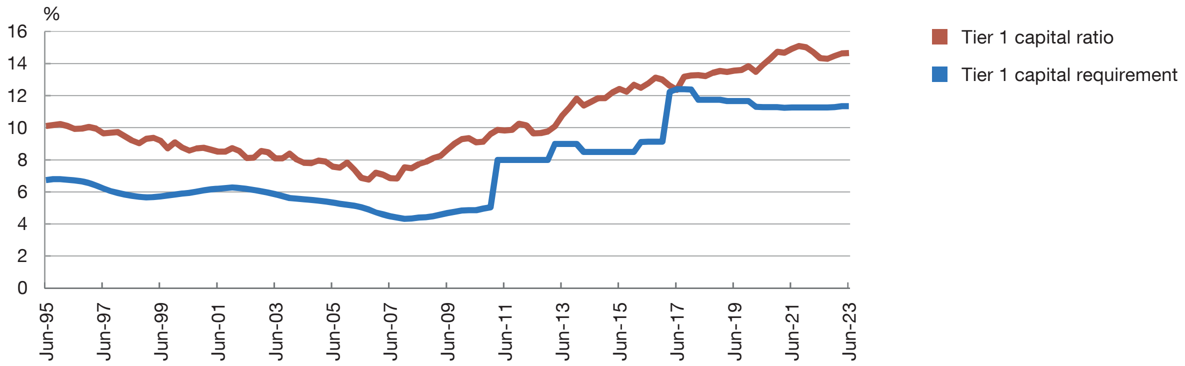
56 The Pillar 1 requirements refer to the minimum capital requirements established by the regulations for all banks.

57 Pillar 2 requirements are bank-specific capital requirements that complement Pillar 1 requirements in cases where the supervisory review and evaluation process (SREP) considers that they undervalue or do not adequately cover certain risks. More information is available on the ECB's website.

58 The combined buffer requirements include the capital conservation buffer, the countercyclical capital buffer, the systemic risk buffers and the capital surcharges to systemically important institutions. See Banco de España's information on the Financial Stability and Macroprudential Policy Framework.

59 Note that, as explained in Section 5.2, although the Tier 1 capital requirement remained at 4%, the availability of non-basic capital instruments was very low in the first years of the sample, so the Tier 1 capital requirement is calculated by deducting from the overall capital requirement (8%) the share of Tier 2 (non-basic) capital over RWAs.

Chart 5.1
Tier 1 capital ratio and capital requirements



SOURCE: Banco de España.

between the capital requirement and the Tier 1 capital ratio actually observed. This difference has an average value of 2.81 pp (a position of excess over requirements) with a minimum of 0 pp and a maximum of 4.6 pp. Minimum values are always reached when there is an increase in capital requirements. Maximum values are reached in anticipation of increases in the requirements.

The recurrent excess of the Tier 1 capital ratio over requirements indicates that banks not only hold capital to meet these obligations, but also maintain a voluntary buffer to minimize the risk of failing to comply with the requirements. Plausibly, the level of capital that banks choose to hold (and therefore the voluntary buffer over requirements) is related to different macro-financial variables, in particular those related to future developments in the macro-financial cycle. These determine a target (or equilibrium) level of capital for banks in each time period (quarter) "t", which we call k_t^*. The difference between the actual level of capital observed in a given period of time, which we call k_t, and the level of capital k_t^* can inform about the future evolution of capital and the management decisions of banks. This difference, which we denote as B_t is calculated as follows:

$$B_t = (k_t - k_t^*)$$

The target level of capital is modelled according to the standard variables in the literature – see for example Mesonnier and Stevanovic (2017) or Berrospide and Edge (2010) – that are available for the period under analysis. In particular,

$$k_t^* = c + \beta M_t \qquad (5.1)$$

In M_t we include:

($M_{1,t}$) Tier 1 capital requirement, calculated as explained in Section 5.2.

($M_{2,t}$) Year-on-year change in the housing price index (HPI) published by the National Statistics Institute (INE).

($M_{3,t}$) Year-on-year change in the volume of banks' non-performing loans to the resident private sector (households, non-financial corporations and other financial corporations) in business in Spain, according to the information reported by banks to Banco de España.

($M_{4,t}$) Ratio of banks' non-performing loans to the resident private sector (households, non-financial corporations and other financial corporations) in business in Spain, according to the information reported to Banco de España.

($M_{5,t}$) Expected GDP growth rate according to *Consensus Economics*.

In this paper, also following the existing academic literature – Mesonnier and Stevanovic (2017), for example – we assume that banks cannot immediately adjust their level of capital:

$$k_t - k_{t-1} = \lambda (k^*_{t-1} - k_{t-1}) + e_t \quad (5.2)$$

where λ is a parameter between 0 and 1, so that the change in the capital ratio in period t ($k_t - k_{t-1}$) on the left side of the equation is explained by a fraction λ of the difference between the observed and the targeted capital in the previous period 't–1', and also by additional factors e_t, other than the existence of that difference.

Substituting (5.1) in (5.2) and rearranging terms we get the following equation:

$$k_t = (1 - \lambda)\, k_{t-1} + \lambda c + \lambda\beta M_t + e_t$$

Thus, a regression of k_t with the explanatory variables (k_{t-1}, M_t) provides coefficients from which the parameters (λ,β) can be calculated. In particular, the estimated regression can be written as:

$$k_t = \alpha_0 + \alpha_1 k_{t-1} + \delta M_t + e_t \quad (5.3)$$

where $\alpha_0 = \lambda c$, $\alpha_1 = (1 - \lambda)$ and $\delta = \lambda\beta$.

We estimate the model in (5.3) using Bayesian methods. These methods start from an *a priori* information about the parameters, for example, guided by economic theory or by well-established empirical evidence, and *a posteriori* estimate is the result of updating these parameters according to the sample information.

5.4 Results on the target or equilibrium capital ratio

The results for the parameters of interest in equation (5.1) show a negative correlation of the target capital ratio k^*_t with the macro-financial cycle, growing when expectations of GDP

Table 5.1

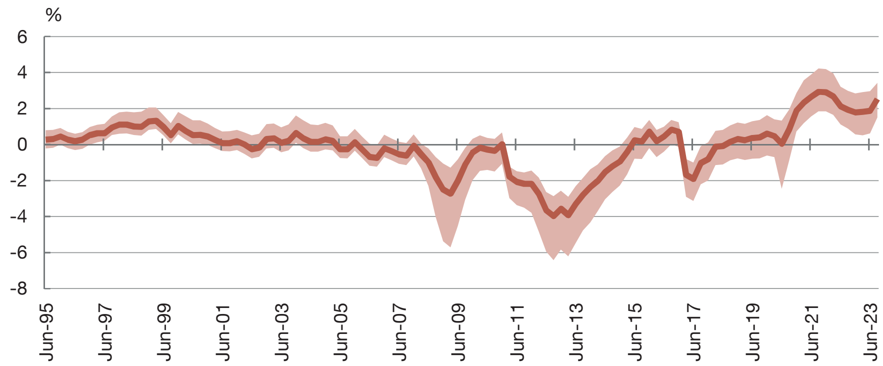
Estimation of parameters

	Coefficients		
	First decile	Median	Ninth decile
Constant	3.51	4.90	6.35
Year-on-year change in house prices	-0.09	-0.03	-0.01
Year-on-year change in non-performing credit	0.00	0.01	0.01
Non-performing loans ratio	0.08	0.20	0.37
Expected rate of GDP growth	-0.47	-0.15	-0.03
Tier 1 capital requirement	0.46	0.68	0.91
Lambda	0.05	0.10	0.15

SOURCE: Banco de España.

Chart 5.2

Evolution of the difference between the Tier 1 ratio and its target level (a)



SOURCE: Banco de España.

a The shaded area represents the 10%-90% confidence interval.

growth deteriorate, when house prices decrease and when the credit quality of banks' loans to the private sector deteriorates. In addition, it is observed that increases in capital requirements are transmitted to a high degree to the target capital ratio, with a coefficient close to 70% in the equilibrium. The observed capital ratio adjusts slowly to banks' capital target, as the estimated value of λ is low (see Table 5.1).

With the estimated parameters, substituting them into (5.1), an estimate of the target capital k_t^* is obtained. In fact, since it is estimated by Bayesian methods, the complete distribution of plausible values of k_t^* is generated. From the observed capital k_t, the full distribution of differences $k_t - k_t^*$ at different dates can also be obtained (see Chart 5.2). As shown in the chart, the difference between banks' level of capital and their target value has fluctuated over time, remaining relatively stable around equilibrium in the first twelve years of the sample.

With the outbreak of the global financial crisis, banks' capital levels fell significantly below their target value, which increased due to the worsening of the macroeconomic situation. This fall was noticeable in the 2011 – 2014 period, due both to the deteriorating situation of the banking system and, above all, to the increase in capital requirements in those years, which raised banks' target capital. The progressive improvement of the solvency of the Spanish banking system contributed to closing this negative gap from 2013. In the most recent period, given the growth of GDP, house prices and the good evolution of credit quality, a surplus of approximately 2 pp of the Tier 1 ratio over the target is estimated, which could provide incentives for stronger credit expansion.

5.5 Results on the relationship between bank solvency, requirements and GDP growth

As we have pointed out above, the difference between the Tier 1 capital ratio actually observed and its target level ($k_t - k_t^*$) can be decisive to know the willingness of banks to provide credit and, therefore, can have a significant impact on the growth rate of economic activity.

In this respect, the relationship between capital requirements and activity will be influenced by increases in capital requirements, as they would reduce the difference $k_t - k_t^*$. According to the estimates, this is due to the fact that they have an immediate and significant effect (see Table 5.1) on target capital k_t^* and a very sluggish effect on the Tier 1 ratio actually observed (since the estimated value of λ is small, the transmission of an increase in requirements to the observed capital ratio takes approximately 10 quarters).

On the growth rate of activity, the effect of changes in capital requirements in the form of releasable macroprudential buffers should be asymmetric at activation and deactivation times, so that the cost-benefit balance is favourable to the measure. Thus, for a measure of this type to have a positive net effect, increases in capital requirements (associated with a decrease in the difference $k_t - k_t^*$), which, if well designed, must occur in times of economic strength, should have a smaller effect on curbing GDP growth than the support to economic growth originating from a release of requirements (with associated increase in the difference $k_t - k_t^*$) in adverse phases of the business cycle.

To examine this question, we first estimate the following auxiliary model with Bayesian methods:

$$Crec\_PIB_t = C + \theta_1 Crec\_PIB_{t-1} + \theta_{21} B_{t-1} I(Crec\_PIB_{t-1} < 0) + \theta_{22} B_{t-1} I(Crec\_PIB_{t-1} > 0) + \varepsilon_t \quad (5.4)$$

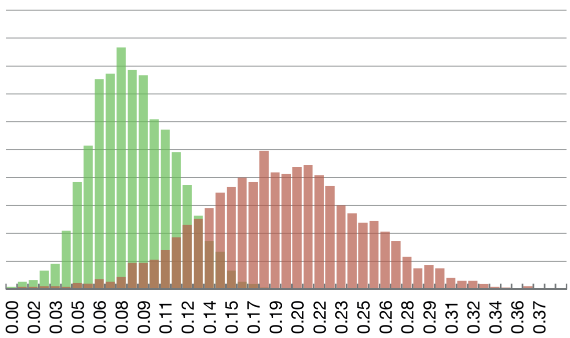
where $Crec\_PIB_t$ is the GDP growth rate in period t.

The variable $I(Crec\_PIB_{t-1} < 0)$ is an indicator function that takes the value 1 if the condition that the economy is in recession at t-1 (GDP growth rate less than 0) is true and 0 otherwise.

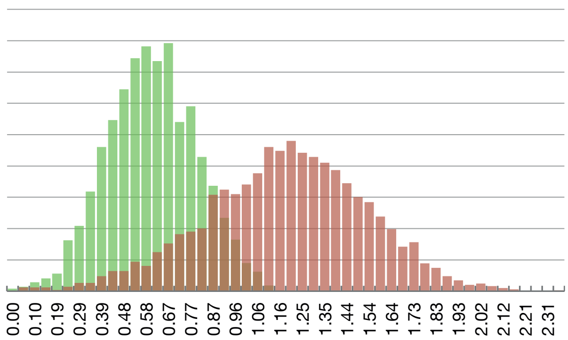
Chart 5.3

Coefficients of the relationship between capital buffers and economic activity at different time horizons (a)

5.3.a One-quarter-ahead horizon



5.3.b Four-quarter-ahead horizon



SOURCE: Banco de España.

a The green (red) histogram refers to periods of economic expansion (recession).

The variable $I(Crec\_PIB_{t-1} > 0)$ is an indicator function that takes the value 1 if the condition that the economy is in expansionary phase at t-1 (GDP growth rate greater than 0) is true and 0 otherwise.

We also consider the effects four periods ahead:

$$Crec\_PIB_{t+3} = C + \theta_1 Crec\_PIB_{t-1} + \theta_{21} B_{t-1} I(Crec\_PIB_{t-1} < 0) + \theta_{22} B_{t-1} I(Crec\_PIB_{t-1} > 0) + \varepsilon_t \quad (5.5)$$

where $Crec\_PIB_{t+3}$ is the annual growth rate of GDP in the period t+3 (between t+3 and t-1, with t-1 being the last available observed data).

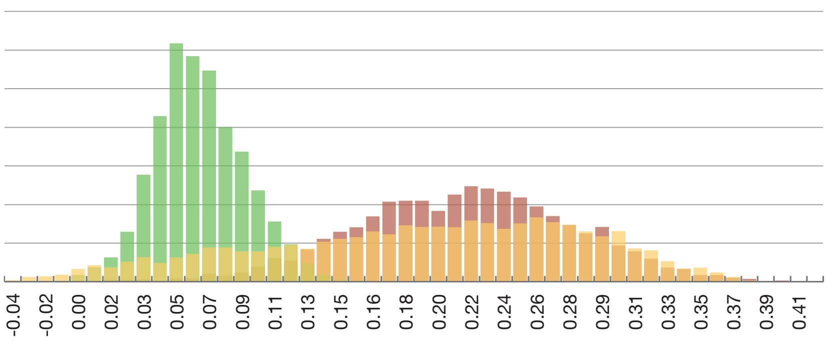
Estimates of θ_{21} and θ_{22} i.e. the sensitivity of GDP growth to increases in the difference between observed and target capital, are presented in Chart 5.3.

As can be seen, the sensitivity of GDP growth to changes in the distance of the Tier 1 ratio from its target ($k_t - k_t^*$) is significantly higher in recessions than in expansions. Thus, the effect of a 1 pp increase in the difference $k_t - k_t^*$ (e.g. by release of requirements) would imply a median impact of 0.08 pp on economic growth in the next quarter in expansionary periods, while that impact in recessionary periods would reach 0.19 pp, more than doubling the effect during expansions. Activating capital requirements in expansionary periods for release in recessionary periods can thus increase average GDP growth over the macro-financial cycle and reduce its volatility.

An additional exercise shows that not only the macroeconomic situation has an impact on the relationship between economic activity and the distance of the Tier 1 ratio

Chart 5.4

Coefficients of the relationship between capital buffers, economic activity and the state of the banking system (a)



SOURCE: Banco de España.

a The green histogram corresponds to periods of GDP expansion with a banking system under normal conditions (the banking indicator below the 80th percentile). The yellow histogram corresponds to periods of GDP expansion with a banking system in a clearly expansionary situation (the banking indicator above the 80th percentile). The red histogram refers to periods of recession.

to its target or equilibrium level. The conditions of the banking system are also decisive for calculating the effect of increasing/decreasing capital requirements in a given period.

To analyse this joint conditioning effect of the growth of real activity and the financial situation of the banking sector, we estimate, again using Bayesian techniques, the following model:

$$Crec\_PIB_t = C + \theta_1 Crec\_PIB_{t-1} + \theta_{21} B_{t-1} I(Crec\_PIB_{t-1} < 0) + \theta_{22} B_{t-1} I(Crec\_PIB_{t-1} > 0)\, I(Bank_{t-1} > 1{,}7) + \theta_{23} B_{t-1} I(Crec\_PIB_{t-1} > 0)\, I(Bank_{t-1} < 1{,}7) + \varepsilon_t \quad (5.6)$$

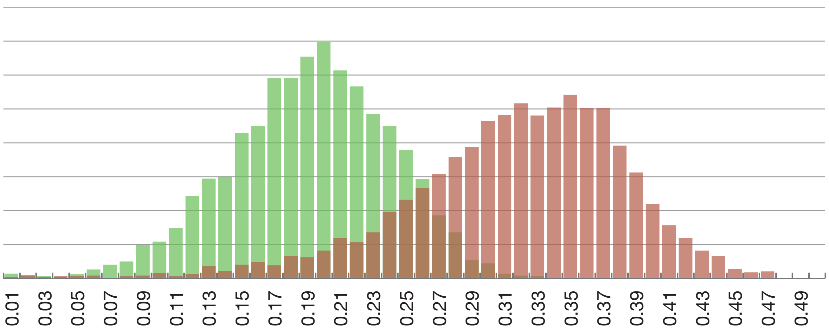
where Bank is the indicator of the financial position of the banking sector presented in Section 2 of the present document (see, for example the fourth panel of Chart 2.1).

The combination of these indicators allows the sample to be divided into three periods. The first type of period is a recession of economic activity (red distribution in Chart 5.4); the second type of period is a GDP expansion with a banking system under normal conditions (the banking indicator below the 80th percentile) (green distribution); and the third type of period corresponds to a GDP expansion with a banking system in a clearly expansionary situation (the banking indicator above the 80th percentile) (yellow distribution).

As shown in Chart 5.4, the sensitivity of GDP growth to changes in the difference between the Tier 1 capital ratio and its target ($k_t - k_t^*$) is lower under normal conditions of GDP growth and financial situation of the banking sector, both of which are consistent with a standard level of cyclical systemic risks, neither particularly high nor low. Conversely, this sensitivity is higher in recessions, which are typically associated with adverse cyclical phases, which would suggest easing capital requirements. This sensitivity is also relatively

Chart 5.5

Coefficients of the relationship between capital buffers and economic activity according to the aggregate index of the economy (a)



SOURCE: Banco de España.

a The green (red) histogram refers to periods of macroeconomic and financial (in)stability according to the aggregate index of the economy.

high, albeit with a wider confidence interval, in times of GDP and banking sector expansion, which may be associated with a higher level of cyclical systemic risks and the accumulation of financial vulnerabilities. In this case, the activation of capital requirements would also restrain this accumulation of vulnerabilities and reduce a GDP growth rate which is associated with an increase in macro-financial imbalances.

Finally, the sensitivity to situations of different positions of the set of indicators of the macro-financial cycle is also examined. In this exercise we use as a variable the aggregate indicator of Section 2 of the present document.

The estimated regression is

$$Crec\_PIB_t = C + \theta_1 Crec\_PIB_{t-1} + \theta_{21} B_{t-1} I(Ind < 0{,}33) + \theta_{22} B_{t-1} I(Ind > 0{,}33) + \varepsilon_t \quad (5.7)$$

where Ind is a variable ranging from 0 to 1 as a function of the distance (in absolute value) to its average of the aggregate indicator of cyclical systemic risks (see, for example Chart 2.2). The purpose of including this variable is to verify whether the economy is very sensitive to changes in capital requirements (and therefore in the buffers) in times of high exuberance and macrofinancial crises, compared to normal times. By measuring the distance to the mean in absolute value, the observation of $Ind > 0.33$ can indicate both exuberance and macro-financial crisis. The results in Chart 5.5 show that indeed the sensitivity is different at different positions of the cycle. The distribution of parameters linking buffers and activity in periods of macroeconomic and financial stability is presented in green. The red distribution corresponds to moments when the macrofinancial cycle is in more extreme positions, with a much greater range of sensitivities.

It should be noted that the higher sensitivity coefficient in more extreme positions of the macrofinancial cycle has two lessons. If the cyclical position is one of exuberance, because of a credit bubble that fuels growth, an increase in capital requirements has the power to curb that bubble. At times of cyclical systemic risks materializing, at the other end of the distribution, with low growth and poor financial situation of various economic agents, a decrease in capital requirements has the power to boost economic activity and growth.

6 Analysis of the use of the CCyB with a dynamic general equilibrium model

6.1 Summary

This section analyses the effect of the introduction of a positive level of the Countercyclical Capital Buffer (CCyB) on the banking sector, in a situation where the cyclical systemic risks of the Spanish economy are at standard levels,[60] and of its subsequent release during economic downturns. To do this, a dynamic stochastic general equilibrium (DSGE) macroeconomic model is calibrated to the Spanish economy. In the model, banks endogenously decide their exposure to a source of cyclical systemic risk, which can be interpreted as a choice over the amount of loans provided to more volatile economic sectors and involving higher risks to growth.

This decision on cyclical systemic risk-taking is affected at every moment of time by, among other factors, the capital requirements to which banks are subject and the prevailing phase of the macro-financial cycle. The calibrated model in this section is able to reproduce the empirical magnitudes observed for a number of macroeconomic and financial variables in the Spanish economy during the last decades, especially those related to the impact of the global financial crisis.

Different studies on bank risk management underline the relevance of moral hazard, that is, the possibility that a bank is exposed to high risks because it does not fully bear the cost of its risk-taking decisions, generating inefficiencies to the economy as a whole. Risk-taking decisions are strongly influenced by high bank leverage and, therefore, capital regulation, which imposes limits on leverage and thus reduces incentives for risk-taking.

Following this line of reasoning, bank incentives to take cyclical systemic risks play a crucial role in determining the severity of crises during adverse phases of the macro-financial cycle.[61] Therefore, the regulation of bank capital should be designed taking into account its effects on cyclical systemic risk-taking by banks and its effects on the frequency and magnitude of cyclical crisis episodes.

This section presents a theoretical model of the costs and benefits of implementing a positive level of the CCyB when cyclical systemic risks are at standard levels. This model incorporates the aforementioned element of moral hazard in the decisions of banks to take systemic risk. It allows to study the dynamic reaction of the economy to changes in bank capital requirements and to different shocks. Furthermore, within the assumptions of the model, it allows for the evaluation of different bank capital requirement policies, in terms of social welfare, and their effect on the level and volatility of economic activity and consumption.

60 Such use of the CCyB would also be compatible with the definition of a neutral positive level of the CCyB, i.e. its activation when cyclical systemic risks are neither particularly low nor high. See e.g. Banco de España (2024) Information note on the revision of the setting framework of the CCyB and BCBS (2022) Newsletter on positive cycle-neutral countercyclical capital buffer rates.

61 This perspective finds support in the empirical evidence presented by, among others, Jordà et al. (2021).

The results of the calibrated model show that the activation of the CCyB at standard levels of cyclical systemic risks effectively reduces the negative impact on the economy during adverse cyclical phases. In particular, it dampens the negative effect on the supply of credit and, as a consequence, allows a higher level of economic activity. All this results in a reduction in the volatility of Spain's business cycle. However, part of this lower volatility also stems from the presence of costs arising from its activation, in the form of lower banking activity in those situations with a standard levels of cyclical systemic risks in which the CCyB is activated.

The rest of the section presents the formal description of the model, its calibration to the Spanish economy and its implications for different economic metrics.

6.2 Model

This analysis is based on an extension of the DSGE model of Abad, Martínez-Miera and Suarez (2024) for the Spanish economy, which incorporates the possibility of introducing a positive CCyB level when cyclical systemic risks are at standard levels. In this section, we briefly describe the most relevant aspects of this theoretical model.

Consider an economy with an infinite horizon where time is indexed by t=0,1,2, ... and a single consumer good is available on each date, which serves as a numeraire, that is, unit of account to value other magnitudes. The household sector of the economy is composed of two types of actors: workers and bankers. These agents interact with each other through a continuum of banks, a representative company that produces consumer goods, a representative company that produces physical capital with direct financing by the household sector, and a continuum of companies that produce physical capital with bank financing.

Workers inelastically supply a unit of labour employed by the representative company producing consumer goods and thus obtain wage income for the household sector. As already mentioned, some companies producing physical capital are dependent on the banking sector and can only be financed by banks.[62] These in turn are financed by a combination of equity and insured deposits, both provided by the household sector. Bankers manage the investments of the household sector in the net worth of banks and this process is subject to different frictions that are detailed below. Finally, there is also a public sector that has an authority in charge of banking regulation and runs a deposit guarantee scheme (DGS) that fully insures bank deposits. The public sector is financed by a lump-sum tax paid by the household.

Firms with non-bank financing and bank dependent firms each produce a different class of physical capital, labelled as h and b respectively. These different types of physical

62 This can be motivated by the need in certain sectors for specialized monitoring for the viability of their investment projects, which can only be provided by the banking sector. See Rajan (1992) and Petersen and Rajan (1994).

capital are not perfect substitutes and can therefore eventually be employed by companies producing consumer goods with different rates of return in equilibrium.

The firm representing the non-banking sector may transform a_t^h units of household consumer goods in period t into $k_{t+1}^h = a_t^h$ units of physical capital of class h in period t+1. The use of this capital in t+1 produces a net rate of return r_{t+1}^h per unit and the recovery of $1 - \delta^h$ units of consumer goods, where δ^h is the depreciation rate. Thus, the gross return on this kind of capital is $R_{t+1}^h = 1 + r_{t+1}^h - \delta^h$.

A firm in group j whose financing is dependent on the banking sector may transform a_{jt}^b units of consumer goods received from banks in period t into $k_{jt+1}^b = \Delta_{t+1}(s_{jt})\, a_{jt}^b$ units of physical capital in class b in period t+1. Using this capital in t+1 produces a gross return $R_{t+1}^b = 1 + r_{t+1}^b - \delta^b$ per unit, where r_{t+1}^b and δ^b are the corresponding net return and depreciation rates. The term $\Delta_{t+1}(s_{jt})$ captures the possibility of investing in two different ways, $s_{jt} = \{0,1\}$, which differ in their exposure to an aggregate binary systemic event, $\xi_{t+1} = \{0,1\}$, which can materialize into t+1. Specifically,

$$\Delta_{t+1}(s_{jt}) = \begin{cases} 1 + \mu s_{jt}, & \xi = 0 \\ 1 - \lambda s_{jt}, & \xi = 1 \end{cases}$$

where $\mu = 0$ and $\lambda \in (0, 1]$. Thus, under the non-systemic mode ($s_{jt} = 0$), each investment unit produces a unit of class b capital independently of the realization of ξ_{t+1}. Under the systemic mode ($s_{jt} = 1$), there is a differential gain μ if a systemic event does not realize ($\xi_{t+1} = 0$) and a differential loss λ when a systemic event is realized ($\xi_{t+1} = 1$). The systemic event occurs with an identical and independent probability π per period and assumes that

$$E_t[\Delta_{t+1}(1)] = (1-\pi)(1 + \mu) + \pi(1 - \lambda) < 1,$$

such that the systemic investment mode produces a lower expected amount of physical capital per unit of investment than the non-systemic mode.[63]

The choice s_{jt} of by firm j in period t is only observable to the firm itself, its creditor banks and the bankers who invest capital in those banks. As shown below, standard distortions in incentives introduced by limited liability and the non-observability of s_{jt} for depositors and the regulator can make the systemic asset, while inefficient for the economy as a whole, attractive to banks.

The representative firm producing consumer goods combines physical capital dependent on non-bank financing k_t^h, physical capital dependent on bank financing k_t^b, and labour l_t to produce:

$$y_t = F(k_t^h, k_t^b, l_t),$$

63 This premise is consistent with those commonly found in the literature on excessive risk-taking by banks, including Keeley (1990), Hellman et al. (2000), and Repullo (2004).

units of the consumer good, where F(·) is a production function with constant returns at scale. The company maximises its profits $y_t - r_t^h k_t^h - r_t^b k_t^b - w_t l_t$ by taking rates of return r_t^h and r_t^b and wage costs w_t, which are determined in equilibrium at the aggregate level, as given.

6.2.1 Bankers

A mass of bankers indexed by $i \in [0,1]$ manages the household's investment in bank capital.[64] Let n_{it}^b be the wealth with which banker i begins period t. The banker can invest these funds in shares of any of the banks in the economy. As we will explain below, banks specialize in financing systemic or non-systemic firms. Bankers look at the risk profile of each bank and decide how much to invest in period t in the capital of non-systemic banks, with gross returns R_{0t+1}^e in t+1, and systemic banks, with gross returns R_{1t+1}^e, in period t+1. Bankers take the distribution of R_{0t+1}^e and R_{1t+1}^e as given. Of the gross returns earned in t+1, an exogenous fraction $(1 - \psi) \in (0,1)$ is paid as dividends to the representative household and the remainder is retained under the management of the banker.[65]

With these elements and letting x_{it} denote the fraction of funds n_{it}^b that banker i invests in banks specializing in systemic enterprises, the banker optimization problem can be recursively formulated as a dynamic programming problem. The banker must choose a rule to determine this fraction x_{it} each period, so that it maximizes the discounted expected value of his equity. This maximization is subject to the constraint that funds raised from the household sector are limited, and their dynamics are affected by banker decisions and various economic shocks. This problem is described in more detail in Abad, Martínez-Miera and Suarez (2024).

6.2.2 Banks

Banks are financial intermediaries that operate under constant returns to scale between two consecutive periods. They maximize the net present value of the net worth (capital) that bankers invest in them. They combine this capital with insured deposits taken from the household sector and finance investment in the companies producing physical capital that are dependent on them. Banks observe the mode of production of the financed enterprises and adopt one of two risk profiles s = {0,1} investing fully in non-systemic (with $s_{ij} = s = 0$) or systemic (with $s_{ij} = s = 1$) mode. In the following, to simplify the exposure, we will refer to a bank representative of each risk profile.

In period t, the bank s issues equity e_{st} and combines it with insured deposits d_{st} to invest

64 Bankers can be interpreted as managers of a 100 % capital-financed banking holding whose shares belong to the representative household and which uses its funds to invest in shares of individual banks.

65 This configuration is isomorphic to the standard in the literature, for example, Gertler and Kiyotaki (2011), in which, in each period, a random fraction of bankers exit or retire with the net worth they manage. As in this literature, $\psi < 1$ allows us to focus on situations where the scarcity of wealth managed by bankers makes capital a privately more expensive source of bank financing than deposits. Implicit payments by might be justified as reflecting some unmodeled agency frictions between bankers and the representative household whose investment in bank stocks they manage.

$$a^b_{st} = e_{st} + d_{st}$$

in firms with investment mode $s_{ij} = s$. It is important to note that e_{st}, d_{st} and a^b_{st} are publicly observable, but the risk profile s is not. The bank's deposits promise to pay a gross interest per unit R^d_{st}, which is insured by the DGS.

Banks are subject to a minimum prudential capital requirement of the form

$$e_{st} \geq \gamma_t a^b_{st},$$

which requires that at least a fraction γ_t of its assets must be financed from own resources.[66]

In t+1 the bank earns gross returns $R^b_{t+1}\Delta_{t+1}(s)a^b_{jt}$ on its assets and pays back to its security holders according to the seniority of their claims. The bank is unable to meet its obligations to its depositors when the return on its assets is below the due payment $R^d_{st}d_{st}$. In this case, the DGS recovers $R^b_{t+1}\Delta_{t+1}(s)a^b_{jt}$ and returns the amount owed to the depositors.

Finally, the return on equity, which is protected by limited liability, is defined as

$$R^e_{st+1}e_{st} = \max\{R^b_{t+1}\Delta_{t+1}(s)a^b_{jt} - R^d_{st}d_{st}, 0\}.$$

6.2.3 The capital requirement

The banking regulator sets the regulatory capital requirement for banks γ_t and administers the DGS. The public sector finances the net cost of the DGS in each period t through a tax T_t on households. The regulatory capital requirement is calculated according to the following formula:

$$\gamma_t = \bar{\gamma} + \min\{\bar{\kappa}, \kappa \max\{(\tau_t - \bar{\tau}), 0\}\}$$

where the first term is the fixed part $\bar{\gamma}$ of the capital requirement, while the second term is the countercyclical buffer. The parameter $\bar{\kappa}$ is the maximum size of the countercyclical buffer, κ indicates the size of the increments of that buffer in each period until it reaches its maximum level, $\bar{\tau}$ is the number of periods in which the buffer remains at zero after the realization of a systemic event, and $\tau \in \{0,1,2,...\}$ is a variable that takes discrete values and indicates the number of periods since the last realization of the systemic event, that is,

$$\tau_t = \begin{cases} \tau_{t+1} + 1, & \xi_t = 0, \\ 0, & \xi_t = 1. \end{cases}$$

6.3 Calibration

The model is calibrated with the aim of representing the behavior of the Spanish economy in recent decades. The calibration is performed in two steps and is adjusted to an annual

66 Consistent with the assumption that banks' risk profile s is not observable for depositors and the government, this requirement does not depend on s. If the capital requirement could be made contingent in s, setting a sufficiently high requirement for the bank with s = 1 could discourage it from operating without having to impose any requirement on the non-systemic bank.

frequency. For a first group of parameters, values commonly used in the literature or values equal to their empirical values (in cases where these are directly observable) are set. The values of the remaining parameters are established simultaneously so that the model is able to replicate key magnitudes of the stochastic steady state (SSS) of the economy and of the response to the realization of a systemic banking crisis.[67]

Table 6.1 reports all parameter values and their calibration sources or targets. Table 6.2 compares the values of the six objective moments in the data and in the model.

Preset parameters. Parameters related to representative household preferences, the aggregate production function, and the rate of depreciation of physical capital are set at standard values in the literature. The subjective discount rate is set at a standard value of 0.98, which translates into a risk-free rate of around 2%. The share in the production of aggregate physical capital is set at a standard value of 0.3 and the depreciation rates for both classes of physical capital are set at 10% per annum.

The probability of a systemic event is set at 5.8%, which is the frequency of financial crises after 1971 reported for Spain by Schularick and Taylor (2012). The value of the systemic risk-taking loss parameter is consistent with the combination of the 45% loss-given-default (LGD) parameter that the Basel II Core Approach (BCBS, 2004 paragraph 287) set for unsecured senior corporate loans and the discounted average resolution cost per unit of assets of 30% estimated by Bennet and Unnal (2015) using FDIC data for failed banks over the period 1986-2007.

The minimum capital requirement in the calibration is set at 8%, consistent with the general requirement under Basel II (BCBS, 2004; Part 2.I, paragraph 40) as well as its predecessor Basel I. For the assessment of our baseline scenario, the minimum capital requirement is set at 12%, consistent with the observed average level of the CET1 ratio for Spanish institutions over the period 2016-2019. With regard to the activation of the CCyB, it is assumed that the economy returns to a standard risk situation four years after a systemic event, and thereafter the required minimum buffer is recharged 25 bps each year to reach its positive neutral level of 1 pp again.[68]

Calibrated parameters. The second set of parameters is calibrated to simultaneously match the objectives listed in Table 6.2. Each parameter can be primarily associated with a target, as indicated in the last column of Table 6.1. Several parameters are set so that some variables in the SSS of the model match the sample averages for the pre-crisis period (1999 to 2008), while others are calibrated so that the model replicates

67 Since the only source of aggregate risk in the model economy is the binary cyclical systemic event, we define the SSS as the invariant equilibrium allocation achieved after a sufficient number of periods without the materialization of cyclical systemic risks.

68 This assumption should not be interpreted as guiding the Banco de España's future policy on the use of the CCyB, which will be informed by a holistic approach that combines theoretical, empirical and judgmental evidence. This assumption is specific to this theoretical analysis whose main objective for the revision of the framework of setting the CCyB is to identify the channels of effect and if possible the increase of social welfare through the reform of the framework. Further theoretical research is needed on the optimality of more or less gradual activations.

Table 6.1
Parameter values for the calibration to the Spanish economy (a)

Parameters		Value	Source / Target
Subjective discount factor	β	0.98	Standard
Output share of physical capital composite	α	0.3	Standard
Depreciation rate of physiscal capital	δ^h, δ^b	(0.1, 0.1)	Standard
Probability of systemic event	π	0.058	Schularick y Taylor (2012)
Risk-taking losses	λ	0.615	BCBS (2004), Bennet y Unal (2015)
Capital requirement	$\bar{\gamma}$	0.08	BCBS (2004)
Maximum level of the CCyB	$\bar{\kappa}$	(0.00, 0.01)	BCBS (2004, 2011)
CCyB time increase	κ	0.0025	BCBS (2011)
Activation period of the CCyB	$\bar{\tau}$	3	Crisis duration (Schularick y Taylor, 2012)
Risk-taking gains	μ	0.027	Crisis fall in GDP
Reteined wealth under management	ψ	0.9025	Return on bank equity
Non-bank-dependent share in capital	ϕ	0.5	Bank/non-bank ratio
Substitution parameter in capital composite	σ	0.45	Crisis fall in ban/non-bank ratio

SOURCE: Banco de España.

a This table reports the values of the parameters in the baseline calibration. The first block of the table contains preset parameters following standards in the literature or direct empirical estimations. The second block contains parameters calibrated to target the moments detailed in Table 6.2.

Table 6.2
Model fit to the Spanish economy (a)

Variable	Data	Modelo
Return on bank equity	11.3	10.7
Bank/non-bank ratio	1.24	1.23
Crisis fall in bank/non-bank ratio*	34.8	35.8
Crisis fall in GDP*	38.8	36.8

SOURCE: Banco de España.

a This table reports model generated moments and their empirical counterparts calibrated using the parameters in the second block of Table 6.1. The model moments marked with an asterisk are defined as the average cumulative fall of the corresponding variable in the 4 years folllowing the materialization of a systemic event (with respect to its SSS value).

the observed changes in systemic banking crises compared to standard times. Following the convention in the empirical literature on banking crises (see Laeven and Valencia, 2013), we establish the moments related to these variations associated with crises by defining a crisis period as the four-year window that begins when systemic events occur.

The profit parameter for risk-taking is established to obtain a cumulative fall in GDP of approximately 38.8% on average (Laeven and Valencia, 2013). In the data, the pre-crisis year is chosen as 2009, while the four-year crisis period covers the years 2010-2013. In the model, the value of the year previous to the crisis is taken as the SSS value of the corresponding variable, while the value of the crisis period is taken as the value of the four years following the realization of a systemic event when the economy is in that SSS.

The retention rate of net worth of bankers, which determines the fraction of it that is transferred as dividends to the representative household, is set at 0.9 to replicate the average real return on bank capital of Spanish entities in the period 2000-2009.[69] The share of non-bank physical capital in the physical capital aggregate is set to coincide with the ratio of bank financing to non-bank financing equal to 1.24, which is obtained following a procedure similar to that used by De Fiore and Uhlig (2011)[70]. The value of the parameter of substitution elasticity in the aggregate of physical capital is established to replicate the fall during the global financial crisis of approximately 34.8% in the ratio of bank to non-bank financing.

6.4 Results

Graphs 6.1 and 6.2 compare the levels in the SSS (left) and the values after the materialisation of cyclical systemic risks (right) of some of the main macroeconomic and financial variables for the baseline scenario (in red) with a constant CET1 capital requirement ($\bar{\gamma} = 12\,\%$, $\bar{\kappa} = 0$) and the alternative scenario (in blue) with a CCyB level of 1 % when the cycle phase is at a standard level ($\bar{\gamma} = 12\,\%$, $\bar{\kappa} = 1$, $\kappa = 0.25\,\%$, $\bar{\tau} = 3$). Figure 6.1.a describes the mechanical behavior of the CCyB design whereby in standard times the level is 1 pp higher than in the baseline scenario, while after the materialization of a systemic event the buffer is released. Graph 6.1.b shows how the level of bank capital that exists following a cyclical systemic risk materialisation event is higher in the economy with a positive CCyB of 1%. This is due to lower systemic risk exposure in this economy, as shown in Figure 6.2.a: a positive CCyB level of 1 % when cyclical systemic risks are at standard levels is capable of reducing systemic exposure during these periods, thus creating greater resilience to potential risk materialisation. In the same way, when systemic risks materialize, and after the release of the buffer, the banking system has more capacity to take risks again. In the same vein, Chart 6.2.b shows how the credit-to-output ratio is slightly lower in the economy with active CCyB of 1 % in times of standard levels of cyclical systemic risks, but after these materialise the credit-to-output ratio sustains relatively higher levels.

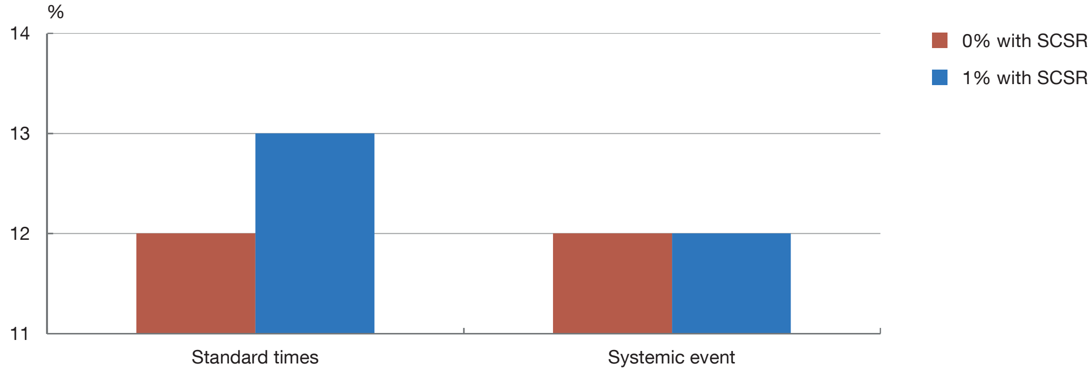
Charts 6.3 and 6.4 present the results for the levels and volatility of the output and consumption variables, respectively. Again two assumptions are shown: the base (left) with a constant CET1 capital requirement of 12% and the alternative assumption (right) with a CCyB level of 1 % when cyclical systemic risks are at standard levels. The activation of a CCyB of 1 % in standard situations of cyclical systemic risks has a negative effect on

69 The average real return on bank capital is calculated as the ratio of net income to net worth. Data available online.

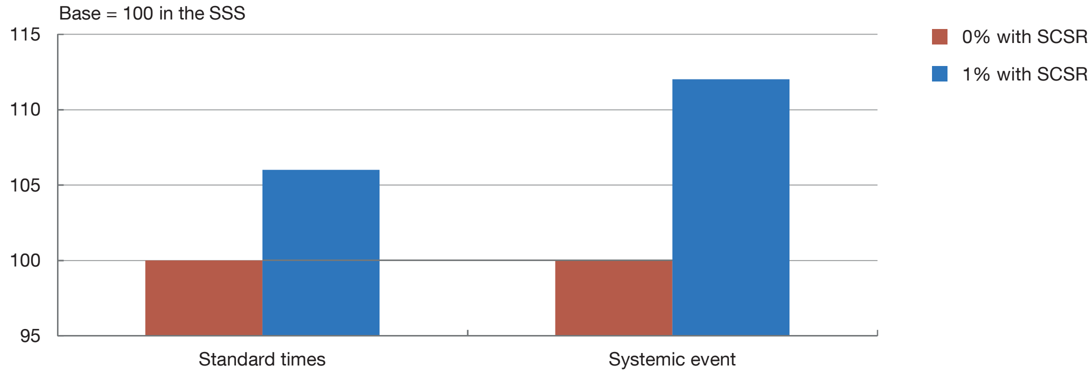
70 In particular, we identify this proportion with the ratio of total liabilities of non-financial corporations in the assets of monetary financial institutions (DMZ10S000NK.Q series) divided by the total liabilities of non-financial corporations (DMZ10S000N0.Q series), excluding the latter those in the assets of non-financial corporations (DMZ10S000NN.Q series), of general government (DMZ10S000NF.Q series), and of the rest of the world (DMZ10S000NP.Q series), between 1993 and 2009, obtained from the financial balance sheet of non-financial corporations of the Financial Accounts of the Spanish Economy (SEC2010), available online.

Chart 6.1
Effect on CET1 ratio and bank capital of variations in the CCyB level in a standard situation of cyclical systemic risks (SCSR)

6.1.a Capital ratio (CET1)



6.1.b Bank capital



SOURCE: Banco de España.

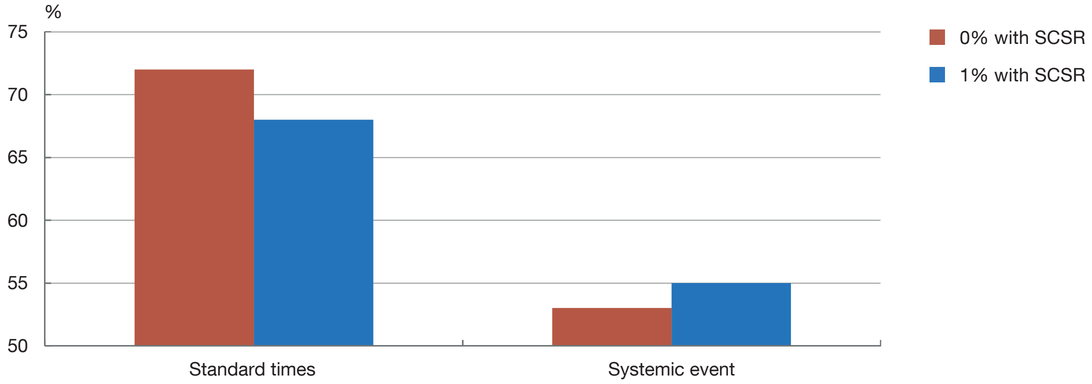
a The baseline case with fixed capital requirements of 12 % is shown in red. The alternative scenario with a CCyB of 1% in a standard situation of cyclical systemic risks (SCSR) is depicted in blue. The bars on the left represent the values of the SSS for each scenario, whereas the bars on the right show the values right after the materialization of a systemic event.

production and consumption due to a lower credit supply in the economy. However, as can be seen in the panels on the right, the CCyB is effective in reducing the volatility of these two variables in the simulation of the economy, thanks to its dampening effect during periods of cyclical systemic risk materialization. These results highlight that the costs of activation have positive effects in reducing the volatility of the business cycle (in addition to those already mentioned in other variables such as the well-being of the economy).

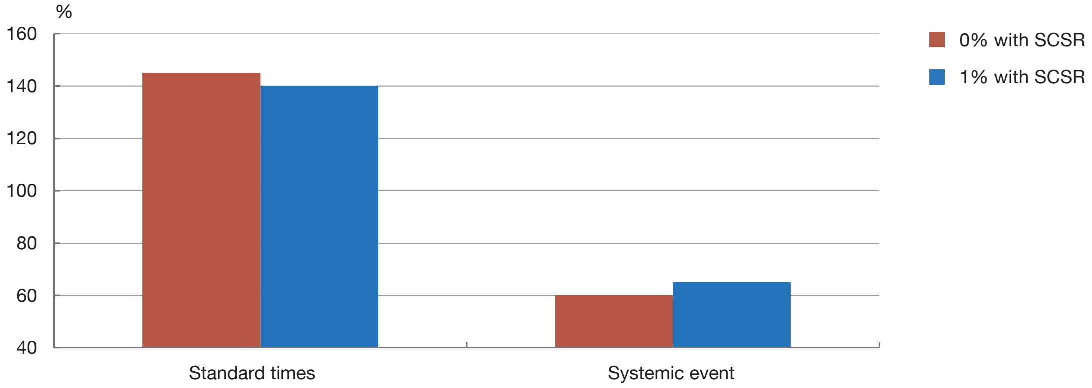
Chart 6.2

Effect on systemic exposure and credit-to-GDP ratio of variations in the CCyB level in a standard situation of cyclical systemic risks (SCSR) (a)

6.2.a Systemic exposure



6.2.b Credit-to-GDP



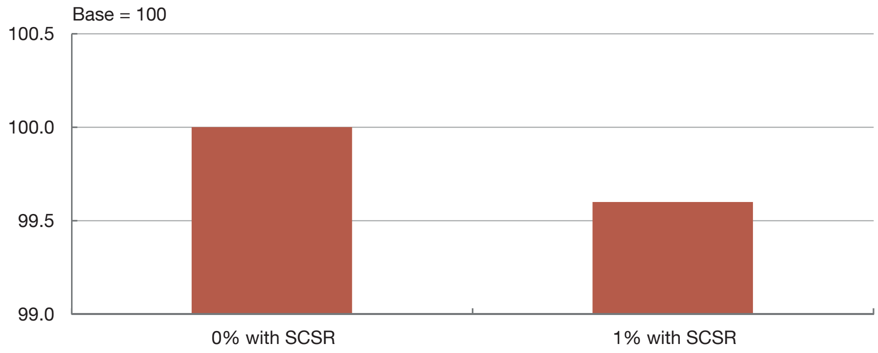
SOURCE: Banco de España.

a The baseline case with fixed capital requirements of 12 % is shown in red. The alternative scenario with a CCyB of 1% in a standard situation of cyclical systemic risks (SCSR) is depicted in blue. The bars on the left represent the values of the SSS for each scenario, whereas the bars on the right show the values right after the materialization of a systemic event.

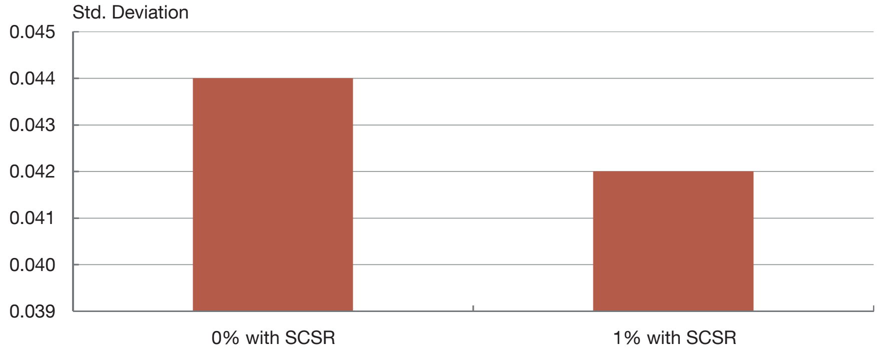
Chart 6.3

Effect on the level and volatility of output of variations in the CCyB level in a standard situation of cyclical systemic risks (SCSR) (a)

6.3.a Output level



6.3.b Output volatility



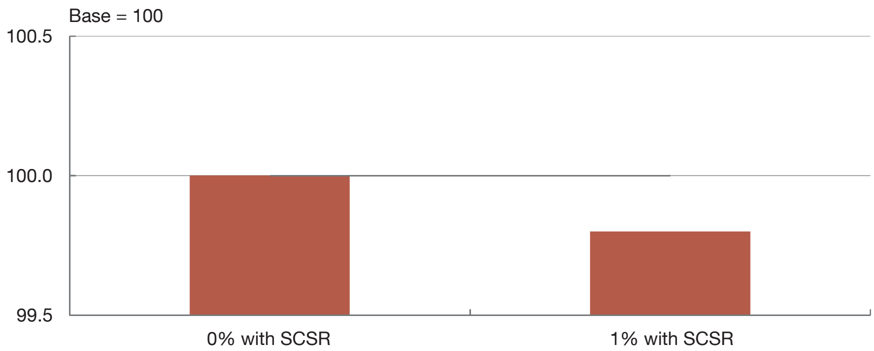
SOURCE: Banco de España.

a The bars on the left show the baseline case with fixed capital requirements of 12 %. The bars on the right show thealternative scenario with a CCyB of 1% in a standard situation of cyclical systemic risks (SCSR).

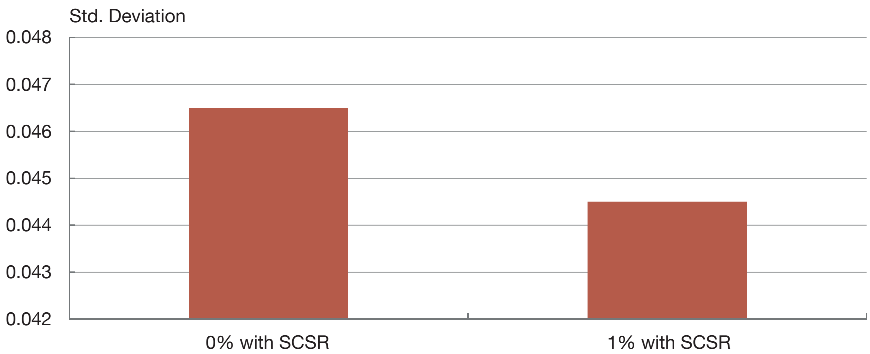
Chart 6.4

Effect on the level and volatility of consumption of variations in the CCyB level in standard situation of cyclical systemic risks (SCSR) (a)

6.4.a Consumption level



6.4.b Consumption volatility



SOURCE: Banco de España.

a The bars on the left show the baseline case with fixed capital requirements of 12 %. The bars on the right show thealternative scenario with a CCyB of 1% in a standard situation of cyclical systemic risks (SCSR).

7 Conclusions

The framework for monitoring cyclical systemic risks described in this document presents several features of interest. First, it represents a holistic approach, which seeks to capture the different cyclical factors that can determine the level of this type of risks, beyond those linked exclusively to credit. To do this, it combines the results of the analysis of synthetic indicators with other quantitative and qualitative information. This combination of approaches and sources of information mitigates the risk of misinterpretation of risk signals.

The application of this framework shows an increasing level of cyclical systemic risks in Spain since the end of the global financial crisis, with this upward trend interrupted only briefly by the outbreak of the COVID-19 pandemic. These would currently be at a standard level, intermediate between a low and a high level. Despite the long-term deleveraging trend of the non-financial private sector in Spain, indicators of the position of the real cycle, house prices, the financial situation of the banking sector and relaxed conditions in financial markets determine this diagnosis.

Cyclical shocks that can destabilize the banking system can take very different forms. The use of simulations using stress testing tools to quantify the potential impact of multiple scenarios is thus appropriate. The application of the Banco de España's macroeconomic projection models and top-down stress-testing framework to estimate bank solvency consumption in the face of real and financial domestic and external shocks to external demand and energy prices points to the materiality of these impacts, even when their intensity is in an intermediate range. Furthermore, these estimates show that an increase in capital buffers (at consolidated level) of around 0.5 pp would be able to absorb the impact of shocks of varying intensity under a broad set of scenarios.

The use of quantile regression techniques applied to European banking sector data in the period after the introduction of Basel III shows that the activation and countercyclical release of capital requirements, such as that which can be achieved with the CCyB, produces significant improvements in the growth at risk of GDP, associated with adverse phases of the macrofinancial cycle. In addition, these are much higher than the cost of these measures in terms of slowdown of activity, provided that their activation occurs in situations where cyclical systemic risks are at a standard or higher level. The application of these same quantile regression techniques to analyze the activation and release of the CCyB in the periods before and after the outbreak of the COVID-19 pandemic also provides complementary evidence of the usefulness for macroeconomic stabilization purposes of having releasable capital buffers.

The document also includes a study of the relationship between capital requirements and growth in economic activity adapted specifically to data from Spain. Through the use of multivariate regressions and a Bayesian approach, an objective or equilibrium level for bank solvency is estimated, based on capital requirements and variables related to the macrofinancial cycle. This target level is in turn used to estimate the relationship between

GDP growth and changes in capital requirements at different cyclical stages. As with the results of quantile regressions for the European sample, it is found that the positive impact of the release of capital requirements in adverse cyclical phases exceeds the costs of their activation during periods of standard or high systemic risks.

Finally, the empirical analyses are complemented by a theoretical analysis using a DSGE model, calibrated to the characteristics of the Spanish economy and banking system in the pre-pandemic period. This analysis also shows a cost-benefit balance favourable to the countercyclical use of capital requirements. In particular, it is within this DSGE framework that the activation of the CCyB in situations of standard cyclical systemic risk can reduce the negative impact on credit supply of adverse cyclical phases, and, as a consequence, allow a higher level of economic activity, thereby reducing the volatility of the business cycle.

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Annex 1 Detailed definitions of indicators

Output gap

The output gap is the difference between the observed level of Gross Domestic Product (GDP) and its potential level. The methodology used at the Banco de España to estimate potential output is based on the production function (Cuadrado and Moral-Benito, 2016).

Annual change in real GDP

Year-on-year rate of change in GDP in real terms.

Unemployment rate

The number of people unemployed as a percentage of the total workforce.

Adjusted credit-to-GDP gap

The adjusted credit-to-GDP gap uses a different calibration from that proposed by the Basel Committee on Banking Supervision[1] and the European Systemic Risk Board.[2] Specifically, the modified statistical filter uses a smoothing parameter (lambda) of 25,000 (instead of 400,000) to better reflect the average duration of the credit cycle in Spain over the last 140 years. For more details, see Galán (2019).

Credit intensity

Calculated as the annual change in lending to the non-financial private sector divided by cumulative GDP over the last four quarters.

Debt service ratio

This indicator aims to capture leverage in the non-financial private sector and is the ratio of payments of interest and principal to aggregate disposable income. Accordingly, it measures the proportion of disposable income used to service debts.[3]

Rate of change of credit to households and firms

Year-on-year rate of change of nominal credit to the non-financial private sector.

Econometric models of credit imbalance

These are (semi-)structural unobserved component models (UCMs) and vector error

1 BCBS Guidance for national authorities operating the countercyclical capital buffer, December 2010.

2 Recommendation ESRB/2014/1 of 18 June 2014 on guidance for setting countercyclical buffer rates.

3 The indicator used here was first proposed, in the context of early warning indicators for financial crises, by C. Castro, A. Estrada and J. Martínez (2014), "The countercyclical capital buffer in Spain: an exploratory analysis of key guiding indicators", in Revista de Estabilidad Financiera – Banco de España, and is currently considered one of the main reference indicators together with the credit-to-GDP gap.

correction (VEC) models for quantification of credit imbalances drawing on macro-financial variables (GDP, interest rates and house prices). For more information, see Galán and Mencía (2021) and Box 3.1 of the November 2018 *Financial Stability Report,* Banco de España.

Rate of change of house prices

Year-on-year rate of change in nominal house prices.

Indicators of price imbalances in the real estate sector

Four indicators are assessed that seek to capture deviations in residential real estate prices from their long-term level: i) real house price gap, ii) house price-to-disposable income gap, iii) house price imbalance vis-à-vis the level implied by long-term disposable income and mortgage rate trends, and iv) long-term house price imbalance vis-à-vis the level implied by prices in previous periods, disposable income, new mortgage rates and tax variables. The first three indicators calculate gaps vis-à-vis long-term trends using the same statistical filter as that used for the credit-to-GDP gap. The fourth indicator is derived from econometric model estimations.

Systemic risk indicator (SRI)

The SRI aggregates 12 individual stress indicators (including volatilities, interest rate spreads, maximum historical losses, among others) of four segments of the Spanish financial system (money market, government debt market, equity market and financial intermediaries). The effect of cross-correlations is taken into account to calculate the SRI, such that it registers higher values when the correlation between the four markets is high (when there is a high – or low – level of stress in all four markets at the same time) and lower values when the correlation is low or negative (when stress is high in some markets and low in others). As it is a contemporaneous indicator, the SRI may be particularly useful for guiding deactivation of the CCyB.

ROE (Return on Equity)

Annualised consolidated net income in the year to date divided by average equity, in accordance with the EBA definition (average of the previous year-end value and the year-to-date value).

ROE Spain

Annualised net income in the year to date divided by average equity, in accordance with the EBA definition (average of the previous year-end value and the year-to-date value), taking into account only business in Spain.

NPL ratio

Ratio of non-performing loans to total loans with counterparty in other resident sectors in business in Spain.

Net interest income to total assets

Net interest income in the year to date divided by total assets, in accordance with the EBA definition (average of the previous year-end value and the year-to-date value).

Price-to-book value

Ratio of stock price to book value in the banking sector market index.

CET1 ratio

Ratio of Common Equity Tier 1 (CET1) capital to risk-weighted assets.

Liquidity coverage ratio (LCR)

Ratio of high quality liquid assets to net expected cash outflows under a liquidity shock over a 30-day period.

Cost-to-income ratio

Ratio of operating expenses to gross income.

Cost of bank liabilities

Ratio of financial costs to average financial liabilities.

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