

# STRUCTURAL RISK INDICATORS FOR THE SPANISH BANKING SECTOR

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### Abstract

Structural risks are long-term non-cyclical risks stemming from the structural characteristics of the financial system and the wider economy. In this respect, the systemic risk buffer (SyRB) is a fairly flexible macroprudential instrument that aims to address such risks. However, the European Union (EU) legislation is still flexible regarding the indicators for activating or releasing this buffer. Although a clear definition of these indicators is key to enabling the early detection of vulnerabilities that may lead to a crisis, in practice, each national authority determines its own set of indicators. This article has a dual aim. First, to select a set of indicators that are relevant for regularly monitoring the Spanish banking sector's structural risks and, second, to develop a heatmap of structural indicators comparing variables for Spain with those for the EU. The empirical evidence suggests that the Spanish banking sector shares most of its structural features with those of the EU economies. According to the analysis, no structural risks are identified at present that might threaten the Spanish banking sector.

**Keywords:** macroprudential policy, systemic risk, structural indicators, heatmap.

## 1 Introduction

The prevention and mitigation of systemic risk is a key objective for macroprudential authorities. Broadly speaking, systemic risk can be analysed in two dimensions: cyclical and structural (see European Systemic Risk Board (ESRB) (2013)). This article addresses this second structural (or cross-sectional) dimension of systemic risk, which stems from different characteristics of the financial system that could make it more vulnerable in the event of a potential adverse shock and more prone to spread throughout the system. In the European Union (EU) legislation, the three main macroprudential tools to prevent these non-cyclical risks are the buffer for global systemically important institutions (G-SIIs), the buffer for other systemically important institutions (O-SIIs) and the systemic risk buffer (SyRB). While the two SII buffers address the externalities caused by these large and interconnected individual institutions, the SyRB can be applied to the mitigation of risks stemming from the structural features of the financial system and the wider economy.<sup>1</sup>

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<sup>1</sup> Article 128(5) of the Capital Requirements Directive (CRD) defines the SyRB and its use is further specified in Article 133 of the CRD. Accordingly, the SyRB can be interpreted as a residual macroprudential instrument that targets structural systemic risks not covered by other measures specified in the Capital Requirements Regulation (CRR) and cyclical risks not addressed by the countercyclical capital buffer (CCyB). It is worth noting that in the latest amendments to the EU prudential framework for the banking sector (the CRD V and CRR II amendments), the application of the SyRB is no longer restricted to long-term non-cyclical systemic risks and can also be applied to sectoral exposures.

The structural features of the financial system are very diverse in nature and include the banking sector's structural characteristics, such as its size and concentration, the degree of interconnectedness among domestic credit institutions or with foreign counterparties, and the level of common exposures in lending or funding. In addition, certain structural features of the economy, such as the composition and size of non-financial private sector and public sector indebtedness, could also pose risks to the financial system. The analysis of an appropriate set of indicators to identify structural risks is crucial,<sup>2</sup> not only to identify such risks but also to guide macroprudential policy decisions that may have to be adopted on the SyRB.<sup>3</sup> However, compared with SII buffers, the EU's CRD<sup>4</sup> is less prescriptive regarding the set of indicators to guide the decisions on the SyRB. The ESRB Handbook (see ESRB (2018)) specifies a taxonomy of three risk categories to be addressed by the SyRB and a non-exhaustive list of indicators. As the identification framework for using the SyRB in the EU is not clear-cut, in practice there is no homogeneous approach to be adopted by national macroprudential authorities to define and classify the indicators of structural systemic risk. In this respect, the ESRB expects that national authorities determine the risks to be addressed by the SyRB and the selected indicators to be regularly monitored (see ESRB (2013), (2017)).

Choosing the most relevant indicators for each economy is not straightforward either. There is an enormous cross-country variation in the structural systemic risk assessment between Member States. National authorities typically use their own metrics to identify the structural vulnerabilities of their financial systems.<sup>5</sup> This circumstance complicates the assessment and the undertaking of comparisons among EU countries, not least because of the unique structural features of each national financial system.<sup>6</sup> Moreover, it is not always easy to distinguish between the cyclical and the structural dimensions of systemic risk, as some structural metrics, such as exposure concentration and asset commonality, are also monitored to detect the emergence of cyclical risks.

The aim of this article is to propose a comprehensive set of structural indicators for the Spanish banking sector. As proposed by the ESRB, the taxonomy of structural risks should be based not only on the current structure and state of the particular economy, but also on a sufficiently broad amount of information to target a wide range of potential risks (see ESRB (2017)). In this spirit, the metrics proposed in this

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2 Among other authors, Cerruti, Claessens and McGuire (2012) and Gambacorta and van Rixtel (2013) show the importance of having better information on structural systemic risks to appropriately monitor risks.

3 In fact, the ESRB recommends the use of appropriate indicators to monitor risks and guide the application of macroprudential instruments. See ESRB/2013/1 Recommendation C.

4 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, amending Directive 2002/87/EC and repealing Directives 2006/48/EC and 2006/49/EC.

5 And only a few authorities, including Finland (see Suomen Pankki – Finlands Bank (2022)), disclose the list of specific indicators used in the assessment methodologies of their SyRB frameworks.

6 In this regard, Mæhlum and Riiser (2019) provide a summary of the main vulnerabilities and indicators used for the activation of the SyRB in countries that apply this buffer, which illustrates the cross-country heterogeneity.

article address not only the financial sector's structural features themselves, but also channels through which these vulnerabilities may amplify systemic risk within the system, as well as characteristics of the economy that could trigger the shocks, as suggested in ESRB (2018). Once the complete set of variables is selected, a heatmap is put forward to assess the level of these structural features for the Spanish banking sector with respect to its EU peers and to historical figures, i.e. a cross-sectional and a time series analysis of the data is performed. This tool could be regularly updated on an annual basis for monitoring purposes that could be useful to inform policy decisions regarding SyRB activation.

After describing the ESRB's taxonomy of structural risks, a set of structural indicators is defined and estimated as inputs for a proposed heatmap. This is followed by an assessment of the main structural characteristics of the Spanish banking system and a study of some selected structural variables by means of a pairwise analysis based on scatterplots. Finally, the article tries to disentangle whether the performance of some of these variables has some impact on growth or on growth volatility.

## 2 Taxonomy of structural risks and relevant indicators

An accurate assessment of structural systemic vulnerabilities should include a broad set of indicators that reflects the most relevant features of the banking sector. However, there are only a few examples of institutions that have developed empirical analysis to assess the structural features that could serve as reference. For instance, the central banks of four countries – namely, Finland, France, Norway and Sweden – have developed empirical research on this topic,<sup>7</sup> and the ESRB regularly updates a set of structural variables for the EU financial system in its Risk Dashboard.<sup>8</sup> Apart from not being widespread among institutions, analysis of the structural variables is not standardised across national macroprudential authorities either.

The proposed set of structural indicators specific to the Spanish banking sector relies on the taxonomy of structural risks in ESRB (2017, 2018). According to this classification, long-term non-cyclical risks could be classified into the following three categories:

- 1 *Structural characteristics of the financial sector.* This category reflects the systemic role of the aggregate banking system in its interplay with the real economy. The main indicators of this group relate to the size and concentration of the domestic banking sector and its importance for the financing of the

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7 For more details, see Suomen Pankki – Finlands Bank (2022), Gabrieli and Jimborean (2020), Krygier and van Santen (2020) and Mæhlum and Riiser (2019), respectively. Specifically, Suomen Pankki – Finlands Bank uses a set of eleven structural indicators for the Finnish financial system and compares them with the median values of the corresponding indicators for the EU countries and the Finnish historical average.

8 For further details, see the [ESRB Risk Dashboard](#) on the ESRB website.

economy. This category also covers the funding and liquidity structure of the banking sector, as well as its constraints on intermediation capacity, such as solvency, profitability and efficiency.

- 2 *Amplification channels.* This group of indicators includes measures to analyse possible channels of amplification and propagation of shocks within the financial system. It addresses not only direct channels of transmission, such as interconnectedness and intra-financial linkages, but also indirect channels, such as common exposures and business model commonalities. In addition, this category also encompasses cross-border banking, such as dependence on foreign intermediaries and exposures to external sources of macroeconomic volatility.
- 3 *Financial structure of the real economy.* Finally, there could be broad macroeconomic shocks, as well as shocks that originate from specific economic sectors in distress, that could lead to losses for the banking sector. The spectrum of characteristics of the real economy that make it more vulnerable to such shocks are country-specific and encompass, among others, a persistently high level of private and public debt, as well as external debt.

Once the taxonomy is set, a selection is made of 20 banking sector indicators that are representative of these three categories and ten subcategories of metrics proposed by the ESRB. The chosen set of indicators is linked to the structural features of the banking sector, as well as the financial system vulnerabilities and those characteristics of the economy that may amplify systemic risk. Table 1 lists and describes these indicators and their calculation methodology. Next, the article briefly discusses the reasons why each indicator subcategory is relevant for monitoring structural vulnerabilities.

## 2.1 Structural characteristics of the financial sector

The first group of indicators on the structural features of the financial sector consists of four subcategories – namely, banking sector size and importance, concentration, funding and liquidity structure, and constraints on intermediation capacity. First, banking sector *size and importance* represents a relevant characteristic to be monitored as, when a banking sector is large and important as a provider of financial services, serious difficulties experienced by this sector could adversely affect financial intermediation and have a negative impact on the real economy (see Laeven, Ratnovski and Tong (2016)).

*Concentration* measures are also relevant for analysing structural risks. There is a long-standing debate among theoretical and policy economists about the relationship

Table 1

**STRUCTURAL RISK TAXONOMY (a)**

Category	Subcategory	Indicator	Calculation methodology
1 Structural features of the financial sector	Size and importance	Banking sector size	Total bank assets as a % of the four-quarter sum of nominal GDP
		Bank lending to the NFPS	Loans provided by the domestic banking sector as a % of total loans to the domestic NFPS
	Concentration	Concentration ratio (CR5)	The five largest banks' share of the domestic banking sector's total assets
		Herfindahl index of total bank credit	Sum of the squares of the market shares of all the credit institutions in the banking sector (b)
	Funding and liquidity structure	Loan-to-deposit (LTD) ratio	Total loans granted by the banking sector as a % of total deposits excluding the European System of Central Banks
		Bank funding by central banks	Banks' deposits vis-à-vis the Eurosystem (for euro area countries) or the national central bank (for other EU countries) as a % of banking sector total liabilities
		Share of variable-rate mortgage loans	New loans for house purchase with a variable rate or an initial rate fixed for a period of up to 1 year as a % of total new loans to households for house purchase
	Constraints on intermediation capacity	CET1	CET1 capital as a % of the total risk exposure amount
		RoA	Total banking sector profit as a % of banking sector total assets
		Cost-to-income ratio	Ratio of total operating expenses to total operating income
2 Amplification channels	Common exposures	Share of mortgage loans	Loans for house purchase as a % of total loans and debt securities granted to the domestic NFPS
		Share of construction and real estate loans	Loans for construction and real estate activities as a % of banking sector total assets
		Exposure to domestic sovereign	General government loans and debt securities as a % of banking sector total assets
	Intra-financial contagion	Share of interbank loans	Interbank loans as a % of banking sector total loans
	Cross-border banking	Share of foreign ownership	Total assets held by foreign subsidiaries and foreign branches as a % of banking sector total assets
		Cross-jurisdictional assets	Share of cross-jurisdictional assets, i.e. all except domestic assets, as a % of banking sector total assets
	3 Financial structure of the real economy	Private sector indebtedness	Household indebtedness
NFC indebtedness			NFC debt securities and loans as a % of the sum of nominal GDP
Public sector indebtedness		Public sector debt	Government debt as a % of the four-quarter sum of nominal GDP
Foreign indebtedness		Net external debt	Net external debt as a % of the four-quarter sum of nominal GDP

**SOURCES:** Devised by authors drawing on ESRB (2018), ESRB Risk Dashboard and ECB Statistical Data Warehouse.

**a** NFPS = non-financial private sector; NFC = non-financial corporation; CET1 = Common Equity Tier 1 ratio; RoA = Return on assets.

**b** See the exact definition from the Banking Structural Statistical Indicators (SSI) dataset from the SDW.

between bank concentration and financial stability (see Beck, De Jonghe and Mulier (2022)).<sup>9</sup> At high levels of banking concentration, the excessive reliance on a few

<sup>9</sup> This analysis relies on two widely used indicators of banking concentration, namely the concentration ratio of the five largest banks (CR5) and the Herfindahl-Hirschman Index (HHI) of total bank credit. Alternatively, Beck, De Jonghe and Mulier (2022) propose a metric that summarises three dimensions of bank sectoral concentration – degree of specialisation, deviation from peer banks and direct interconnectedness.

banks to finance the economy could lead to significant shortcomings in the provision of financial services under difficulties experienced by this low number of banks, so that replacing their services would require significant capital and other capacity from other credit institutions (see Calice and Leonida (2015)).<sup>10</sup> However, concentration has various dimensions and other authors – such as Giannetti and Saidi (2019) – find that higher concentration may favour financial stability.<sup>11</sup>

Indicators on the funding and liquidity structure of the banking system show how its business, primarily lending, is financed and whether it is capable of repaying its investors and depositors. The loan-to-deposit (LTD) ratio is a commonly used indicator of stable funding and liquidity mismatch (see Van den End (2016)).<sup>12</sup> When the LTD ratio is too high, it suggests that the banking system may not have enough liquidity to cover any unforeseen funding requirements in an adverse scenario, the so-called funding gap. In this situation, banks often access funding from their central bank, so that a high dependence on central bank funding could signal a shortage of private funding. The extent to which banks rely on such support is proxied by borrowing from the central bank as a percentage of total bank liabilities. In addition, the sensitivity of funding costs to external shocks is measured by the proportion of variable-rate loans.<sup>13,14</sup> The cost of financing of variable-rate loans fluctuates throughout the life of the loan due to policy rate changes, but also to other types of disturbances, such as shocks in financial markets. This adds uncertainty regarding its future course: if investor confidence in banks is undermined, banks' funding costs may become higher.

Finally, the subcategory related to the *constraints on intermediation capacity* includes indicators of bank solvency, profitability and efficiency. While bank solvency indicators – such as the Common Equity Tier 1 (CET1) ratio – measure the loss absorption and precautionary means to protect the economy from a financial crisis, profitability metrics – such as the return on assets (RoA) – provide information about the overall efficiency of the banking system and its capacity to generate income and capital. Finally, the cost-to-income ratio is used to measure banking efficiency. This indicator captures the relative performance of cost management with respect to income generation.<sup>15</sup>

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10 According to these authors, at low levels of concentration, a higher concentration could improve banking system stability via profitability, so that an intermediate level of concentration may be optimal in terms of welfare.

11 Giannetti and Saidi (2019) conclude that credit concentration may enhance financial stability as it affects the way in which industry shocks are transmitted along the supply chain and become systemic.

12 The LTD ratio measures the share of the loan book that is covered by deposits received from customers.

13 In the case of variable interest rate loans, the changes in the revenue on these loans are tied to the changes in their funding costs. This is because the latter are renewed more frequently, in line with interbank market yields, given the prevalence of short-term loans.

14 The proportion of variable-rate loans could be interpreted as two-tailed. Thus, a high proportion of variable-rate loans on banks' balance sheets could indicate a potential vulnerability in the case of a sudden interest rate rise, as this will affect borrowers' debt servicing capacity and could lead to an increase in impairments. On the other hand, a high proportion of fixed-rate loans issued at low rates with long maturities in the event of rising rates could put pressure on interest income, unless properly hedged against these events.

15 The cost-to-income ratio takes into account not only purely operational performance, but also other more structural factors affecting both components, such as provisioning linked to asset quality, challenges in income generation and rigid cost structures.



## 2.2 Amplification channels

The second group of indicators, amplification channels, includes representative metrics of three subcategories: common exposures, intra-financial contagion and cross-border banking.

First, high levels of *common exposures* concentrated in specific sectors across the banking system, such as in real estate, increase the likelihood of simultaneous distress. Serious disruptions to these sectors could pose a direct or indirect threat to the functional capacity of a number of credit institutions and the system as a whole (see ESRB (2016)). Mortgage loans and construction and real estate loans as a percentage of total loans are used to monitor these developments. In this subcategory the exposure of the banking system to domestic sovereign debt is also considered. Banks' exposures to sovereign debt were one of the channels through which the sovereign-bank nexus operated during the euro area sovereign debt crisis.

Regarding *intra-financial contagion*, a closely interconnected banking system offers a network to absorb liquidity shocks through diversification, but it also allows these shocks to propagate and sometimes it may amplify them, spreading financial weaknesses throughout the banking system (see Rochet and Tirole (1996), Brunnermeier (2009) and Elliot et al. (2014)).<sup>16</sup> A higher value for the selected interconnectedness indicator, defined as interbank loans as a percentage of total bank loans, means larger transmission channels between banks, which may produce contagion in an adverse scenario.

The *cross-border banking* subcategory includes two complementary indicators. The first one – the share of foreign ownership – quantifies the importance of foreign banks in the banking sector in terms of balance sheet size. This indicator is a proxy of the ability of the banking sector to finance the economy and channel domestic savings. There is no general conclusion as to whether foreign banks amplify systemic risk or not. Rather, the question relates to the substitutability of activities performed by foreign banks in the event of propagation of foreign-originated shocks.<sup>17</sup> In addition, management misalignments between a parent and its subsidiaries and branches may create additional vulnerabilities. The second indicator, cross-jurisdictional assets as a percentage of total assets, measures the exposure and vulnerability of the banking system to foreign shocks, which may be associated with non-synchronised business cycles, more complex monitoring and compliance, and geopolitical or country-specific risks. A higher value for this indicator could denote potential higher structural systemic vulnerabilities, as the banking system is more exposed to shocks beyond its borders. In terms of macroprudential policy

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<sup>16</sup> For instance, funding problems in one bank can spread to other banks and amplify losses in the banking sector.

<sup>17</sup> There is evidence that foreign-owned banks may be more procyclical regarding credit supply in crisis times and amplify credit constraints (see Albertazzi and Bottero (2014)).

effectiveness, it is important to consider both indicators, as they could provide insight into the level of exposure and the degree of possible inward and outward cross-border spillover effects (see European Central Bank (ECB) (2020)).

### 2.3 Financial structure of the real economy

Finally, the third category of risk indicators includes features related to the financial structure of the real economy, namely private and public sector indebtedness and external debt. Shocks to the financial system may originate outside the banking sector, and the risk of such shocks could also depend on the vulnerabilities of other participants, such as households, non-financial corporations (NFCs) and the public sector. Regarding *private sector debt*, under persistently high levels of household and NFC indebtedness, even a small shock might negatively affect borrowers' debt servicing capacity. In addition, indicators that measure *public indebtedness* address the potential risk of spillovers from the sovereign to the banking system. This impact between both sectors might be driven by shocks to revenues and interest rates when repaying debt and to the unavailability of funds for debt refinancing or for issuing new debt.

Finally, high *external debt* is also an element of vulnerability as it exposes issuers to a potential rollover risk and higher financing costs if the conditions for accessing international markets tighten or become more expensive. More generally, external indebtedness is a measure of external leverage (see Krygier and van Santen (2020)). Previous research has shown that large current account deficits have often preceded financial crises (see ECB (2019)). Similarly, persistently elevated levels of net external debt could raise economies' dependence on global financial markets and accentuate their vulnerability to swings in investor sentiment.

## 3 Data and methodology

To provide an assessment of the Spanish banking sector's structural risks and its relative position within the EU, a set of 20 indicators is obtained (see Table 1). The data source is the aggregate balance sheet information from the ECB's Statistical Data Warehouse (SDW). Some of the indicators were obtained from this source directly, while others require some calculations.<sup>18</sup> The data set runs from 1997 Q3 to 2021 Q4 and the country sample consists of the 28 EU Member States.<sup>19</sup> The panel is unbalanced as not all the indicators are available for all countries from the

18 Nine indicators (CR5, HHI, LTD ratio, proportion of variable-rate loans, CET1, RoA, cost-to-income ratio, share of interbank deposits and public sector indebtedness ratio) can be directly obtained from the SDW, while the remaining metrics require some calculations.

19 From 2019 Q4 the country sample consists of 27 countries as the UK data series was discontinued in the SDW as a result of Brexit.

beginning of the sample period. Most indicators (16 out of 20) are quarterly. For those variables that are not available at a quarterly frequency annual data are used instead.<sup>20</sup> Following ESRB (2017, 2018), it is assumed that all indicators are one-tailed, so that a higher level of the indicator represents higher vulnerability.<sup>21</sup>

Next, a heatmap is constructed to identify the potential build-up of structural risks in the Spanish banking sector. Heatmaps are data-based monitoring tools that offer a visual assessment of the values of large panels of indicators. This instrument consists of a two-dimensional table that assigns to each indicator a colour code linked to its current position on the percentile scale of its corresponding frequency distribution. Colour codes tend to range from red to green, the former being associated with higher risk and the latter with a normal range of values.

Given their simplicity and straightforward interpretation, heatmaps are broadly used to monitor the emergence of systemic risks by central banks and other institutions. Among others, for instance, the IMF regularly monitors in its *Global Financial Stability Report* (GFSR) a broad set of indicators in a matrix defined by types of macro-financial imbalances across types of lenders and borrowers (see Adrian, He, Liang and Natalucci (2019)). Other institutions, such as the Federal Reserve Board (see Aikman, Kiley, Lee, Palumbo and Warusawitharana (2017)) or Norges Bank (see Arbatli and Johansen (2017)), also use heatmaps as a monitoring tool. In the case of Spain, Mencía and Saurina (2016) propose a heatmap to identify potential systemic risks to the Spanish banking system. Additionally, Alonso and Molina (2021) develop a vulnerability dashboard that focuses on 27 emerging market economies (EMEs) whose situation may pose a threat to financial stability in Spain. Despite this widespread use of heatmaps, they are simply a graphical representation of the data. Therefore, they should always be reinforced by expert judgement and complemented by more sophisticated models.

To address the evolution of these indicators in their time-series dimension, a heatmap is built using a methodology similar to that in Mencía and Saurina (2016). Additionally, as in Alonso and Molina (2021), the proposed heatmap for structural risks also covers the cross-sectional dimension, which allows us to analyse the extent to which the structural characteristics of the Spanish banking system are similar to those of other EU countries.

After obtaining 20 indicators, a heatmap for structural variables is developed in two steps. First, threshold values are estimated to represent the different warning levels for each indicator that allow us to assess the structural risk level of all the EU national

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20 There are three indicators that are not available at a quarterly frequency: CR5, HHI and the share of interbank deposits. RoA is conveniently analysed at an annual frequency, although it can also be assessed at a quarterly frequency.

21 In theory some of the indicators, such as the proportion of variable-rate loans, could be two-tailed. However, for simplicity purposes and to ensure comparability with other indicators, in this empirical work it is assumed that all indicators are one-tailed.

banking sectors, before shifting the focus of our attention to the particular case of Spain. For each indicator three sets of thresholds – corresponding to three different exercises – are computed. The first one is obtained from the cross-section sample only for the last available observation, that is, 2021 Q4. Then, the second set of warning threshold levels is based on the entire sample period, so that the indicators' entire time series is needed to perform the assessment. Finally, a third set of thresholds from the last five years of the sample (from 2017 Q1 to 2021 Q4) is obtained so as to take into account the most recent evolution of the indicators that could signal the build-up of systemic imbalances. For these three sets of thresholds, three percentiles of the distribution of the indicators are calculated, namely p75, p90 and p95.<sup>22</sup> All the percentiles are calculated using the interpolation approach.<sup>23</sup> In any case, given the structural nature of these characteristics, these indicators tend to be rather stable, so that these percentiles are quite sensitive to small variations.

Second, a comparison is made between the current levels of the 20 structural indicators for the Spanish banking sector as of 2021 Q4 and the warning levels. To this end, a colour code linked to the position of each indicator on the percentile scale of its frequency distribution distinguishes four different levels of risk. If the level of an indicator is below p75 it is interpreted that it is within a normal range of values (green colour coding). Then, as the indicator departs from the normal range, the level of risk increases from moderate risk (yellow; p75-p90), to medium risk (orange; p90-p95) and, lastly, to the maximum level of risk (red; p95 and above).<sup>24</sup> In any case, the structural risk assessment obtained with this heatmap only provides information about the relative position of the variables. Therefore, departures from normal ranges should not be interpreted as early warning signals of future risks, as the properties of these indicators as leading indicators must be further analysed.<sup>25</sup> Consequently, this analysis should be complemented by expert judgement.

## 4 Assessment of the Spanish banking system's main structural risks

The results of the heatmap for the 20 structural indicators for the Spanish banking sector are summarised in Table 2. The overall comparison across the three exercises suggests that most indicators are green coloured, so that they are in a normal range, both in terms of their own time series and in comparison with European peers.

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22 For the CET1 ratio and RoA, the percentiles p25, p10 and p5 are used in the reverse order to signal vulnerabilities.

23 If the  $k$ -th percentile does not correspond to a specific data point, the interpolation between points is performed to determine the value at the  $k$ -th percentile. The range of percentiles is between 0 and 100, inclusive. For more details, see NIST/SEMATECH (2022).

24 These intervals include the lower bound, but not the upper bound.

25 Indeed, the definition of the normal range depends on the distribution considered for each exercise and variable. The main advantage of this approach is that it takes into account the average range for the euro area, while allowing us to monitor developments in domestic banking sectors over time.

Table 2

**STRUCTURAL RISKS HEATMAP FOR 2021 Q4**

Category	Subcategory	Indicator	Cross-section 2021 Q4	Panel 2017 Q1 - 2021 Q4	Panel 1998 Q4 - 2021 Q4
1 Structural features of the financial sector	Size and importance	Banking sector size	Yellow	Yellow	Green
		Bank lending to the NFPS	Yellow	Yellow	Green
	Concentration	CR5 ratio	Green	Green	Green
		Herfindahl index of total bank credit	Green	Green	Green
	Funding and liquidity structure	LTD ratio	Green	Green	Green
		Bank funding by central banks	Orange	Red	Orange
		Share of variable-rate mortgage loans	Green	Green	Green
	Constraints on intermediation capacity	CET1 ratio	Red	Orange	Orange
		RoA	Green	Green	Green
		Cost-to-income ratio	Green	Green	Green
2 Amplification channels	Common exposures	Share of mortgage loans	Green	Green	Green
		Share of construction and real estate loans	Green	Green	Green
		Exposure to domestic sovereign	Green	Green	Green
	Intra-financial contagion	Share of interbank loans	Green	Green	Green
	Cross-border banking	Share of foreign ownership	Green	Green	Green
		Cross-jurisdictional assets	Yellow	Orange	Orange
3 Financial structure of the real economy	Private sector indebtedness	Household indebtedness	Green	Green	Green
		NFC indebtedness	Green	Green	Green
	Public sector indebtedness	Public sector debt	Yellow	Orange	Orange
	Foreign indebtedness	Net external debt	Orange	Yellow	Yellow

**SOURCES:** ECB Statistical Data Warehouse and devised by authors.

**NOTE:** For each indicator, the colours indicate the position of the Spanish banking sector relative to the thresholds, which are calculated from each sample and correspond to three percentile scores: p75, p90 and p95. Green indicates no risk, yellow indicates moderate risk, orange indicates high risk and red indicates severe risk.

#### 4.1 Structural features of the financial sector

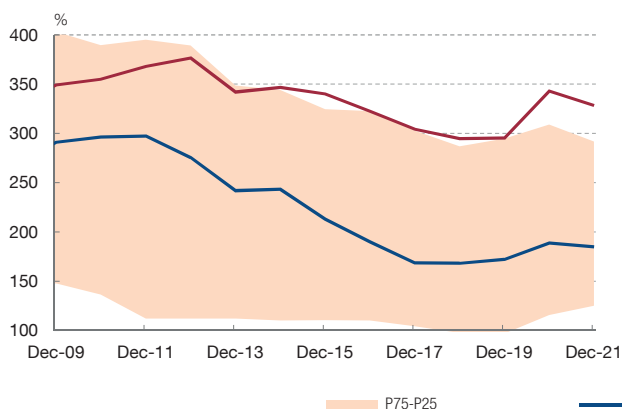
The analysis of the first risk category (structural features of the financial sector) shows that four out of the ten indicators, namely, banking sector size, bank lending to the NFPS, bank funding by central banks and the CET1 ratio, are relatively high both in the time and in the cross-sectional dimensions. Chart 1 shows the evolution of these four variables in Spain and in the EU.

When the entire historical perspective is considered (see the third column of Table 2) the size and importance for the NFPS signal no potential structural risk. However, in the exercises that analyse the cross-section of countries and the short sample panel (see the first and second columns of Table 2), these indicators suggest a moderate level of risk. Thus, as illustrated in Charts 1.1 and 1.2, although both variables are above p75 with respect to the European countries in the last six years of the sample, both variables exhibit a downward trend (since 2012 in the case of banking sector size and since 2007 in that of bank lending to the NFPS). Additionally, in the case of lending to the NFPS, the

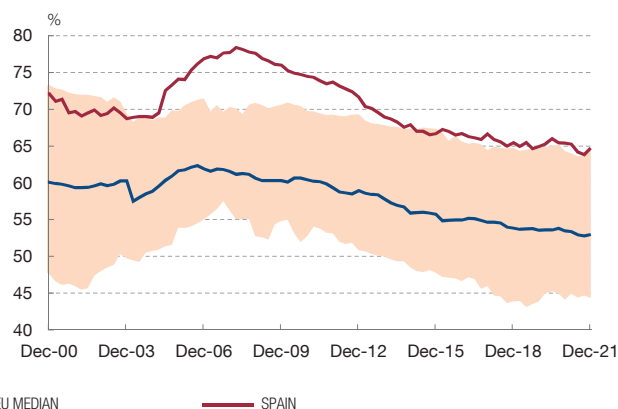
Chart 1

**STRUCTURAL FEATURES OF THE BANKING SECTOR: INDICATORS THAT DEPART FROM THEIR NORMAL RANGE**

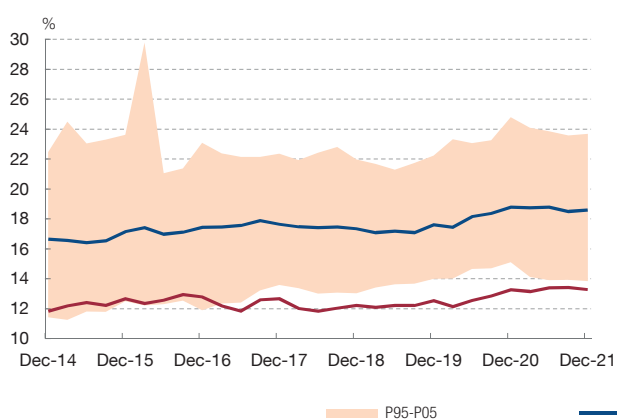
1 BANKING SECTOR SIZE (a)



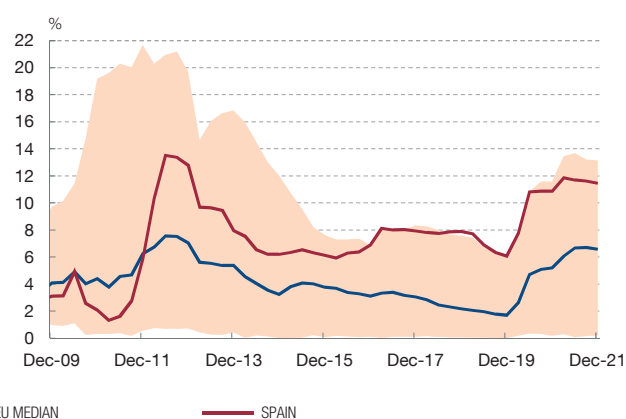
2 BANK LENDING TO THE NFPS (a)



3 CET1 RATIO (b)



4 BANK FUNDING BY CENTRAL BANKS (b)



**SOURCE:** Own calculations drawing on the ECB Statistical Data Warehouse.

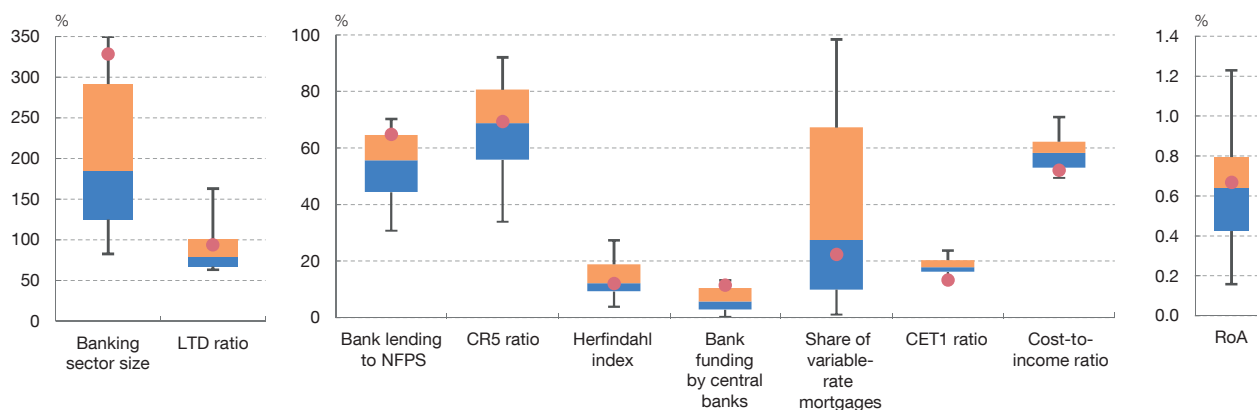
- a The median and the interquartile range of the EU distribution – that is, the difference between the third and the first quartile –, are calculated in each quarter.
- b The median and the range between the 95th (p95) and the 5th (p05) percentiles of the EU distribution are calculated in each quarter.

downward trend for Spain has been steeper than that for the rest of the countries, while the starting point was well above p75 in 2006, but converged to it during 2013-2014.

The other two indicators – bank funding by central banks and the CET1 ratio –, suggest potential structural vulnerabilities to some extent in the three exercises. Regarding the bank solvency indicator, in 2021 Q4 the CET1 ratio of the Spanish banking system was below percentile p5 of the EU distribution. That is, in terms of its CET1 ratio the Spanish banking industry ranks among the lowest. This difference could be related to Spanish banks' higher risk weight densities and structural factors such as the more widespread use of the standardised approach to calculate capital requirements for credit risk (see Banco de España (2022)). In addition, the CET1 ratio has been increasing in recent years, as shown in Chart 1.3, so that although the level of CET1 of Spanish banks

Chart 2

**DISTRIBUTION OF STRUCTURAL INDICATORS IN THE EU: STRUCTURAL FEATURES OF THE FINANCIAL SECTOR (a)**



**SOURCE:** Own calculations drawing on the ECB Statistical Data Warehouse.

**a** For each indicator, the red dots indicate the position of the Spanish banking sector. The colour boxes represent the interquartile range, the upper whisker corresponds to p95 and the lower one to p5. Data as of 2021 Q4.

remains relatively low, their solvency is gradually becoming sounder. Regarding bank funding by central banks, central bank funding as a percentage of total Spanish banking system funding increased during the sovereign debt crisis between 2011 and 2012, as illustrated in Chart 1.4. As sovereign debt concerns receded, the reliance on this type of funding slowly decreased, alongside similar developments in the rest of the EU. However, the onset of the COVID-19 pandemic led to an increase in this indicator throughout the EU.

Chart 2 shows the box-and-whiskers plots of each variable as of 2021 Q4. This chart provides further details on the distribution of the metrics of the structural features of the financial sector category. Each box represents the interquartile range and the median, while the whiskers characterise the range between the p95 and p5 percentiles. The red dots indicate the position of the Spanish banking system. On the negative side, as reported in the heatmap in Table 2, the Spanish banking system is in the tail of the distributions of the four metrics showing some warning signals. On the plus side, the banking efficiency indicator (the cost-to-income ratio) is in the first quartile, which suggests a favourable performance of Spanish banks compared with other EU countries. In addition, four of the indicators for structural features exhibit a relative position of the Spanish banking sector that is close to the EU median (namely the two concentration measures, the share of variable-rate mortgage loans and RoA).

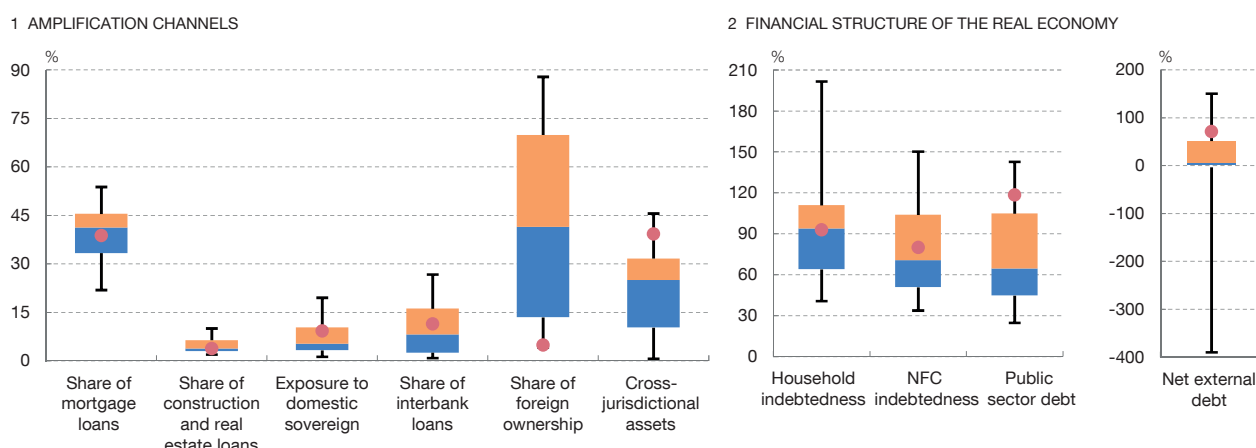
## 4.2 Amplification channels and financial structure of the real economy

All the indicators of the second category of structural risks (amplification channels) in the heatmap are in a range considered to be normal, except for the cross-



Chart 3

**DISTRIBUTION OF STRUCTURAL INDICATORS IN THE EU: AMPLIFICATION CHANNELS AND FINANCIAL STRUCTURE OF THE REAL ECONOMY (a)**



**SOURCE:** Own calculations drawing on the ECB Statistical Data Warehouse.

**a** For each indicator, the red dots indicate the position of the Spanish banking sector. The colour boxes represent the interquartile range, the upper whisker corresponds to p95 and the lower one to p5. Data as of 2021 Q4.

jurisdictional assets indicator. This metric exceeds warning levels under the three metrics shown in Table 2. Specifically, this indicator has historically been somewhat higher than the percentile p90 of the EU distribution. However, the latest data suggest that the relative position of Spanish banking sector exposure to cross-jurisdictional assets has been gradually decreasing and is currently just above the percentile p75. This fact highlights the potential vulnerability of the Spanish banking system to cross-border banking activities, specifically to the asset holdings of Spanish banks abroad. However, this result should be qualified given the structure of independent subsidiaries in the specific case of the Spanish banking sector.

Finally, the indicators of the third category of structural risks, which correspond to risks arising from the real economy, confirm that the high levels of public and external debt are outside their normal range in the three exercises. The increased public and foreign indebtedness make the economy more sensitive to the tightening of financing conditions that could spill over to the banking system as well. On a more positive note, indicators of private indebtedness do not show signs of structural vulnerability, potentially due to the correction that took place after the global financial crisis.

Chart 3 depicts the distribution of the indicators in the amplification channels and financial structure of the real economy categories. Most of these indicators are within the interquartile range, which denotes values comparable to the majority of other EU banking sectors. It is worth noting that the share of foreign ownership is relatively low – below percentile p5 –, so that this indicator evidences the minor role of foreign-owned banks in Spain. However, as previously mentioned, the cross-jurisdictional assets indicator shows relatively high exposures compared with those of the European



peers. Regarding the financial structure of the economy indicators, household and NFC indebtedness are around the EU median.

## 5 Pairwise analysis of the selected structural indicators

The structural characteristics of the banking system analysed in this article are not necessarily independent. Some vulnerabilities may be intensified if they tend to simultaneously coexist with others. To explore potential interrelations, this section analyses some pairs of variables linked to the profitability, liquidity and the portfolio risk concentration of banks, as well as their degree of interconnectedness. Chart 3 shows the scatterplots of these structural indicators that represent the cross-section of the selected indicators as of 2021 Q4 for the EU countries. This pairwise analysis is not exhaustive. The objective is to highlight the usefulness of this combined study of individual variables.

First, Chart 4.1 shows the distribution of the cost-to-income ratio and RoA across the EU countries. Low structural profitability and low cost efficiency could pose a notable vulnerability for the more traditional banking business models. In the particular case of the Spanish banking sector, its profitability is just above the EU median, while its efficiency is one of the highest, corresponding to a low cost-to-income ratio, far from any sign of vulnerability.

Next, Chart 4.2 displays the distribution of the share of bank funding by central banks and the LTD ratio. Typically, banks collect deposits to finance their lending, but when they find themselves in trouble they opt for central bank funding. The onset of the COVID-19 pandemic was associated with higher liquidity risk, so that central bank funding as a precautionary measure was increasingly used by banks. The relative position of the Spanish banking sector is in the highest quartile of the cross-country distribution for both indicators, which might indicate a potential vulnerability. It is likely that, in the current context of monetary policy normalisation in the EU, deposits from central banks will decrease.

Regarding portfolio risk concentration, Chart 4.3 shows the scatterplot of the share of variable-rate mortgage loans and household indebtedness. The combination of high household indebtedness and an elevated proportion of variable-rate loans makes the banking system particularly vulnerable to both a decline in household income and higher interest rates. In the cross-country comparison, the Spanish banking sector is in the lowest quartile of the distribution for both indicators, and the proportion of variable-rate loans is below the EU median.<sup>26</sup> Therefore, no vulnerability is identified after combining both dimensions.

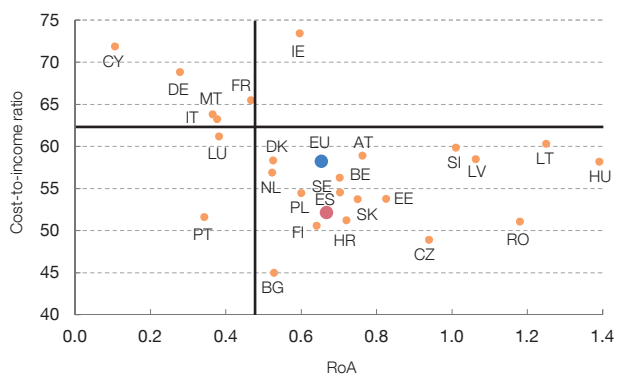
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<sup>26</sup> Since 2016 the ratio of variable-rate mortgage loans in the Spanish banking sector has been decreasing, against the backdrop of 'low for longer' interest rates and increasing competition among banks as well as from non-banks.

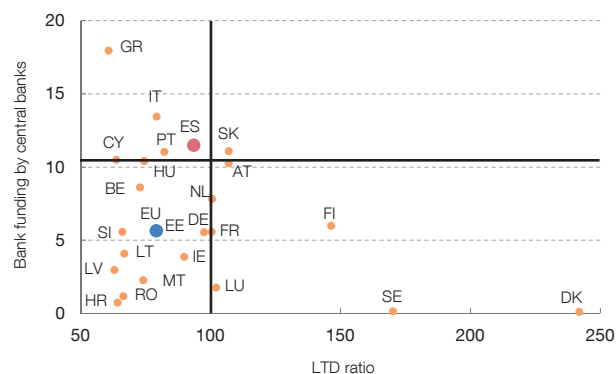
Chart 4

SCATTERPLOTS OF KEY STRUCTURAL INDICATORS

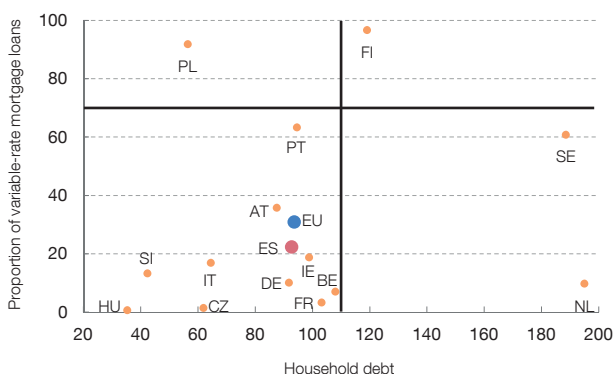
1 COST-TO-INCOME RATIO AND ROA (%) (a) (b)



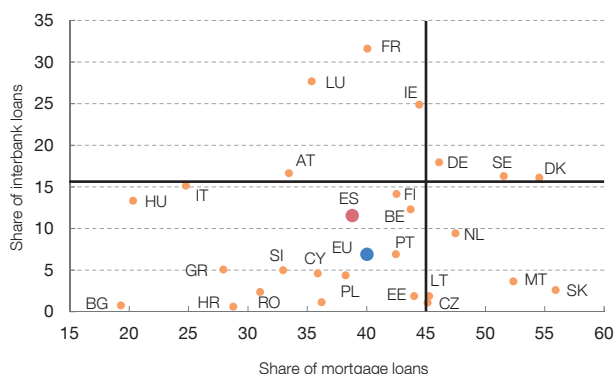
2 BANK FUNDING BY CENTRAL BANKS AND LTD RATIO (%) (a)



3 PROPORTION OF VARIABLE-RATE LOANS AND HOUSEHOLD DEBT (%) (a)



4 INTERCONNECTEDNESS AND SHARE OF MORTGAGE LOANS (%) (a)



SOURCE: Own calculations drawing on the ECB Statistical Data Warehouse.

- a Each orange dot represents a value of the indicator for the banking sector of one EU country. The red dot corresponds to Spanish data and the blue dot represents the EU median. The solid lines stand for the third quartile of the EU distribution of each indicator.
- b The solid line in the horizontal axis represents the first quartile of the EU distribution of RoA.

Finally, Chart 4.4 shows the share of interbank loans, which proxies interconnectedness, and the share of mortgage loans for the sample of EU countries. Concentration risk, such as that in mortgage portfolios, and interconnectedness may jointly amplify risks of shock propagation. According to the distribution of these indicators, the Spanish banking sector is in the lowest quartile for both, while it is above the EU median for the share of interbank loans.

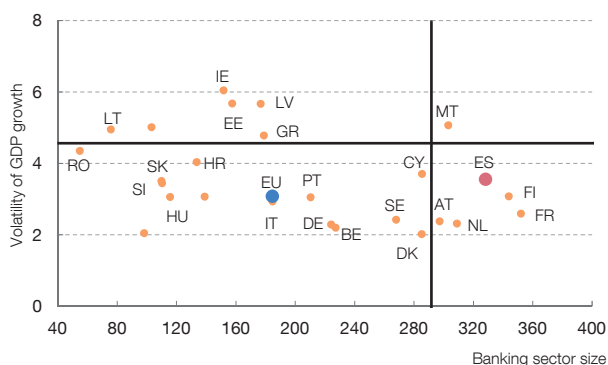
## 6 Structural risks indicators and growth

The macro-financial environment is also related to the structural characteristics of the banking system. Thus, in a context of weakening economic conditions and economic deterioration, structural vulnerabilities in banking systems would also be

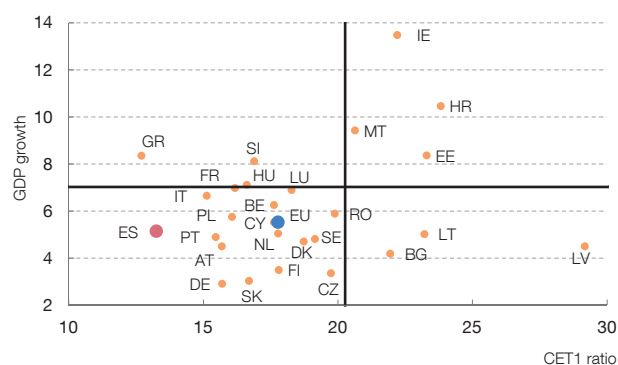
Chart 5

**STRUCTURAL RISK INDICATORS AND GROWTH**

1 VOLATILITY OF GDP GROWTH AND BANKING SECTOR SIZE (%) (a) (b)



2 GDP GROWTH AND CET1 RATIO (%) (a) (c)



**SOURCES:** Own calculations drawing on the ECB Statistical Data Warehouse and the World Bank indicators.

- a Each orange dot represents a value of the indicator for the banking sector of one EU country. The red dot corresponds to Spanish data and the blue dot represents the EU median. The solid lines stand for the third quartile of the EU distribution of each indicator.
- b GDP growth volatility is calculated from 1997 to 2021. Banking sector size is the average from 1997 to 2021.
- c Data as of Q4 2021.

affected and might affect credit and growth in turn. For instance, while lower growth puts a general drain on bank profitability via reduced asset quality across all business models, a lower interest rate environment would pose a more severe challenge to banking systems with business models largely relying on net interest income (NII) paired with a strong maturity mismatch. On the other hand, under interest rate increases there would be improvements in profitability, but such higher interest rates could pose risks to the debt servicing capacity of highly indebted agents, which could negatively impact growth.

In the literature, the link between the financial structure of the economy and economic growth has also been studied. In particular, Gambacorta, Yang and Tsatsaronis (2014) and Law and Singh (2014) discuss how the determinants of the financial sector might affect economic growth. They conclude that there is a positive correlation between the size of the financial system and economic growth. However, there is a point of negative returns so that, beyond it, additional banking intermediation is associated with lower growth. Furthermore, a large and well-capitalised banking sector could support the real economy during economic downturns, especially if the crisis is exogenous to the financial system.

Chart 5.1 displays the correlation between the size of the banking sector and GDP growth volatility. In line with Gambacorta, Yang and Tsatsaronis (2014), there is higher output volatility among countries with smaller banking sectors. Chart 5.2 suggests a positive correlation between the CET1 ratio and GDP growth. One possible interpretation of this result is that favourable economic conditions could

provide more room to the banking system to increase its resilience that could protect the economy during bad times.

## 7 Conclusions

This article puts forward a set of 20 indicators that could be relevant for regularly monitoring the Spanish banking sector's structural risks. In addition, a heatmap of these structural indicators is developed to compare the variables for Spain with those for the EU as a whole. The empirical evidence suggests that the Spanish banking sector shares most of its structural features with those of the EU economies.

However, some of the indicators for the Spanish banking sector depart from their normal range, both compared with our European peers and with their historical range. Yet the relatively high level of some indicators cannot be interpreted as posing a risk to financial stability. As a result, the analysis should be complemented with expert judgement. For instance, its relatively large banking sector (in terms of GDP) is mostly due to a high international presence, which increases exposure and vulnerability to foreign shocks and could negatively impact the domestic banking system. Further, Spanish banks' deposit deficit was one of the largest in the EU, but it has decreased sharply over the last decade. Next, the share of central bank funding, which has increased since 2012 and is above the EU median, is expected to decrease amid higher interest rates. Solvency and profitability are cross-cutting structural vulnerabilities that affect the whole European banking system. Finally, high public and foreign indebtedness make the economy more sensitive to the tightening of financing conditions that could have spill-over effects on the banking system as well.

From a policy perspective, the set of indicators and methods discussed in this article represent a helpful tool to analyse the existence of potential structural vulnerabilities in the Spanish banking sector, as well as to inform the activation of macroprudential instruments that could address structural systemic risks, such as the SyRB.

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