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Support measures in the banking sector: loan moratoria

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Abstract

This article presents a detailed analysis of the loan moratoria. The first part of the article describes the characteristics of the five types of moratoria and how the numbers of applications made and moratoria granted have evolved to date. It then outlines the status of the existing moratoria and the classification of loans whose moratoria have expired. In the second part of the article, an econometric analysis is performed to determine the impact of borrower and bank characteristics on the probability of loans being subject to moratoria, on the type and duration of the moratoria and on the classification of loans when the moratoria have expired. The results suggest that vulnerable households, those in regions most affected by the pandemic and lower income households are generally subject to legislative moratoria for longer or are more likely to transfer to non-legislative moratoria when the former expire. They also suggest that, when the moratoria expire, these households' loans are more likely to be classified as Stage 2 (a significant increase in credit risk) or non-performing.

1 Introduction

One year on from the onset of the COVID-19 pandemic, it is still having a very significant contractionary impact in Spain (and worldwide). In an endeavour to mitigate, insofar as possible, this negative shock, from both an economic and a social standpoint, various support measures were introduced in Spain for firms, workers, households and vulnerable groups. Loan moratoria – which suspend repayment of principal or payment of interest on various types of loans for a specific period – are one such measure.

In particular, loan moratoria have enabled individuals to defer their loan payment commitments. They have also provided additional support for the productive sectors most sensitive to the pandemic – by way of the tourism and transport sector moratoria – and have thus helped mitigate economic agents' liquidity problems. Yet the positive effects of the loan moratoria should not be allowed to mask other possible side effects of their implementation: they could undermine the payment culture, give rise to moral hazard or hold default rates at artificially low levels. For this reason, moratoria must be used prudently, and how they evolve and the effects they produce must be subject to continuous oversight and monitoring.

To date, five different types of loan moratoria have been approved, applicable to different types of loans and borrowers, according to the requirements and conditions set out in the corresponding Royal Decree-Laws (hereafter, RDLs).

The first, RDL 8/2020 on extraordinary urgent measures to address the economic and social impact of COVID-19, approved on 17 March 2020, introduced the legislative moratorium for mortgage loans for individuals.[1] It was followed, on 31 March 2020, by RDL 11/2020 adopting supplementary urgent economic and social measures to address the impact of COVID-19, which introduced the moratorium for non-mortgage loans (including consumer credit). Essentially, the two moratoria have the same conditions and effects, but they apply to different types of loans. The debtors eligible for these moratoria were individuals whose pre-pandemic income was below a certain threshold and who subsequently became economically vulnerable as a consequence of the health crisis that began in March 2020.

Specifically, pursuant to Article 16 of RDL 11/2020, in order to be considered economically vulnerable, all of the following conditions must be met: i) debtors must be unemployed or, in the case of entrepreneurs, have lost at least 40% of their income; ii) household income, in the month previous to applying for the moratorium, must be no more than three times (with some exceptions) the IPREM (a Spanish public income indicator); iii) mortgage payments plus essential expenses and utility costs must exceed 35% of net household income; and iv) households' economic circumstances must have changed significantly as a result of the health crisis, such that their mortgage payments have multiplied by at least 1.3 as a proportion of their household income.

Regarding the effects of these measures, during the duration of the legislative moratoria (a maximum of three months)[2] the lending bank cannot demand any mortgage payments, nor any part thereof (repayment of capital or payment of interest), neither in full nor in part, and no interest is accrued. As a result of this temporary suspension of payment obligations, the loan maturity is extended by the duration of the moratorium.

Subsequently, in May 2020, in addition to the two legislative moratoria described above, a special regime was established for banking sector framework agreements, through the banking associations,[3] on the deferral of loans of customers affected by the COVID-19 crisis. These framework agreements instigated by associations representing banks, savings banks, cooperative banks and specialised lending

1 Initially, this moratorium applied only to main residence mortgages, but Article 19 of RDL 11/2020 of 31 March 2020 subsequently extended the scope to include property used by self-employed professionals and entrepreneurs for their economic activity, and also rented housing other than the main residence in cases in which the mortgagor/lessor ceased to receive rent payments by application of the measures introduced to assist tenants as a consequence of the state of alert.

2 RDL 3/2021 of 2 February 2021, adopting measures to narrow the gender gap and on other Social Security and economic matters, extended the duration of the moratoria to nine months.

3 RDL 19/2020 of 26 May 2020 adopting supplementary measures in the agricultural, scientific, economic, employment and social security and taxation sphere to alleviate the effects of COVID-19.

institutions[4] extended the scope of the moratoria from both a subjective and an objective standpoint.

From a subjective standpoint, because individuals applying for these moratoria do not need to meet the eligibility requirements established in Article 16 of RDL 11/2020 for the legislative moratoria. Rather, any individual borrowers with loans that had not previously been in default and who have been economically affected by the COVID-19 crisis – becoming unemployed or subject to furlough schemes (ERTEs by their Spanish acronym), or facing the suspension of or restrictions on their economic activity, or other equivalent circumstances – are eligible for these banking sector moratoria.

From an objective standpoint, because the new moratoria can last longer than the legislative ones. Specifically, the maximum duration is 12 months for the mortgage loan moratorium and six months for the personal loan moratorium.[5] As regards their effects, unlike the legislative moratoria, the banking sector moratoria only suspend repayment of principal, while interest payments continue to fall due throughout.

Lastly, in early July, two further moratoria were introduced, in this case not only for individuals but also for legal entities. These moratoria apply to loans granted to the tourism sector[6] and to the public transport of goods and charter bus sector.[7]

Most European countries have introduced moratorium schemes as an integral part of their support policies in response to the crisis. In this respect, the European Banking Authority (EBA) approved a series of conditions that loans had to satisfy in order for the moratoria to have a more flexible prudential treatment. These conditions included a deadline for application of the moratoria, which has been extended in successive Guidelines[8] (first up to 30 September 2020 and subsequently up to 31 March 2021) owing to the uncertainty surrounding economic activity and its potential recovery.

For all five types of moratoria, lenders must report data to the Banco de España on the number of moratorium applications submitted by borrowers, the number of moratoria granted, the number of beneficiaries and whether they are wage-earners or self-employed, the outstanding amount of loans subject to moratoria and, for the

4 Spanish Banking Association (AEB) framework agreement (2020), Spanish Confederation of Savings Banks (CECA) framework agreement (2020), Spanish Association of Credit Cooperatives (UNACC) framework agreement (2020) and Spanish Association of Specialised Lending Institutions (ASNEF) framework agreement (2020).

5 In the case of banking sector moratoria that are a follow-on from legislative moratoria, this maximum duration includes the effective duration of the latter. Accordingly, if the three-month term of the legislative moratorium had expired, the remaining duration would be either nine months (mortgage loan moratorium) or three months (personal loan moratorium).

6 RDL 25/2020 of 3 July 2020 on urgent measures to support economic recovery and employment.

7 RDL 26/2020 of 7 July 2020 on economic recovery measures to address the impact of COVID-19 on transport and housing.

8 EBA (2020a).

self-employed, the economic sector in which they operate.[9] Drawing on this information provided by banks, since April 2020 the Banco de España has been publishing a monthly briefing note on the legislative and banking sector moratoria.[10] In addition, this ongoing monitoring of moratoria contributes to complying with Recommendation 2020/8 of the European Systemic Risk Board (ESRB) of May 2020[11] which, inter alia, recommends that EU national macroprudential authorities monitor the measures adopted and analyse their implications for financial stability.[12]

This article analyses the key factors that explain why households with a mortgage decide to take up a moratorium introduced in response to the impact of COVID-19, and the probability that they will choose a legislative moratorium. In addition, drawing on duration analysis, we estimate the probability of an original legislative moratorium expiring or being transferred to one of the other forms of moratoria.[13]

Clarifying the factors that explain the take-up of moratoria and the probability of their being legislative moratoria, as well as the exit therefrom and transfer to other types of moratoria, is key to understanding some of the implications that these measures will have in the coming months, once the period of more flexible prudential treatment established for them by the EBA comes to an end. It is important to note that legislative moratoria (which account for barely 5% of the outstanding credit stock subject to moratoria at end-2020) must be granted by law to applicants who satisfy the requirements established in the corresponding regulations (RDLs), but there is no obligation on banks to maintain the moratorium measures once the legally-established period ends. Accordingly, at that stage mortgage portfolio management decisions, among others, come into play.

The results of the econometric analysis show that the following groups record the highest take-up of moratoria: households that were more disadvantaged (for example, lower income households) or more vulnerable (households with higher debt or with mortgages with less favourable conditions) at the start of the pandemic; the self-employed; those hardest hit in terms of employment (in provinces with a higher unemployment rate or higher percentage of furloughed workers owing to COVID-19); and those linked to the economic sectors most affected (such as retail, hospitality or transport). This is consistent with the purpose of these schemes. Moreover, this would appear to be the case above all among the weakest banks (in

9 Pursuant to: Article 16 bis of RDL 8/2020 of 17 March 2020; Article 27 of RDL 11/2020 of 31 March 2020; Article 9 of RDL 25/2020 of 3 July 2020; Article 23 of RDL 26/2020 of 7 July 2020; and Article 6.3 of RDL 19/2020 of 26 May 2020.

10 Banco de España (2021).

11 ESRB (2020).

12 In the case of Spain, this ESRB recommendation is addressed to the Spanish macroprudential authority (AMCESFI) in which the Banco de España participates, along with the Ministry of Economic Affairs and Digital Transformation and the National Securities Market Commission (CNMV). The ESRB monitors these measures for the whole of the European Union (see ESRB (2021)).

13 For alternative analyses of the trajectory and different characteristics of the loans and borrowers subject to moratoria, see Banco de España (2020) and Alves et al. (2020 and 2021).

terms of lower capital ratios or higher NPL rates). All the above highlights the important role that the moratoria have played to cushion the initial impact of the pandemic, but also the need to monitor these schemes, on account of the high risk of borrowers falling into default if economic activity fails to normalise in the near term.

In this respect, the results also seem to suggest that households with a higher debt-to-income ratio, those located in regions heavily affected by the pandemic and lower income households tend to be subject to legislative moratoria for longer (or are more likely to take up non-legislative moratoria when the former expire). This is consistent with the possibility of a latent risk in banking sector moratoria portfolios for a certain household segment. The findings also show that loans that are classified as Stage 2 (i.e. with a significant increase in credit risk) or non-performing when the moratoria expire are especially those that were initially subject to legislative moratoria and those pertaining to households with lower income, higher debt ratios or poorer credit histories, older households or those that had a personal guarantee, and those located in regions where COVID-19 has had a more severe impact on employment. In this respect, it is important to note that although the take-up of legislative moratoria by the self-employed has been proportionally higher, reflecting the severe impact of the crisis on this group, the findings do not suggest that when their mortgage loans exit moratoria they are more likely to be classified as Stage 2 or non-performing.

The remainder of the article is structured as follows. The next section analyses how the total volume of applications made and moratoria granted has evolved and the status of the existing moratoria. Section 3 describes the characteristics of the granular data used for the econometric analysis of the moratoria, followed in Section 4 by a definition of the empirical strategy used. Section 5 describes the distribution and main characteristics of the variables considered and Section 6 comments on the results obtained. The last section presents a summary of the main conclusions.

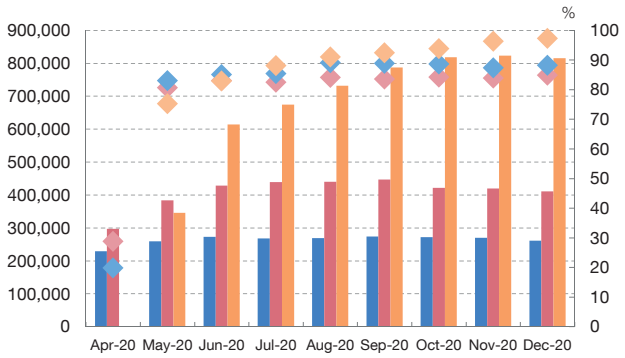
2 Trajectory and current status of moratorium applications, moratoria granted and outstanding moratoria

Drawing on the information provided by banks to the Banco de España, the number of applications rose swiftly from the outset. The number of moratoria granted also rose rapidly, such that acceptance rates have been high from the start. For instance, at end-May 2020 acceptance rates were already over 80% for legislative mortgage and non-mortgage moratoria and over 75% for banking sector moratoria (see Chart 1.1). Moreover, this high level of acceptance was widespread across banks. With data at end-December, more than 260,000 applications had been made for legislative mortgage moratoria, of which 222,000 had been granted, an acceptance rate of 85%. In the case of legislative non-mortgage moratoria, the applications

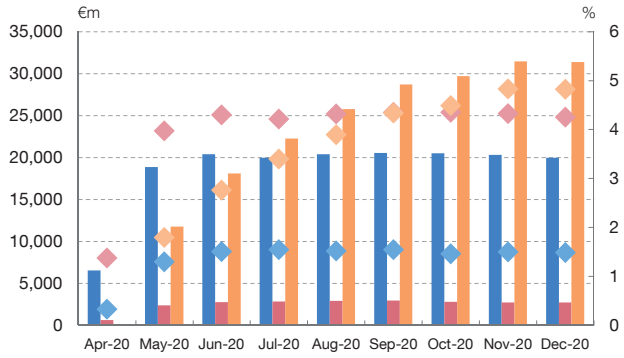
Chart 1

NUMBER AND OUTSTANDING AMOUNT OF LEGISLATIVE AND BANKING SECTOR LOAN MORATORIA

1 CUMULATIVE NUMBER OF APPLICATIONS AND ACCEPTANCE RATE BY MORATORIUM TYPE (a) (b)



2 OUTSTANDING AMOUNT OF MORATORIA, AND AS PERCENTAGE OF TOTAL LOANS ELIGIBLE FOR MORATORIUM SCHEMES (c) (d)



SOURCE: Banco de España.

a For each moratorium scheme, the bars denote the cumulative total of applications (left-hand axis) and the diamond the percentage of that total that was approved (right-hand axis).

b The number of applications for legislative and non-legislative mortgage moratoria, and the number granted, fell from October. According to the explanations provided in the information reported by banks, this was due to: reclassification of some of these moratoria to banking sector moratoria, given that the customer failed to evidence vulnerability; elimination of applications in which, ultimately, the customer failed to present the necessary documentation; updating of claims; or adjustment of the information reported after verifying operations that had been rejected or cancelled by the customer. All these reasons, except for the first, also explain the decrease in the number of applications for banking sector moratoria, and in the number granted, between November and December.

c For each moratorium scheme, the bars denote the take-up volume (left-hand axis) and the diamond denotes this volume as a percentage of the total eligible loan book (for example, the legislative mortgage moratoria as a percentage of total mortgage credit to individuals) (right-hand axis).

d From October, the outstanding amount of legislative mortgage and non-mortgage moratoria declined. According to the explanations provided in the information reported by banks, this was due to: reclassification of some of these moratoria to banking sector moratoria, given that the customer failed to evidence vulnerability; elimination of applications in which, ultimately, the customer failed to present the necessary documentation; updating of claims; or adjustment of the information reported after verifying operations that had been rejected or cancelled by the customer. All these reasons, except for the first, also explain the decrease in the outstanding amount of banking sector moratoria between November and December.

numbered more than 410,000, of which more than 363,000 had been granted, an acceptance rate over 88%. Given their less strict requirements, at end-December the acceptance rate for banking sector moratoria was even higher, at 97.4%, with more than 794,000 applications having been granted of the more than 815,000 submitted.

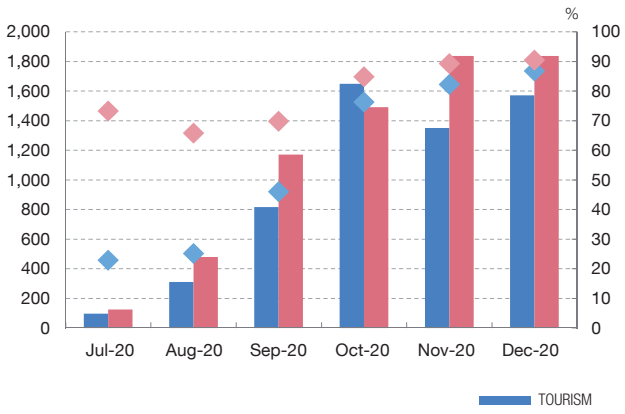
The outstanding amount of the loans subject to legislative mortgage moratoria was almost €20 billion (4.3% of the total outstanding amount of mortgage credit to individuals) (see Chart 1.2), much higher than the total for legislative non-mortgage moratoria (almost €2.7 billion, 1.5% of the total outstanding amount of non-mortgage credit to individuals). In turn, the outstanding amount of the loans subject to banking sector moratoria was over €31 billion (4.8% of the total outstanding amount of mortgage and non-mortgage credit to individuals).

For the last two types of moratoria, relating to the tourism and transport sectors, the number of applications and moratoria granted is much lower. Specifically, at end-

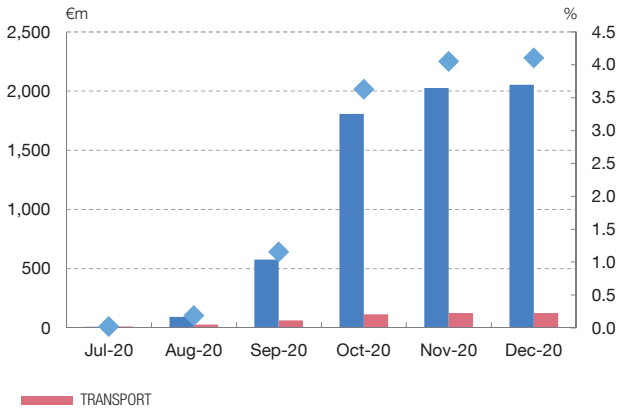
Chart 2

NUMBER AND OUTSTANDING AMOUNT OF TOURISM AND TRANSPORT SECTOR LOAN MORATORIA

1 CUMULATIVE NUMBER OF APPLICATIONS AND ACCEPTANCE RATE BY MORATORIUM TYPE (a)



2 OUTSTANDING AMOUNT OF MORATORIA, AND AS PERCENTAGE OF TOTAL LOANS ELIGIBLE FOR THESE SCHEMES (b)



SOURCE: Banco de España.

a For each moratorium scheme, the bars denote the cumulative total of applications (left-hand axis) and the diamond the percentage of that total that was approved (right-hand axis).
b For each moratorium scheme, the bars denote the take-up volume (left-hand axis) and the diamond denotes the tourism sector moratoria as a percentage of total tourism sector credit (right-hand axis).

2020, 1,570 applications had been submitted for the tourism sector legislative moratorium, of which 1,362 had been granted, an acceptance rate of almost 87% (see Chart 2.1). In the case of the transport sector legislative moratorium, 1,836 applications had been submitted, of which 1,661 had been granted, an acceptance rate of over 90%. The outstanding amount of the loans subject to the tourism sector moratorium was over €2 billion (4.1% of the total outstanding amount of the eligible loan book), while in the case of the transport sector moratorium it was just €125 million (see Chart 2.2).

For the three types of moratoria for individuals (the two legislative and the banking sector moratoria), the vast majority of the borrowers benefiting from these measures are wage-earners, who account for more than 75% of the total. However, considering that the Spanish labour market has a much higher number of wage-earners,[14] in proportional terms the take-up of the self-employed is higher; this highlights the severe impact the crisis has had on this group. The breakdown by economic sector of the self-employed who have taken up moratoria shows that retail, hospitality and other services together account for 56% of the total moratoria, followed at a considerable distance by professional, scientific and technical activities, transportation, construction, and manufacturing. Overall, these seven economic sectors account for almost 80% of the total moratoria granted to the self-employed.

14 According to National Statistics Institute (INE) data, at 1 January 2020 there were 1.9 million self-employed in Spain, compared with almost 20 million wage-earners.

To sum up, the various loan moratorium schemes adopted in response to the health crisis have attracted a high number of applications: almost 1.5 million at end-December 2020, of which 1.38 million had been granted, a very high acceptance rate verging on 93%. As a result of this high number of applications received and moratoria granted, at end-December 2020 the volume of loans subject to moratoria was over €56 billion (8% of all outstanding credit in the eligible loan books). This notably enhances the beneficiaries' ability to meet their financial obligations and their available liquidity in the near term, in accordance with the goals of these schemes.

However, the data provided by banks under the provisions of the RDLs[15] have their limitations. The main constraint is that they refer exclusively to the cumulative stock of applications for moratoria and moratoria granted since the schemes were first launched, irrespective of whether or not the moratoria are still in place. In consequence, to ascertain the current status of the moratoria, it is essential to identify the repayment flows – of moratoria that have expired or have been cancelled – so as to determine the volume of existing moratoria at each point in time. To obtain this information, the data contained in the Banco de España's Central Credit Register (CCR) are used. These data provide the latest available information (for this article, up to December 2020) on the performance of each loan subject to any kind of moratorium since origination. The CCR data include, in addition to the types of moratoria referred to above, all other moratoria – bilateral moratoria – granted as a consequence of the COVID-19 pandemic, backed by the principle of freedom of contract envisaged in the Spanish Civil Code and which may be agreed between parties even though they are not covered by a sector-wide framework agreement.

Accordingly, based on the CCR data, we now draw a distinction between two large groups of moratoria: legislative moratoria, which include the mortgage and non-mortgage moratoria for individuals and the tourism and transport sector moratoria; and conventional moratoria, which include the banking sector and bilateral moratoria.

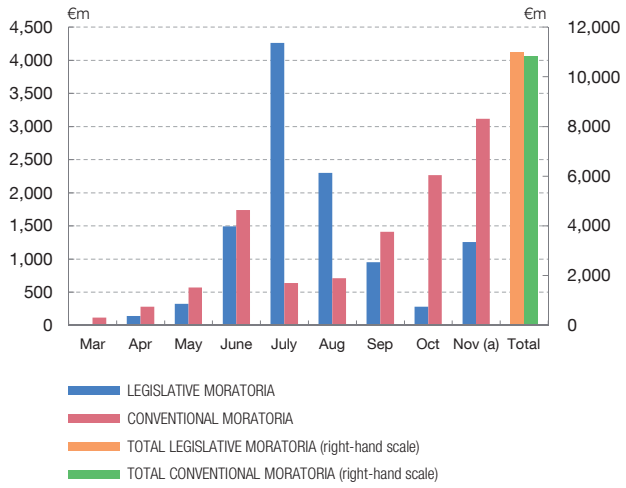
Chart 3.1 depicts the flows of expiries of loan moratoria as a consequence of discharges, repayments and cancellations (three ways by which moratoria come to an end and which are referred to hereafter as "reductions in moratoria"). The pattern of reductions is very different for the two groups, as a result of their different duration. For legislative moratoria, consistent with the higher volumes granted in April and May, the biggest reductions are in July and August, i.e. three months later, since as indicated earlier this was the duration of the legislative mortgage and non-mortgage moratoria up to the publication of RDL 3/2021 (see footnote 2). Specifically, 60% of the reductions in legislative moratoria occurred in July and August, and 77% had occurred up to August.

15 See footnote 9.

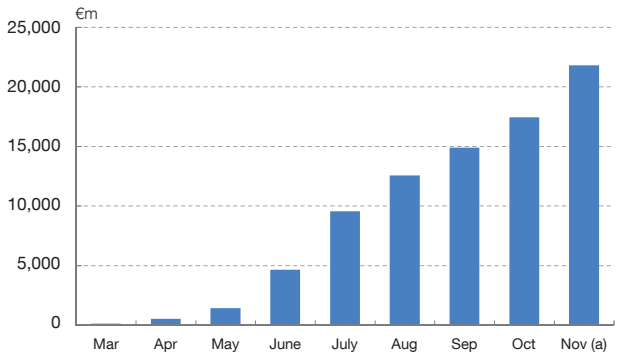
Chart 3

LOAN MORATORIA EXPIRED OR CANCELLED

1 FLOW OF LOAN MORATORIA EXPIRED OR CANCELLED, BY MONTH



2 CUMULATIVE TOTAL OF LOAN MORATORIA EXPIRED OR CANCELLED



SOURCE: Banco de España.

a The reductions data run to November, consistent with the criterion used to calculate the moratoria outstanding at December (moratoria that expire in December are not considered to have expired until end-December).

By contrast, the reductions in conventional moratoria, which have a longer duration, came later (see Chart 3.1), with half of these reductions occurring in October and November. On the latest data available, the cumulative total of reductions is very similar in the two groups of moratoria, amounting to some €11 billion in each group.

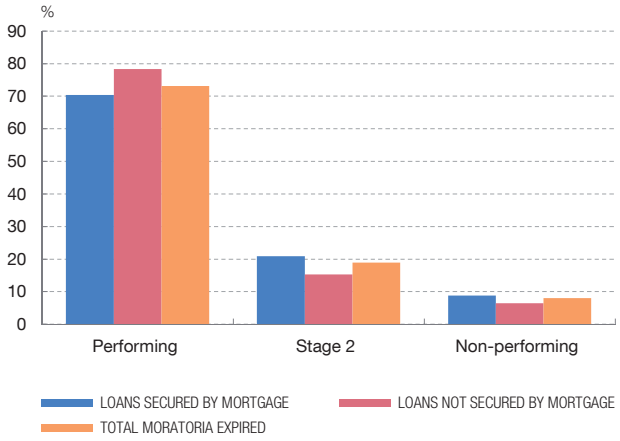
The different exit pattern for the two groups gives rise to a sustained increase in the cumulative total (see Chart 3.2) from June (up to May, only 9% of the total reductions had occurred), owing to legislative moratoria in the early months and conventional moratoria in the later months.

To recap, the cumulative amount subject to moratoria (some €28 billion in each group) and the cumulative amount expired (around €11 billion in each group) are similar for both groups, such that it could be concluded that the outstanding amounts subject to moratoria in the two groups are also similar (at around €17 billion). Yet nothing could be further from the truth, since there is another element to be considered, i.e. transfers between groups of moratoria. Specifically, over the course of 2020, loans initially subject to legislative moratoria amounting to €15.2 billion were transferred to conventional moratoria. This is because, as indicated earlier, the shorter duration of the legislative moratoria is conducive to their being transferred, upon expiry, to banking sector or bilateral moratoria. Accordingly, at end-December, the difference between legislative and conventional moratoria is much greater in terms of the outstanding amount than in terms of the cumulative total of applications

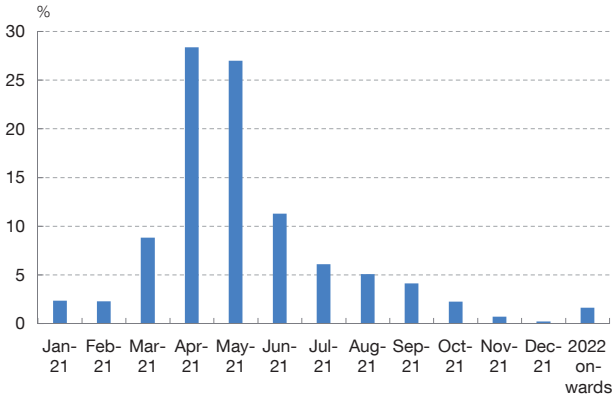
Chart 4

CREDIT QUALITY OF LOANS EXITING EXPIRED MORATORIA AND EXPIRIES OF OUTSTANDING MORATORIA

1 CREDIT QUALITY OF LOANS EXITING EXPIRED OR CANCELLED MORATORIA (a)



2 EXPIRIES OF TOTAL OUTSTANDING MORATORIA, BY MONTH, AT DECEMBER 2020 (% OF TOTAL)



SOURCE: Banco de España.

a Non-performing loans include loans that are non-performing for subjective reasons and loans that are non-performing for objective reasons (>90 days past due).

and moratoria granted: the loans outstanding subject to moratoria stood at around €34 billion, the bulk of which are conventional moratoria (over €32 billion, 95% of the total), while legislative moratoria accounted for just €2 billion (5% of the total outstanding).

As regards the classification of the loans amounting to almost €22 billion whose moratoria have expired or have been cancelled, most (almost three-quarters of the total) are performing, that is, their risk has not increased since origination. Almost 20% are classified as Stage 2, i.e. their risk has increased and their credit quality has declined since initial recognition, but no credit losses have been recorded. Lastly, just 6% are non-performing, that is, they have become impaired and credit losses have appeared. By type of collateral, 21% of loans secured by mortgage that were subject to moratoria are classified as Stage 2 (15% of unsecured loans or loans not secured by mortgage) and 9% are classified as non-performing (6% for all loans not secured by mortgage) (see Chart 4.1).

Lastly, regarding the outstanding moratoria, which amount to more than €34 billion, Chart 4.2 depicts the expected expiries in the coming months (from January 2021). Given that conventional moratoria account for the bulk (95%) of the total volume of outstanding moratoria at December 2020, they fully shape the expiry pattern. Chart 4.2 also shows that some 85% of the total will expire in the first six months of 2021, and that the main expiries (more than 50%) are concentrated between April and May.

In any event, the trajectory of the loan moratoria over the coming months (specifically, the total volume of loans subject to moratoria and the possible new moratoria granted) may change, given the current uncertainty surrounding the course of economic activity, the fact that the EBA is reactivating its Guidelines on the deadline for application of moratoria[16] and the entry into force of RDL 3/2021. In consequence, the expiry profile shown to date could alter. The experience of these months shows that support measures of this kind are flexible and that they may be activated and withdrawn relatively quickly. It also shows that they must be used prudently, so as to ensure that at the same time as they ease borrowers' potential liquidity problems they also preserve adequate repayment incentives.

3 Databases

In order to describe as fully as possible the quality of the mortgage loans subject to some sort of deferral measure, whether through the legislative or banking sector moratorium schemes linked to the COVID-19 health crisis or through individual bilateral moratoria, two administrative registers are used: the Banco de España's CCR, which has granular data on the characteristics of all credit transactions in Spain and on some borrower characteristics, and the data obtained from banks' own balance sheets, included in their regular reporting to the Banco de España.

The CCR is a confidential database belonging to the Banco de España that has data on all bank loans extended since 1984 in Spain over €6,000. The data are reported monthly and include loan characteristics (interest rate, maturity, loan amount, collateral, etc.) and also some borrower characteristics (gender, age, economic sector, employment status, postcode, etc.). Drawing on all this information it is possible to analyse bank lending on a monthly basis and the key characteristics of the loans granted.

The analysis in this article considers only households' mortgage loans in force as at 31 December 2019. The main characteristics of these loans will be described, drawing on certain variables taken from the loan register, such as original term to maturity (in months), interest rate, number of borrowers, and whether or not there is a personal guarantee. In addition, any changes in the payment commitment status that may arise throughout the period considered are also taken into account. For this purpose, using data recently incorporated into the loan register, which enhance banks' reporting on their exposure to loans affected by the support measures approved to address the social and economic impact of the pandemic, it is possible to identify mortgages that are benefiting from a payment moratorium and to ascertain

16 See EBA (2020b) in which the EBA reactivated the application of its Guidelines up to 31 March 2021, thus extending for borrowers that had not previously benefited from payment moratoria on bank debt the opportunity to do so.

whether their grace period is linked to the COVID-19 crisis (in other words, whether it is a legislative, banking sector or bilateral moratorium).

Certain borrower characteristics are also identified, to determine the loan's credit risk, using for this purpose data available in the CCR since 2016. Specifically, characteristics of the household reference person (assumed to be the oldest borrower) are considered, as a synthesis of the characteristics of the mortgagor household: their age in 2019, if they are foreign or self-employed and also their past credit history (if they have had loans classified as non-performing before 2019). In addition, other less granular data are used to proxy certain household characteristics that are not available in the CCR and that are highly relevant to measure households' ability to pay, such as income and the employment situation in their region. Average gross household income in 2016 in the postcode in which the mortgaged property is located is used to proxy gross household income and the household debt-to-income ratio. Other variables used are the percentage of furloughed workers and the unemployment rate in the province in which the property is located, to quantify the probability that the household may have undergone a negative income shock affecting its ability to meet its payment obligations.

In addition, to include aspects that may influence banks' decisions, information included in their regular supervisory financial reporting to the Banco de España is used. Specifically, their asset volume, a measure of capital close to the leverage ratio (net equity to assets, which we call the "capital ratio"), their profitability (rate of return on average total assets (ROA)), their liquidity ratio (liquid assets to total assets), their NPL ratio (non-performing assets to loans to other resident actors) and a measure of their mortgage lending over the last five years.

By combining these data sources, a relatively complete description is obtained of the characteristics of each loan at the mortgage/bank level. This allows us to analyse which supply-side factors (linked to the bank) and demand-side factors (linked to the borrower or the macroeconomic situation of the province in which the property is located) could be most useful to explain the probability: i) that a household will have taken up any of the various types of COVID-19 moratoria; ii) that it will have transferred from one type of payment moratorium to another; and iii) that it will have exited the moratorium.

4 Empirical identification

The main aim of this study is to investigate the specific characteristics of mortgages that have been subject to any of the different types of payment moratoria introduced in response to the impact of COVID-19, be they legislative, banking sector or bilateral moratoria. It also aims to characterise the households that took up legislative moratoria and the performance of the moratoria over time, highlighting any transfers between moratoria that may have taken place.

As discussed in the previous section, CCR data on mortgages that were in force as at December 2019 are used; this provides us with more than 5.3 million observations. The CCR database includes a large number of variables as to households, mortgages, regions of Spain and mortgagee banks, but the drawback is that some of the data on households are static. We assigned them to each household, drawing on the information available at the postcode level (for instance, for average household income), or on the macroeconomic data available at the province level to proxy information that is not available in the CCR at a more granular level. Nevertheless, taking into account all these factors enables us to gain a better understanding of how these support measures have functioned, which households have been most affected by them and which banks are making most use of them and are consequently most exposed to how they evolve going forward. This can provide us with indications as to the future risk for the banking system when these measures come to an end.

First, access to the moratorium schemes and the characteristics of the mortgages subject to the schemes are analysed. The dependent variable is a dichotomous variable that takes the value 1 if the mortgage is, or has been, subject to any of the three types of moratoria (legislative, banking sector or bilateral moratoria) during 2020 (up to 31 December), and the value 0 otherwise. Thus, this variable is $Moratorium_{ij}$, where subscript "i" is the loan and subscript "j" is the lending bank. This would be an estimated ordinary least squares linear probability model, thus:[17]

$$\begin{aligned} Moratorium_{ij} = {} & \Omega_1 \text{ Household characteristics}_i + \Omega_2 \text{ Mortgage characteristics}_i + \\ & \Omega_3 \text{ Province characteristics}_i + \Omega_4 \text{ Bank characteristics}_j + u_{ij}, \end{aligned} \quad [1]$$

where four sets of variables are introduced as explanatory factors: 1) household characteristics (synthesised through the information on the household reference person, deemed to be the oldest household member who is a mortgagor), including average household income (drawing on National Statistics Institute (INE) postcode data for 2016), the age of the household reference person, their credit history, their total bank debt-to-income ratio in 2019 and, for the self-employed, their profession or economic sector;[18] 2) loan characteristics, including the interest rate level, whether it is fixed or variable, whether the loan has a personal guarantee, and the logarithm of its original maturity; 3) characteristics of the situation at the provincial level, reflecting the impact of the pandemic on employment through the percentage of furloughed workers and the unemployment rate (both obtained from the National Public Employment Service (SPEE)); and 4) bank characteristics, including bank size (logarithm of total assets), capital ratio (net equity to assets), liquidity ratio (liquid

17 A linear probability model, rather than a binary probit type model, has been used for several reasons: first, to facilitate the interpretation of the estimated coefficients, in particular the effect of the interactions; second, because it enables standard errors to be corrected by multi-cluster; and third, because there is no intention to use the estimated coefficients for predictions.

18 See Table 1 for the complete list of the characteristics considered.

assets to total assets), profitability (ROA) and NPL ratio (non-performing assets to credit to other resident sectors), as an indicator of whether a bank's mortgage business has grown more than the system average over the last five years. In addition, u_{ij} represents the error component, and in the estimation standard errors are simultaneously corrected for bank and property postcode clusters.

The possible heterogeneity of the results is also analysed, estimating the same model as that contained in equation [1], adding interactions between certain variables. Thus, for example, we match the debt-to-income ratio to household income, to check whether the effect of the debt diminishes as income diminishes, and we analyse which banks are more likely to have mortgages subject to moratorium schemes according to the mortgage risk profile, captured by the interest rate, original maturity or the bank debt-to-income ratio.

Lastly, we also investigate whether legislative moratoria differ in any way from the other types of moratoria, whether they are greater risk or have a greater presence at certain types of banks. In addition, focusing on legislative moratoria, we analyse which of their characteristics are conducive to their expiring or being transferred to a different type of moratoria. This enables us to identify the characteristics of mortgages that are transferred from legislative to non-legislative moratoria and to detect the risk building up owing to the new grace periods.

To ascertain the key factors that determine the probability of a mortgage loan subject to moratorium being initially subject to a legislative moratorium, a linear regression model is estimated where the dependent variable is a binary variable that takes the value 1 if the original moratorium in 2020 was a legislative moratorium, with the following equation:

$$\begin{aligned} \text{Original legislative moratorium}_{ij} = {} & \Omega_1 \text{ Household characteristics}_i + \\ & \Omega_2 \text{ Mortgage characteristics}_i + \Omega_3 \text{ Province characteristics}_i + \\ & \Omega_4 \text{ Bank characteristics}_j + u_{ij}, \end{aligned} \qquad [2]$$

where the sample is limited to mortgages subject to any of the types of moratoria. In this case also, standard errors are simultaneously corrected for bank and property postcode clusters.

To analyse the transitions of a legislative moratorium at expiry or at change in status, a duration model is considered in which the moratorium is monitored from the point of origination to the last observation, be it upon expiry or change of status or simply because it remains outstanding. This type of model allows us to analyse the length of time the loans remain in a certain status and, at the same time, to control for the fact that moratoria are observed that have not yet either expired or changed status (censored observations), because there are no more observations available on them.

For the purposes of this analysis, two types of exit from or transition between moratoria are studied: expiry of outstanding legislative moratoria, either ahead of term or when the moratorium ends; and change in status of outstanding legislative moratoria, becoming banking sector or bilateral moratoria. In both cases a Cox proportional risk model[19] is used, where the exit rate takes the following form:

$$h(t) = h_o(t) \times \exp\left(\begin{array}{c}\Omega_1 \text{ Household characteristics}_i + \Omega_2 \text{ Mortgage characteristics}_i + \\ \Omega_3 \text{ Province characteristics}_i + \Omega_4 \text{ Bank characteristics}_j\end{array}\right), \quad [3]$$

where the rate of exit is the probability in each period "t" (month) of the moratorium ending with a transition (expiry or change of status). In this case, standard errors are corrected only for bank cluster, as it is not possible to simultaneously correct for postcode cluster.

Lastly, we also analyse the factors that explain why a loan whose moratorium has expired is classified as non-performing or Stage 2 as at December 2020. For this purpose, we use a similar model as in equation [2], but we replace the dependent variable with a binary variable that takes the value 1 if the loan whose moratorium has expired is classified as non-performing or Stage 2 at end-2020, and a value 0 otherwise. In this case, the sample is limited to expired moratoria. The equation is as follows:

$$\begin{array}{c}\text{Loan whose moratorium has expired and which is classified as non-performing} \\ \text{or Stage 2}_{ij} = \Omega_1 \text{ Household characteristics}_i + \Omega_2 \text{ Mortgage characteristics}_i + \\ \Omega_3 \text{ Province characteristics}_i + \Omega_4 \text{ Bank characteristics}_j + u_{ij}\end{array} \quad [4]$$

5 Descriptive statistics

As indicated earlier, this article draws on information on mortgage loans granted to households in Spain in force as at 31 December 2019. Table 1 depicts the average, the standard deviation, the first quartile, the median and the third quartile of the variables used in the analysis. The set of mortgages considered is classified according to whether they were subject to payment moratoria in 2020. The loans that were are then classified into two groups, according to whether they were originally legislative moratoria and to the possible changes in their payment deferral status over the year.

Table 1 shows that around 5% of residential mortgages granted to households in force as at 31 December 2019 benefited from a payment moratorium in 2020; of these, around three-fifths were initially legislative moratoria. In other words, at least

19 A Cox model, entailing a risk function h(t) with parameter θ constant and equal to 1, was used for the sake of simplicity.

Table 1
DESCRIPTIVE STATISTICS

	Unit	Average	SD	p25	Median	p75
Moratorium	0/1	0.050	0.217	0.000	0.000	0.000
Initially legislative moratorium	0/1	0.559	0.496	0.000	1.000	1.000
Legislative moratorium expired	0/1	0.478	0.500	0.000	0.000	1.000
Legislative moratorium changed status	0/1	0.518	0.500	0.000	1.000	1.000
Moratorium expired - loan classified as non-performing or Stage 2	0/1	0.230	0.421	0.000	0.000	0.000
Household characteristics						
Log(Average household income)	Log(€)	9.741	0.435	9.380	9.794	10.061
Log(Debt-to-income ratio)	Log(%)	5.527	0.884	5.021	5.668	6.171
Log(Age)	Log(Months)	6.372	0.217	6.229	6.363	6.519
Foreign	0/1	0.051	0.219	0.000	0.000	0.000
Self-employed	0/1	0.111	0.314	0.000	0.000	0.000
Poor credit history	0/1	0.081	0.272	0.000	0.000	0.000
Mortgage characteristics						
Interest rate	%	1.627	1.429	0.543	1.103	2.210
Personal guarantee	0/1	0.159	0.365	0.000	0.000	0.000
Log(Original maturity (months))	Log(Months)	5.725	0.321	5.501	5.724	5.905
More than one mortgagor	0/1	0.639	0.480	0.000	1.000	1.000
Province characteristics						
Percentage furloughed workers	%	18.207	4.388	15.889	18.032	21.057
Unemployment rate	%	14.519	4.694	10.600	14.080	18.290
Bank characteristics						
Log(Assets bank)	Log(€1,000)	18.669	1.382	17.713	19.157	19.810
Capital ratio/bank	%	8.148	2.455	6.309	7.668	9.312
ROA bank	%	0.484	0.194	0.369	0.487	0.668
Liquidity ratio/bank	%	8.573	4.045	7.178	7.845	9.860
NPL ratio/bank	%	4.981	1.810	3.966	5.177	5.634
High mortgage lending growth	0/1	0.474	0.499	0.000	0.000	1.000

SOURCE: Devised by authors, drawing on CCR data.
NOTE: The table depicts the average, the standard deviation (SD) and the first, second and third quartiles of the distribution of some characteristics of the mortgages in force as at December 2019.

55.9% of the households that obtained a mortgage payment moratorium in 2020 were vulnerable households in accordance with the definition established in RDL 8/2020 and RDL 11/2020.[20] In addition, of the total mortgage moratoria that were originally legislative moratoria, 47.8% concluded before the end of 2020 and 51.8% were transferred to another type of moratorium (mainly banking sector) between March and December 2020. Lastly, of the moratoria that expired, 23% of the

20 This entails, as discussed in the introduction, that households' mortgage payments plus utility costs and essential expenses (electricity, gas, water, telecommunication services and service charge) account for more than 35% of their net household income, and that their debt-to-income ratio has changed significantly (their mortgage payments have multiplied by at least 1.3 as a proportion of their household income).

corresponding loans were classified as non-performing or Stage 2 as at December 2020.

Regarding the characteristics of the households considered, the logarithm of gross income per household (in euro) averages 9.74, with a standard deviation of 0.44 (in other words, average gross income per household is approximately €11,855). The household reference person (the oldest mortgagor) has an average age of 58 (the logarithm of the age of the household reference person in months averages 6.37), is foreign in 5% of households, self-employed in 11% and has a poor credit history in 8.1%.

The mortgage characteristics show that the average mortgage rate is 1.6%, although it varies enormously, with a dispersion coefficient of 87.8%. Of the mortgages considered, 15% have a personal guarantee and the logarithm of the number of months to maturity at origination is 5.73 (i.e. average original maturity of slightly more than 25 years).

In the provinces where the housing subject to the mortgages considered is located the unemployment rate is 14.5% (slightly below the nationwide rate, which was 16.2% in December 2020). The percentage of furloughed workers is 18.2% (also below the nationwide level, which was around 24% in January 2021).

As regards the average characteristics of the mortgagee banks, in the period previous to that considered in the analysis (i.e. in 2020 Q1), the logarithm of their total assets averaged 18.7 (over €128,153 million), their average leverage ratio was 8.15% and their average NPL ratio was 5%. Their ROA stood at 0.48% and in 0.47% of cases the banks' mortgage business had grown more than the system average over the last five years.

6 Results

This section first analyses the extent to which borrower and bank characteristics can determine the probability of a mortgage payment moratorium being obtained during the period considered. It also includes an in-depth analysis of possible heterogeneous effects by borrower income levels and banks' balance sheet strength. This is followed by an analysis of the impact of these borrower and bank characteristics on the probability of a mortgage loan being initially subject to a legislative moratorium in 2020, of those initially legislative mortgage moratoria concluding before 31 December 2020, and of their status changing (transfer to banking sector or bilateral moratoria or cancellation) in 2020.

6.1 Probability of being subject to a mortgage payment moratorium

Table 2 presents the results of the specification in equation [1], an estimated ordinary least squares linear probability model, to determine the extent to which the borrower, bank and mortgage characteristics, and also the macroeconomic situation of the province in which the mortgaged housing is located, may be relevant to determine the probability of a mortgage payment moratorium being obtained in the period March to December 2020.

The results of the estimation are set out in three columns: column (1) shows the controls specified for each of the aspects considered; column (2) includes additional information on the activity status of the household reference person; and column (3) includes information on the economic sector with which the household reference person identifies, in accordance with the CCR data available. To avoid differences in the coefficients reported owing to changes in the sample size, the analysis is limited to 5,308,499 mortgages for which all the necessary data are available to estimate the specification with more controls.

In accordance with the results shown in Table 2, both the borrower and the mortgage characteristics, and also the macroeconomic situation in the region where the housing is located, are relevant to explain the probability of a mortgage moratorium being in place in 2020, and their effects are stable in the different specifications considered.

Thus, the higher the household income, the lower the probability of a mortgage in force at end-2019 becoming subject to a payment moratorium in 2020. Specifically, the probability of a household in the third income distribution quartile having a moratorium is 19.2% lower than that for a similar household in the first quartile. Conversely, households whose reference person is older have a higher probability of having a mortgage payment moratorium. Specifically, the average probability of having a mortgage moratorium is 8.8% higher for households whose reference person is in the third age-group quartile (around 56 years of age) than for those whose reference person is in the first age-group quartile (around 48 years of age). Likewise, if the household reference person is foreign, the probability of having a mortgage moratorium is three percentage points (3 pp) higher, i.e. the probability is 60.3% higher. If the household reference person is self-employed, the probability of having a mortgage payment moratorium is 4 pp higher, almost double the average. The impact is similar if the household reference person has a poor credit history (an increase of 107% in the average probability).

Considering the employment status of wage-earners or the economic sector of the self-employed, columns (2) and (3) of Table 2 analyse their impact on the likelihood of having a moratorium in greater detail. As column (2) shows, the probability of having a mortgage moratorium is lower for public employees, employees of the

Table 2

DETERMINANTS OF TAKE-UP OF COVID-19 MORATORIA

Household, mortgage, regional and lending bank characteristics are all relevant to explain the probability of having a mortgage moratorium as a consequence of the effects of the COVID-19 pandemic. Take-up of the moratoria is highest among households that were more disadvantaged or more vulnerable at the start of the pandemic, the self-employed, those employed in the economic sectors most affected by the pandemic, households with higher debt-to-income ratios and those with mortgages in provinces hardest hit in terms of employment. Higher interest rates, longer repayment periods and a higher debt-to-income ratio also increase the probability, as does having a mortgage granted by a larger bank, with a higher NPL ratio or whose lending business has grown more than the system average over the last five years.

Coefficients expressed in per-unit values	(1)	(2)	(3)
Dependent variable	Mortgage subject to moratorium		
Household characteristics			
Log(Household income)	-0.014***	-0.013***	-0.015***
	(0.003)	(0.003)	(0.003)
Log(Debt-to-income ratio)	0.013***	0.014***	0.013***
	(0.002)	(0.002)	(0.002)
Log(Age)	0.015**	0.021***	0.015**
	(0.007)	(0.006)	(0.007)
Foreign	0.030***	0.028***	0.028***
	(0.006)	(0.006)	(0.005)
Self-employed	0.048***	0.044***	0.044***
	(0.005)	(0.004)	(0.003)
Poor credit history	0.053***	0.051***	0.053***
	(0.009)	(0.009)	(0.009)
Mortgage characteristics			
Interest rate	0.005***	0.005***	0.005***
	(0.002)	(0.002)	(0.002)
Personal guarantee	0.010***	0.009***	0.010***
	(0.003)	(0.002)	(0.003)
Log(Original maturity (months))	0.030***	0.029***	0.030***
	(0.004)	(0.004)	(0.004)
Province characteristics			
Percentage furloughed workers	0.002***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)
Unemployment rate	0.002***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)
Bank characteristics			
Log(Assets bank)	0.009***	0.009***	0.009***
	(0.002)	(0.002)	(0.002)
Capital ratio/bank	-0.000	-0.000	-0.000
	(0.001)	(0.001)	(0.001)
ROA bank	0.013	0.013	0.013
	(0.014)	(0.015)	(0.014)
Liquidity ratio/bank	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)
NPL ratio/bank	0.003**	0.003*	0.003**
	(0.001)	(0.001)	(0.001)
High mortgage lending growth	0.015**	0.014**	0.014**
	(0.007)	(0.007)	(0.007)

SOURCE: Banco de España.
NOTE: The table presents the results of a linear probability regression that explains the determinants of mortgagors at end-2019 having applied for and been granted a moratorium in 2020 as a consequence of the effects of the COVID-19 pandemic. The first row depicts the coefficients and the second row the robust standard deviations (corrected for mortgaged property postcode and lending bank clusters), followed by the corresponding significance levels: *** significance at 1%, ** significance at 5%, * significance at 10%.

Table 2
DETERMINANTS OF TAKE-UP OF COVID-19 MORATORIA (cont'd)

Household, mortgage, regional and lending bank characteristics are all relevant to explain the probability of having a mortgage moratorium as a consequence of the effects of the COVID-19 pandemic. Take-up of the moratoria is highest among households that were more disadvantaged or more vulnerable at the start of the pandemic, the self-employed, those employed in the economic sectors most affected by the pandemic, households with higher debt-to-income ratios and those with mortgages in provinces hardest hit in terms of employment. Higher interest rates, longer repayment periods and a higher debt-to-income ratio also increase the probability, as does having a mortgage granted by a larger bank, with a higher NPL ratio or whose lending business has grown more than the system average over the last five years.

Coefficients expressed in per-unit values	(1)	(2)	(3)
Dependent variable	Mortgage subject to moratorium		
Type of employment and economic sector			
Public employee		-0.034***	
		(0.005)	
All other employees		0.008***	
		(0.002)	
Primary sector			-0.054***
			(0.005)
Manufacturing			-0.017***
			(0.002)
Energy and water			-0.036***
			(0.006)
Construction			-0.025***
			(0.002)
Wholesale and retail trade			0.005*
			(0.003)
Transportation			0.021***
			(0.006)
Hospitality			0.103***
			(0.011)
Public sector			-0.047***
			(0.012)
Financial sector			-0.036***
			(0.004)
Number of observations (million)	5.308	5.308	5.308
R2	0.034	0.037	0.037

SOURCE: Banco de España.
NOTE: The table presents the results of a linear probability regression that explains the determinants of mortgagors at end-2019 having applied for and been granted a moratorium in 2020 as a consequence of the effects of the COVID-19 pandemic. The first row depicts the coefficients and the second row the robust standard deviations (corrected for mortgaged property postcode and lending bank clusters), followed by the corresponding significance levels: *** significance at 1%, ** significance at 5%, * significance at 10%.

banking group extending the loan and pensioners (60%, 28% and 98% lower, respectively), while for wage-earners it is 16% higher than the average probability. Similarly, for employees in retail, transport and hospitality (the economic sectors most affected by the pandemic and for which, in the case of transport and tourism, there are also sector-specific moratoria in place), the average probability is higher (10%, 42% and 207% higher, respectively), while for employees in all the other sectors considered it is lower.

The mortgage characteristics are also relevant to explain the probability of having a mortgage payment moratorium. Higher interest rates, longer repayment periods and

a higher debt-to-income ratio and, albeit to a lesser extent, having needed a guarantor, raise the probability of having a mortgage payment moratorium. Specifically, an increase in the mortgage interest rate from the first interest rate distribution quartile to the third (an increase of 1.6 pp) lifts the average probability of having a payment moratorium by 16.8%, while an extension of the repayment period from the first to the third quartile (a difference of some 11 years between the two quartiles) raises the average probability by 24%. Having needed a personal guarantee increases the average probability of having a mortgage payment moratorium by 1 pp (an increase of 2% in the average probability), and an increase in the debt-to-income ratio from the first to the third quartile lifts the average probability by 22%.

The macroeconomic situation in the province is also relevant to explain the probability of having a mortgage payment moratorium in 2020. Specifically, every percentage point of increase in the unemployment rate or in the percentage of furloughed workers in the province lifts the average probability of having a mortgage payment moratorium by 0.2 pp. In this case, given that cross-province dispersion is higher in the unemployment rate (difference of 7.7 pp between the third and the first quartile) than in the percentage of furloughed workers (difference of 5.2 pp between the third and the first quartile), from a province in the third quartile to one in the first quartile the increase in average probability is higher (31% compared with 21%) in both distributions.

As regards bank characteristics, the results presented in Table 2 suggest that having a mortgage granted by a larger bank (higher asset volume),[21] with a higher NPL ratio or whose lending business has grown more than the system average over the last five years raises the probability of the mortgage being subject to a payment moratorium on a stable basis in all the specifications considered. Specifically, an increase in the NPL ratio from the third to the first quartile lifts the probability by 10%, while the fact that the banks' lending business has grown more than the system average over the last five years raises the average probability by 1.5 pp (around 30%).

All these results provide robust evidence that the support measure in the form of legislative or banking sector moratoria is coherent. It has tended to have most impact on households that were more disadvantaged or more vulnerable before the pandemic and on those that have been hardest hit by the pandemic, such as

21 A possible explanation for the positive correlation between bank size and the number of moratoria granted is that larger banks were able to adapt their organisational structure and internal processes more swiftly in view of the restrictions introduced as a result of the pandemic. The fact that they were initially better prepared to adapt to remote working, having had more previous experience in this respect, could have enabled them to maintain their level of activity with fewer distortions, compared with others whose structures were less well adapted to remote working. Larger banks would thus have faced fewer operational hurdles, enabling them to respond swiftly to requests for deferral from customers who needed to address the temporary difficulties emerging as a consequence of the onset of the pandemic. Accordingly, all other things being equal, this would increase the probability of a mortgage granted by a larger bank having a legislative or banking sector moratorium approved during this period.

Table 3

DETERMINANTS OF INITIALLY LEGISLATIVE MORATORIA AND TRANSFERS. HETEROGENEOUS EFFECTS

To analyse the heterogeneous effects in the results, interactions among some of the characteristics that explain the probability of having a mortgage moratorium as a consequence of the effects of the COVID-19 pandemic are included. The analysis shows that from the first to the third income quartile, the effect of the debt-to-income ratio is halved. Likewise, bank weakness, captured both by a lower leverage ratio and a higher NPL ratio, accentuates the impact of other characteristics that proxy mortgage risk, such as a longer repayment period or a higher interest rate.

Coefficients expressed in per-unit values	(1)	(2)	(3)
Dependent variable	Mortgage subject to moratorium		
Household characteristics			
Log(Household income)	-0.012***	-0.015***	-0,014***
	(0.003)	(0.003)	(0.003)
Log(Debt-to-income ratio)	0.008***	0.013***	0.014***
	(0.001)	(0.001)	(0.001)
Log(Age)	0.016**	0.015**	0.015**
	(0.008)	(0.007)	(0.006)
Foreign	0.026***	0.030***	0.030***
	(0.006)	(0.006)	(0.006)
Self-employed	0.046***	0.048***	0.047***
	(0.005)	(0.005)	(0.005)
Poor credit history	0.048***	0.053***	0.053***
	(0.009)	(0.009)	(0.010)
Mortgage characteristics			
Interest rate	0.007***	0.005***	0.006***
	(0.002)	(0.002)	(0.001)
Personal guarantee	0.008***	0.010***	0.010***
	(0.003)	(0.003)	(0.003)
Log(Original maturity (months))	0.029***	0.030***	0.032***
	(0.005)	(0.004)	(0.003)
Province characteristics			
Percentage furloughed workers	0.002***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)
Unemployment rate	0.002***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)

SOURCE: Banco de España.
NOTE: The table presents the results of a linear probability regression that explains the determinants of mortgagors at end-2019 having applied for and been granted a moratorium in 2020 as a result of the effects of the COVID-19 pandemic. The first row depicts the coefficients and the second row the robust standard deviations (corrected for mortgaged property postcode and lending bank clusters), followed by the corresponding significance levels: *** significance at 1%, ** significance at 5%, * significance at 10%.

households in regions where COVID-19 has had more impact on employment or in economic sectors that have felt the brunt of the pandemic. This is coherent with the purpose for which these schemes were created.

Table 3 analyses the heterogeneity of the results obtained, adding interactions to analyse how certain variables are interlinked. For example, how households' debt-to-income ratios may vary for different income levels, or in accordance with banks' balance sheet strength (banks' leverage and NPL ratios). Column (1) of Table 3

Table 3

DETERMINANTS OF INITIALLY LEGISLATIVE MORATORIA AND TRANSFERS. HETEROGENEOUS EFFECTS (cont'd)

To analyse the heterogeneous effects in the results, interactions among some of the characteristics that explain the probability of having a mortgage moratorium as a consequence of the effects of the COVID-19 pandemic are included. The analysis shows that from the first to the third income quartile, the effect of the debt-to-income ratio is halved. Likewise, bank weakness, captured both by a lower leverage ratio and a higher NPL ratio, accentuates the impact of other characteristics that proxy mortgage risk, such as a longer repayment period or a higher interest rate.

Coefficients expressed in per-unit values

	(1)	(2)	(3)
Dependent variable	Mortgage subject to moratorium		
Bank characteristics			
Log(Assets bank)	0.009***	0.008***	0.008***
	(0.002)	(0.001)	(0.001)
Capital ratio/bank	0.000	0.000	0.001
	(0.001)	(0.001)	(0.001)
ROA bank	0.017	0.014	0.020
	(0.015)	(0.014)	(0.014)
NPL ratio/bank	0.003*	0.003**	0.002
	(0.001)	(0.001)	(0.001)
High mortgage lending growth	0.018**	0.014**	0.011
	(0.008)	(0.007)	(0.007)
Heterogeneous effects			
Log(Debt-to-income ratio) × Log(Household income)	-0.012***		
	(0.003)		
Log(Debt-to-income ratio (2019)) × Capital ratio/bank		0.000	0.001
		(0.001)	(0.000)
Log(Debt-to-income ratio (2019)) × NPL ratio/bank		0.003***	0.002***
		(0.001)	(0.001)
Log(Original maturity (months)) × Capital ratio/bank			-0.002*
			(0.001)
Log(Original maturity (months)) × NPL ratio/bank			0.008***
			(0.001)
Interest rate × Capital ratio/bank			-0.002**
			(0.001)
Interest rate × NPL ratio/bank			0.001**
			(0.001)
Number of observations (million)	5.308	5.308	5.308
R2	0.039	0.035	0.036

SOURCE: Banco de España.

NOTE: The table presents the results of a linear probability regression that explains the determinants of mortgagors at end-2019 having applied for and been granted a moratorium in 2020 as a result of the effects of the COVID-19 pandemic. The first row depicts the coefficients and the second row the robust standard deviations (corrected for mortgaged property postcode and lending bank clusters), followed by the corresponding significance levels: *** significance at 1%, ** significance at 5%, * significance at 10%.

includes the interplay between households' debt-to-income ratios and the logarithm of household income. Column (2) includes the interplay between households' debt-to-income ratios and banks' capital and NPL ratios. Lastly, column (3) incorporates into the column (2) specification interactions between mortgage characteristics, such as original maturity or interest rate, and banks' capital and NPL ratios.

As Table 3 shows, in the case of household income, from the first to the third percentile of the distribution the positive impact of the debt-to-income ratio is halved (for an increase in the latter from the first to the third quartile), down from an increase of 22% to one of just 11%. In turn, an increase of 1.7 pp in the default rate (which corresponds to an increase from the first to the third percentile of the distribution) doubles the impact of the debt-to-income ratio, lifting the average probability by 42%. In addition, bank weakness, captured both by a lower leverage ratio and a higher NPL ratio, also accentuates the impact of other characteristics that proxy mortgage risk, such as a longer repayment period or a higher interest rate. Thus, for example, extending the repayment period or raising the interest rate (in an amount similar to moving from the first to the third quartile), for a similar change in the NPL ratio, would increase the average probability by 35% or 61%, compared with the 24% or 31% commented in Table 1. The effect of bank solvency is also significant: banks with a lower capital ratio are more likely to have moratoria with a higher risk profile, although the impact is less relevant from an economic standpoint than that of the NPL ratio (an exercise similar to that described above would raise the probability by 29% and 37%, respectively). These results appear to suggest, either that the weakest banks tend to have a higher proportion of low-quality borrowers, and thus a higher percentage of moratoria for this market segment, or that they are the ones that have made most use of this tool for this type of households, in an endeavour to counter the negative impact of the pandemic on their provisioning and, ultimately, on their solvency.

6.2 Transfers

Table 3 focuses on initially legislative moratoria. Specifically, column (1) estimates the factors that determine the probability of a moratorium initially being a legislative moratorium (for loans effectively subject to moratoria in 2020). Column (2) analyses the impact of these same characteristics on the probability of a return to normal in terms of the obligation to meet mortgage payments (i.e. cessation of moratorium). Lastly, column (3) examines the probability of a legislative moratorium being transferred to another kind of moratorium. These situations are, by definition, restricted to mortgage loans that were subject to moratorium in the period considered. In consequence, a total of 264,051 mortgages are considered in column (1), while in columns (2) and (3) the analysis is limited to moratoria that were initially legislative, i.e. 143,014 loans during the period considered.

6.2.1 Probability of a moratorium being initially legislative

To explain the probability of a moratorium being initially legislative, for loans subject to moratorium at any time in 2020, the household, loan and bank characteristics variables continue to be relevant. By contrast, the macroeconomic situation in the

Table 4

DETERMINANTS OF INITIALLY LEGISLATIVE COVID-19 MORATORIA AND TRANSFERS

Take-up of initially legislative moratoria is highest among households that were more vulnerable at the start of the pandemic and those that were most affected in terms of employment. These households also tend to remain subject to legislative moratoria for longer, or are more likely to transfer to other (banking sector or bilateral) moratoria when the former expire. Moreover, loans subject to initially legislative moratoria pertaining to more vulnerable households or to those in regions hardest hit by the crisis have a higher probability of being classified as credit risk. Interestingly, in the case of the self-employed, although they are more likely to have legislative mortgage moratoria, once these moratoria expire the probability of their mortgage loans being classified as non-performing or Stage 2 is no higher.

Coefficients expressed in per-unit values	(1)	(2)	(3)	(4)
Dependent variable	Initially legislative moratorium	Legislative moratorium expired	Legislative moratorium changed status	Moratorium expired - loan classified as non-performing or Stage 2
Initially legislative moratorium				0.075*
				(0.043)
Household characteristics				
Log(Household income)	-0.046***	0.025	-0.044*	-0.030**
	(0.012)	(0.050)	(0.026)	0.0
Log(Debt-to-income ratio)	-0.058***	-0.073**	0.079***	-0.030**
	(0.011)	(0.033)	(0.009)	(0.012)
Log(Age)	-0.125***	-0.282*	0.239***	0.024***
	(0.036)	(0.160)	(0.043)	(0.005)
Foreign	0.033***	0.017	-0.011	0.098***
	(0.010)	(0.025)	(0.014)	(0.024)
Self-employed	0.059***	-0.035	0.059*	0.011
	(0.015)	(0.050)	(0.034)	(0.008)
Poor credit history	-0.006	0.006	0.045***	0.019
	(0.015)	(0.029)	(0.016)	(0.014)
Mortgage characteristics				
Interest rate	0.016**	0.040	-0.014	-0.011
	(0.007)	(0.029)	(0.021)	(0.014)
Personal guarantee	0.045***	0.081*	-0.095**	0.028***
	(0.013)	(0.043)	(0.040)	(0.006)
Log(Original maturity (months))	0.197***	-0.090	0.117	0.28
	(0.046)	(0.120)	(0.096)	(0.024)

SOURCE: Banco de España.
NOTE: The table presents the results of regressions that explain the determinants of the legislative moratoria, and of their change in status, for outstanding mortgages at December 2019 that were granted a moratorium in 2020 as a consequence of COVID-19. Column (1) shows the results of estimating a linear probability model to explain that a mortgage becomes subject to the COVID-19 legislative moratorium. Columns (2) and (3) show the results of a duration model, using a Cox model, where the exit event is expiry of the moratorium (column (2)) or a change of status (column (3)). The first row depicts the coefficients; the second row depicts the robust standard deviations in brackets, corrected for the lending bank cluster (columns (2) and (3)) and for the mortgaged property postcode cluster (column (1)), followed by the corresponding significance levels: *** significance at 1%, ** significance at 5%, * significance at 10%.

province ceases to be a determinant factor, reflecting the more dynamic and complementary nature of the banking sector moratoria.

As column (1) of Table 3 shows, the income, age and nationality of the household reference person, and also whether they are self-employed, are relevant to explain the probability of having an initially legislative mortgage payment moratorium. Yet their credit history is not relevant here, whereas it was relevant to explain the

Table 4

DETERMINANTS OF INITIALLY LEGISLATIVE COVID-19 MORATORIA AND TRANSFERS (cont'd)

Take-up of initially legislative moratoria is highest among households that were more vulnerable at the start of the pandemic and those that were most affected in terms of employment. These households also tend to remain subject to legislative moratoria for longer, or are more likely to transfer to other (banking sector or bilateral) moratoria when the former expire. Moreover, loans subject to initially legislative moratoria pertaining to more vulnerable households or to those in regions hardest hit by the crisis have a higher probability of being classified as credit risk. Interestingly, in the case of the self-employed, although they are more likely to have legislative mortgage moratoria, once these moratoria expire the probability of their mortgage loans being classified as non-performing or Stage 2 is no higher.

Coefficients expressed in per-unit values	(1)	(2)	(3)	(4)
Dependent variable	Initially legislative moratorium	Legislative moratorium expired	Legislative moratorium changed status	Moratorium expired - loan classified as non-performing or Stage 2
Province characteristics				
Percentage furloughed workers	-0.001	-0.003	0.004*	-0.000
	(0.001)	(0.007)	(0.003)	(0.001)
Unemployment rate	0.003	-0.016**	0.004	0.004***
	(0.002)	(0.006)	(0.005)	(0.001)
Bank characteristics				
Log(Assets bank)	-0.096***	0.100	0.090	0.017*
	(0.017)	(0.098)	(0.086)	(0.009)
Capital ratio/bank	0.001	-0.126**	0.000	0.005
	(0.008)	(0.056)	(0.058)	(0.006)
ROA bank	0.008	-1.152*	0.761	-0.246**
	(0.186)	(0.621)	(0.685)	(0.115)
Liquidity ratio/bank	0.006	0.030***	-0.012	0.007*
	(0.008)	(0.009)	(0.039)	(0.004)
NPL ratio/bank	-0.008	0.0	-0.024	-0.001
	(0.015)	(0.039)	(0.065)	(0.008)
Number of observations (million)	0.264	0.143	0.264	0.085
R2	0.236			0.203

SOURCE: Banco de España.

NOTE: The table presents the results of regressions that explain the determinants of the legislative moratoria, and of their change in status, for outstanding mortgages at December 2019 that were granted a moratorium in 2020 as a consequence of COVID-19. Column (1) shows the results of estimating a linear probability model to explain that a mortgage becomes subject to the COVID-19 legislative moratorium. Columns (2) and (3) show the results of a duration model, using a Cox model, where the exit event is expiry of the moratorium (column (2)) or a change of status (column (3)). The first row depicts the coefficients; the second row depicts the robust standard deviations in brackets, corrected for the lending bank cluster (columns (2) and (3)) and for the mortgaged property postcode cluster (column (1)), followed by the corresponding significance levels: *** significance at 1%, ** significance at 5%, * significance at 10%.

probability of being subject to a moratorium. This shows that whether households have a good or a poor credit history is not a significant factor in the case of legislative moratoria. As regards income, the higher the household income, the lower the probability of the first payment moratorium of a mortgage in force at end-2019 being a legislative moratorium in 2020. Specifically, from the first to the third income quartile, the average probability of this occurring falls by 5.6%. Moreover, the probability of having an initially legislative mortgage payment moratorium in 2020 is lower for households whose reference person is older. Specifically, the average probability is 6.5% lower for households whose reference person is in

the third age-group quartile compared with those whose reference person is in the first age-group quartile.[22]

Regarding the mortgage characteristics, having higher interest rates and longer repayment periods and, albeit to a lesser extent, having needed a guarantor, raise the probability of having an initially legislative moratorium, whereas having a higher debt-to-income ratio reduces the probability, if the loan becomes subject to moratorium, of it being a legislative moratorium.

Specifically, an increase in the mortgage rate from the first interest rate distribution quartile to the third (1.6 pp) lifts the average probability of having an initially legislative moratorium by 5%, while an extension of the repayment period from the first to the third quartile (a difference of some 11 years between the two quartiles) raises the average probability of having an initially legislative moratorium by 14%. These results are consistent with the fact that in order to be eligible for the legislative moratoria, certain conditions relating to households' difficulties meeting their monthly payment obligations – captured by the mortgage interest rate and repayment period – must be met.

Turning to bank characteristics, having a mortgage granted by a larger bank (higher asset volume) or whose lending business has grown more than the system average over the last five years reduces the probability of the mortgage being subject to an initially legislative moratorium. Specifically, an increase in the logarithm of total assets from the third to the first quartile lifts the probability by 344%, while the fact that the bank's lending business has grown more than the system average over the last five years reduces the average probability by 55%.

6.2.2 Probability of an initially legislative moratorium being cancelled

To explain the rate of termination of initially legislative payment moratoria over the course of 2020, of the household characteristics variables only age appears to be relevant.[23] Households whose reference person is older are less likely to return to normal; in other words, they remain subject to legislative moratoria for longer. Specifically, the average probability of an initially legislative moratorium being cancelled is 28.1% lower for households whose reference person is in the third age-group quartile, compared with those whose reference person is in the first age-group quartile.

22 The sign of the age coefficient could be capturing a lower initial level of sensitivity of older households' income to the COVID-19 shock. This could mean that older households with outstanding mortgages were less likely to satisfy the income conditions in order to be considered vulnerable households and, therefore, to be eligible to apply for legislative moratoria than younger households.

23 This may be partly due to the characteristics of the household-level data used, since they require that each household be assigned certain variables linked to their postcode.

Moreover, the higher the household debt-to-income ratio, measured by its logarithm, the lower the probability of cancellation of an initially legislative moratorium. Thus, from the first quartile to the third quartile of the logarithm of the household debt-to-income ratio, the average probability of this occurring falls by 27.6%.

The macroeconomic situation of the province seems to have some relevance to explain the exit from moratorium. Thus, from a province with an unemployment rate in the first quartile to one with an unemployment rate in the third quartile the probability of a legislative moratorium expiring falls by 4.1%; that is, these mortgages remain subject to legislative moratoria for longer.

Turning to bank characteristics, the probability of initially legislative moratoria being cancelled is higher for loans granted by banks with a higher liquidity ratio and lower for those granted by banks with a lower capital ratio. Specifically, from the first capital ratio quartile to the third, the average probability of this occurring falls by 123%, whereas in the case of the liquidity ratio the probability rises by 27.6%.

6.2.3 Probability of an initially legislative moratorium being transferred to a banking sector moratorium

In this case, both household income and age affect the probability of transfer to banking sector or bilateral moratoria, although higher household income reduces the probability whereas higher household age increases it.[24] A poor credit history is also relevant here, as it raises the probability of a legislative moratorium being transferred to another type of moratorium by 4.5 pp (some 8.8%). Self-employment also raises this probability (although this variable has limited statistical significance).

As regards the effect of the loan characteristics, the household debt-to-income ratio and having needed a personal guarantee appear to be the most important variables to explain transfer to a banking sector moratorium. The higher the debt-to-income ratio, the higher the probability of transfer from an initially legislative moratorium to a banking sector or bilateral one. Thus, from the first to the third quartile of the logarithm of the household debt-to-income ratio, the probability of this occurring increases by 17.7%. Conversely, having needed a personal guarantee reduces the probability of transfer to a banking sector moratorium by 9.5 pp (17.5% compared with the probability of transfer to another status from a legislative moratorium).

The employment effect, captured by the regional variables, shows that moratoria in provinces with a higher percentage of furloughed workers tend to remain in place for

24 The second factor reflects the greater difficulty older, more vulnerable households face to recover their pre-pandemic ability to meet their payments.

longer (a 5% increase). In this case, no correlation is observed between lending banks' characteristics and transfer from an initially legislative moratorium.

In consequence, the results appear to suggest that households that have higher debt-to-income ratios, are in regions most affected by the pandemic or are lower income households tend to remain subject to legislative moratoria for longer or are more likely to change to another type of moratoria.

6.2.4 Probability of loans being classified as non-performing or Stage 2 when moratoria expire

In an endeavour to understand the explanatory factors behind the classification of loans exiting moratoria, equation [4] has been estimated. The results show that loans subject to moratoria that were initially legislative are 33% more likely to be classified in a category other than performing. In addition, more vulnerable households (in the first quartile of the income distribution) and more indebted households (in the third quartile of the debt distribution) have a 9% and 12%, respectively, higher probability of being classified in a category other than performing than those in the third or first quartile of their respective distributions. Likewise, the average probability of loans being classified as non-performing or Stage 2 once the moratoria are no longer in place is 12% higher for loans covered by a personal guarantee or pertaining to households whose reference person is older (again comparing the third quartile with the first quartile). Notably, in the case of the self-employed – despite, as we have seen, being more likely to apply for legislative moratoria, reflecting the severe impact of the crisis on this group[25] – we do not observe a higher probability of their loans being classified as Stage 2 or non-performing upon expiry of their mortgage moratoria. Lastly, for households in regions hardest hit by the pandemic in terms of employment, this probability is 13% higher.

7 Conclusions

Loan moratoria are one of the support measures for households and firms introduced against the backdrop of the crisis triggered by the COVID-19 pandemic. They have enabled households and firms to defer their loan payment commitments, notably enhancing their ability to meet their financial obligations and their available liquidity in the near term.

To date, five different types of loan moratoria have been approved (legislative mortgage and non-mortgage moratoria, banking sector moratoria and sector-specific moratoria for the tourism and transport industries), applicable to different

25 See the available evidence in Fernández Cerezo et al. (2021).

types of loans and borrowers, according to the requirements and conditions set out in the corresponding Royal Decree-Laws.

For these five types of moratoria, lending banks report a specific set of data to the Banco de España, which is supplemented by the data obtained through the CCR. Drawing on both these sources, some 1.5 million applications for moratoria have been made, of which 1.38 million have been granted, a very high acceptance rate verging on 93%. The volume of loans subject to moratoria is over €56 billion, which is 8% of all existing credit in the eligible loan books.

Most of the borrowers benefiting from the moratoria for individuals (the two legislative moratoria and the banking sector moratoria) are wage-earners, who account for more than 75% of the total. As for the self-employed who have benefited from the moratoria, their main economic sectors are retail, hospitality and other services (which together account for 56% of the moratoria granted to the self-employed).

Given that the moratoria had been in operation for almost a year at end-December 2020, some have expired, as a consequence of discharges, repayments or cancellations (reductions in general). The pattern of reductions is very different for the different groups of moratoria: for legislative moratoria, given the higher volumes granted in April and May 2020, the biggest reductions are in July and August, whereas for conventional moratoria, which have a longer duration, the reductions come later (specifically half of these reductions, in October and November).

Considering that the cumulative total under both groups of moratoria is slightly over €56 billion, that the cumulative total expired amounts to some €11 billion in each group, and that some €15.2 billion have been transferred between groups (loans initially subject to legislative moratoria transferred to conventional moratoria, given that the shorter duration of the former is conducive to their being transferred, upon expiry, to banking sector or bilateral moratoria), at end-December 2020 the loans outstanding subject to moratoria amounted to some €34 billion. Conventional moratoria accounted for the bulk of this sum (over €32 billion, 95% of the total) and legislative moratoria for just some €2 billion (5% of the total outstanding).

As regards the classification of the loans whose moratoria have expired or have been cancelled, almost three-quarters are classified as performing, 20% are classified as Stage 2 and just 6% are classified as non-performing. Lastly, of the outstanding moratoria (over €34 billion), approximately 85% will expire in the first six months of 2021, the great majority of which between April and May.

The results of the econometric analysis performed show that the following groups record the highest take-up of moratoria: households that were more disadvantaged (lower income) or more vulnerable (higher debt) at the start of the pandemic; those hardest hit in terms of employment (in provinces with a higher unemployment rate or

higher percentage of furloughed workers owing to COVID-19); and those linked to the economic sectors most affected by the pandemic (such as retail, hospitality or transport). This is consistent with the purpose of these schemes. Moreover, it would appear to be the case, above all, among the weakest banks, in terms of lower capital ratios or higher NPL rates. Furthermore, the results also appear to suggest that vulnerable households, those in regions most affected by the pandemic and lower income households tend to be subject to legislative moratoria for longer (or are more likely to transfer to non-legislative moratoria when the former expire), and that when the moratoria expire, these households' loans are more likely to be classified as Stage 2 or non-performing. All the above highlights the important role that the moratoria have played to cushion the initial impact of the pandemic, but also the latent risk in moratoria pertaining to more disadvantaged or more highly indebted households, which could give rise to higher future provisioning requirements for banks.

To sum up, the analysis performed and the evidence built up in 2020 since the moratoria were introduced show that these are flexible support measures that can be activated and withdrawn relatively quickly. But they must be used prudently, so as to ensure that at the same time as they ease borrowers' potential liquidity problems they also preserve adequate repayment incentives.

REFERENCES

Alves P., F. Arrizabalaga, J. Delgado, J. Galán, E. Pérez Asenjo, C. Pérez Montes and C. Trucharte (2021). "Recent developments in financing and bank lending to the non-financial private sector", Analytical Articles, *Economic Bulletin* 1/2021, Banco de España.

Alves P., R. Blanco, S. Mayordomo, F. Arrizabalaga, J. Delgado, G. Jiménez, E. Pérez Asenjo, C. Pérez Montes and C. Trucharte (2020). "Recent developments in financing and bank lending to the non-financial private sector", Analytical Articles, *Economic Bulletin* 4/2020, Banco de España.

Asociación Española de Banca (AEB) (2020). Acuerdo sectorial promovido por la AEB sobre aplazamiento de operaciones de financiación de clientes afectados por la crisis del coronavirus.

Asociación Nacional de Establecimientos Financieros de Crédito (ASNEF) (2020). *Acuerdo sectorial promovido por ASNEF sobre aplazamiento de operaciones de financiación de clientes de entidades asociadas afectados por la crisis del coronavirus.*

Banco de España (2020). "Loan moratoria developments, analysis of characteristics of beneficiaries and of the potential impact on default", Box 1.2, *Financial Stability Report,* Autumn.

Banco de España (2021). *Briefing note on application of moratoria established by law and by the banking sector up to 31 March 2021*, April.

Confederación Española de Cajas de Ahorros (CECA) (2020). Acuerdo sectorial sobre aplazamiento de operaciones de financiación de clientes afectados por la crisis del coronavirus.

European Banking Authority (2020a). *Guidelines on legislative and non-legislative moratoria on loan repayments applied in the light of the COVID-19 crisis (EBA/GL/2020/02).*

European Banking Authority (2020b). *The EBA reactivates its Guidelines on legislative and non-legislative moratoria,* December.

European Systemic Risk Board (2020). *Recommendation of the European Systemic Risk Board of 27 May 2020 on monitoring the financial stability implications of debt moratoria, and public guarantee schemes and other measures of a fiscal nature taken to protect the real economy in response to the COVID-19 pandemic (ESRB/2020/8).*

European Systemic Risk Board (2021). *Financial stability implications of support measures to protect the real economy from the COVID-19 pandemic,* February.

Fernández Cerezo, A., B. González, M. Izquierdo and E. Moral-Benito (2021). "The economic impact of COVID-19 on Spanish firms according to the Banco de España Business Activity Survey (EBAE)", Analytical Articles, *Economic Bulletin* 1/2021, Banco de España.

Unión Nacional de Cooperativas de Crédito (UNACC) (2020). *Acuerdo sectorial de la unión nacional de cooperativas de crédito sobre aplazamiento de operaciones de financiación de clientes afectados por la crisis del coronavirus.*

Estimating the cost of equity for financial institutions

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Abstract

This article estimates the cost of equity for a large sample of European financial institutions. To this end, two main approaches are considered: (i) a dividend discount model for a broad market index, combined with a single-factor framework to estimate the cost of equity for individual stocks; and (ii) a multi-factor time-series model combining stock and bond-market factors. It is found that, while the two approaches generally yield similar results, both in terms of their levels and their time series dynamics, discrepancies can be substantial. All in all, the dividend discount model is a less data-intensive approach that may be more effective to monitor the cost of equity in real time. In contrast, multi-factor models are more data intensive and hence less convenient for regular monitoring. At the same time, though, this latter methodology is more useful to capture the impact of developments not captured by the broad market index, owing to its multi-factor structure.

1 Introduction

The banking system is facing a challenging environment since the global financial crisis. In addition to the absorption of the losses generated by that crisis, over the last years banks have been subject to a low interest rate environment that has put more pressure on profitability. The COVID-19 pandemic, which erupted in March 2020 in Europe, has intensified these difficulties even more. In this context, it is important to assess the sustainability of banks' business models. At the most basic level, sustainability requires that banks' profits remain in the long run above the costs that they face to fund their activity. Among these costs, the cost of equity is an essential one, as equity is the main loss-absorbing element protecting depositors and other counterparties against banks' losses.

The cost of equity is the total return that investors expect for holding the equity of a particular firm, and being compensated for the risk that this entails. Investors may receive this return through either price appreciation of the stock itself or through dividends. It is usually expressed in annualised terms. However, due to the intrinsic uncertainty in the stock market, there is no guarantee that investors will earn this expected return at any pre-specified horizon. As a matter of fact, the cost of equity is not formally agreed, because it is an implicit and unobservable measure. This contrasts with debt funding, where the cost is explicitly set at issuance. For this reason, it is necessary to develop econometric models to estimate it.

One of the most popular approaches to estimate the cost of equity is based on the dividend discount model proposed by Fuller and Hsia (1984). This methodology is

commonly employed by various national and international institutions to estimate banks' cost of equity [see e.g. European Central Bank (2016)] but it has also been used to estimate the cost of equity for non-financial firms [see Alonso Sánchez and Marqués Sevillano (2006)]. Importantly, the most recent estimates show that a non-negligible proportion of euro area banks are currently unable to yield a return on equity higher than the overall cost of equity [see European Central Bank (2019)]. This result draws a very dark picture about the prospects of the euro area banking system. At the same time, though, such a conclusion is surrounded by a cloud of uncertainty, as it relies on a particular estimation approach that cannot be tested in practice. Hence, such results might be sensitive to the model's assumptions. Furthermore, as the dividend discount model is usually calibrated for the average bank, certain banks' specificities might explain the positive gap identified between the estimated average cost of equity and the return on equity observed for individual institutions.

In this paper, we assess the reliability of the dividend discount model by comparing the results that it produces with the alternative multi-factor approaches previously employed for the US by Adrian, Friedman and Muir (2015) and Kovner and Van Tassel (2019), and Altavilla et al. (2021) for the euro area, among others. The cost of equity obtained with the dividend discount model is typically computed for the overall market. Then, the measure for a specific bank or group of banks is obtained by multiplying the original broad result by the beta from a Capital Asset Pricing Model (CAPM for short) [see Sharpe (1964) and Lintner (1965)]. Hence, a multifactor approach is a natural way to generalise the dividend discount model by introducing several factors to account for the existing cross-sectional heterogeneity in a more flexible way. However, the shift to a multi-factor setting also comes at a cost, because in this extended framework we can no longer easily incorporate the forward-looking dividend discount approach. Instead, we have to fully rely on backward-looking econometric regressions.

We estimate the cost of equity under our proposed alternative econometric approaches using data from a large sample of European financial institutions whose equity is traded in the stock markets. In the case of the multifactor model, we consider stock and bond-market factors, as well as a factor related to banks' profitability, and then select our preferred factor model using their optimal combination. We compare the results that our alternative approaches provide for the whole sample on average as well as their dynamic evolution through overlapping rolling estimation windows. Lastly, we also consider exponentially decreasing weights in the regressions with overlapping expanding windows, so that the cost of equity estimates reflect the conditions at specific points in time (the end of each overlapping window) more accurately, rather than the average conditions on each window.

The rest of the paper is organized as follows. Section 2 describes the two cost of equity modelling approaches that we consider. Section 3 shows the main empirical results and finally Section 4 concludes.

2 Existing methodologies to estimate the cost of equity

There are many different alternative approaches to estimate the cost of equity in the literature [see Duarte and Rosa (2015) for a review]. However, most of these approaches can be grouped into two main methodologies. The first one consists of the combination of time series and cross-sectional regressions to back out the cost of equity from historical data. In contrast, the second approach, which is based on a dividend discount model, is more reliant on forward looking information (surveys, forecasts) to estimate the cost of equity using some sort of discount formula for the forecasted future cash flows. Nevertheless, even in this second case, some historical or backward-looking information is also needed to obtain cost of equity estimates for specific firms or groups of firms, due to the unreliability of the available forward-looking information at the firm level.

2.1 Factor model: estimating the cost of equity from historical data

The first approach is based on a multi-factor framework. Under this setting, the cost of equity of a firm depends on the sensitivity of that firm to a series of risk factors, as well as on the price of risk of each for these factors. Intuitively, the price of risk for a particular factor measures the compensation demanded by the market for being exposed to that factor. Idiosyncratic risks of particular firms are not priced by the market, because they can be diversified away in a portfolio, so the exposures to global risk factors are the only relevant magnitudes in this formulation.

To implement this approach, we first need to identify the relevant risk factors. The simplest possible setting is the traditional CAPM, in which the only modelled factor is a proxy that is representative of the average return of the whole market[1]. Alternatively, we consider a multi-factor extension, which allows the inclusion of several factors in addition to the average market return proxy. As is well known [see for example Fama and French (1993)], the additional factors help to account for some pricing anomalies of the CAPM model. Once the relevant factors are selected, the cost of equity is estimated in two steps. In the first step, we fit time series regressions for each firm in our sample, in which we regress the equity return of that firm in excess of a risk-free rate proxy (or excess return for short), with respect to the risk factor(s) that we consider,

$$y_{it} - r_t = \alpha_i + \beta'_i \cdot X_t + \varepsilon_{it}, \qquad [1]$$

where yit, rt, and Xt denote the firm's stock return, the risk-free rate and the vector of selected risk factors, respectively, while β'_i is the vector of factor loadings for the factors in Xt. Intuitively, the degree of time-series co-variation between the returns of a firm and a given risk factor quantifies the exposure of that firm to that risk factor.

1 Barnes and López (2005), King (2009) and Da, Guo and Jagannathan (2012) have previously used the CAPM to estimate the cost of equity.

In the second step, we estimate the risk premium demanded by the market in excess of the risk-free rate as a cross sectional regression of the average realised excess returns of all the firms in our sample on the factor loadings estimated in the first step:

$$\overline{y}_t - \overline{r} = \lambda \cdot \hat{\beta}'_i + \epsilon_i, \qquad [2]$$

where $\overline{y}_t$ and $\overline{r}$ denote the average historical stock return and risk-free rates, respectively,and $\hat{\beta}'_i$ is the vector of factor loadings estimated in [1]. We can compute these average values for the whole sample, as well as for overlapping windows to obtain time-varying estimates. The errors ϵ_i in [2] might be correlated. In order to obtain consistent standard errors, we follow the approach of Fama and MacBeth (1973). Our goal is to estimate [2] at each point in the time series, obtaining a time-varying estimate of l, which we denote as lt, and then average those estimates. The standard error is estimated from that average, using the Newey and West (1987) procedure to account for autocorrelation. In order to maximize efficiency, we carry out the cross-sectional regressions using Weighted Least Squares (WLS), with weights proportional to the inverse of the variance of the residuals from [1]. The main output of this second step is an estimate of the vector l (lt for the time-varying estimates), which captures the prices of risk associated to each risk factor. Thus, the equity premium for each firm computed with this first approach is the sum of all the factor loadings for this firm, multiplied by their respective prices of risk:

$$EP_i = \tilde{\lambda}' \cdot \hat{\beta}_i, \qquad [3]$$

where $\tilde{\lambda}$ is the vector estimated in [2]. Finally, the cost of equity is the sum of the equity premium EPi, plus the mean risk-free rate.

2.2 Dividend discount model: estimating the cost of equity with forward looking information

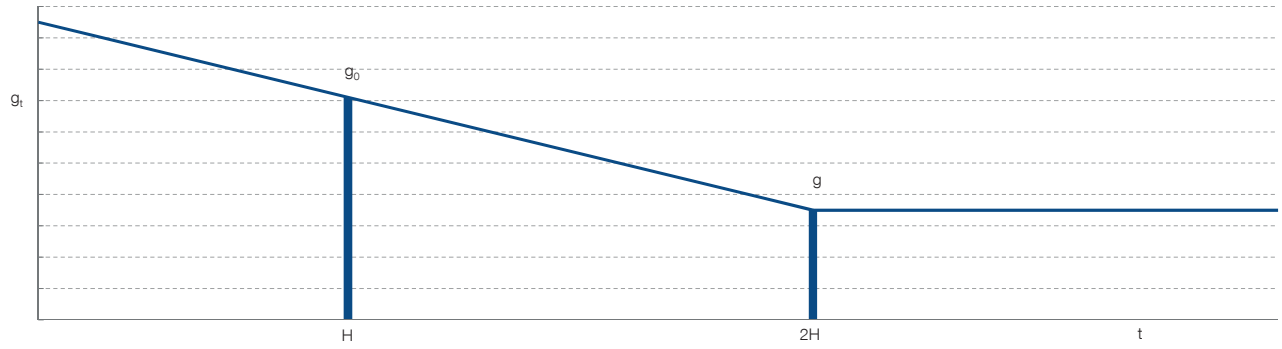
In this second case, we first estimate the cost of equity for the market as a whole. Specifically, we use as a reference a market index that is representative of the whole market and then we estimate the market's equity premium using the dividend discount model developed by Fuller and Hsia (1984). As shown in Chart 1, this model assumes that dividends initially grow at a rate g_0, but that this rate linearly changes over the following periods until it eventually converges 2H periods later to a long-term growth rate g.

Fuller and Hsia (1984) apply this methodology and show that the equity premium can be expressed as:

$$EP_{market} = \frac{D_0}{P_0}\left[(1+g) + H(g_0 - g)\right] + g - r, \qquad [4]$$

where D_0 / P_0 denotes the initial dividend yield and r the risk-free rate.

Chart 1
IMPLICIT DIVIDEND GROWTH IN THE DIVIDEND DISCOUNT MODEL



SOURCE: Authors' elaboration.

Usually, the initial dividend growth rate g_0 is obtained from analysts' expectations for corporate profits, while the long-term growth rate g comes from consensus GDP forecasts.

In principle, it would be operationally feasible to compute the equity premium directly for specific firms from the dividend discount model, based on the analysts' forecasts for those firms. However, this approach generally yields rather noisy results, as such forecasts tend to be more reliable and smoother on average for the whole market than for individual companies. For this reason, the standard approach [followed, for example in European Central Bank (2016)], is to compute the equity premium for a particular firm in a second step as the product of the equity premium estimated in [4] for the whole market and the CAPM beta of that firm.

$$EP_i = \beta_{CAPM,i} \cdot EP_{market}. \qquad [5]$$

Finally, as with the previous methodology, the cost of equity would be the result of summing the mean risk-free rate to EP_i.

3 Empirical analysis

In this section, we empirically estimate and compare the two approaches described in the previous section.

3.1 Factor model

We obtain from Datastream the weekly stock price data for the financial constituents of the Euro Stoxx 600 index from January 1999 until September 2020. These

constituents include several financial sectors: banks, life and non-life insurance companies, as well as other financial services companies. This list includes euro area firms as well as firms from other EU and non-EU European countries.[2] We convert all non-euro area stock returns into euros. We exclude from the sample Greek companies, to avoid the distortions generated by the Greek sovereign debt crisis, and the two companies from the Euro Stoxx 600 index domiciled in Luxembourg.[3] We consider return index data, which is adjusted for dividend payments.

We compute weekly excess returns with respect to the Euro-Mark weekly deposit rate, which is our risk-free rate proxy.[4] In our view, the weekly frequency offers a good compromise between the daily frequency, where some stocks seem to offer insufficient liquidity, and the monthly frequency, which would make us lose many observations. As the liquidity of the stock data is not homogenous over the sample, we need to filter out some outliers to eliminate the distortions that they would generate. Specifically, we eliminate returns that are larger than 20% in absolute terms, which only affects 0.8% of the original raw data. We also eliminate those returns that equal 0%, which are mostly due to official holidays (many of them are common and easily identifiable across European countries, but some purely national holidays are largely specific for each country).

As our factor model specifications, we consider several alternative settings, drawn from three blocks of factors. The first one is based on stock-market factors. Specifically, we consider the three stock-market factors proposed by Fama and French (1993):

— The excess return of an overall European stock market index.[5]

— SMB or small-minus-big factor. This factor can be interpreted as a size factor, as it captures the stock return spread between small and large companies (below the 10th percentile and above the 90th percentile in size), with size measured by market capitalisation.

— HML or high-minus-low factor. This factor mimics the spread between companies with high and low book-to-value ratios (below the 30th percentile and above the 70th percentile in book-to-value ratios).

2 The non-euro area countries in the sample are the Czech Republic, Denmark, Norway, Sweden, Switzerland and the United Kingdom.

3 We eliminate the firms domiciled in Luxembourg due to the specificities of this international financial center, and in particular the predominance of custodian banks. The complete list is available from the authors on request.

4 This interest rates is based on Eurocurrency deposits, which consist on short term fixed-rate time deposits in a given currency (euros in this case), normally held in London. As this is a very active market, it generally offers liquid and reliable short term interest rate data. The Euro-Mark deposit rate is basically identical to the Euro Deposit rate since 1999, but it offers the advantage of a much longer history.

5 For consistency, we consider the market index from Fama and French. As it is expressed in dollars, we need to convert this index back to euros and to transform it from daily to weekly frequency. In any case, it is very similar to the Stoxx 600 Europe Index, as the correlation between the weekly returns of these two indices is about 98%.

We have downloaded the European time series for these factors from the Kenneth R. French web database.[6] As they are expressed in dollars, we have converted them back to euros.[7]

In addition, we also consider bond-market factors to complement the overall stock-market index, as an alternative to the SMB and HML stock-market factors. This variant was already considered by Fama and French (1993), but we explore an extended factor model that is specifically designed for the European market, following closely the specifications considered by Fama and French (1993) themselves and more recently by Gálvez and Mencía (2018), among others. Specifically, we include the following factors in our second specification:

— The excess return of the Fama and French overall European stock-market index.

— Term spread: 10 minus 2-year sovereign yield for Germany.

— Credit spread: Corporate 10 year A-rated yield minus the 10-year sovereign German yield.

— TED: 3-month Euribor minus 3-month OIS.

— Sovereign change: weekly change in the German sovereign yield.

— Sovereign volatility: cross sectional volatility of European sovereign yields.

The sovereign volatility factor can be interpreted as a fragmentation proxy, especially for the euro area, as recent experience shows that fragmentation tensions are reflected through an increasing dispersion of national sovereign yields.

Furthermore, following Adrian, Friedman and Muir (2015), we consider two additional factors:

— A financial sector premium factor (financial premium factor, for short), measured as the difference between the weekly returns of the Datastream financial index for Europe, and those of the Datastream non-financial index, also for Europe.

6 http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

7 In the cases of the SMB and HML factors, generating the time series in euros is not trivial, as it is necessary to start from the 6 size and book-to-market sorted portfolios (also reported in the Fama and French database), rather from the SMB and HML factors. Specifically, we first convert the 6 size and book-to-market sorted portfolios at a daily frequency back to euros. Then, we compute the weekly returns from these 6 indices. Finally, we use the formulas available in the Fama and French webpage to construct the SMB and HML factors from these six portfolios.

— A return-on-equity (RoE) factor, measured as the difference between the weighted average of the equity returns of banks in the 5th quintile in terms of RoE, and those of the 1st quintile.

For the sake of completeness, we also consider a CAPM single-factor specification, in which the only factor would be the overall market index.

Chart 2 shows the kernel densities of the factor loadings that we obtain when we estimate [1] for the whole sample. We can observe that the factor loadings on the overall market factor tend to cluster around 1 in all the estimations, from the one-factor CAPM setting to the other multifactor approaches. This is a standard result in the asset pricing literature, reflecting the fact that the overall stock index is a weighted average of all trading stocks. We observe a wider dispersion in the SMB and HML factor loadings, although the majority of the estimates are positive. Fama and French (1993) also obtained positive factor loadings on the SMB factor, which tended to be larger for smaller stocks. In contrast, they generally obtained negative coefficients for the HML factor, especially for the stocks with low book-to-value ratios. In the specification with bond-market factors (Chart 2b), we obtain highly dispersed estimates for the loadings on the TED and Sovereign change factors. This reflects the fact that the influence of these factors tend to be extremely idiosyncratic, possibly reflecting an estimation artefact rather than systematic influences. In contrast, the kernel densities of the credit spread, the term spread and sovereign volatility are much less disperse. In the Adrian, Friedman and Muir (2015) FCAPM specification (Chart 2c), the loadings of the RoE factor are tightly clustered around zero, suggesting an insignificant effect of this factor. The loadings of the financial sector risk premium, SMB and HML factors show similar densities, suggesting some redundancies.

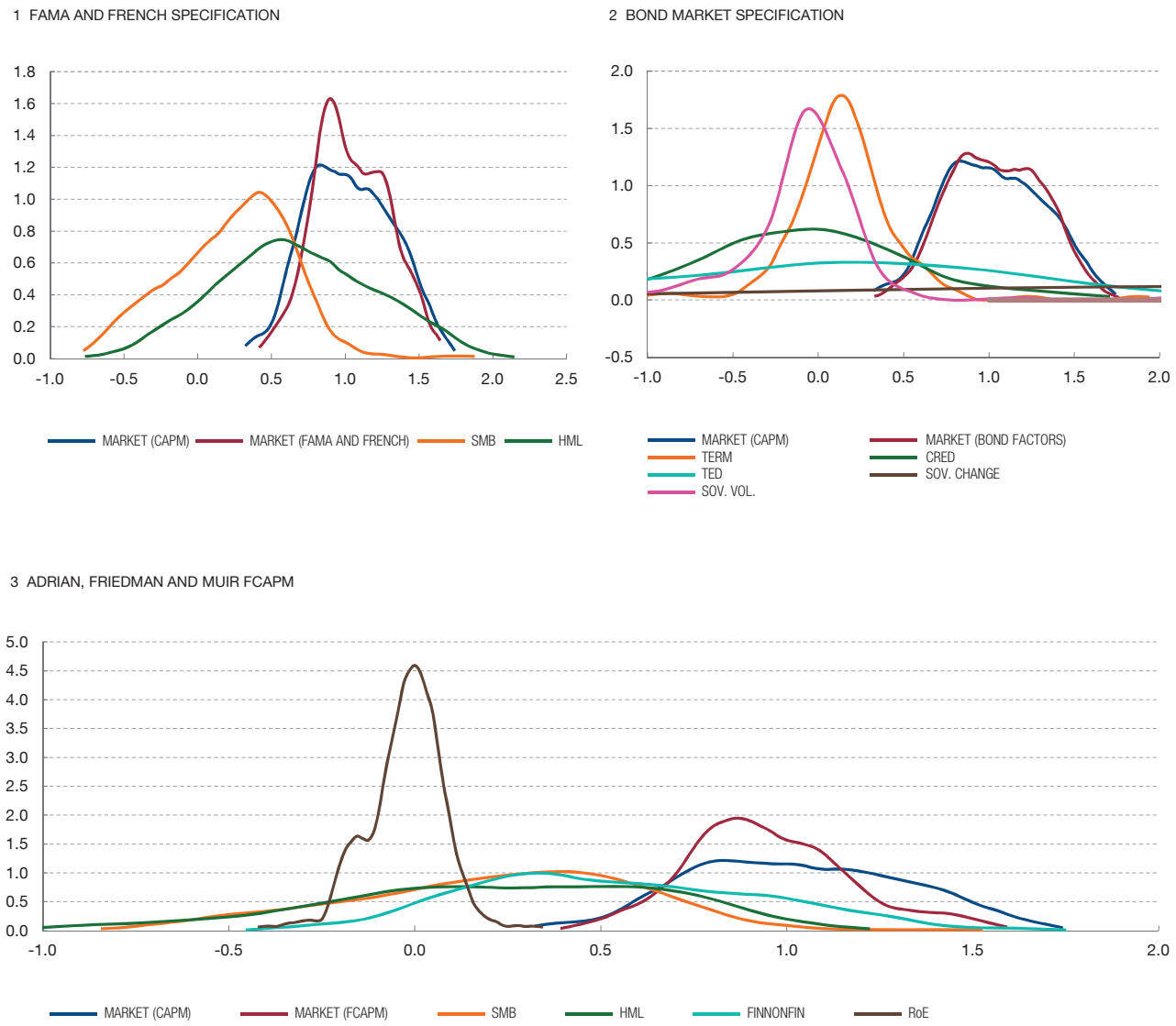
We then proceed with the second step, in which we estimate [2] to study whether these factors are priced by the market. Prior to the regression, we drop all the companies with a negative realised average excess return over the sample. Intuitively, a rational investor should not be willing to invest in a risky asset that offers a lower return than a risk-free asset. Although this may occur in finite samples, the probability of a negative realised excess return should tend to zero in the long run.

Table 1a shows the parameter estimates for the standard cross-sectional regressions, while Table 1b shows the Fama and MacBeth (1973) estimates. The first column in both tables exclusively considers the general market index as the only factor. This is why this column is labelled as CAPM. Column 2 only considers the Fama and French factors, while column 3 adds the financial premium and RoE factors. Then, the fourth column considers the bond-market factors instead of the stock-market factors. Finally, the fifth column pools all the stock and bond-market factors. A comparison of the adjusted R-squares shows that stock-market factors tend to provide a higher explanatory power than bond-market factors, but the

Chart 2

FACTOR LOADINGS OF THE TIME SERIES REGRESSIONS FROM THE FACTOR MODEL

Kernel densities of the factor loadings from time series regressions by firm of weekly excess returns on a series of factors.



SOURCE: Authors' elaboration.

financial premium and RoE factors do not add much explanatory power with respect to the Fama and French factors. In addition, only a few bond-market factors turn out to be statistically significant, whereas the three Fama and French factors are highly significant.

When we pool all the stock and bond-market factors in a single regression (fifth column in Tables 1a and 1b), then much of the statistical significance disappears, except for the market, HML and financial premium factors. Perhaps pooling all the factors in a single regression may overstretch too much the limited number of

Table 1

ESTIMATION OF THE PRICES OF RISK IN THE MULTI-FACTOR MODEL

The results reported in Panel (a) are the coefficients of a cross-sectional regression of average excess returns on the factor loadings resulting from a previous regression. The results reported in Panel (b) are averages of the coefficients of cross-sectional regressions of weekly excess returns on the factor loadings resulting from a previous regression [following Fama and MacBeth (1973)]. The previous regression consists on time series regressions by firm of weekly excess returns on a series of factors.

	(a) Cross-sectional regressions					(b) Fama and MacBeth (1973) regressions				
	CAPM	Fama and French	FCAPM	Bond Factors	All	CAPM	Fama and French	FCAPM	Bond Factors	All
Market	0.189***	0.252***	0.268***	0.231***	0.259***	0.183**	0.231***	0.243***	0.221***	0.223***
	(0.0121)	(0.0181)	(0.0278)	(0.0145)	(0.0277)	(0.0746)	(0.0723)	(0.0732)	(0.0703)	(0.0738)
SMB		0.0847***	0.0613**		0.043		0.0938**	0.060		0.043
		(0.0224)	(0.0296)		(0.0296)		(0.0437)	(0.0481)		(0.0406)
HML		-0.137***	-0.126***		-0.106***		-0.115**	-0.086		-0.0812*
		(0.0234)	(0.0276)		(0.0236)		(0.0502)	(0.0531)		(0.0457)
CRED				0.031	0.004				-0.011	0.001
				(0.0308)	(0.0307)				(0.0527)	(0.0515)
TERM				-0.086	-0.088				-0.060	-0.082
				(0.0601)	(0.0597)				(0.0653)	(0.0666)
TED				0.020	0.005				0.007	0.024
				(0.0152)	(0.013)				(0.0253)	(0.0266)
Sov. Change				-0.0132***	0.000				-0.0175***	0.000
				(0.0042)	(0.00504)				(0.00613)	(0.0062)
Sov. Vol.				-0.054	-0.053				-0.134	-0.090
				(0.0333)	(0.0325)				(0.091)	(0.0826)
Fin. Premium			-0.0884**		-0.0781**			-0.076		-0.061
			(0.0396)		(0.037)			(0.0608)		(0.0575)
RoE			0.207		0.192*			0.209		0.214
			(0.126)		(0.107)			(0.145)		(0.131)
Obs.	126	126	126	126	126	1,134	1,134	1,134	1,134	1,134
Adj. R-sq	0.647	0.785	0.794	0.7	0.793	0.284***	0.329***	0.349***	0.328***	0.373***

SOURCE: Authors' calculation.
NOTE: Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

observations in the cross section. However, the estimate on the HML factor offers some interesting insights, as it is generally negative and significant, even in the Fama and MacBeth regression pooling all the variables. We have investigated this issue in greater detail, and found that the coefficient of this factor was positive before the global financial crisis (not reported in the table). This may reflect a change in the nature of financial companies, especially banks. Specifically, they performed as growth stocks in normal times before the global financial crisis, but since then their stocks have become value stocks, as they are trading well below their book value in many cases. As a result, the negative coefficient that we observe for the HML factor in Table 1 effectively generates a higher risk premium in bad times, when the beta estimated in the first step tends to decrease.

3.2 Dividend discount model

As we have explained in the previous section, this two-stage approach combines features from the dividend discount model of Fuller and Hsia (1984) with the CAPM. In the first stage, we estimate [4] for the Euro Stoxx index. We have downloaded the dividend-yield data for this index from Datastream.[8] We proxy the initial profits variable g_0 from the analysts' expectations collected by the Institutional Brokers Estimate System database (I/B/E/S), which reports a median forecast for the annual earnings growth rate of the Euro Stoxx, weighting the forecasts for each Euro Stoxx constituent by its market cap. Then, we use GDP expected long term growth, taken from Consensus Economics, as our proxy for long-term growth, g. Following European Central Bank (2016), we set H to 5 years. Thus, we assume that dividend growth initially equals the profit growth estimated by investors, with dividends accounting for a fixed proportion of profits, and that thereafter dividend growth will gradually converge towards expected long-term economic growth. In the second stage, we estimate the banking sector equity premium for each European country, following [5]. Specifically, we consider the product of the equity risk premium for the Euro Stoxx by the CAPM beta corresponding to the banking sectoral index of each country. Our sectoral indices are the Datastream national indices for the Banking sector. We compute the CAPM betas using daily data.[9] Finally, we use the yields on a French inflation-linked government bond index to compute the cost of equity from the equity premia in real terms.

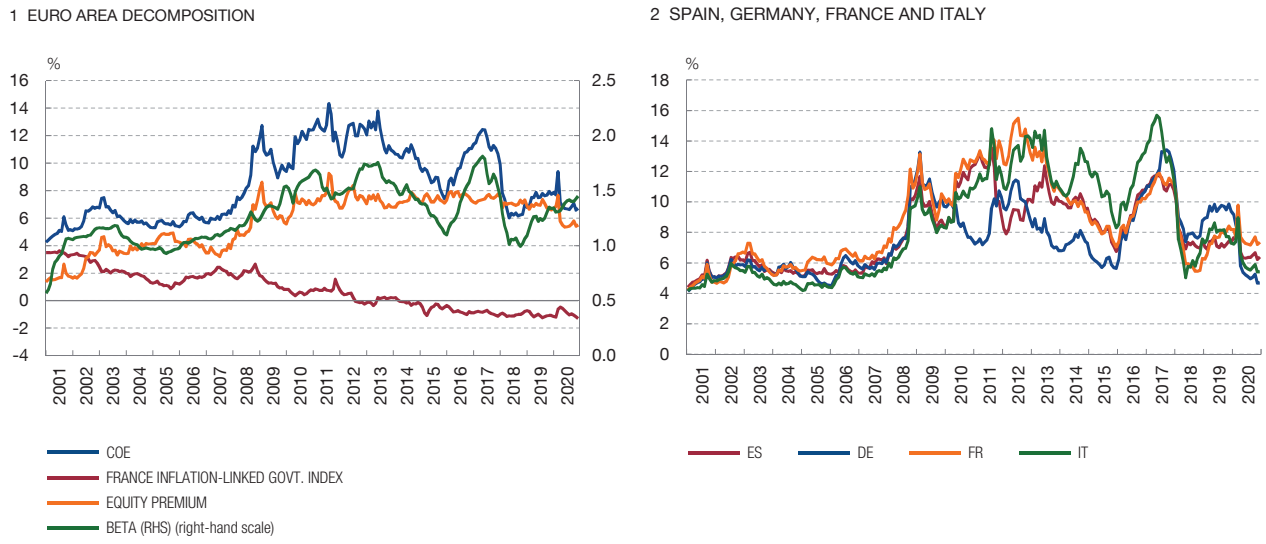
Chart 3 shows the monthly evolution of the cost of equity for the whole euro area (Panel a), as well as for its largest Members (Panel b). We also show in Panel a the evolution of some auxiliary variables: the equity premium for the whole Euro Stoxx and the CAPM beta for the euro area banking sector. We consider one-year rolling windows to estimate the CAPM beta, in order to obtain time-varying estimates that reflect possible changes in the values of these coefficients over the sample. Chart 3 shows that the cost of equity remained relatively stable at values close to 6% between 2000 and 2007, with limited cross-country differences. From the onset of the global financial crisis, we observe several relevant developments. First, the cost of equity rapidly increased for all countries to values above 8%. Secondly, the dispersion among countries quickly increased after 2010, roughly coinciding with the outbreak of the euro area sovereign debt crisis. From 2015 on a reduction in the dispersion across countries of the cost of equity can be observed, but not a reduction in their levels. In fact, the cost of equity estimates reached a peak around 2016-2017, in the aftermath of the turbulences generated by the Brexit referendum, and have not yet returned to those observed before the global financial crisis. Lastly, we observe

8 This corresponds to D_0 / P_0 in [4].

9 In this case, we are confident that we can consider the daily frequency in these CAPM regressions, as they only involve liquid indices, not individual stocks. Thanks to this higher frequency, we can shorten the size of the overlapping windows in these regressions, which makes the beta estimates much more representative of the latest developments at each point in time.

Chart 3

MONTHLY EVOLUTION OF THE COST OF EQUITY ESTIMATES FROM THE DIVIDEND DISCOUNT MODEL (2001-2020)



SOURCE: Authors' calculations.

a final spike in March 2020, related to the intense but short-lived financial turbulences at the beginning of the COVID-19 pandemic [see Fernández Lafuerza and Mencía (2020) for a thorough analysis of the cost of equity over this period].

3.3 Comparing the cost of equity estimates from the two methodologies

We compare in Table 2 the average cost of equity for the whole sample, estimated with our two alternative approaches for the largest European countries, the whole euro area and the rest of Europe. We show the results obtained from the dividend discount model and the two specifications of the factor model estimated in subsection 3.1: the CAPM and the specification with the three Fama and French factors, which is the multifactor specification providing more robust and consistently significant results.[10] For the whole sample, the dividend discount model yields results in the 6-9% range, while the factor approaches estimates lie in the 6-14% range. In particular, the dividend discount model tends to provide lower cost of equity estimates than the single-factor CAPM model, but higher values than the Fama and French specification, except for Germany. The Fama and French specification yields lower cost of equity estimates than the CAPM model, primarily because of the HML factor. In our results we see that higher market value institutions tend to be more exposed to this factor, having lower cost of equity. This effect is not

10 For consistency with the dividend discount model, we also consider the same French inflation-linked Government bond index to compute the cost of equity from the equity premium in the factor models.

Table 2
ESTIMATES OF THE COST OF EQUITY

In the CAPM and Fama and French models the cost of equity is aggregated at the country level performing a market value weighted average of the bank figures.

	Whole sample (1999-2020)					
	ES	DE	FR	IT	Euro	Other Europe
Discount model	7.90	7.60	8.60	8.40	8.50	6.5
CAPM	13.10	12.70	14.60	13.40	13.60	12.9
Fama and French	5.90	10.50	6.60	5.90	7.90	10.3

SOURCE: Authors' calculation.

captured in the simple CAPM model (where higher market value institutions tend to have higher cost of equity). Since the results in Table 2 are weighted by market value, the Fama and French specification will tend to yield lower values. We should bear in mind that we can only estimate the cost of equity for listed companies. Therefore, the figures that we obtain may not be equally representative for each European countries. For instance, in Spain a large share of the banking sector is currently composed by listed banks. This is not the case in other European countries, where non-listed savings banks or cooperatives are more prevalent.

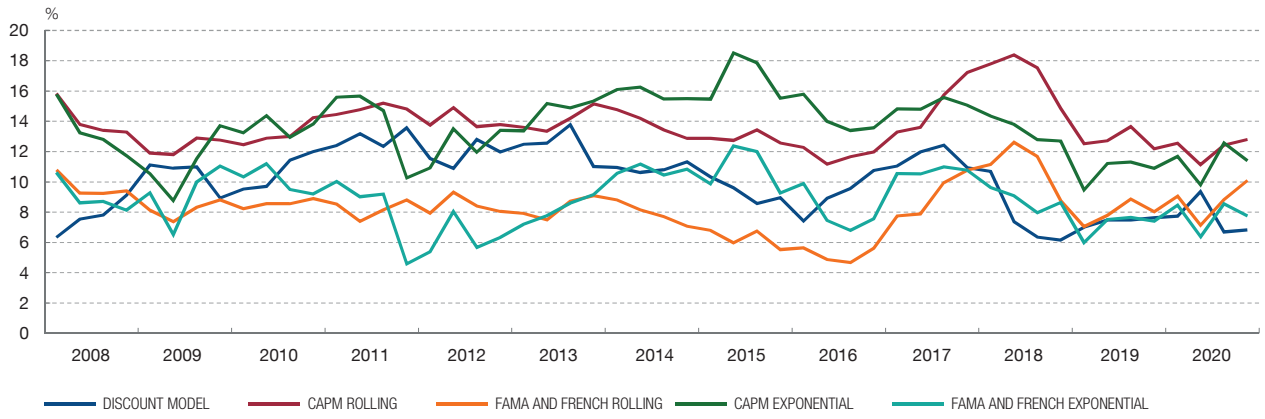
In addition, we also compare the time-series evolution of the different approaches in Chart 4. We consider two different methods to obtain time-dependent estimates of the cost of equity in the factor based approach. The first one simply uses nine-year overlapping rolling windows. Such long time windows are necessary to ensure that the results from the factor model are reliable and stable, as this approach is highly data-intensive. The second one uses expanding windows that end in the month of interest, but when computing the betas and the lambdas, observations are weighted with weights that decay exponentially the further away that the observations are from the present.[11] Hence, this second approach yields estimates that offer a more realistic picture of the situation at each point in time, rather than the average of the last 9 years as with the first approach. In both cases, the time-dependent cost of equity of all euro area institutions in the sample is aggregated by weighting those institutions by their market value. We can observe that all the series generally evolve similarly over the sample. The only exception is the sovereign-crisis period (from 2010 to 2012), in which the results from the Fama and French approach tend to diverge from the dividend discount model and the CAPM. In general, the exponentially-weighted approach seems to yield results that respond more quickly to changes in financial conditions (as captured by the dividend discount model), and it generally produces series with closer dynamics to the dividend discount model, suggesting that it is preferable to the simple overlapping window approach. For instance, once

11 At time t, observations of time $t_1 < t$ are weighted as $\exp(-2(t-t1)/9)$, with t and t_1 expressed in years.

Chart 4

HISTORICAL EVOLUTION OF THE COST OF EQUITY

Estimates label "Rolling" are based on nine year moving windows, while those labelled "Exponential" consider all past observations, exponentially weighted. The line labelled "Discount model Euro" is plotted using quarterly estimates.



SOURCE: Authors' elaboration.

again we observe a spike in the cost of equity in March 2020 with the discount model. We also observe a similar spike with the Fama and French multifactor model, albeit one month later, but only when we employ the exponentially weighted approach.

In a recent work, Altavilla et al. (2021) use the dynamic conditional beta approach of Engle (2016) to estimate time-varying betas. Compared with the overlapping windows method, they find that the conditional beta approach yields estimates that respond more timely to current developments. However, this approach requires assuming a fully parametric model for the time varying covariance matrix. In this sense, our exponentially weighted methodology is likely to be a more robust non-parametric approach, as it does not require to identify the true data generating process.

4 Conclusions

In this paper, we compare the cost of equity estimates resulting from the dividend discount model with those of a multifactor approach, estimated from a large panel of European financial institutions. We are reassured by our findings that the alternative approaches that we consider generally yield results with similar dynamics. However, the dividend discount model and our preferred multifactor approach can ocassionally yield very different estimates. It is very important to have this range in mind, in order to understand the high degree of uncertainty of cost of equity estimations. After our analysis, we still view the dividend discount model as the main benchmark for the regular monitorisation of the average cost of equity for a banking system. This approach is more forward-looking in nature than our alternative approach. It is also

less data intensive, which is very helpful to update the cost of equity estimates at high frequencies or to immediately gauge the impact of certain shocks in the financial markets. At the same time, the multifactor model is more flexible to account for cross-sectional heterogeneity thanks to its ability to incorporate several factors. This is an essential feature if we want to develop cost of equity estimates that react to developments beyond those captured by the overall market index.

Our analysis leaves several important questions for future work. For instance, it would be very interesting to extend the multifactor framework by introducing forward looking elements in this setting, thus bringing together the best features of the two alternative approaches that we have considered. Furthermore, another interesting avenue would be to explore ways to incorporate national and bank-level specificities in the cost of equity measures. Lastly, it would also be potentially relevant to explore non-linear extensions, as non-linearities are particularly likely to exist in such an elusive measure as the cost of equity.

REFERENCES

Adrian, T., E. Friedman, and T. Muir (2015). *The cost of capital of the financial sector,* Staff Reports, 755, Federal Reserve Bank of New York.

Alonso Sánchez, F., and J. M. Marqués Sevillano (2006). "Un indicador del coste de financiación de las sociedades no financieras españolas", *Boletín Económico,* diciembre, Banco de España, pp. 43-50.

Altavilla, C., P. Bochmann, J. De Ryck, A.-M. Dumitru, M. Grodzicki, H. Kick, C. M. Fernandes, J. Mosthaf, C. O'Donnell and S. Palligkinis (2021). *Measuring the cost of equity of euro area banks,* Occasional Paper Series, 254, European Central Bank.

Barnes, L., and J. A. López (2005). "Alternative measures of the Federal Reserve Banks' cost of equity capital", *Journal of Banking & Finance,* 30(6), pp. 1687-1711.

Da, Z., R.-J. Guo and R. Jagannathan (2012). "CAPM for estimating the cost of equity capital: Interpreting the empirical evidence", *Journal of Financial Economics,* 103(1), pp. 204-220,

Duarte, F., and C. Rosa (2015). *The equity risk premium: a review of models,* Staff Report, 714, Federal Reserve Bank of New York.

Engle, R. (2016). "Dynamic conditional beta", *Journal of Financial Econometrics,* 14(4), pp. 643-667.

European Central Bank (2016). "Recent developments in the composition and cost of bank funding in the euro area", *ECB Economic Bulletin*, Issue 1/2016, pp. 26-44.

European Central Bank (2019). *Financial Stability Review,* May.

Fama, E. F., and K. R. French (1993). "Common risk factors in the returns on stocks and bonds", *Journal of Financial Economics,* 33, pp. 3-56.

Fama, E. F., and J. D. MacBeth (1973). "Risk, Return, and Equilibrium: Empirical Tests", *Journal of Political Economy,* 81(3), pp. 607-636.

Fernández Lafuerza, L., and J. Mencía (2020). "Recent developments in the cost of bank equity in Europe", Analytical Articles, *Economic Bulletin,* 4/2020, Banco de España.

Fuller, R. J., and C.-C. Hsia (1984). "A simplified common stock valuation model", *Financial Analysts Journal,* 40(5), pp. 49-56.

Gálvez, J., and J. Mencía (2018). *Conditional return asymmetries in the sovereign-bank nexus,* CEMFI Working Paper No. 1813.

King, M. R. (2009). "The cost of equity for global banks: a CAPM perspective from 1990 to 2009", *BIS Quarterly Review,* September, pp. 59-73.

Kovner, A., and P. Van Tassel (2019). *Evaluating regulatory reform: banks' cost of capital and lending,* Staff Reports, 854, Federal Reserve Bank of New York.

Lintner, J. (1965). "The valuation of risky assets and the selection of risky investments in stock portfolios and capital budgets", *Review of Economics and Statistics,* 47, pp. 13-37.

Newey, W. K., and K. D. West (1987). "A Simple, Positive Semi-definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix", *Econometrica* 55(3), pp. 703-708.

Sharpe, W. (1964). "Capital asset prices: a theory of market equilibrium under conditions of risk", *Journal of Finance,* 19, pp. 425-442.

Adapting the supervision of credit institutions to the COVID-19 crisis

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Abstract

The Banco de España has had to adapt its supervisory priorities, methodologies and approaches to respond to the crisis triggered by the COVID-19 pandemic. This response has been coordinated with the European Central Bank (ECB) and the other regulatory and supervisory bodies with which it collaborates.

Ongoing off-site monitoring activities have mainly adapted by realigning supervisory priorities, reassigning tasks and resources and changing procedures. This has ensured, since the onset of the crisis, the availability of timely information on the pandemic's impact on institutions and the adoption of the measures required for them to continue providing banking services to the general public. Working from home has barely affected supervisory activity, since most of the teams already worked on a remote basis.

On-site supervision, usually conducted physically at institutions, has had to adapt its methodology and processes to remote working. Following the return of the inspection teams posted at institutions in Spain and abroad, and the introduction of remote working, on-site inspections were reorganised and replanned. As a result, a significant volume of inspections was maintained and completed in 2020.

In an adverse environment of heightened uncertainty, adapting the supervisory function to remote working has not only been successful, but it will also allow us to incorporate some of the lessons learned into our usual work procedures and methodologies.

1 Introduction

The effects of the outbreak of the COVID-19 pandemic have triggered an unprecedented shock across all areas, from healthcare to economic systems, not to mention private life and work. Naturally, this situation has also affected the Banco de España, particularly its supervisory function.

At the end of 2019, the first cases of COVID-19 were detected in China and we began to hear about a city called Wuhan. At that time, we watched the news from Asia from a safe distance, without much concern. But gradually things began to change and, at a certain point, events started to unfold at great speed, shaking the foundations on which our everyday lives were built.

For the Banco de España, and for the country as a whole, March 2020 marked a turning point in the way we went about our lives and interacted with others. In early March, the first restrictions on international travel were introduced, soon to be extended to national travel too, leading to the return and centralisation of all the teams working on-site. The Directorate General Banking Supervision was one of the most affected, mainly because of the many on-site inspections under way (with teams deployed at supervised institutions) in different parts of Spain and Europe. The health situation continued to worsen and on 11 March the Banco de España decided to implement remote working as the preferred option, maintaining on-site work only for essential tasks that were necessary to guarantee the continuity of the bank's critical processes. Finally, a state of alert was declared in Spain on 14 March.

At the Banco de España, making the change to remote working was not easy. Although a pilot project for remote working had been under way for a few years, it only included a small number of employees and the majority had not worked from home previously. The Directorate General Banking Supervision was in a privileged position compared with other areas, since practically all employees had laptops connected to the Bank's central systems, precisely because they frequently had to perform their work from the supervised institutions. Moreover, the Banco de España's services reacted very quickly to this situation, adapting systems in record time to enable all employees to work from home, connecting them to central data and platforms and establishing new collaborative communication systems.

In addition to the necessary development, expansion and implementation of the appropriate technological infrastructure, working arrangements also had to change since physical interaction between work colleagues and third parties was no longer possible.

Prominent among these third parties are the institutions and particularly the ECB. It is worth recalling here that microprudential supervision[1] in Spain is carried out jointly by the ECB and the Banco de España, within the framework of the Single Supervisory Mechanism (SSM). The ECB is tasked with the direct supervision of significant institutions (SIs), i.e. those that are larger or have a greater relative significance, which it performs in coordination with the national competent authorities, in our case, the Banco de España. Additionally, the Banco de España is responsible for the direct supervision of less significant institutions (LSIs) and actively participates in the working groups of the ECB and the European Banking Authority (EBA) and in other European and international fora.

The pandemic has also forced supervisory activity to be refocused, not only in terms of the way we work, but, more importantly, in terms of the content of that work, so

1 Supervision of individual institutions, as opposed to macroprudential oversight, which entails the monitoring and analysis of the banking system as a whole.

that it addresses the most immediate risks arising from the crisis without interfering with the necessary operational adaptation by banks to the new situation.

The following sections describe the impact of the pandemic on operational aspects, owing to the implementation of remote working, and on the Banco de España's supervisory activity and processes, focusing on the two primary facets of the microprudential supervision function:

- **Ongoing off-site monitoring activities,** aimed at analysing the financial situation of banks and assessing their risk profile in order to define priorities and the scope for future supervisory tasks.

- **On-site supervision, centred on verifying,** in an independent, in-depth and timely manner, any risk areas requiring particular attention revealed during ongoing monitoring, and on assessing the models used to calculate capital requirements.

2 Impact of COVID-19 on ongoing off-site supervision

With the outbreak of the COVID-19 pandemic, the supervisory community has had to exercise flexibility to adapt its supervisory approaches and processes, including the following: i) balancing supervisory activities to avoid increasing the operational burden for banks; ii) making adjustments to the data collection process, and iii) having the adaptability to rapidly adjust supervisory planning, resources, processes and actions to counter the new risks arising from the crisis.

In the ongoing off-site supervision carried out by the Banco de España, this need for adaptation has affected both operational aspects and working arrangements internally and with institutions, and has led to the adoption of measures to temporarily relieve supervisory pressure. It has also significantly altered supervisory priorities, processes and activities.

Naturally, institutions have also had to adapt to ensure continuity in the provision of banking services to the general public.

This section describes how supervisors and institutions have adapted to the new situation.

Ongoing supervision of SIs is performed by joint supervisory teams comprising ECB and Banco de España staff.[2] Although the explanation below refers to SIs,

2 When the banking group has subsidiaries in SSM countries, staff from the national supervisory authority also participate.

it can also be generally applied to LSIs, bearing in mind the principle of proportionality and the fact that supervisory functions are concentrated in the Banco de España.[3]

2.1 Operational measures

From an operational standpoint, all supervisory activity had to be carried out remotely, using collaborative technological tools enabling remote meetings to be held and information to be shared quickly and securely. Ongoing off-site supervision was not greatly affected, since the ECB and Banco de España joint supervisory teams already worked remotely and used means of remote communication in their daily interactions with institutions.

On the whole, these working arrangements have proved effective. However, the move to full online supervision and the reduced interaction and involvement owing to the lack of physical meetings has proved a challenge for team managers, who have had to learn to be "tele-managers". This has entailed spending more time on ensuring team cohesion, productivity and coordination.

As regards institutions' preparedness, on 3 March 2020, the ECB asked all SIs to review their business continuity plans and to consider what actions could be taken to enhance their preparedness so as to minimise the potential adverse effects of the spread of the coronavirus. The ECB recommended the following eight measures: i) infection control in the workplace, ii) assessing to what extent the contingency plans included a pandemic scenario with measures commensurate with the geographical location and business model; iii) assessing how quickly these measures could be implemented; iv) establishing alternative workplaces; v) urgently testing whether large-scale remote/flexible working arrangements could be activated to ensure business continuity; vi) testing the capacity of IT infrastructure and its cyber resilience; vii) assessing risks of increased cybersecurity-related fraud, and vii) ascertaining whether critical service providers would be able to ensure continuity in a pandemic. The Banco de España made the same recommendations to LSIs on 6 March.

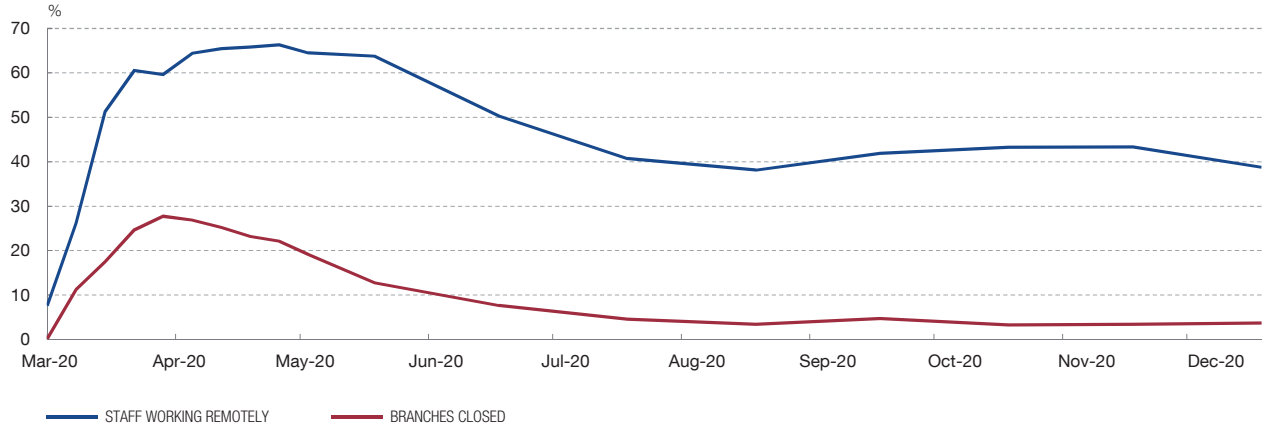
Overall, institutions were quick to react, implementing preventive measures similar to those adopted by the Banco de España and the ECB (cancelling or restricting travel, meetings and events), testing remote working mechanisms, in some cases moving staff to back-up sites, and ascertaining whether critical service providers had continuity plans. Indeed, except for a few minor incidents in the first few days, institutions were able to adapt quickly to the new situation and to continue

3 The teams monitoring LSIs comprise only Banco de España staff.

Chart 1

THE EFFECTS OF THE PANDEMIC ON BRANCH CLOSURES AND THE INCREASE IN REMOTE WORKING IN SPANISH SIs

The COVID-19 crisis has had a clear impact on the widespread implementation of remote working at Spanish credit institutions. Despite the return of a large part of the workforce from June 2020, the percentage of those who continued to work from home for the rest of the year remained fairly high. In addition, the declaration of the state of alert and lockdown led to the closure of nearly 30% of the branch network.



SOURCE: Banco de España (2021).

providing banking services, keeping a significant number of branches open to the general public and functioning normally during lockdown, despite the risks involved. Central services had, and to a large extent still have, the highest percentage of employees working remotely. Chart 1 shows the trends in remote working and branch closures.

Also in March 2020, the ECB adopted a series of measures to alleviate part of the operational burden of SSM supervision, enabling institutions to concentrate their efforts on continuing to operate, on assessing the impact of the pandemic and on ensuring the continuity of their core business. As regards ongoing monitoring, these measures notably included: i) extending the deadlines for complying with certain non-critical recommendations made by the supervisor; ii) postponing the deadline for submitting certain supervisory reports, and iii) supporting the EBA's decision to postpone the EU-wide banking system stress test exercise to 2021. Box 1 lists the measures notified by the ECB to SIs.

Additionally, the EBA recommended that supervisors reduce data requests to what was strictly necessary for monitoring institutions in the context of COVID-19, and asked supervisors to exercise flexibility regarding institutions' compliance with the deadlines for publication of their Pillar 3 disclosures.[4]

4 European Banking Authority (2020b).

Box 1

RELIEF MEASURES PUBLISHED BY THE EUROPEAN CENTRAL BANK IN MARCH 2020 REGARDING THE OPERATIONAL ASPECTS OF SUPERVISION[1]

1 Postpone, by six months, the existing deadline for remedial actions imposed in the context of on-site inspections and the internal capital model investigations.

2 Postpone, by six months, the verification of compliance with qualitative SREP measures.

3 Postpone, by six months, the issuance of on-site follow-up letters and internal model decisions not yet communicated to institutions, unless a decision is requested by the bank.

4 Regarding the 2020 recovery plans, permit banks to submit only the core elements (indicators, options, overall recovery capacity), focusing on the stress scenarios triggered by coronavirus, ensuring that the plans can be implemented effectively and in a timely manner if needed.

1 European Central Bank (2020b and 2020c).

2.2 Adapting ongoing off-site monitoring activities: what should we supervise?

The exceptional situation brought about by the COVID-19 pandemic also led to a review of supervisory priorities in 2020, shifting the focus towards monitoring of the pandemic-related risks and their impact on institutions' risk profile. In parallel, routine monitoring tasks were scaled down.

2.2.1 Shift in supervisory priorities

Briefly, particular emphasis was initially placed on institutions' liquidity and contingency plans, primarily in relation to cybersecurity and business continuity. This was followed by monitoring of the application of moratoria and the use of public guarantee schemes, identifying the sectors hardest hit by the crisis, and of the management policies and provisioning for distressed debtors, which remain the main focus of the analysis of the pandemic's impact on asset quality. Lastly, the effects of the pandemic on institutions' activity, income statement and capital levels have been closely monitored.

Supervisory priorities and actions for 2021 continue to be marked by the pandemic,[5] and focus mainly on credit risk.

2.2.2 Scaling down routine monitoring tasks

In order to ease the operational burden, ongoing monitoring teams ceased to perform some of their routine tasks and focused on analysing banks' ability to withstand the impact of the pandemic.

5 For more details, see Banco de España (2021).

To this end, the ECB took a pragmatic approach to implementing its annual core activity – the Supervisory Review and Evaluation Process (SREP) –, in line with EBA guidelines.[6] The simplified SREP methodology for 2020 centred on assessing banks' ability to address the challenges and risks arising from the crisis, by scaling down the other activities involved in this process.[7] Specifically, the supervisory analysis of each risk area has prioritised the aspects that might be particularly affected by the crisis, or that could have an impact on the institution's capacity to operate properly in future. The Banco de España has applied the same pragmatic approach to LSIs.

2.3 Adapting ongoing off-site monitoring activities: how should we supervise?

The pandemic has also had a significant impact on **the way supervision is conducted, mainly in four aspects:** greater interaction with institutions, coordination with other supervisors, centralised coordination of impact measurement, managed primarily through transversal actions, and the need for more frequent ad hoc reporting.

2.3.1 Greater interaction with institutions

The need for closer contact with institutions in order to have access to the most up-to-date information, which is part and parcel of any crisis, was heightened by the distinctive nature of COVID-19, to ensure early detection of how the crisis was affecting banks and the services they provide to the general public, and to establish procedures to monitor this impact and to swiftly adopt preventive measures, should they be required.

From early March 2020, the monitoring teams established remote contact with institutions, practically on a daily basis. Conversations focused on liquidity management, market conditions, business continuity issues relating to remote working, the impact on other risks anticipated by the institution, particularly credit risk, and the internal governance structures set up to monitor the crisis. Supervisory teams reported to the ECB and the Banco de España's senior management regarding these conversations on a weekly basis, using standardised templates, or immediately if deemed necessary.

These meetings became less frequent once liquidity tensions eased, although the supervision teams continued to prepare a weekly dashboard to monitor the impact

6 For more information, see the European Banking Authority (2020c).

7 For more information, see European Central Bank (2021a).

of the pandemic on supervised institutions, which required maintaining close contact with them.

As regards LSIs, the Banco de España has remained in constant contact with all the institutions through numerous remote meetings and has requested contingency plans. Some institutions have been asked to submit periodic reports on aspects that are similar to those affecting SIs.

2.3.2 Coordination with other supervisors

With respect to ongoing monitoring, contacts with other banking supervisors from non-euro area countries were strengthened, in order to understand the implications of the pandemic and the measures implemented in those countries. Moreover, in 2020, meetings of the supervisory colleges were held by videoconference in a shorter duration format, and the main point of discussion was the impact of COVID-19 on the different banking risks. It should be noted that meeting in this way renders the colleges less effective, since there is less dialogue and no social interaction to consolidate supervisory relationships.

2.3.3 Centralised coordination of impact measurement through transversal actions

The ECB set up a multidisciplinary team to coordinate monitoring of the pandemic, tasked mainly with:

— Establishing communication channels with supervisory teams in order to provide them with, inter alia, action guidelines, transversal actions and information to be requested from institutions.

— Reporting to senior management on the effects of the pandemic on the different banking risks and proposing intervention measures to be approved, ultimately, by the Supervisory Board of the ECB, of which the Banco de España is a member.

— Designing indicators and other tools to support the ongoing monitoring teams in their review tasks.

The shift to a transversal and multidisciplinary approach in the procedures was one of the distinctive features of ongoing monitoring of the crisis in 2020. There was a move from monitoring tailored to each institution's particularities to a more transversal and centralised approach, through activities and actions affecting all or several institutions. Benchmarking exercises promptly revealed good and bad practices in

Box 2

LETTERS FROM THE EUROPEAN CENTRAL BANK TO SIGNIFICANT INSTITUTIONS ON CREDIT RISK (PUBLISHED)[1]

1.4.2020. "IFRS 9 in the context of the coronavirus (COVID-19) pandemic": provides guidance to institutions on the use of macroeconomic forecasts to avoid excessively procyclical assumptions in their expected credit loss estimations.

28.7.2020. "Operational capacity to deal with distressed debtors in the context of the coronavirus (COVID-19) pandemic": clarifies supervisory expectations to enable institutions to provide sustainable solutions for distressed debtors.

4.12.2020. "Identification and measurement of credit risk in the context of the coronavirus (COVID-19) pandemic": refers to supervisory expectations regarding management and coverage of credit risk.

1 European Central Bank (2020d, 2020e and 2020f).

aspects that neither the institutions nor the supervisors had previously been faced with.

Some of these initiatives were backed by the publication of the letters sent to institutions, as in the case of credit risk, one of main supervisory priorities. A list of these letters is included in Box 2.

The Banco de España has also carried out specific transversal tasks to monitor credit risk which may help to quantify and track its potential impact on the banking system. These include credit portfolio segmentation based on the level of vulnerability to the crisis triggered by COVID-19, and definition of early warning indicators to anticipate the course of credit impairment, which are available to ongoing monitoring teams.

2.3.4 The need for more frequent ad hoc reporting

During crises, periodic regulatory reporting is often needed on a more frequent basis, so that more accurate and specific analyses can be conducted. This need was accentuated during the COVID-19 crisis, owing to its unprecedented nature (systemic, global and not caused by endogenous economic or financial factors). Furthermore, the traditional supervision metrics, used to assess and monitor institutions, have proved less helpful owing to the government support measures introduced for debtors (moratoria and public guarantees), which may delay the recognition of distressed debtors.

Initially, a number of data templates were designed, as the need arose, usually submitted on a weekly basis. In addition, national authorities began to ask the institutions in their jurisdictions to provide data. In order to avoid overlaps, the ECB created a working group with the national authorities to design a monthly prudential

reporting request to complement the quarterly regulatory returns. The request refers to the application of moratoria and public guarantee measures (using a common ECB/EBA template), the use of committed credit lines, operational continuity indicators, and projections of key prudential indicators.

The first compilation contained data as at May 2020, and was also made available to national authorities.

Moreover, the data collection platforms have had to be upgraded, as have data management tools, to achieve greater flexibility and speed, in order to provide monitoring teams with new indicators and useful comparative information on which to base their analysis of the new supervisory focal points.

Nonetheless, data is an area which needs to be improved. At some institutions, shortcomings have been found in the aggregation, availability and quality of data and in the capacity to process data quickly.

Added to this are the difficulties of conducting forward-looking analyses. As a result of the uncertainty over the pandemic's effects on the economy, the analysis of income and capital projections under different scenarios has become a major focus of ongoing monitoring activities.

2.4 Assessment and outlook for 2021

Ongoing supervision has adapted swiftly and effectively to the new situation prompted by the pandemic, thanks to: i) the availability of the necessary technological resources and familiarity with remote working; ii) measures to allow the swift refocusing of supervisory activities and the flexible reallocation of resources, and iii) the establishment of a centralised ongoing monitoring procedure led by the ECB.

The situation of banks stabilised in 2020 H2 and is likely to remain stable during much of 2021 thanks to the moratoria not yet having expired and to the public guarantee programmes. However, the impact of COVID-19 on the banking sector and the uncertainty surrounding expectations for economic recovery have shaped the priorities for 2021. The main focal point will remain credit risk, followed by business sustainability, capital planning and governance. In contrast to 2020, the year could be viewed as a return to normality in terms of procedures and the main supervisory activities.[8]

8 A full SREP will be conducted for each institution, setting capital requirements, although some adjustments have been made to the methodology to prioritise the aspects most affected by the pandemic. In addition, the EBA stress tests that were postponed in 2020 will be conducted. From the operating standpoint, remote working is likely to continue during much of the year.

One new development is that transversal activities are here to stay. The organisational change to ECB supervision implemented in October 20209 reinforced the transversal functions, with experts from specific risk areas supporting the joint ongoing monitoring teams and the consistency of supervisory actions being ensured through benchmarking. The challenge we face this year is to strike the right balance between tailored monitoring, based on each bank's specific circumstances and expert opinion, and the transversal actions in which results are obtained through benchmarking.

3 Impact of COVID-19 on on-site supervision

On-site supervision complements ongoing supervision. A permanent in-depth knowledge of the institutions is maintained through ongoing supervision, which mainly relies on the information reported by the institutions themselves. On-site inspections check, among other aspects, the validity and accuracy of the information used to conduct ongoing supervision.

The key characteristic of on-site supervision is precisely the fact that the **inspection team is deployed on-site** at the supervised institution. In addition, this is not work that can be performed single-handedly; **teamwork** is an essential feature. As a result, the outbreak of the pandemic represented an even greater shock in terms of continuing with the work.

The adjustment to the new environment entailed a transition through three very distinct phases. First, the centralisation of all resources deployed outside of the Banco de España. Second, the tasks were rapidly assessed and adjusted against a backdrop of heightened uncertainty and volatility. Lastly, once the new situation had been assimilated, the fact that the pandemic would persist for longer than initially envisaged had to be recognised, which prompted a more stable adjustment with a medium-term outlook.

This section does not differentiate between the supervision of SIs or LSIs, since on-site inspections are substantially similar for both.

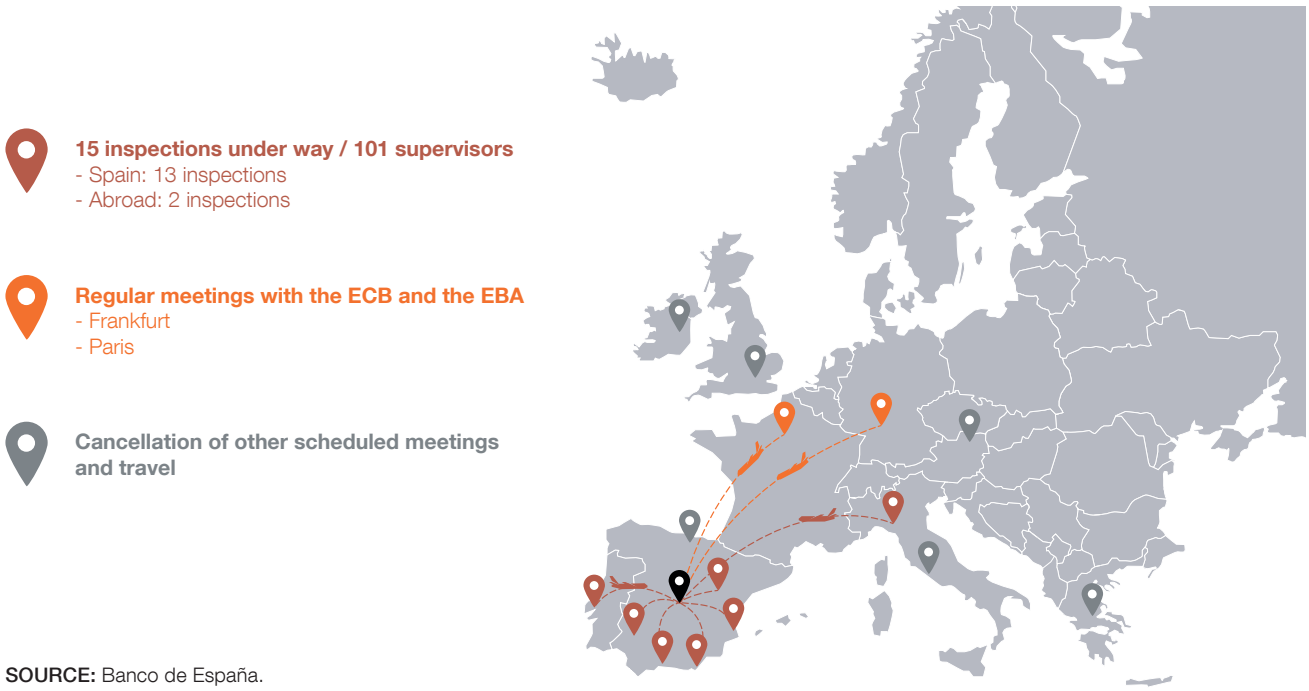
3.1 Phase 1: centralisation of resources

Owing to the spread of the pandemic and the recommendations to keep travel to a minimum, the decision was made to **cancel all inspection team deployments.** These deployments included inspections of Spanish institutions, inspections of

9 For more information, see European Central Bank (2021c).

Figure 1
STATUS OF INSPECTION TEAMS IN MARCH 2020

Owing to the spread of the pandemic and the recommendations to keep travel to a minimum, the inspection teams cancelled their deployments in March 2020.



SOURCE: Banco de España.

other European institutions[10] and regular meetings[11] with other supervisory and regulatory authorities (mainly the ECB and the EBA).

Specifically, in early March 2020 the Banco de España had 15 inspections under way, with more than one hundred supervisors deployed among various teams. Of those inspections, 13 were being conducted in Spain and the remaining two in other European countries.

In light of the uncertainty regarding the severity and duration of the crisis, in this first stage the working approach was to compile the analyses conducted and the discussions held hitherto for each of the inspections and to document the findings. This succeeded in mitigating the absence of interaction with the institutions and, almost as importantly, the limited interaction with the other members of each team, at a time when systems were being adapted to accommodate remote working arrangements.

10 Cross-border inspections of other European institutions are organised as part of the Banco de España's membership of the European SSM and are coordinated by the ECB. For more information, see European Central Bank (2018).

11 The Banco de España actively participates in working groups of both the ECB and the EBA, and in other international bodies and fora.

3.2 Phase 2: limited and gradual resumption of activity

Inspection work was initially suspended in response to the declaration of the state of alert and with the commencement of remote working. The aim at that time was to avoid interfering with the adjustments required at the institutions to adapt to the new reality, allowing them to focus their resources on the essential tasks of managing operations, risks and liquidity.

However, it rapidly became clear that the pandemic would not disappear in a matter of weeks; the number of infections and their severity increased every day and the state of alert was extended further. This posed the need to refocus the supervisors' activities.

First, from an organisational standpoint, the resumption of supervisory activity entailed adapting to remote working. However, this adaptation was similar to that required in numerous other areas, with nothing particularly characteristic relating to on-site inspections.

Second, and more specific to on-site inspection work, an assessment was required of how to proceed with the inspections under way at that time.

The first concern was to determine **which inspections should be cancelled and which should be continued.** As a standard approach, the idea was to continue any inspections that were in advanced stages, provided that the institutions concerned were able to dedicate sufficient attention to them, such that proceeding with the work would not significantly hinder the management of the institutions at such a delicate juncture. Accordingly, there was a **marked difference between general inspections**[12] **and inspections of internal models** used to calculate regulatory capital. Model investigations usually take place at the institutions' request; for instance, when internal models need to be adjusted to ensure their adequate functioning, which requires prior supervisory validation.[13] In addition, such inspections mainly involve highly specialised resources at the institutions, meaning a limited impact on those activities that were prioritised at the outbreak of the pandemic.

Thus, the impact in terms of inspection cancellations was uneven, with a high rate of cancellations among general inspections, whereas the bulk of the model inspections went ahead. However, approximately 60% of the overall inspections planned for 2021 remain scheduled.

The second concern was the allocation of projects to individuals whose inspections had been cancelled. Numerous inspectors suddenly became

12 Those focused on aspects such as credit risk, liquidity, governance and systems, among others.

13 Indeed, 2020 was a very busy year in terms of model adjustments due to the need for changes on account of new European regulatory criteria. For more information, see European Banking Authority (2019).

available when their scheduled tasks were called off. Several initiatives were swiftly put into action:

— Specific horizontal analysis projects, such as the analysis and assessment of the most common and most significant findings identified in inspections conducted in the SSM, for the different areas and risk types.

— Cross-departmental collaboration and support.

— Bolstering training programmes through the design and provision of new courses, tutorials and learning materials.

3.3 Phase 3: full adaptation to remote inspections

Once the inspections that could continue were identified, the working methods needed to be adjusted to accommodate the new remote working conditions. To this end, the approach to several elements needed to be reviewed.

3.3.1 Scope of the inspection

The new circumstance meant that the scope of each inspection had to be assessed, considering matters such as the following:

— Could all of the originally defined areas be suitably inspected on a remote basis?

— Which non-essential aspects could be omitted from the scope?

— Should the original inspections be divided into two or more reviews?

— Did the inspection team need to be expanded and was more time required?

This analysis was conducted for each of the inspections already under way, and likewise for those that were kept on the annual plan and would be launched in the subsequent months.

3.3.2 Inspection methodology

Certain inspection methods are based on on-site activity: file reviews, code or process review working sessions and case-specific discussion workshops (e.g. property foreclosure processes). These methods had to be adapted to remote working arrangements through the following procedures:

— Videoconferencing.

— Virtual workshops.

— Increased exchange of questions with the institution.

— Findings quantification requests.

3.3.3 Communication with the institution

In the initial phase, communication with the institution was adapted by increasing the number of virtual meetings and question exchanges. To ensure more efficient exchanges, the prior planning and preparation had to be bolstered, including greater detail on the pre-established agenda.

As regards information and data sharing, new mass data exchange channels were set up (virtual data rooms, cloud, etc.).

In the second phase, the institutions provided corporate laptops to facilitate data processing and to allow access to applications and source databases. Communication with inspection teams also improved thanks to the use of common software.

3.3.4 Internal communication and logistics

Internal communication within inspection teams was greatly affected by remote working, since it was impossible to hold the short, "spontaneous" meetings that are standard practice. To mitigate this effect, communication platforms were used intensively to convene regular meetings with the entire team and with the inspection sub-teams. The Head of Mission had to play a pivotal role in centralising and organising the inspection, even more so than under normal conditions.

3.4 Assessment of remote inspections

Following completion of the remote inspections conducted in 2020, their implementation and results can be assessed, focusing on the following factors:

— **Implementation time:** remote inspections require more time, essentially on account of the less fluid communications, although good organisation and adapting the scope of the inspection to the extent possible can ensure a negligible impact on the expected duration.

— **Planning:** such inspections require greater organisation and planning, given that some processes may suffer efficiency losses (those more easily performed on-site), while others can be performed more efficiently (for instance, drafting inspection reports).

— **Interaction:** the institutions' cooperation is essential, not only in providing the means to access their systems, but also in the adaptation to efficient remote working arrangements.

— **Difficulty:** the most challenging tasks are those relating to file reviews and the validation of technological processes. However, in some cases these have been performed using an appropriate device (such as the institutions' laptops or through virtual access).

— **Experience:** it is difficult to conduct these inspections remotely without experienced staff. Indeed, incorporating new members into the work team can be particularly challenging.

— **Communication:** internal communication is impacted most, although communication with institutions is also affected.

— **Supervision:** the depth of knowledge that these actions aim to yield can be maintained, despite the inspections being conducted remotely.

— **New supervisory technologies:** significant progress has been made during recent years in applying advanced technologies in the field of supervision (suptech). The experience of remote inspections has demonstrated their usefulness. Numerous initiatives in this field have been reinforced owing to the needs associated with remote working and the attendant lessons learned.

As a general assessment, remote inspections are clearly no replacement for on-site work. However, the following is also true:

— Remote working arrangements can yield satisfactory results where necessary.

— On-site arrangements may be enhanced by including those processes that can be performed more efficiently on a remote basis.

3.5 Medium and long-term outlook

At present, the near-term outlook is for **remote inspection arrangements to be continued** given the uncertainty surrounding the pandemic and based on the

positive results thus far. The current situation is one of greater stability and some prospects of a gradual return to normal inspection volumes. The aim for end-2021 is to restore usual levels in terms of the number of inspections.

As regards general inspections, the medium-term goal is to focus the supervision on aspects directly related to the impact of the pandemic-induced crisis, aligning the supervisory function of these inspections with that of remote ongoing supervision.

In the longer term, the target is to resume on-site supervisory activity as soon as possible, incorporating the lessons learned from remote working into the ordinary supervisory activity. The forced implementation of remote inspections has posed numerous challenges but has equally brought certain opportunities, which may be harnessed as **additional tools at the supervisor's disposal.** For instance, implementing inspections of varying intensity (with the possibility of partially or fully conducting these remotely) for certain cases of more limited scope, thereby optimising the number of inspections that need to be performed.

4 Conclusion: initial lessons and future considerations

In spite of the abrupt shift to remote activity and the general complications stemming from the extraordinary situation, the conclusions regarding the adaptation of the supervisory function to the crisis prompted by COVID-19 are very positive. Three key reasons explain this success:

— The professional and personal **effort** of the Banco de España's and the ECB's supervisors, and likewise of the supervised institutions.

— The **appropriate technology,** with devices and collaborative tools to enable remote working.

— **Adaptability,** which has been evident in the following:

- A rapid organisational response to refocus the ongoing supervisory work in light of the new requirements, to reallocate resources and to adjust procedures to yield more timely information on the institutions' situation.

- Approximately 60% of the inspections planned for 2020 went ahead, while new high value-added tasks and projects not initially envisaged were identified and implemented, which was made possible by the sudden availability of resources.

The impact of the pandemic on supervisory activities has varied across the areas of ongoing supervision and on-site supervision. In ongoing supervision,

the adaptation essentially focused on the content of the supervision, which was shifted towards monitoring pandemic-related risks and the impact on the institutions' risk profile. In addition, the way supervision is conducted changed in three main aspects: increased interaction with the institutions and other supervisors, the measurement of the impacts being centrally coordinated by the ECB and the need for more frequent ad hoc reporting.

By comparison, on-site supervision has been more affected in terms of how the work is conducted, given that a sizeable component of the **methodology** is performed on-site at the institutions. Although the pandemic prompted the cancellation of approximately 40% of the originally programmed inspections, those that could be performed remotely were completed successfully and upholding the usual quality standards.

Both areas of supervision faced **common challenges,** such as adapting teamwork to the remote working arrangements, managing teams remotely and planning and organising priorities in the new context.

The adaptation of supervisory functions to remote working has not only posed challenges, it has also highlighted a series of **opportunities and lessons** that can be incorporated into the standard working arrangements. In on-site supervision in particular, the flexibility inherent in remote working offers the opportunity to find an **optimal balance between remote working and on-site activity.** This balance means identifying those tasks that can be performed efficiently on a remote basis and those that require an on-site presence.

Meanwhile, it is vital that **advanced technologies continue to be adopted in the field of supervision,** from communication and information-sharing systems through to the identification of standard supervisory processes that could benefit from the use of such technologies. Institutions must also move forward and improve their data infrastructure and models to produce higher quality forward-looking information.

In an adverse environment of heightened uncertainty, adapting the supervisory function to remote working has not only been successful, but it will also allow us to incorporate numerous lessons learned into our usual work procedures and methodologies.

REFERENCES

Banco de España (2021). *2020 Supervision Report*, March.

Basel Committee on Banking Supervision (2012). *Core Principles for Effective Banking Supervision*, September.

European Banking Authority (2019). *Progress Report on the IRB Roadmap*, July.

European Banking Authority (2020a). *EBA statement on actions to mitigate the impact of COVID-19 on the EU banking sector*, press release of 12 March.

European Banking Authority (2020b). *Statement on supervisory reporting and Pillar 3 disclosures in light of COVID-19*, 31 March.

European Banking Authority (2020c). *Guidelines on the pragmatic 2020 supervisory review and evaluation process in light of the COVID-19 crisis*, July.

European Central Bank (2018). *Guide to on-site inspections and internal model investigations*, September.

European Central Bank (2020a). *Contingency preparedness in the context of COVID-19,* letter from Andrea Enria to all significant institutions, 3 March.

European Central Bank (2020b). *ECB Banking Supervision provides further flexibility to banks in reaction to coronavirus*, press release of 20 March.

European Central Bank (2020c). *FAQs on ECB supervisory measures in reaction to the coronavirus*, press release of 20 March (with subsequent updates).

European Central Bank (2020d). *IFRS 9 in the context of the coronavirus (COVID-19) pandemic*, letter from Andrea Enria to all significant institutions, 1 April.

European Central Bank (2020e). *Operational capacity to deal with distressed debtors in the context of the coronavirus (COVID-19) pandemic*, letter from Andrea Enria to the CEOs of significant institutions, 28 July.

European Central Bank (2020f). *Identification and measurement of credit risk in the context of the coronavirus (COVID-19) pandemic*, letter from Andrea Enria to the CEOs of significant institutions, 4 December.

European Central Bank (2021a). *2020 SREP aggregate results*, January.

European Central Bank (2021b). *2020 ECB Annual Report on supervisory activities*, March.

Euro area bank profitability and consolidation

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Abstract

Consolidation in the euro area banking sector has been slow since the end of the global financial crisis, despite the persistent weak bank profitability. The coronavirus (COVID-19) pandemic has reinforced profitability risks in the euro area banking sector, and coincided with worse performance of some banks, notably those burdened with legacy non-performing loans. Consolidation among banks may bring benefits from both a micro- and a macroprudential perspective by generating cost synergies, increasing revenue diversification and strengthening the resilience of the banking sector. However, it comes with attendant execution risks, which need to be properly managed by banks. Consolidation may give rise to competition concerns, although empirical evidence suggests that there is room for further domestic concentration in some euro area countries and for greater cross-border integration of the European banking market. Bank mergers also increase the systemic footprint of the resulting institutions, which might be addressed by the existing macroprudential and resolution frameworks. The European Central Bank assesses consolidation from a prudential perspective, focusing on the current and future ability of the combined bank to comply with prudential requirements. To this end, it published a Guide in January 2021 in which it clarified its expectations and approach to three key prudential issues arising in the context of consolidation: setting Pillar 2 capital requirements, treatment of badwill and use of internal models.

1 Introduction

Consolidation has long been seen by policymakers as part of the solution to the excess capacity and weak profitability of the euro area banking sector [see, among others, Constâncio (2014) and Af Jochnick (2019)]. In spite of the lively discussion on the need for bank consolidation and related challenges and obstacles, not many bank mergers and acquisitions have taken place in the last decade. Many of these acquisitions were executed in the context of resolution or financial distress of the target bank, rather than being driven by purely commercial interests. At the same time, bank profitability remained subdued during the economic upswing between 2013 and 2019. The COVID-19 pandemic, and the likely pressure it will put on banks' profits, has again brought the challenges associated with weak bank profitability and the related discussion on bank consolidation into the spotlight, and some consolidation has begun to happen.

This article revisits the arguments in favour of consolidation as a remedy for bank profitability challenges and elaborates on ways in which consolidation in the banking sector can contribute to improving financial stability. In doing so, the article combines

micro- and macroprudential perspectives. Highlighting the latest supervisory expectations announced by the European Central Bank (ECB), the article outlines the key areas of supervisory attention and the approach to selected key issues [ECB (2021)]. It also points to other issues which are relevant for consolidation, but which lie outside of the remit of micro- and macroprudential authorities.[1]

2 Why bank profitability matters for financial stability and banking supervision

Sustainable bank profitability is one of the necessary conditions for achieving financial stability. The ECB defines financial stability as a state in which the financial system – which comprises financial intermediaries, markets and market infrastructures – is capable of withstanding shocks and the unravelling of financial imbalances [Fell and Schinasi (2005)]. Banks play a key role in the financial system in the euro area, being the largest provider of credit. Their profits are a key source of the new capital that is needed to support financial intermediation and economic growth. Strong earnings also provide the first line of defence against losses in a downturn, which increases the resilience of banks and helps them fulfil their role as lenders to the real economy [Jiménez et al. (2012)]. In turn, robust credit supply facilitates recoveries from economic downturns.

Focusing on the safety and soundness of individual institutions, bank supervisors take an interest in bank profitability for similar reasons. Weak profitability reduces the resilience of banks, indicating heightened risks to capital. It may also be a symptom of structural weaknesses in business models. The European Banking Authority (EBA) expects bank supervisors in the European Union (EU) to conduct regular business model analysis as part of the annual Supervisory Review and Evaluation Process (SREP), which leads to the setting of bank-specific Pillar 2 capital requirements. Through such analysis, authorities aim to determine whether a bank is able to generate acceptable returns over a horizon of at least three years [EBA (2014a)].

The presence of unprofitable banks in the economy could amplify risks to financial stability. Banks which do not earn their cost of capital may face a higher cost of funding and be more vulnerable to liquidity runs, which may cause contagion to other banks. Unprofitable banks may also have an incentive to take on additional risk (or otherwise gamble for resurrection), as the downside to their shareholders would be limited, while they stand to benefit under an optimistic outcome in which risks do not materialise [see Baldursson and Portes (2013)]. Such behaviour could also put unhealthy competitive pressure on the sounder banks, thereby negatively affecting the wider banking sector. At the systemic level, exuberant risk-taking may fuel credit booms and asset price bubbles, which, once burst, can cause financial crises and severe recessions.

1 Throughout this article, the terms “microprudential authority” and “macroprudential authority” commonly refer to “competent authority” and “designated authority”, respectively, under the EU capital requirements directive and regulation (CRD/CRR).

3 Euro area bank profitability during the COVID-19 crisis

Euro area banks were already underperforming vis-à-vis their international peers before the start of the pandemic. Chart 1 below shows that the return on equity (RoE) in the euro area in 2017, 2018 and 2019 was persistently lower than that achieved by US banks. Moreover, for many banks, returns were below the estimated cost of equity, which is the return investors would require to invest in bank equity (see Chart 2). That being said, some euro area banks were able to earn more than their cost of equity before the outbreak of the coronavirus in 2020, and these well-performing banks could be found among banks following different business models and operating in different countries [ECB (2018)]

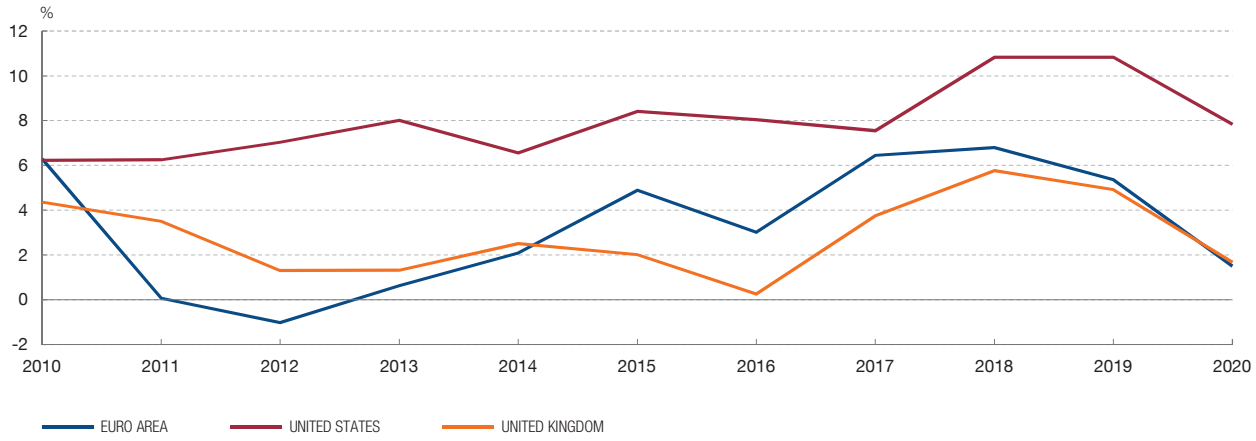
Both cyclical and structural factors explain the low bank profitability in the euro area. As regards the former, the macro-financial environment in the euro area after 2007 was challenging. The global financial crisis of 2007/2008 morphed into the sovereign debt crisis, leading to a double-dip recession. Consequently, provisioning costs surged, resulting in a strong decline in bank profits between 2010 and 2012 (see Chart 1), while at the same time banks accumulated a large stock of non-performing loans (NPLs). In the second half of 2010s, amid a more supportive growth environment, bank profitability recovered from the trough. Yet, it never returned to levels in line with cost of equity. In response to the very low inflation prevailing in that period, monetary policy adopted a historically accommodative stance. In that environment, bank interest margins were gradually eroded, adding cyclical challenges to profitability. On the other hand, monetary policy reduced the cost of credit risk and cost of funding, and enabled banks to benefit from one-off capital gains associated with higher asset prices [see Albertazzi et al. (2020) and Altavilla et al. (2019)].

While cyclical factors are important, they only partly explain weak bank profitability in the euro area. Structural inefficiencies, in particular operational inefficiencies at the level of individual banks and significant overcapacity in the sector overall, are also relevant [see ECB (2018)]. As already explained by Andreeva et al. (2019), these two phenomena are related. Overcapacity in the euro area tends to manifest itself in a fragmented marketplace with numerous competitors with limited capacity to sustainably cover their costs, including the cost of risk (too many weak banks). These in turn maintain costly overlapping branch networks (excess of physical infrastructure) [see Gardó and Klaus (2019)].

Much of the weakness in euro area bank profitability in the period 2015-2018 was found to relate to a set of institutions which persistently underperformed throughout that period [see Andreeva et al. (2019)]. Although, at first sight, these underperforming institutions were quite diverse in terms of geographical location, balance sheet structure and size, they in fact formed three relatively clearly defined groups. The first group included banks that were burdened by high levels of NPLs. They also

Chart 1

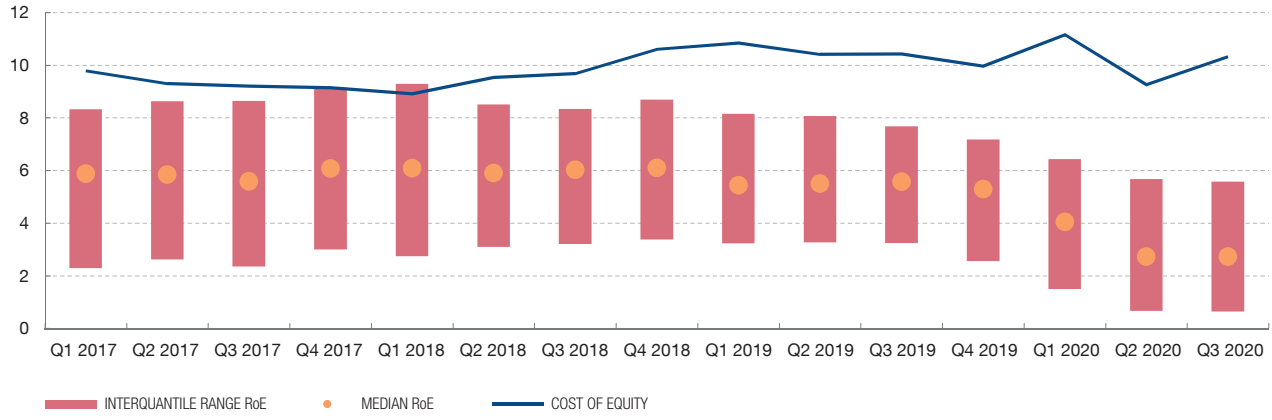
BANK PROFITABILITY SINCE 2010 (RETURN ON EQUITY; PERCENTAGES PER ANNUM)



SOURCES: Bloomberg and ECB calculations.
NOTE: Based on a sample of 21 banks in the euro area, five in the United Kingdom and 17 in the United States for which long time series are available. Aggregate RoE equal to the sum of net income divided by the sum of total equity for all banks in each region.

Chart 2

DISTRIBUTION OF EURO AREA BANKS' RoE (PERCENTAGES PER ANNUM; TRAILING FOUR QUARTER PROFITABILITY)

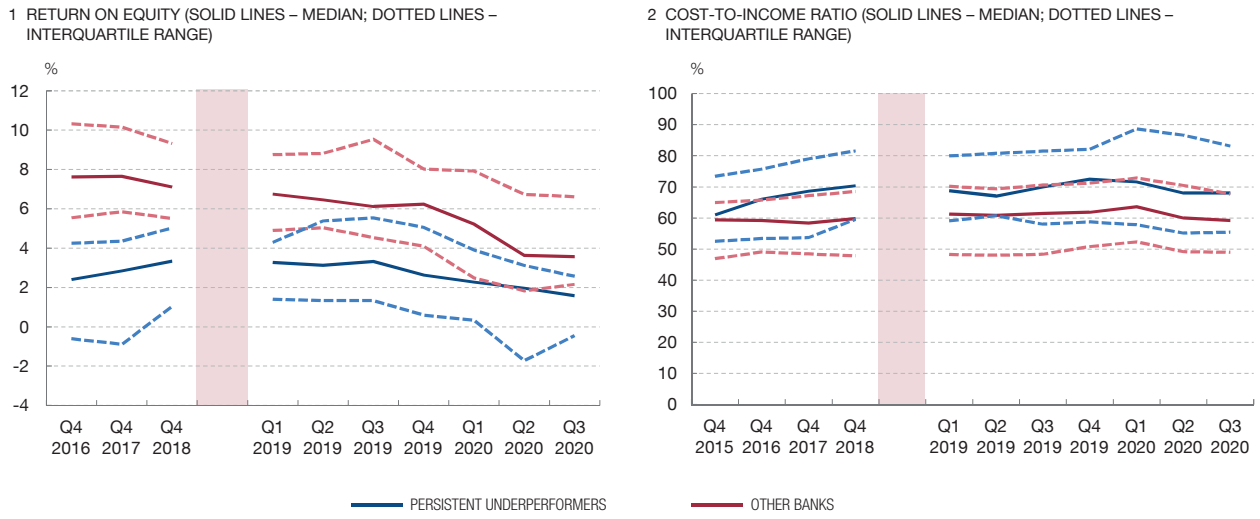


SOURCES: CB and ECB calculations.
NOTE: RoE based on a sample of significant institutions. Cost of equity estimates based on a model averaging approach [see Altavilla et al. (2021)].

exhibited relatively high income-to-assets ratios (probably reflecting higher interest rates on loans, given the risky profile of their borrowers) and clearly elevated cost-to-income ratios (probably reflecting the cost of managing a large legacy asset portfolio). The second group comprised banks with a weak income-generating capacity, all of which displayed a low income-to-assets ratio. Despite a lean cost structure, their cost-to-income ratios were clearly elevated between 2015 and 2018. The third group included banks with multiple sources of weak profitability, typically a combination of cost-side and revenue-side problems.

Chart 3

BANKS THAT UNDERPERFORMED BETWEEN 2015 AND 2018 CONTINUE TO COMPARE UNFAVOURABLY TO THEIR PEERS



SOURCES: ECB and ECB calculations.
NOTE: Based on a sample of significant institutions. The group of underperformers includes 37 banks.

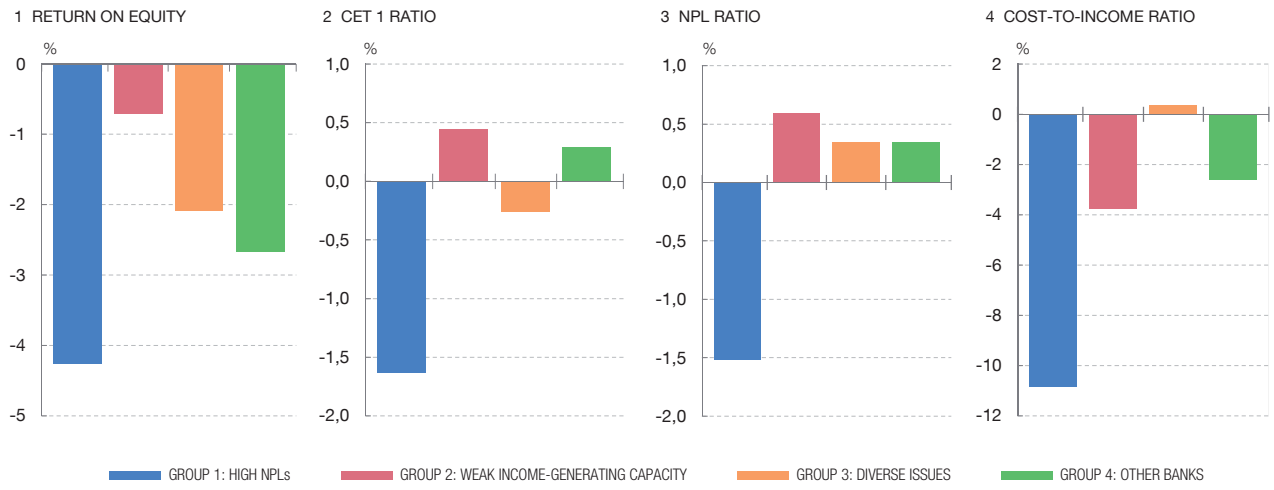
Unfortunately, these institutions are continuing to underperform. Chart 3 compares the evolution of RoE and cost-to-income ratios of these underperforming banks and their healthier peers. Looking at the median bank in each group, underperformers continue to generate only half the RoE of their peers and operate at a cost-to-income ratio comparable to the top quartile of other banks.

The decline in profitability in 2020 has been steeper for the set of institutions carrying a high burden of legacy NPLs (see Chart 4) as their cost of risk increased, although this partly reflects management actions initiated before the pandemic. These banks continued to make progress in cleaning balance sheets from legacy assets (visible in a continued decline in NPL ratios) and improved their operational efficiency (a combination of leaner cost structures and stronger revenue sides). Moreover, given that their RoE was the lowest to start with, in late 2020 (the latest data available) the high NPL group was in fact making sizable losses. By contrast, the group of institutions with weak income-generating capacity was not as significantly affected.

Overall this result is not surprising. A key difference between the high NPL group and the weak income-generators is the average riskiness of their assets. The legacy asset carriers have lending relationships with riskier borrowers, while banks with weak income-generating capacity are focused on low-risk, low-return investments. Since weaker borrowers are generally affected more strongly and quickly by cyclical downturns, and may not have been able to benefit from

Chart 4

THE COVID-19 CRISIS DISPROPORTIONATELY AFFECTED BANKS BURDENED WITH HIGH NPLs (PERCENTAGE POINT CHANGES BETWEEN Q4 2019 AND Q3 2020)



SOURCES: ECB and ECB calculations.
NOTES: Based on a sample of significant institutions. Changes in cross-sectional median RoE, CET1 ratio, NPL ratio and cost-to-income ratio between Q4 2019 and Q3 2020 (the latest available data point). There were 37 underperforming banks, of which seven were in Group 1, 11 in Group 2 and 19 in Group 3.

government support measures such as loan guarantees,[2] the provisioning costs of the high NPL group increased markedly, adversely affecting bottom-line profitability.

Financial market participants expect a gradual recovery in euro area bank profitability over the next two years (see Chart 5). Industry analysts expect RoE to be around 3% in 2021 and to increase further to 5% in 2022. As in the pre-pandemic period, the performance of euro area banks compares unfavourably to their international peers (see Chart 5, left panel). In 2022 more than half of the listed institutions for which analyst expectations are available are expected to generate RoE of less than 6%, the lower end of the range for banks' cost of equity. The availability of earnings forecasts is limited and does not allow firm conclusions to be drawn on the expected profitability of underperforming banks, even less so of the three groups of underperformers. Nonetheless, market analysts continue to see them lagging behind their peers in early 2021 (see Chart 5, right panel).

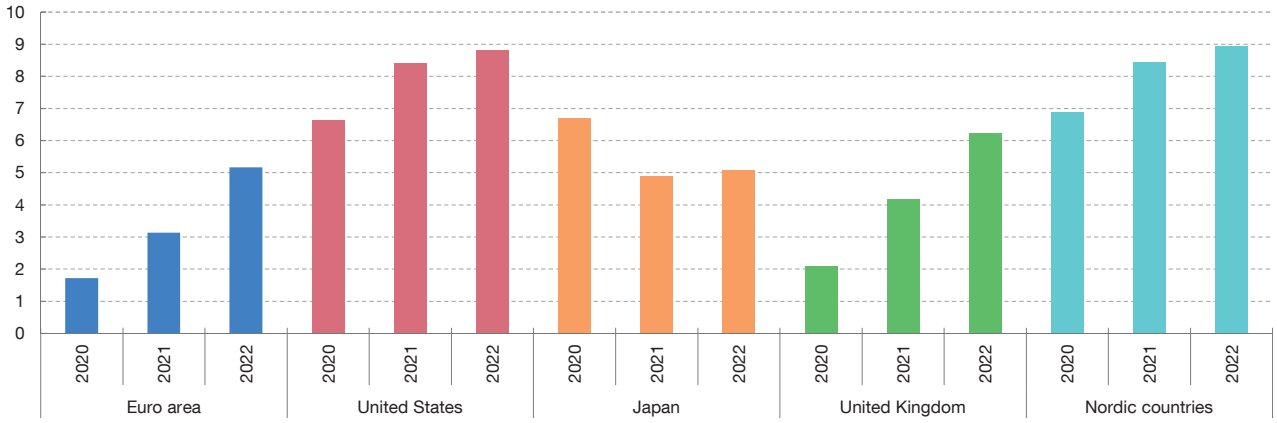
The performance of the three groups of underperforming banks reaffirms the conclusions of Andreeva et al. (2019), who identified consolidation as the most appropriate strategy for banks with sound balance sheets but weak income-generating capacity. Indeed, this group of banks seems to not only have been the

2 Access to such measures was often conditional upon borrowers having no prior financial difficulties, so as to confine government support to viable companies.

Chart 5

EXPECTED BANK PROFITABILITY IN THE EURO AREA IS WEAKER THAN IN OTHER ADVANCED ECONOMIES POST-COVID-19

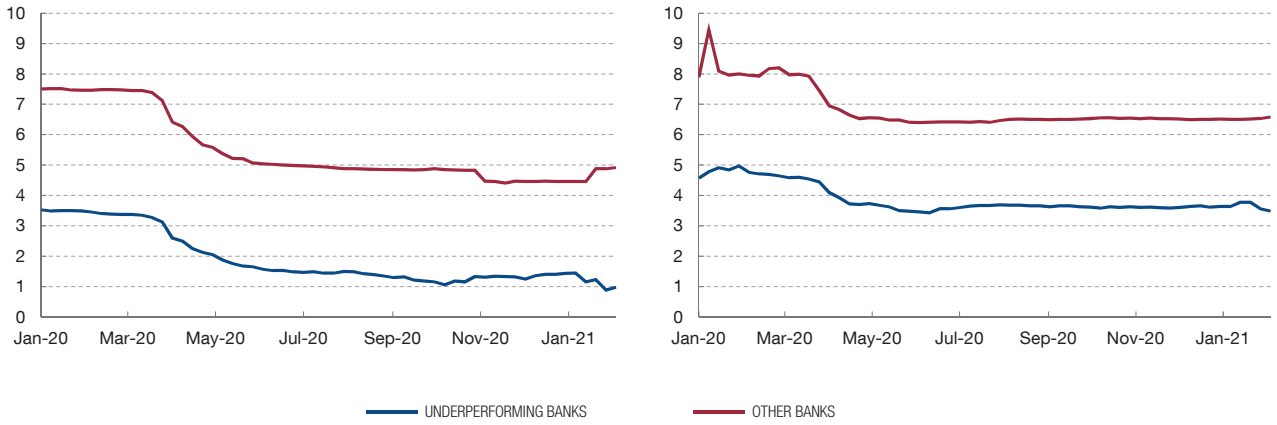
1 BANK ROE FORECASTS BY REGION



2 ANALYST EXPECTATIONS FOR RoE OF EURO AREA BANKS IN 2021 AND 2022 FOR UNDERPERFORMING BANKS AND THEIR PEERS
(Percentages, average within group)

2.1 EXPECTED RoE 2021

2.2 EXPECTED RoE 2022



SOURCES: Bloomberg and Refinitiv.
NOTE: The chart shows the median analyst forecast across listed banks in each jurisdiction based on a large sample of listed banks. Nordea is included in the Nordic region. Based on 36 listed euro area banks.

most resilient among underperformers to the shock of the pandemic but also more resilient than the average bank which did not underperform in the past, indicating that the financial risks arising from their hypothetical participation in mergers and acquisitions (M&As) would have been contained. These banks also made progress towards reducing their excessive cost base during the pandemic. By contrast, Andreeva et al. (2019) suggested that where profitability was weak due to a high stock of NPLs, and NPL problems were idiosyncratic to a specific bank, acquisition of the sound parts of the business by a healthy bank may be possible. Where NPL problems are systemic in nature, system-wide measures to reduce NPLs may have to complement consolidation in remediating the weak profitability.

4 Consolidation as part of the solution

Consolidation in the banking sector may address some of the root causes of weak bank profitability in the euro area. Acquisitions can reduce overcapacity and provide an opportunity to decisively reduce the excessive cost base of the banking sector, but they also entail risks for the banks involved and side effects for competition, market structure and financial stability which need to be carefully analysed. Although consolidation activity may give rise to substantial benefits, the ECB remains neutral on specific consolidation projects, which should be first and foremost driven by market forces and the economic interests of the parties involved. The role of supervisors is to assess such transactions from a prudential perspective. Consolidation may also not always be the right solution, and should not crowd out other means of restoring sustainable profitability, such as tackling cost inefficiencies and improving income diversification.

4.1 Potential benefits and risks associated with bank M&As

Merger and acquisition activity in the European banking sector has been slow since the end of the global financial crisis [see ECB (2020)]. Consolidation of European banks proceeded in two waves. Strong domestic M&A activity in the late 1990s and early 2000s[3] was followed by a brief slowdown during the economic downturn, reaching a trough in 2003. As the European economy grew rapidly and European economic and financial integration progressed in the run-up to the global financial crisis, cross-border transactions accounted for a major part of overall M&A activity, culminating in 2007.[4] Since the crisis, the value of bank mergers has remained at a small fraction of pre-crisis levels. This has been ascribed to low bank valuations, weak profitability, and increasing regulatory constraints [Hartmann et al. (2017) and Krusec (2020)]. Low valuations in particular may have discouraged banks from bidding for potential acquisition targets during this period, as the costs of consolidation (e.g. in terms of restructuring charges) were seen as difficult to absorb without raising new, costly capital, which could dilute existing shareholders. However, low valuations of a potential target offer an opportunity for a healthy acquirer who may be able to purchase the target at a sizeable discount relative to the fair value of acquired assets and liabilities. The resulting badwill could help absorb the costs of consolidation and reinforce the capitalisation of the merged entity. In such cases, robust valuation of badwill would be essential, as an overly generous estimate of badwill might be perceived as inflating the value of assets which may in the future

3 For example, this wave resulted in the creation of BBVA through the merger of BBV and Argentaria (1999), the creation of Unicredit and Banca Intesa through a series of mergers of Italian banks, and the merger of Banque Nationale de Paris and Paribas to form BNP Paribas (2000).

4 Prominent examples include the 2007 acquisition of ABN AMRO by a consortium of Fortis, Royal Bank of Scotland and Banco Santander, which at the time was the largest bank merger in the world, as well as the acquisitions of Bayerische Hypo- und Vereinsbank by Unicredit in 2005 and of Abbey National by Banco Santander in 2004.

require a write-down. Lifting some misconceptions about these issues in order to favour resilient consolidations was one important motivation for the publication of the Guide on the ECB's supervisory approach [see ECB (2021)].

Motivations for bank consolidation vary depending on the type of transaction. Bijsterbosch and Deghi (2017) found that cost synergies are a frequent rationale for mergers, particularly in the domestic context, and that less cost-efficient banks have a greater probability of becoming the target of an acquisition. At the same time, cross-border transactions are often associated with seeking new business opportunities, although the dearth of cross-border mergers since the global financial crisis suggests that this case for mergers might have lost some of its appeal amidst the overall reduction in the size and international footprint of European banks in recent years. The literature also notes that some M&A transactions may not follow value-creation objectives. Misaligned incentives generated by management remuneration linked to the growth of banks may be a motivation for acquisitions [Anderson et al. (2004)]. Such transactions may be particularly problematic from a prudential perspective, because bank executives may not have the right incentives to conduct appropriate due diligence or to manage the risks of the transaction.

By enabling investment, unlocking economies of scale and allowing diversification, consolidation should facilitate banks' preparations to face long-term challenges. Lower marginal costs allow the merged entity to invest and adjust its business model to the long-term challenges, such as those related to adoption of digital technologies and the transition towards a low-carbon economy. The scale of such investments may be unsustainable for smaller banks, but achievable for the merged entities.

The track record of bank mergers is mixed and indicates that proposed transactions should be carefully evaluated. Altunbas and Marqués-Ibáñez (2004) assessed the effect of mergers on bank profitability in Europe as moderately positive based on data from the 1990s and early 2000s. They also noted the strategic diversification benefits provided by cross-border mergers. But more recent assessments have come to less positive conclusions. Beccalli and Frantz (2009), whose data end in the mid 2000s, found that M&As undertaken by European banks led to a slight deterioration in bank profitability, as efficiency gains were largely passed on to the customers. Behr and Heid (2011) estimate the medium-term effects to be broadly neutral. Based on a review of empirical literature, Kolaric and Schiereck (2014) conclude that the evidence of performance improvements following M&A transactions is mixed and may vary across countries. When focusing on stock market reactions to M&A transactions, they find that shareholders in target entities seem to benefit from M&As, but that the benefits to the acquirer are less clear-cut.

Case studies underscore the financial and operational risks that bank mergers bring. Examining one of the most prominent banking collapses in the global financial crisis, namely Royal Bank of Scotland (RBS), the UK Financial Services Authority [FSA (2011)]

concluded that the acquisition of ABN AMRO by RBS was among six key factors in its subsequent failure. The FSA found that the acquisition had been conducted without appropriate heed to the risks and with insufficient due diligence. RBS was judged to have overpaid for the target, to have accepted a risky funding strategy for the deal, and to have been overconfident in its ability to integrate the business of ABN AMRO. Similarly, insufficient due diligence regarding legacy assets acquired in the takeover of Dresdner Bank contributed to the financial distress and state-led recapitalisation of Commerzbank in 2008. Analysing the factors that led to the financial sector assistance programme for Spain, the European Commission (2012) noted that bank mergers in the savings bank sector – owing to the specificities of their applicable regulations and their limitations to raise capital – involved institutions with the same business model, helped reduce excess capacity and sometimes created larger entities that were not more resilient. Subsequently, several of the savings banks required recapitalisation by the Spanish authorities.[5]

Consolidation can carry benefits and risks to financial stability and market structure. A transaction which improves the resilience and business models of individual firms is likely to be positive from a financial stability perspective, as the merged entity becomes more resilient and therefore a shock absorber rather than a shock amplifier in times of crisis. By absorbing weaker targets, acquirers would remove the weakest players that have been unable to earn their cost of capital for many years, sometimes since the financial crisis of 2008. When well-designed and well-executed, consolidation transactions can contribute to the overall financial soundness of the banking system [Fernandez-Bollo (2020)]. When mature acquirers decide to absorb weaker targets in the market, the latter benefit from the best practices and good governance framework of the acquirers, which creates significant efficiency gains for the system [Shaffer (1993), Ayadi et al. (2013)]. This would also strengthen the stability and resilience of the banking system. In the monetary union, cross-border bank penetration leads to stronger private risk-sharing, which helps smooth the effect of domestic shocks on consumption [Giovannini et al. (2018)].

There is evidence that, despite risks to competition, further consolidation may improve the structure of the euro area banking market. On one hand, consolidation may distort the competitive banking market structure. Increasing their market power, larger banks could extract rent from customers, leading to a socially suboptimal provision of financial services. Hartmann et al. (2017) and Andreeva et al. (2019) show that concentration and market power in the European banking market have increased over the last two decades and that the market power of euro area significant institutions is markedly higher than that of less significant institutions. Nevertheless, at least on aggregate, consolidation of the euro area banking sector

5 The Spanish authorities committed €10.5 billion in 2010 to facilitating integration processes among savings banks. Spanish banks received further capital support amounting to €44.3 billion between 2011 and 2013 directed mainly at the former savings banks [see FROB (2019)].

has not come at the expense of customers. The increase in estimated market power came through reduced marginal cost of providing banking services, rather than through banks' ability to charge higher mark-ups. Anolli et al. (2015) also conclude that there is further room for consolidation that would not give excessive market power to individual banks. The competitive landscape in the European banking sector could therefore become healthier, while maintaining a sound degree of competition. Cross-border consolidation may also be beneficial to customers if new entrants improve the quality of banking services or are able to offer lower prices than incumbents.

Consolidation may also raise concerns about increased systemic risks owing to the increasing importance of large banks, although these are mitigated by the international regulatory framework. The creation of even larger and more systemically important banks through mergers may have adverse side effects, as the merged banks may increasingly benefit from an implicit subsidy associated with them being perceived as "too big to fail". The presence of very large banks may also make the financial sector prone to contagion, as sparse interbank networks dominated by a few central nodes could be less resilient to stress than more decentralised banking systems [Acemoglu et al. (2015)]. Excessive size may also lead to diseconomies of scale, as large financial conglomerates may be unwieldy to manage [Huljak, Martin and Moccero (2019)]. Following the global financial crisis, global and European regulators have scrutinised the systemic importance of large and complex banks and have adopted a range of reforms aimed at containing the systemic risks posed by such institutions and at ensuring that they can be resolved in an orderly fashion if they fail. Their evaluation is ongoing, and the preliminary findings suggest that banks have been made more resilient and resolvable [FSB (2020)]. However, the effectiveness of these reforms remain to be tested in practice.

4.2 Compatibility of M&As with prudential objectives: an assessment framework

The above considerations show clearly that not every proposed M&A transaction would improve financial stability and resilience of the firms involved. Banking supervisors should carefully assess each transaction on its own merits. Consolidation among banks should meet a number of criteria (see below) to ensure that it is compatible with prudential objectives and that the risks outlined in the previous section do not materialise.

4.2.1 Generate synergies

A consolidation project should lead to operating and financial synergies that will enhance revenues, reduce operating costs and lower capital costs [Copeland and

Weston (1988), Ayadi et al. (2013)]. Cost and revenue efficiencies are key elements in ensuring that the merged bank is less exposed to risks and becomes more resilient [Fiordelisi et al. (2011)]. However, to achieve these synergies, the merged entity needs to formulate a strategy that would identify, assess and exploit them efficiently, while avoiding over-optimistic assumptions. More precisely, the strategy underlying the consolidation project should consider cost complementarities, the integrations of infrastructures and the rationalisation of banking networks [Ayadi et al. (2013)].

4.2.2 Diversify sources of revenue

The consolidation strategy should provide a clear understanding of the main profitability drivers of the project. The strategy should aim at diversifying the sources of revenue and exploiting the revenue synergies resulting from the business combination. In the current low interest rate and low growth environment, there is an increasing pressure on banks to generate revenue. With low organic growth in mature banking markets in Europe, acquisition offers a possible way for banks to remediate the long-lasting concern about revenue generation. It is also a way to diversify revenue sources through access to new products or markets, for example by increasing fee income activities and diversifying from net interest income, or by accessing a new geographical market. Moreover, cross-border mergers can provide strategic diversification benefits [Altunbas and Marqués-Ibáñez (2004)]. A more diversified business mix can be more resilient to risks as long as individual business lines are not perfectly correlated [Elsas et al. (2010)]. This can help banks to become more profitable, increase performance and reduce risks. Diversification benefits should be measured and managed in a prudent and balanced way.

4.2.3 Ensure that the merged firm is well capitalised

An important criterion for a successful consolidation is the capitalisation level of the merged entities, as the capitalisation of banks affects their efficiency [Berger and DeYoung (1997), Kwan and Eisenbeis (1997), Williams (2004)]. Indeed, well-capitalised banks are more likely to reduce their costs through an adequate cost-reduction strategy and to become more efficient [Jeitschko and Jeung (2005), Fiordelisi et al. (2011)]. Stronger capitalisation also provides larger capital buffers to deal with the materialisation of any downside risks to the transaction. It is therefore important that the strategy underlying the consolidation project sets up a proper capitalisation plan that ensures full compliance with regulatory requirements and that can be adequately monitored by the merged entity. A thorough capital plan is a key factor in obtaining long-term efficiency gains that will ultimately guarantee the sustainability of the bank.

4.2.4 Ensure a stronger refinancing base

The consolidation project should be based on a sound funding strategy that guarantees a funding mix in line with the business model of the merged entity. It should aim at achieving stable funding. Lower risk and improved profitability catalysed by the merger can translate into a lower cost of funding and better funding conditions, and deliver a stronger refinancing base for the merged entity.

4.2.5 Strong governance and management of change

Acquirers should be well-equipped to integrate the target, at both the operational and the strategic level. Indeed, in order to obtain the desirable technical efficiency and resilience, the consolidation project should rely on a proper strategy to manage the merged entities' resources and adopt adequate input-output mixes depending on prices, costs, the risk diversification strategy and revenue synergies [Ayadi et al. (2013)].

Nevertheless, execution of the strategy is as important as its design and planning in ensuring a successful consolidation. Strong governance and management structures are key elements in ensuring the monitoring and proper steering of the operational and strategic aspects of the consolidation project. For the consolidation to be efficient, the merged entity should be able to take managerial actions which translate the strategy into tangible results. Its management body and board of directors should be able to respond with corrective actions in the event of deviations from the initial strategy [Weber (2017)]. A strong management structure should generally follow the principles set out in the EBA Guidelines on internal governance (EBA/GL/2017/11). More precisely, in the case of a consolidation project, those principles imply developing, for the post-merger phase, a clear decision-making capacity for the new structure of the group, a consistent allocation of responsibilities and decision-making processes, a strong leadership team with a proven track record, not only in banking but also in consolidation projects, and a risk management and internal control framework which should be implemented in a timely fashion to be efficient. Furthermore, the consolidation strategy needs to be supported by adequate remuneration schemes to ensure that management incentives are aligned with the objectives of the merger.

5 Practical response to the expected interest in consolidation

5.1 ECB guide on consolidation: overview of the supervisory approach

5.1.1 Role of the ECB as a supervisor in the context of consolidation

In the context of consolidation, the role of ECB Banking Supervision is to assess from a prudential perspective M&A transactions arising in the market. Consolidation must remain a market-driven process, and therefore supervisors do not aim to promote specific types of consolidation. They monitor whether transactions prompted by the market comply with prudential requirements and supervisory expectations. Transactions should be based on a credible business and integration plan which improves the sustainability of the business model and respect high standards of governance and risk management to ensure that the combined entity achieves a viable and sustainable prudential position overall.

Over recent years, market participants have expressed an increasing interest in understanding how ECB Banking Supervision would assess proposed mergers and acquisitions concerning banks under its supervision. Although the risks associated with low profitability and overcapacity in the banking sector in Europe are widely recognised, there might have been a misperception in the market that ECB Banking supervision was in practice opposed to consolidation [Enria (2020)].

In order to address market concerns and clarify its supervisory expectations regarding sustainable consolidation projects, on 12 January 2021 ECB Banking Supervision published its Guide on the supervisory approach to consolidation in the banking sector [ECB (2021)].

Greater transparency is intended to make supervisory actions more predictable and to avoid any misperceptions of supervisory expectations. This article is part of ECB Banking Supervision's effort to increase the transparency and predictability of supervisory approaches and supervisory outcomes.

5.1.2 Main principles followed by the ECB in the assessment process

The Guide lays down the main principles that ECB Banking Supervision uses as a starting point when assessing consolidation projects. However, as ECB Banking Supervision knows from experience, there cannot be a "one size fits all" approach to banking sector consolidation. Consequently, ECB Banking Supervision takes a case-by-case approach, based on the proportionality principle, and the main principles of its Guide will be tailored to the specificities of each transaction.

The ECB expects the applicants to present a credible strategy underlying the consolidation transaction. That strategy should be based on conservative assumptions and demonstrate that the merged entity would be able to maintain full compliance with the applicable prudential requirements. The ECB will assess the plausibility of the strategy in the light of expected macroeconomic and financial developments. In doing so, it will take into account the criteria for consolidation outlined in the previous section. Among other elements, it will review balance sheet and profitability projections, the liquidity and funding structure and the governance and risk management framework. Regarding the latter, the ECB expects that it would follow the principles laid down in the applicable EBA guidelines and that it would be adequate to deal with possible execution risks and integration challenges.

The Guide provides particularly focused guidance on three key prudential aspects: the setting of Pillar 2 capital requirements and guidance, the treatment of badwill and the use of internal models. In so doing, the Guide aims to clarify how supervisors use their powers with respect to consolidation projects within the current regulatory framework.

5.1.3 Capital requirements

The Guide clarifies that the determination of Pillar 2 requirements (P2R) and Pillar 2 guidance (P2G) of the combined entity will use the weighted average of the pre-merger P2R and P2G levels of the two combining entities as a starting point. Subject to a case-by-case assessment, this starting point can be adjusted upwards or downwards. More precisely, two principles will be given due consideration for the determination of the post-merger P2R and P2G:

- an assessment of the risk profile with a particular focus on the strategy to mitigate the weaknesses of the combined entity and the execution risk in the business plan;

- the reflection of the risk profile of the combined entity in the level of Pillar 2 capital.

ECB Banking Supervision undertakes to provide an indication of the capital requirements applicable to the combined entity during the application process. These capital requirements are expected to remain unchanged for a least a year in order to provide certainty to the combined entity. Adjustments to these initial requirements can be expected if any substantial new developments arise during the implementation phase. As a general rule, it is expected that the first post-merger regular SREP will not result in an increased own funds requirement. However, following the completion of the consolidation project, the combined entity will be

subject to enhanced monitoring, which may lead to further adjustments to capital requirements

The intensity of the supervisory response of ECB Banking Supervision will mainly reflect material deviations from the business plan, considering that the costs of a business combination are generally frontloaded, whereas the benefits come later. Capital requirements could be lowered if the bank is able to demonstrate that the business combination is generating an effective improvement in the resilience and risk profile of the merged entity, for example owing to materialisation of diversification benefits and/or cost synergies.

In its action, where appropriate ECB Banking Supervision will liaise with relevant authorities, such as the Single Resolution Board, to anticipate, inter alia, issues regarding the resolvability of the combined entity. ECB Banking Supervision will also liaise with the relevant macroprudential authorities.

5.1.4 Badwill

ECB Banking Supervision expects profits stemming from badwill to contribute to the capital of the combined entity. In its Guide, ECB Banking Supervision clarifies its supervisory expectations regarding the treatment of badwill. Badwill is generated if an entity acquires another entity at a price that is below the estimated fair value of its assets net of the value of its liabilities. This accounting gain is recognised as a one-off profit. However, badwill is likely to reflect external investors' uncertainties regarding the valuation and the profitability perspectives of the acquired entity. Therefore, in order to address those concerns, the acquirer is expected to invest in the sustainability of the business model of the combined entity and not to pay out profits stemming from badwill as dividends until the soundness of the business model has been firmly established.

ECB Banking Supervision expects badwill to be subject to a thorough and prudent valuation. It will recognise "duly verified accounting badwill from a prudential perspective, expecting it to be appropriately calculated after thorough accounting recognition and valuation of assets and liabilities". This valuation is also expected to fully reflect the adjustments required by prudential regulations and to take into account ECB Banking Supervision guidance.

5.1.5 Internal models

In the case of a consolidation transaction, the continued use of internal models can raise concerns, as approval to use internal models is not transferable from one legal entity to another. As explained in the Guide, if the consolidation transaction results

in the formation of a new legal entity, a legal issue arises, as new legal entities cannot have approval to use internal models from the outset. If the consolidation transaction results in one legal entity absorbing another legal entity, the acquirer may have neither approval to apply its internal models to the newly acquired exposures, nor permission to use the model of the acquired entity.

However, ECB Banking Supervision will accept the temporary use of existing internal models subject to a strong roll-out plan aimed at tackling specific internal model issues created by the merger. This temporary tolerance will apply until banks have adapted their models to the new consolidated entity and received approval for their use. Indeed, a temporary return to the standardised approach could lead unnecessarily to higher capital requirements and a reduction in risk sensitivity. Therefore, the aim of this temporary tolerance is to prevent any supervisory burden that could result from such a situation.

ECB Banking Supervision will set the duration of this temporary tolerance, taking into account the specificities of each situation. Sufficient time will be provided for such transition to be performed smoothly and ensure that the updated internal model framework of the combined entity fully meets the requirements of ECB Banking Supervision.

5.2 Issues outside of the remit of the banking supervisor

The expected interest in bank consolidation is also likely to raise issues that fall outside the remit of banking supervisors. M&A transactions affect the structure of the market, may reduce competition, and could amplify systemic risks associated with the presence of large and complex banks. These issues are of concern to, among others, macroprudential authorities. They may also be of interest to competition authorities, resolution authorities and other stakeholders in the public sector. Cooperation between these authorities and microprudential supervisors is therefore essential when assessing a specific consolidation proposal.

5.2.1 Market structure and competition concerns

Within the single market and the banking union, consolidation could be assessed from a competition and market structure angle from both a European and a national perspective. The choice of perspective may be related to the nature of the business. Some banking services lend themselves more to being offered on a cross-border basis, such as investment banking or lending to large corporates, while markets for other services may be domestic or even, as in case of retail banking services in some countries, regional. As a general consideration, the implications of consolidation for market structure and competition may be of less concern in the case of cross-

border mergers than domestic mergers and in the case of mergers which aim at diversifying revenues than mergers aimed at generating cost synergies.

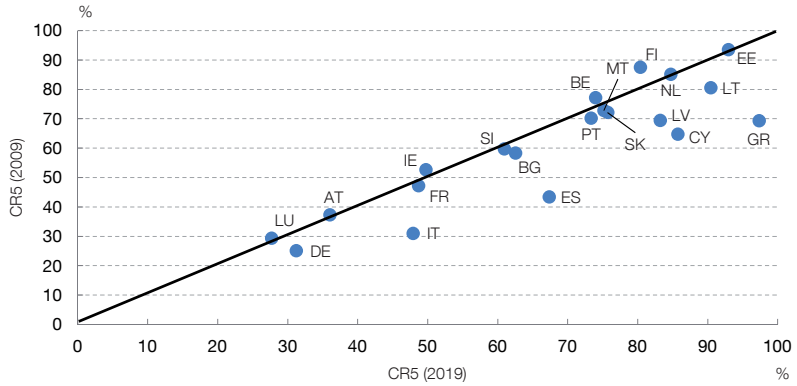
Market structures differ substantially between national banking markets in the euro area, and this has implications for the desirable direction of further consolidation. The share of the five largest credit institutions, which is a standard measure of market concentration, varies from about 30% in Luxembourg and Germany to over 90% in Estonia, Greece and Lithuania (see Chart 6). Looking at a broader range of competition indicators, Gardó and Klaus (2019) also conclude that the contribution of competition to the comprehensive indicator of overcapacity in the euro area banking sector varies significantly between countries. Recent ECB studies suggest that, at the aggregate euro area level, there is room for further consolidation without endangering financial stability, and that the recent increases in concentration seem advantageous to financial stability [Huljak, Reghezza and Rodriguez d'Acri (2019)]. However, this aggregate conclusion may not apply to every country, and the room for domestic consolidation in the countries where the banking sector is already highly concentrated and individual banks command high market power may therefore be limited.

Further reduction in competition may lead to suboptimal outcomes for both consumers and financial stability. Lower market power of banks is often associated with greater access to finance and lower cost of finance [Claessens and Laeven (2005), Chauvet and Jacolin (2017)], although evidence supporting an opposite view has also been brought forward [Fungacova et al. (2017)] and ascribed to a weakening of lending relationships caused by increased competition, which in turn increases monitoring costs for lenders. Economic literature suggests that the relationship between competition and financial stability is ambiguous and may vary due to country-specific factors [Beck, De Jonghe and Schepens (2013)]. More competition could encourage stronger risk-taking [Allen and Gale (2004)], but also serve as an incentive to improve the efficiency of banks and to lower lending rates, which increases the prospect that borrowers might be able to repay their debts [Martínez-Miera and Repullo (2010)]. This may produce an inverted U-shaped relationship in which both too little and too much competition could put financial stability at risk.

Concerns regarding market power are a matter for competition authorities, whose approval is required for consolidation operations alongside approval from supervisory authorities. It is the role of competition authorities to assess whether concentration is detrimental to customers and ECB Banking Supervision takes their stance fully on board when assessing consolidation projects. There is a balance to be struck between competition which encourages market participants to innovate and to improve their products, and competition which might lead market participants to take excessive risks, for example by increasing their share of riskier assets, a situation that could be detrimental to financial stability.

Chart 6

CONCENTRATION IN NATIONAL BANKING MARKETS IN THE SSM AREA



SOURCE: ECB macroprudential database.
NOTE: CR5 denotes the share of the five largest credit institutions in the total assets of the national banking sector. Countries below (above) the bisecting line show a higher (lower) concentration ratio in 2019 than in 2009. Countries: AT - Austria, BE - Belgium, BG - Bulgaria, CY - Cyprus, DE - Germany, EE - Estonia, ES - Spain, FI - Finland, FR - France, GR - Greece, IE - Ireland, IT - Italy, LT - Lithuania, LU - Luxembourg, LV - Latvia, MT - Malta, NL - The Netherlands, PT - Portugal, SI - Slovenia, SK - Slovakia. For Croatia (HR), the CR5 stands at 79.8% in 2019 (no data available for 2009).

Competition authorities and prudential authorities need to liaise closely to find this balance [Angeloni (2016)].

Cross-border consolidation may offer a solution to competition concerns. In principle, take-overs of domestic banks by new entrants would not materially change the market structure, but could help unlock synergies and diversification benefits. Nevertheless, cross-border consolidation comes with specific risks that warrant careful assessment.

Remaining regulatory impediments to cross-border mergers in the Single Market should be carefully assessed and, where possible, lifted. The development of the single rulebook has significantly reduced the regulatory fragmentation of the European banking landscape, and the creation of the Single Supervisory Mechanism (SSM) led to further harmonisation of supervisory practices. The SSM also harmonised the application of many of the existing national options and discretions available to supervisors in EU Member States participating in the banking union [ECB (2016)]. These actions should facilitate cross-border consolidation by addressing many of the constraints identified in the economic literature [Buch and DeLong (2012)]. The existence of a Single Resolution Mechanism (SRM) is also an important factor in ensuring homogeneous treatment of banking difficulties in the banking union. That notwithstanding, national specificities remain embedded in national laws [see Gardella et al. (2020)].

Cross-border banking groups are often unable to manage their capital and liquidity on a fully consolidated basis. Among other issues, this is due to the presence of national large exposure limits and to ring-fencing of capital and bail-in-able liabilities in the local subsidiaries [Praet (2018)]. While supervisors may grant liquidity waivers

to banking groups, liquidity requirements applied at the individual bank level and national ring-fencing measures may prevent parent companies from efficiently managing their liquidity resources within the group, even within the banking union [see Enria and Fernandez-Bollo (2020), who estimate that about €200 billion of high-quality liquid assets in cross-border subsidiaries of significant credit institutions are not transferable].

Further harmonisation would only be possible if lawmakers take the initiative to reduce further such obstacles to cross-border consolidation. Indeed, more can be done to remove incentives for ring-fencing by providing safeguards for the resilience of subsidiaries in cross-border groups. In particular, the enforceability of intra-group financial support agreements could be strengthened. As proposed by Enria and Fernandez-Bollo (2020), one possibility would be to link the granting of cross-border liquidity waivers to the presence of adequate intragroup financial support agreements included in the recovery plans to map out the appropriate triggers for providing intragroup support at an early stage, which would be well before the bank might be considered to be failing or likely to fail, and granting the supervisor the power to enforce the provision of support under specific circumstances.

5.2.2 Macroprudential concerns related to systemically important banks

Macroprudential authorities also need to assess concerns related to consolidation where it would increase the systemic footprint of large banks. As with all macroprudential instruments specified in EU law, the role of the ECB in this context is laid down in the SSM Regulation.[6] The national designated authorities are tasked with setting macroprudential capital buffers, subject to a review by the ECB, which has the power to object to the national decisions or to set higher capital buffers than proposed by the national authorities.

The regulatory framework already provides for instruments that address the systemic risks generated by the presence of large and complex banks.

Since the global financial crisis, regulators have implemented an integrated set of policy measures to reduce the probability and impact of the failure of systemically important financial institutions. While consolidation may mechanically lead to an increase in the systemic importance of a bank, this effect could be countered by appropriate macroprudential measures and measures taken to ensure that the merged bank remains resolvable. Macroprudential authorities are mandated to set capital buffers for systemically important institutions, at both the global level (G-SIIs)

6 Article 5 of the Council Regulation (EU) No. 1024/2013 of 15 October 2013 conferring specific tasks on the European Central Bank concerning policies relating to the prudential supervision of credit institutions (OJ L 287, 29.10.2013, p. 63).

and the domestic level (referred to as Other Systemically Important Institutions or O-SIIs). The calibration of these capital buffers should be related to the size, interconnectedness, cross-border activities, complexity and substitutability of activities of the identified banking groups vis-à-vis the rest of the banking system [EBA (2014b)]. In most EU countries, macroprudential authorities have adopted bucket schemes based on ranges of scores of systemic importance to determine the calibration of O-SII capital buffers [EBA (2020)]. This standard approach mechanically links a meaningful increase in the systemic footprint of a merged firm to a larger capital buffer, thereby in principle recognising and appropriately addressing the greater risks resulting from the increased systemic importance at the domestic level. From 2023 onwards, G-SIIs will be additionally subject to a surcharge on their leverage ratio requirements. Banks are also required to hold additional loss-absorbing capacity to facilitate their effective resolution. Finally, concerns about increased systemic footprint could also be mitigated by the positive effects of risk diversification which consolidation often aims to achieve.

Notwithstanding this progress, the buffer framework, owing to its reliance on consolidated group-level data, may put cross-border mergers at a disadvantage, in particular in the banking union setting, where the resolution of systemically important banks is funded and implemented at the European level. A cross-border transaction would substantially increase the systemic importance of the acquiring bank, and that increase would be particularly steep if the bank is based in a country where the banking sector is domestically focused.[7] The acquisition of a bank operating in another country may, in certain circumstances, be more capital-intensive than a domestic acquisition of the same size.[8] However, this would not account for two important dimensions. A cross-border acquisition could produce diversification benefits that reduce the risk to the domestic financial sector. In the banking union context, where the large banks fall under the remit of the Single Resolution Board (SRB), the risks associated with the potential failure of an internationally active bank would also fall on the entire banking union and not solely on the domestic financial sector.

EU lawmakers have already accounted for the existence of the banking union in the context of the capital buffers for G-SIIs. In addition to the standard and well-established methodology agreed by the Basel Committee on Banking Supervision

7 Under the harmonised scoring methodology provided for under the EBA Guidelines on the criteria to determine the conditions of application of Article 131(3) of Directive 2013/36/EU (CRD) in relation to the assessment of other systemically important institutions (O-SIIs) (EBA/GL/2014/10), cross-border exposures have a fixed weight of 16.66% in the total O-SII score. In an extreme case where the banking sector has no prior cross-border exposure, a foreign acquisition may therefore increase the score of the acquiring bank mechanically by at least 1,666 basis points, which is likely to significantly increase the applicable O-SII buffer rate. These effects would be less pronounced if the acquiring bank operates in a banking system which has non-negligible cross-border operations.

8 In fact, as the O-SII framework provides a relative measure of banks' systemic importance within the system, it can eventually yield a perverse outcome in which the O-SII buffer applicable to the bank taking over a foreign bank increases mechanically, while the O-SII buffers of its competitors decrease (as the higher score obtained by the merged bank mechanically reduces in the scores of the other banks).

(BCBS), national designated authorities may also use an alternative EU-specific methodology which treats cross-border activities within the banking union as domestic activities. They may subsequently reduce the capital buffer for a G-SII based in their country if the G-SII score obtained under this alternative methodology is suitably lower.[9]

Extending such an approach to the O-SII framework would address the currently unequal treatment of domestic and other cross-border exposures within the banking union. As a European authority, the ECB treats the euro area and all other EU countries participating in European banking supervision as a single jurisdiction. A European perspective on systemic importance and "too big to fail" – which is different from the national perspective of the Member State – is justified by the common supervision and resolution framework applicable within the banking union.

ECB Banking Supervision fully recognises the potential issues raised by the increased systemic importance of banks participating in mergers and acquisitions. The ECB monitors the level of O-SII buffers to ensure that relevant systemic and macroprudential risks are addressed in a consistent manner within and across SSM countries, as specified in the SSM Regulation, in close relationship with macroprudential authorities. As resolvability is a key part of risk mitigation, resolution authorities, in particular the Single Resolution Board, also play an important role in addressing the side effects of bank consolidation on the systemic footprint of large banks.

6 Conclusions

Euro area bank profitability was weak prior to the COVID-19 pandemic, and the weaknesses have been amplified by the macro-financial shocks associated with the pandemic. However, the decline in profitability was unevenly distributed among the underperformers, as banks holding large legacy NPL stocks saw a steep decline in profitability. Another major group of weak performers – banks whose income-generating capacity was low – seem to have been more resilient, as their aggregate profitability remained broadly unchanged, albeit at a continued low level.

The pandemic could be a catalyst for bank consolidation which could, in the medium to long term, address some of the profitability challenges in the euro area banking

9 This alternative methodology allows national macroprudential authorities to assign a G-SII to the next lower subcategory of G-SIIs than that implied by the standard G-SII score. G-SIIs already assigned to the lowest subcategory cannot be moved to a lower subcategory. See Article 131(10)(c) of the Capital Requirements Directive (CRD) (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, OJ L 176, 27.6.2013, p. 338) and the EBA's draft regulatory technical standard amending Commission Delegated Regulation (EU) No. 1222/2014 on the specification of the methodology for the identification of global systemically important institutions (RTS/2020/08).

sector. Consolidation could unlock cost savings and revenue synergies and improve the operational and financial resilience of the institutions involved. It could also be beneficial from a financial stability perspective, by improving the resilience and efficiency of the banking system and strengthening its ability to adapt to structural challenges. However, as illustrated by many historical case studies, bank consolidation may give rise to execution and financial risks, and it comes with side effects, such as the increase in the systemic importance of large banks and in the market power of individual banks. Some of these side effects could be addressed by cross-border consolidation within the Single Market.

In view of the expected interest in bank consolidation, the ECB has recently issued supervisory expectations which clarify how the ECB will assess mergers from a microprudential perspective. Consolidation should remain a market-driven process, but not all mergers would be aligned with the micro- and macroprudential objectives. The merger applicants should demonstrate that a specific transaction would not put compliance with prudential requirements at risk, and that the financial and execution risks are well understood and managed. The ECB has also clarified its approach to capital requirements, use of internal models, and prudential treatment of badwill. Mergers may also require an assessment by competition authorities, and may have structural implications for macroprudential policy. The ECB will continue to liaise with relevant authorities as appropriate.

Finally, more regulation targeted at furthering financial integration will be necessary to complete the banking union, and further contribute to enhancing the level playing field in the Single Market in order to achieve a genuinely single rulebook for banking, free from national discretions and “home biases”. Ultimately, implementation of the European Deposit Insurance Scheme should fully remove incentives for ring-fencing. Higher integration is expected to facilitate cross-border consolidation and cross-border banking, thereby allowing the banking sector to fully reap the profitability and financial stability gains of a truly single banking jurisdiction.

REFERENCES

Acemoglu, D., A. Ozdaglar and A. Tahbaz-Salehi (2015). "Systemic Risk and Stability in Financial Networks", *American Economic Review,* 105(2), pp. 564-608.

Af Jochnick, K. (2019). "Banking performance, competition and financial stability: a supervisory view", speech at the 7th Frankfurt Conference on Financial Market Policy entitled "European Banking – Too Much Competition?", 15 November.

Albertazzi, U., D. Andreeva, M. Belloni, A. Grassi, C. Gross, J. Mosthaf and T. Shakir (2020). "Prospects for euro area bank lending margins in an extended low-for-longer interest rate environment", *Financial Stability Review,* ECB, November.

Allen, F., and D. Gale (2004). "Competition and Financial Stability", *Journal of Money, Credit and Banking,* Vol. 36, pp. 453-480.

Altavilla, C., D. Andreeva, M. Boucinha, and S. Holton (2019). *Monetary policy, credit institutions and the bank lending channel in the euro area,* Occasional Paper Series, No. 222, ECB, June.

Altavilla, C., P. Bochmann, J. De Ryck, A.-M. Dumitru, M. Grodzicki, H. Kick, C. Melo Fernandes, J. Mosthaf, C. O'Donnell and S. Palligkinis (2021). *Measuring the cost of equity of euro area banks,* Occasional Paper Series, No. 254, ECB, January.

Altunbas, Y., and D. Marqués-Ibáñez (2004). *Mergers and acquisitions and bank performance in Europe – the role of strategic similarities,* Working Paper Series, No. 398, ECB, October.

Anderson, C., D. Becher and T. Campbell (2004). "Bank mergers, the market for bank CEOs, and managerial incentives", *Journal of Financial Intermediation,* Vol. 13, pp. 6-27.

Andreeva, D., M. Grodzicki, C. Móré and A. Reghezza (2019). "Euro area bank profitability: where can consolidation help?", *Financial Stability Review,* ECB, November, pp. 107-118.

Angeloni, I. (2016). "Bank Competition and Bank Supervision", speech at CaixaBank, Barcelona, 4 July.

Anolli, M., E. Beccalli and G. Borello (2015). "Are European banks too big? Evidence on economies of scale", *Journal of Banking & Finance,* Vol. 58, Issue C, pp. 232-246.

Ayadi, R., J.-P. Boussemart, H. Leleu and D. Saidane (2013). "Mergers and Acquisitions in European banking: higher productivity or better synergy among business lines?", *Journal of Productivity Analysis,* Vol. 39(2), pp. 165-175.

Baldursson, F., and R. Portes (2013). *Gambling for resurrection in Iceland: the rise and fall of the banks,* CEPR Discussion Paper, No. 9664, September.

Beccalli, E., and P. Frantz (2009). "M&A Operations and Performance in Banking", *Journal of Financial Services Research,* Vol. 36.

Beck, T., O. De Jonghe and G. Schepens (2013). "Bank competition and stability: Cross-country heterogeneity", *Journal of Financial Intermediation,* Vol. 22, pp. 218-244.

Behr, A., and F. Heid (2011). "The success of bank mergers revisited. An assessment based on a matching strategy", *Journal of Empirical Finance,* Vol. 18, pp. 117-135.

Berger, A. N., and R. DeYoung (1997). "Problem loans and cost efficiency in commercial banking", *Journal of Banking & Finance,* Vol. 21, pp. 849-870.

Bijsterbosch, M., and A. Deghi (2017). "Cross-border mergers and acquisitions in the EU banking sector: drivers and obstacles", *Financial Stability Review,* ECB, November, pp. 154-157.

Buch, C., and G. DeLong (2012). "Banking Globalization: International Consolidation and Mergers in Banking", in A. Berger, P. Molyneux and J. Wilson (eds.), *The Oxford Handbook of Banking,* Oxford University Press.

Chauvet, L., and L. Jacolin (2017). "Financial Inclusion, Bank Concentration, and Firm Performance", *World Development,* Vol. 97, pp. 1-13.

Claessens, S., and L. Laeven (2005). *Financial Dependence, Banking Sector Competition, and Economic Growth,* Policy Research Working Paper, No. 3481, World Bank.

Constâncio, V. (2014). "Banking Union: meaning and implications for the future of banking", speech at Banking Union Conference organised by the Master in Banking and Financial Regulation, Navarra University, Madrid, 24 April.

Copeland, T. E., and J. F. Weston (1988). *Financial Theory and Corporate Policy,* Pearson, 3rd edition.

Elsas, R., A. Hackethal and M. Holzhäuser (2010). "The anatomy of bank diversification", *Journal of Banking & Finance,* Vol. 34, Issue 6, pp. 1274-1287.

Enria, A. (2020). *Introductory statement at the press conference on the results of the 2019 SREP cycle,* Frankfurt, 28 January.

Enria A., and É. Fernandez-Bollo (2020). "Fostering the cross-border integration of banking groups in the banking union", *The Supervision Blog,* ECB, 9 October.

European Banking Authority (2014a). *Guidelines on common procedures and methodologies for the supervisory review and evaluation process (SREP)* (EBA/GL/2014/13), December.

European Banking Authority (2014b). *Guidelines on the criteria to determine the conditions of application of Article 131(3) of Directive 2013/36/EU (CRD) in relation to the assessment of other systemically important institutions (O-SIIs)* (EBA/GL/2014/10), December.

European Banking Authority (2017). *Guidelines on internal governance under Directive 2013/36/EU* (EBA/GL/2017/11), September.

European Banking Authority (2020). *EBA report on the appropriate methodology to calibrate O-SII buffer rates,* December.

European Central Bank (2016). *ECB Guide on options and discretions available in Union law,* November.

European Central Bank (2018). *SSM thematic review on bank profitability and business models – Report on the outcome of the assessment,* September.

European Central Bank (2020). *Financial Integration and Structure in the Euro Area,* March.

European Central Bank (2021). *Guide on the supervisory approach to consolidation in the banking sector.*

European Commission (2012). *The Financial Sector Adjustment Programme for Spain,* European Economy Occasional Papers, No. 118, October.

Fell, J., and G. Schinasi (2005). "Assessing financial stability: Exploring the boundaries of analysis", *National Institute Economic Review,* No. 192, April.

Fernandez-Bollo, É. (2020). "Consolidation can secure safe and sound banks", *Supervision Newsletter*, ECB, August.

Financial Services Authority (2011). *The failure of the Royal Bank of Scotland: Financial Services Authority Board Report,* December.

Financial Stability Board (2020). "Evaluation of the effects of too-big-to-fail reforms", 28 June.

Fiordelisi, F., D. Marqués-Ibáñez and P. Molyneux (2011). "Efficiency and risk in European banking", *Journal of Banking & Finance,* Vol. 35, pp. 1315-1326.

FROB (2019). *10 years of FROB. 2009-2019. A decade for financial stability,* Madrid.

Fungacova, Z., A. Shamshur and L. Weill (2017). "Does bank competition reduce cost of credit? Cross-country evidence from Europe", *Journal of Banking & Finance,* Vol. 83, pp. 104-120.

Gardella, A., M. Rimarchi and D. Stroppa (2020). *Potential regulatory obstacles to cross-border mergers and acquisitions in the EU banking sector,* EBA Staff Paper Series, No. 7, February.

Gardó, S., and B. Klaus (2019). *Overcapacities in banking: measurements, trends, and determinants,* Occasional Paper Series, No. 236, ECB, November.

Giovannini, A., P. Hartmann, J. Imbs and A. Popov (2018). "Financial integration, capital market development and risk sharing in the euro area", keynote speech at the 8th International Conference of the Financial Engineering and Banking Society, Rome, 4 June.

Hartmann, P., I. Huljak, A. Leonello, D. Marqués-Ibáñez, R. Martin, D. Moccero, S. Palligkinis, A. Popov and G. Schepens (2017). "Cross-border bank consolidation in the euro area", *Financial Integration in Europe,* ECB, May.

Huljak, I., R. Martin and D. Moccero (2019). *The cost efficiency and productivity growth of the euro area banks,* Working Paper Series, No. 2305, ECB, August.

Huljak, I., A. Reghezza and C. Rodriguez d'Acri (2019). "Market power, competitiveness and financial stability of the euro area banking sector", *Financial Stability Review,* ECB, November.

Jeitschko, T. D., and S. D. Jeung (2005). "Incentives for risk-taking in banking – A unified approach", *Journal of Banking & Finance,* No. 29, pp. 759-777.

Jiménez, G., S. Ongena, J. Peydró and J. Saurina (2012). "Credit Supply and Monetary Policy: Identifying the Bank Balance Sheet Channel with Loan Applications", *American Economic Review,* Vol. 102, pp. 2301-2326.

Kolaric, S., and D. Schiereck (2014). "Performance of bank mergers and acquisitions: a review of the recent empirical evidence", *Management Review Quarterly,* Vol. 64, pp. 39-71.

Krusec, D. (2020). "Cross-border bank consolidation in the euro area: a global perspective", *Financial Integration and Structure in the Euro Area,* ECB, March.

Kwan, S., and R. Eisenbeis (1997). "Bank Risk, Capitalization and Operating Efficiency", *Journal of Financial Services Research,* Vol. 12, pp. 117-131.

Martínez-Miera, D., and R. Repullo (2010). "Does Competition Reduce the Risk of Bank Failure?", *The Review of Financial Studies,* Vol. 23, pp. 3638-3664.

Molyneux, P., K. Schaeck and T. M. Zhou (2014). "Too systemically important to fail' in banking – Evidence from bank mergers and acquisitions", *Journal of International Money and Finance,* Vol. 49, pp. 258-282.

Praet, P. (2018). "Creating an enabling environment for pan-European banks in the Banking Union", speech at the Eurofi Financial Forum 2018, Vienna, 5 September.

Shaffer, S. (1993). "Can megamergers improve bank efficiency?", *Journal of Banking & Finance,* Vol. 17(2-3), pp. 423-436.

Weber, A. (2017). *Bank Consolidation, Efficiency, and Profitability in Italy,* IMF Working Paper, WP/17/175.

Williams, J. (2004). "Determining management behaviour in European Banking", *Journal of Banking & Finance,* Vol. 28, pp. 2427-2460.

Function and application of the new macroprudential tools available to the Banco de España

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BANCO DE ESPAÑA

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FUNCTION AND APPLICATION OF THE NEW MACROPRUDENTIAL TOOLS AVAILABLE TO THE BANCO DE ESPAÑA

Abstract

Following the global financial crisis, banking regulation incorporated macroprudential policy into the authorities' toolkit with the aim of mitigating so-called "systemic risk". This is namely the risk of financial instability becoming so widespread that it hampers the functioning of the financial system, to such an extent that economic growth and citizens' well-being are adversely affected. One of the distinctive characteristics of this risk is that it is multi-dimensional; accordingly, a broad range of specific tools is needed to be able to tackle each of these dimensions. Up to a year ago Spanish regulations, deriving from European regulations, basically provided for macroprudential tools that could bear on banks' solvency requirements. Since then it has added other tools, some of which are common to other jurisdictions, that allow action to be taken on specific credit portfolios or on specific characteristics of the loans granted by banks. This article sets out these new tools, discussing their main properties and their potential scope for operating in practice. It also reviews some of the challenges that future revisions or future extensions of the macroprudential toolbox may pose.

1 Introduction

The global financial crisis late in the first decade of this century highlighted the fact that ensuring the solvency and liquidity of each financial institution individually is not sufficient to guarantee financial stability; rather, it is necessary to supervise the system as a whole. Indeed, one of the key lessons of that crisis was that the authorities should include an additional objective in their macroeconomic policies: the mitigation of systemic risk. In this respect, a fundamental principle that should be followed in designing economic policies is that each of the authorities' objectives should have differentiated tools to prevent policy clashes (Tinbergen (1956)). Given that a new objective requires a new policy, regulation incorporated the macroprudential policy, initially in the form of instruments resting above all on new capital and liquidity requirements for credit institutions.

There is no standardised definition of systemic risk. One of those most commonly accepted is that of the ECB (European Central Bank (2009)), which defines it as the risk of financial instability becoming so widespread that it hampers the functioning of the financial system, to such an extent that economic growth and citizens' well-being suffer. This definition underscores the multi-dimensional nature of this risk. It is thus essential that the authority responsible for the application of macroprudential policy should have a wide range of tools, allowing each of these dimensions to be tackled as efficiently as possible.

The theoretical and empirical literature appear to concur that there are at least two dimensions to systemic risk: a time/cyclical dimension (relating to the systemic risks that evolve over the course of the credit cycle) and a cross-sectional/structural dimension (relating to the impact on the systemic risk arising, for example, from the size, complexity and interconnectedness of banks). The dynamic characteristic of systemic risk means that, as in the case of economic cycles, there are different stages or phases in the gestation of a possible systemic crisis. These stages usually occur one after another, although they do not always have the same duration. Both the succession of stages and their duration will depend, among other things, on the measures adopted to mitigate them. Precisely for this reason, it would be desirable to have macroprudential instruments adapted to each stage that can be activated sequentially if they do not manage to mitigate the systemic risk in a prior stage.

It is generally considered that, in the initial stages of systemic risk build-up (or in the gestation of a systemic crisis), it would suffice for macroprudential instruments to mitigate the effects of such risk by requiring banks to accumulate additional resources (in the form of capital) with which to counter the consequences of the risk materialising. Some papers have shown that this type of instrument could also contribute to tempering the build-up of systemic risk. Firstly, because, by requiring more capital for each loan granted, banks would have fewer incentives to assume greater risks since they would have more skin in the game (see, for instance, Taleb and Sandis (2014)). Secondly, because in certain circumstances they could lead banks to raise the interest rate on loans, thereby reducing the demand for lending (Estrada and Mencía (2021)). The most emblematic instrument of this type is the countercyclical capital buffer (CCyB), which was introduced into banking regulations under the Basel III reforms after the global financial crisis. These are in fact the types of instruments envisaged in the main by current legislation following the transposition of the European capital requirements Directive and Regulation (CRD/CRR) (see Table 1).

However, at later stages in the development of systemic risk, it may be necessary to act directly on lending standards and, thereby, exert a more decisive impact on the volume of credit in specific or in all portfolios. Here, there are other instruments whose effectiveness may be deferred over time or be more immediate, meaning their use will once more depend on how urgent it is to act. First, there are relatively proportionate options for banks that involve restricting the flow of new lending by, for example, setting more restrictive lending conditions. The empirical evidence available shows, moreover, that this reduces the risk of borrower default, since looser lending conditions at the time of loans being granted are associated with a greater probability of subsequent default. Second, much more drastic and, therefore, last-resort instruments might also be envisaged, bearing directly on the total volume of lending admissible, e.g. limiting banks' lending-to-capital ratios. These are two of the instruments now available to the Banco de España, following Spanish Parliamentary authorisation, given that they do not exist in the attendant European regulations (although they do in many euro area countries).

Table 1
MACROPRUDENTIAL TOOLS PROVIDED FOR IN THE CRD/CRR

Tool	Legal basis	Description
Countercyclical capital buffer (CCyB)	CRD: 130, 135-140	Additional capital buffer, built up during upswings and released during downswings to smooth the credit cycle and absorb losses
Buffer for systemically important institutions	CRD: 131	Additional capital buffers to internalise the externalities created by systemic institutions, both global (G-SII) and national (O-SII)
Systemic risk buffer (SRB)	CRD: 133, 134	Capital buffer to prevent and mitigate non-cyclical systemic risks not covered by the CRR
Flexibility package	CRR: 458	Stricter requirements for capital, conservation buffer, liquidity, large exposures, information and risk weightings
Higher risk weightings for real estate exposures (standard approach)	CRR: 124	Tools for the real estate sector available to the competent authority
Higher Loss Given Defaults (LGDs) for real estate exposures (internal models)	CRR: 164	

SOURCE: Banco de España.

Logically, this new range of instruments will enhance the likelihood of macroprudential policy being successful in its preventive action against macrofinancial imbalances building up. But we must also consider the possibility that none of these preventive instruments will suffice and that systemic risk may ultimately materialise. Or that the financial system is disrupted as a result of an exogenous shock not preceded by an accumulation of systemic risk, as has been the case with the COVID-19 pandemic. To contend with this type of situation, macroprudential instruments also have to be palliative in nature, enabling banks to continue performing their function of providing financing for both firms' and households' solvent projects. But in this connection, it must be possible to release (or use) the built-up capital buffers when the risk materialises. Given the experience of COVID-19 and the lessons that may be drawn from it, it would be desirable to consider the need for possible adjustments to the current design of buffers so as to address systemic shocks exogenous to the financial system; these shocks are not preceded by an accumulation of systemic risks and, consequently, under current operating arrangements, releasable buffers are not built up. The instruments that restrict specific characteristics of the loans granted by banks reinforce, above all, borrower solvency (and, indirectly, that of the banks, which will experience fewer defaults), meaning that their deactivation will be less effective as a palliative measure, since they do not release funds that can be used by banks when a crisis breaks.

Concerning the second, cross-sectional/structural dimension of systemic risk, the strong financial interconnectedness of banks and financial sector sub-sectors (via markets, common positions and cross-positions) involves major efficiency gains for

the economy as a whole. This is because it allows risks to be distributed among more agents and enables each risk to be managed by the institution best prepared to do so. But it is also a source of vulnerabilities, which macroprudential policy must take into account and seek to mitigate. This interrelatedness means that the actions or problems of one financial institution can affect all the others. Moreover, there will be shocks that affect all of them in unison, jeopardising the system in a way that shocks only bearing down on one bank in isolation would not.

Included within this dimension, in particular, would be the risks arising from the presence of systemically important institutions. These types of institutions have far more capacity to affect the system's stability than smaller or less interconnected banks. Indeed, in many circumstances the authorities have not let such institutions go to the wall to prevent the entire system from falling into difficulties (the "too-big-to-fail" doctrine). These potentially higher costs for society would warrant an extra layer of protection against shocks being demanded of these banks. Some researchers have also stressed that a potential bailout by the authorities may lead these banks to enjoy preferential treatment by the markets and depositors in their funding, which would give such banks a competitive edge over others. Therefore, current legislation envisages the possibility of establishing additional capital buffers for these types of institution (global or domestic systemically important bank (G-SIB or D-SIB) buffers), and other types of buffers for more specific cross-sectional risks (systemic risk buffer (SyRB)).

The cyclical and structural dimensions of systemic risk are not isolated but interact with each other (Freixas, Laeven and Peydró (2015)). A good example of this interaction is the potential existence of a sectoral component of systemic risk. In fact, past experience shows that there have been situations in which systemic risk has originated in a specific sector and that, indeed, that sector has drained financial resources from the other sectors. This is why it must be possible to apply macroprudential instruments sectorally. Logically, the sectors considered should be materially significant for there to be any possibility of them deriving in a systemic risk. However, it should be borne in mind that these sectoral risks also have a dynamic component. Accordingly, it appears that sectoral instruments also need to be able to address systemic risk in the different stages of its development over time. First, by acting on banks' capital; this is why the third macroprudential instrument the Banco de España now has is the sectoral countercyclical capital buffer (SCCyB). Second, by exerting an impact on the amount, conditions and composition of the flow of lending. Thus, the instruments that set conditions on loans may also be applied with a degree of sectoral granularity and, ultimately, on the volume of lending to specific portfolios, as is the case with the limits on sectoral concentration.

As has been shown, the macroprudential instruments available up to a year ago under the regulations did not allow some of the situations described to be tackled, and did not therefore provide sufficient flexibility. In particular, the systemic risk

buffer alone provides for use on sectors or sub-sectors of banks' credit portfolios. However, this buffer cannot be applied in the case of cyclical risks that are already covered by the general CCyB, and nor do the regulations provide for how they may interact. Moreover, nor is the sectoral SyRB governed by the CCyB's principle of "guided (or bounded) discretion". This principle is especially useful for mitigating the time dimension of systemic risk, since it provides greater transparency and communication, allowing agents to anticipate to some extent its future changes and to incorporate it into their decision-making. Articles 124 and 164 of the CRR do enable sectoral imbalances to be tackled, although only when real estate exposures are involved. Nor does Article 458 of the CRR, known as the "flexibility package", offer clear alternatives to the measures envisaged in the proposal. This article is conceived for use under exceptional conditions, once the use of the other macroprudential instruments in the CRD/CRR has been shown to be inappropriate or insufficient. In fact, among the wide range of measures this article authorises, in no case does it allow strict limits to be set on lending standards or on concentration. Another alternative to introducing new instruments is the use of non-binding recommendations made by the macroprudential supervisor to banks. In this connection, several European countries have opted to introduce recommendations on lending standards rather than binding measures. Yet the evidence available shows that legally binding macroprudential measures are far more effective than non-binding recommendations for checking the growth of house prices and of lending in expansionary phases (see Poghosyan (2019)).

The rest of this article analyses these three new macroprudential instruments in greater detail. The second section describes their objectives and general workings, and the third section presents the empirical evidence available on their effectiveness, compared with that of the instruments already available. However, given the interrelatedness between dimensions and the degree of development of systemic risk, it may so occur that both the new instruments and those already available have to be combined under certain circumstances. The limited experience in their use and the modest (but rapidly growing) empirical evidence are naturally a significant limitation, which the passage of time will progressively mitigate. Nevertheless, section 4 of the article offers some considerations on this matter, assessing specific situations that might occur in practice. Lastly, section 5 sets out some of the challenges that future revisions or extensions of the macroprudential toolbox available to the authorities may pose.

2 The new macroprudential instruments

Pursuant to Article 2 of Royal Decree-Law 22/2018, a series of amendments were made to Law 10/2014 of 26 June 2014 on the regulation, supervision and solvency of credit institutions to include the new macroprudential instruments. Article 15(1) of Royal Decree 102/2019 provides for the use by the Banco de España of these

instruments in systemic risk situations, adding to those instruments already available for application through their inclusion in the CRD/CRR.

The three new instruments available are:

a) **CCyB applicable to exposures to a specific sector (i.e. SCCyB):** as provided for in Articles 43 to 49 of Law 10/2014. Specifically, four sectors are considered: lending to individuals under mortgage guarantee, without a mortgage guarantee, for productive construction and development activities and for other productive activities.

b) **Limits on the conditions governing lending and other operations by credit institutions (i.e. borrower-based instruments (BBI)):** considered by virtue of Article 69 ter of Law 10/2014.

c) **Limits on the concentration by credit institutions in a specific sector of economic activity (i.e. sectoral concentration limits (SCL)):** set in accordance with Article 69 bis of Law 10/2014. Two further sectors are added to the list envisaged in the SCCyB: credit institutions and other financial institutions.

A newly drafted Banco de España circular is scheduled to cover the development and implementation of these tools, and compliance therewith.

2.1 Sectoral countercyclical capital buffer

As discussed in the introduction, it has occasionally been the exposures to specific sectors that have concentrated most systemic risk. In such a situation (excessive credit growth in a particular sector, but whose magnitude does not significantly affect total credit initially), activating aggregate macroprudential instruments might not be an effective measure and, in fact, could be counter-productive.

In this case, while the activation of the CCyB could help build up a buffer capable of absorbing the future losses that credit exposures in general (including those in this sector) were to bring about, it might not be useful for actually deterring the excessive growth of credit to the sector with imbalances. Indeed, although the CCyB would increase the cost for banks of continuing to expand total credit, the relative price of extending credit to the sector identified would remain unchanged compared with the price of lending to other sectors. Accordingly, insofar as loans to the sector identified were to provide a higher return (a greater risk) than other types of loans, the incentives to continue increasing credit and its concentration would persist, even at the cost of reducing credit to other less risky sectors. Also, nor would introducing the CCyB be able to ensure that the terms under which these loans were granted were excessively loose in relation to those of the other sectors. Conversely, if the measure were to

affect one or a specific group of sectors, the relative cost of lending to the sectors would increase, altering the relative returns on the various portfolios to the detriment of the sector, or sectors, that are generating the systemic risk.

In any event, the application of a sectoral instrument should be accompanied by the strict monitoring of its potential spillover effects to the other sectors. The aim here would be to prevent, for example, the problem of excessive credit growth from shifting across sectors. Moreover, the sectors considered should have a systemic dimension, to prevent the instrument from being microprudential in nature. For example, there should be evidence that developments in these sectors, if not duly controlled, may contribute in the future to increasing risks in other sectors or at the aggregate level.

2.1.1 General description of the functioning of the sectoral countercyclical capital buffer

From a technical standpoint, the SCCyB can be seen as an extension of the design of the CCyB, by allowing its application both to overall exposures and to certain sectors, or even to both simultaneously.[1] Hence, the main purpose of the SCCyB is to tackle systemic risk stemming from the imbalances potentially generated in a specific sector of economic activity, and to endow institutions with sufficient capital resources to withstand the potential losses that might arise should there be a disorderly spread of the sectoral cyclical imbalances created.

Following the guidelines laid down in the principles published by the Basel Committee on Banking Supervision (BCBS) (Basel Committee on Banking Supervision (2019a)) and the pertinent literature, as with the CCyB, the activation, accumulation and deactivation of the SCCyB will be guided by different categories of indicators, including: i) sectoral lending volumes / measures of credit growth, intensity and gaps; ii) asset prices / changes and measures of disequilibrium, specialised for each sector, and iii) sectoral macrofinancial imbalances / debt, net wealth, net borrowing or lending, saving rate and investment, inter alia.

Any rule guiding the use of the SCCyB in practice should comply with certain protocols allowing its correct interaction with the CCyB:

a) When there is an increase in credit risk, total required capital, whether through the general CCyB or through the sectoral component, should be increased.

b) As the level of the CCyB increases, the absolute cost of granting credit to the sector identified as the source of systemic risk should increase.

1 See Castro, Estrada and Martínez (2014 and 2016) for an explanation of the general functioning of the CCyB and its operationalisation in Spain.

2.2 Borrower-based instruments

In situations in which there is an excessive and widespread easing in lending conditions without regard to its systemic consequences, borrower-based instruments (BBI) allow, for macroprudential reasons, limits to be set on these conditions at the time the loans are granted (e.g. limits on collateral coverage ratios, borrower ability-to-pay ratios, loan maturity terms, etc.). Accordingly, the aim of BBI is to attempt to influence lending standards, which directly affect the flow of new lending and the subsequent probability of default.

By setting limits on new lending conditions, BBI could be applied when, for example: house price overvaluation reaches such a level that potential future corrections would lower the collateral value to below that of the loan made; borrowers not in a sufficiently sound financial situation can gain access to credit; or lending indicators for a significant percentage of the credit portfolio reach worrying levels from a solvency standpoint.

2.2.1 General description of the functioning of borrower-based instruments

Royal Decree-Law 22/2018 states that the Banco de España may, among other measures, set limits or conditions on:

i) the maximum debt allowed to a borrower based on the value of the collateral provided (i.e. using the loan-to-value ratio (LTV) or loan-to-price ratio (LTP), depending on whether the appraisal value of the property or the transaction value is used);

ii) the proportion of a borrower's income that a specific loan (loan-to-income ratio, LTI) or all of their loans (debt-to-income ratio, DTI) represents;

iii) the share of the borrower's disposable income dedicated to paying down a specific loan (loan-service-to-income ratio, LSTI) or all of their loans (debt-service-to-income ratio, DSTI);

iv) the maturity of the loan.

BBI can be applied to various loan characteristics. The decision to impose conditions on certain characteristics and not on others will therefore depend on the specific situation that needs to be addressed, i.e. the nature of the systemic risk and the most effective characteristic for its mitigation. However, setting conditions on one characteristic might prompt excesses in others. Accordingly, it may be necessary to

act on several characteristics simultaneously. In other words, several limits may sometimes have to be activated simultaneously, and limits may need to be combined with other existing macroprudential tools.

There could also be spillover effects to other credit portfolios not subject to the limits introduced, e.g. from mortgage to non-mortgage loans, which could lead to the measures being extended to those segments. Regulation of this instrument should also provide for the possibility of adjusting the conditions according to the characteristics of the borrower and the lender, thus ensuring their efficacy and preventing the disproportionate concentration of their effects on certain groups of potential borrowers.

2.3 Sectoral concentration limits

Like the SCCyB, this tool focuses on overall exposures to a specific sector. Concentration is defined in terms of the ratio of sectoral exposure to common equity tier 1 capital (CET1). Therefore, it does not place an absolute quantitative cap on exposure (i.e. the limit is activated when the ratio between exposure and capital exceeds a certain threshold). It is also a sectoral instrument, meaning its objectives are aligned with those of the SCCyB (in particular, limiting excessive credit growth). The potential effects of spillovers to other sectors must also be carefully analysed. Further, the sectors must have a systemic dimension and be consistent, as far as possible, with those envisaged for the SCCyB.

The fundamental difference between this tool and the SCCyB is that its activation would inhibit the growth of sectoral concentration more directly (via the "quantity" effect), while the SCCyB only provides a disincentive, making it more expensive, in relative capital terms, to increase credit exposure to the targeted sector or sectors. As a result, there are benefits and challenges to its use. For one thing, it is implemented through a quantitative reference as to concentration, meaning this tool more directly limits the banks' – and consequently the system's – degree of exposure to a specific sector. However, such a quantitative reference poses challenges in terms of its correct calibration and practical use, if distortions and unintended consequences on the system's and banks' normal functioning are to be avoided. Lastly, unlike the SCCyB, the exposures to which SCL refer are not risk weighted.

2.3.1 General description of the functioning of sectoral concentration limits

Given their ties with the SCCyB, there should be some consistency and continuity when defining the sector or sectors to which SCL would be applied. Further, as with the SCCyB, periodic monitoring and analysis is required to consider the potential need for their activation. The indicators already envisaged for the SCCyB are useful

in this respect, along with certain additional indicators that can also serve to determine the temporary thresholds which banks cannot exceed. Possible indicators include changes in the aggregate exposure to each sector, its historical share of total exposures and recent changes, its relevance in GDP and in sectoral value-added, and, naturally, its weight in aggregate CET1.

SCL may be imposed on a specific sector or on several sectors simultaneously if exposure concentration occurs across various sectors at once. They may also be applied simultaneously with other macroprudential tools if deemed necessary to increase their effectiveness.

As regards the sequencing of the above-mentioned instruments, SCL are considered a tool of last resort. Although the evidence suggests that activating BBI tends to have a swift impact on credit growth, it is important to bear in mind that they only affect the flow of new lending and not the volume of existing loans. This is further reason to consider activating SCL in exceptional circumstances.

3 Empirical evidence on the effectiveness of the new macroprudential tools

Broadly speaking, analysis of the effectiveness of macroprudential tools seeks to measure or assess – both conceptually and empirically – how effective macroprudential instruments are in staving off systemic risks (ex ante resilience) or in mitigating them should they materialise (ex post resilience). In other words, it aims to assess, first, their ability to reduce the probability of systemic risks materialising (which would entail losses for banks and the system) and, second, their ability to lessen the impact should they materialise (if they have sufficient resources to absorb the losses and allow banks and the system to continue their financial intermediation activity).

3.1 Sectoral countercyclical capital buffer

Although only a handful of countries have activated the aggregate CCyB, and in most cases it has only been recently deactivated as part of the response to the COVID-19 crisis, the empirical literature on this tool is growing. By contrast, literature on the SCCyB is far sparser (see, for example, BCBS (2019b)), since very few countries provide for it in their legislation. This section therefore sets out evidence based on studies of the CCyB or of the observed effects in other instances of increased capital requirements in specific sectors.[2]

The literature review conducted by the BCBS (2018a) mentions a series of instances in which specific capital requirements were applied to sectors such as residential

2 For example, Ferrari et al. (2017) analyse the increase in risk weights, which can be regarded as equivalent to raising capital requirements.

and commercial real estate, consumer loans and foreign currency loans. However, few papers have conducted an empirical assessment of their effectiveness. In fact, thus far only Switzerland has introduced a SCCyB, targeted at the real estate sector. Based on that experience, Basten and Koch (2017) find that while its activation in 2013 did not affect the loan approval rate, it did have an impact on the lending interest rates offered by the more capital-constrained banks and mortgage-specialised banks. For mortgage-specialised banks, they also found that annual mortgage loan growth decreased after the measure was introduced. In respect of measures raising capital requirements for certain sectors, Ferrari et al. (2017) find that the increase in risk weights for mortgage exposures in Belgium has had a limited effect on mortgage loan interest rates and on their growth. By contrast, Martins and Schechtman (2014) and Afanasieff et al. (2015), who study the effects of an increase in risk weights for auto loans in Brazil, find a material impact on the volumes of targeted loans. It appears, therefore, that there is mixed evidence regarding the impact generated by such sectoral measures on loan volumes, both in terms of quantity and price (BCBS (2019b)).

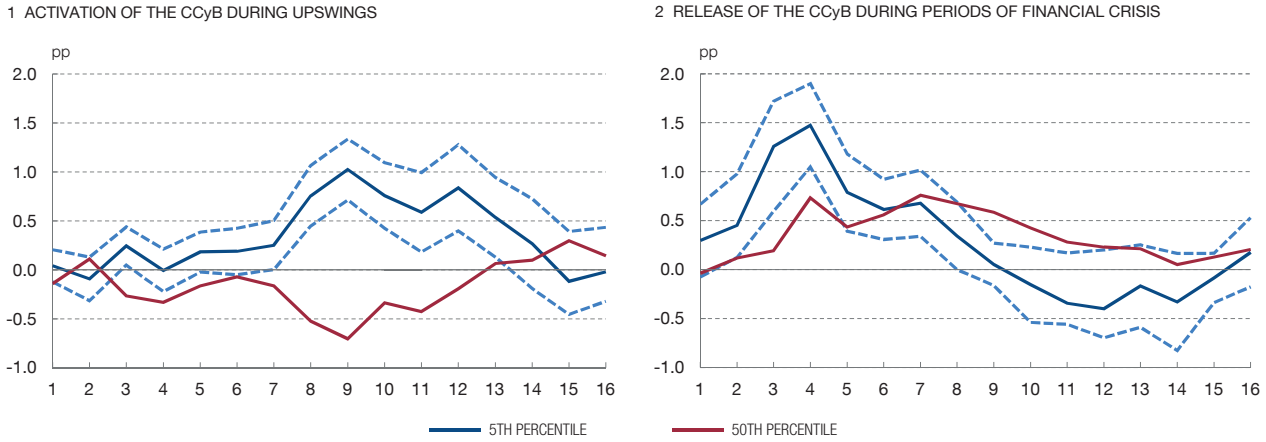
However, there is greater consensus on the positive effect of sectoral capital tools such as the SCCyB on ex post resilience; i.e. as a means to help absorb losses and sustain the flow of credit to the economy, thereby avoiding credit crunches. The recent evidence emerging from certain jurisdictions which have deactivated any of their existing capital buffers (generally the CCyB) in response to the COVID-19 crisis seems to suggest that deactivating such instruments has made the buffers more readily available to banks to be used to maintain the flow of credit to the real economy (see Castro and Estrada (2021)).

Despite the scant direct evidence on the effectiveness of the SCCyB, the studies conducted on the general CCyB are potentially relevant to understanding the impact on aggregate credit and other variables. In keeping with the results generally observed internationally, the empirical evidence available in Spain, for the period of systemic risk build-up preceding its materialisation during the global financial crisis, suggests that the CCyB is able to slightly temper credit growth (Jiménez et al. (2017)),[3] but that its strongest effect comes upon its release in response to the materialisation of systemic risk, easing credit supply constraints. These findings are borne out when broader historical periods are considered (see Bedayo et al. (2020)). The study of credit cycles over the past 150 years indicates that a 1% increase in the capital ratio of banks during upturns would moderate credit growth by close to 0.8 percentage points (pp), while the GDP growth rate would be reduced by around 0.4 pp. These effects appear to be concentrated in the period one to two years after activation. However, the benefits of releasing the

3 The study by Jiménez et al. (2017) is based on Spain's experience of dynamic provisioning. Provisions do not form part of banks' capital, but the workings of dynamic provisioning and its economic interpretation make them distinctly similar to the CCyB.

Chart 1

IMPACT OF THE ACTIVATION AND RELEASE OF THE CCyB ON THE 5TH AND 50TH PERCENTILES OF THE GDP GROWTH DISTRIBUTION OVER TIME HORIZONS OF BETWEEN 1 AND 16 QUARTERS (a)



SOURCE: Galán (2020).

a The solid blue and red lines represent the estimated impact on the 5th and 50th percentile of the conditional distribution of GDP growth, respectively. The dotted blue lines represent the confidence band at 95% obtained through bootstrapping.

CCyB in economic downturns would clearly outweigh these costs, since the credit fall-off during downswings could be mitigated by as much as 4.5 pp and the decline in GDP by 2 pp.

Further, applying a methodology that makes it possible to estimate the impact of the macroprudential instruments on the entire GDP growth distribution function (Galán (2020)) suggests differential effects not only in terms of the time horizon but also in the distribution.[4] In particular, it would significantly lessen the extreme falls in GDP that would occur in a severe crisis two years after its activation, but would also prompt a modest decline in expected growth. This would suggest that, although the expected average impact could be negative (in line with the results of the above-described methods), there would be a favourable effect in return: a smaller GDP contraction in the event of a severe recession. Also, the effects of releasing a CCyB during periods of financial crisis would be positive across the entire GDP growth distribution and would be felt more immediately, in just one year.[5] This exercise confirms that the benefits of increasing the CCyB would clearly outweigh the costs, and that the benefits are most evident when the buffer is released during crisis periods (see Chart 1).

4 These estimates are based on a growth-at-risk approach, using quantile regression models in which the dependent variable is future GDP growth over time horizons of between one and 16 quarters. The sample for the estimates comprises a panel of advanced and emerging economies with quarterly data.

5 Trucharte (2021) conducts a counterfactual exercise estimating the size of the buffers that Spanish banks would have built up in the run-up to the global financial crisis had these tools been available and activated mechanically pursuant to the recommendations established for the CCyB.

3.2 Instruments based on the borrower's ability to pay

Past experience shows that, in general, the most severe systemic financial crises have been associated with imbalances, boom and bust cycles and weaknesses in the real estate sector (see, for example, Reinhart and Rogoff (2008 and 2009), Crowe et al. (2013) and Hartman (2015)). Accordingly, the monitoring of real estate sector risks and the analysis of potential instruments and measures for prevention or mitigation of these risks have been central to the development of macroprudential policy since the outset.

Indeed, the rationale for using BBI is based on the empirical observation that mortgage loans extended under stricter standards in terms of their leverage, repayment schedule and maturity (i.e. with shorter maturities) subsequently present significantly lower default rates. Further, loan contracts in which several of these credit standards are looser tend to show appreciably higher probabilities of default than loans in which only one of them is looser.

Credit standards are key to ensuring the safety and soundness of banks, since they bolster borrowers' creditworthiness and, therefore, reduce potential subsequent losses for lenders. Accordingly, assessing banks' lending policies is crucial for diminishing the impact of future shocks. And this should not be limited to mortgage loans; rather, it should extend to all other credit portfolios, including corporate portfolios, as is the case under Spanish legislation. Unfortunately, analysis of this tool's effectiveness is necessarily limited to mortgages, as these are the only portfolios to which such tools are applicable in most of the countries that have them. Here, Spanish regulation is quite unique, since it extends their use to other credit portfolios.

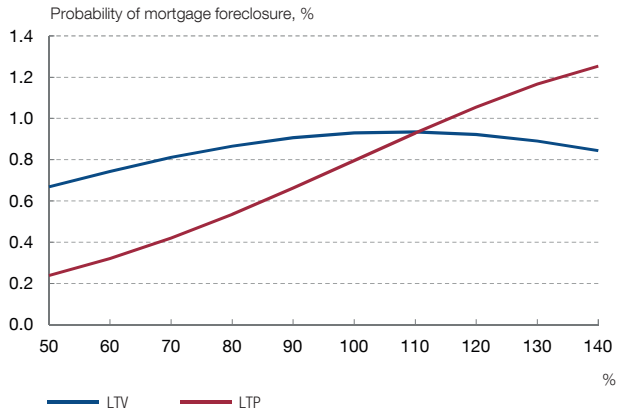
Specifically, various empirical studies identify positive effects of borrower-based measures in terms of moderating credit and house prices (Claessens et al. (2013) and Cerutti et al. (2017)) and reducing mortgage risk (Campbell and Cocco (2015) and Aron and Muellbauer (2016)). For their part, studies analysing the impact on economic growth of activating such measures have found adverse effects (see Richter et al. (2019)). These findings may owe to the above papers focusing on models that exclusively identify the near-term impact on average GDP, where the immediate costs of tighter macroprudential policy are evident. Moreover, the handful of studies that analyse the effects of deactivating these tools in crisis periods find negligible impacts on credit or GDP (Galán (2020)). However, banks' losses in crisis periods would probably also be reduced, given the lower ex ante build-up of risk on their balance sheets.

More specifically, in the case of Spain, Galán and Lamas (2019) find empirical evidence suggesting that the variables pertaining to credit standards at origination, such as the LTV, LTP and LSTI ratios or loan maturity, are key indicators of ex ante

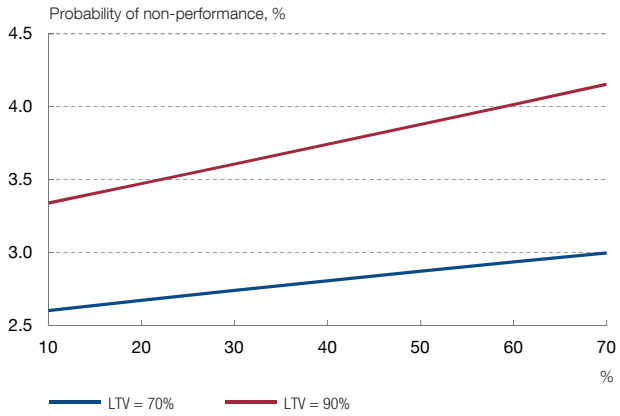
Chart 2

PROBABILITY OF MORTGAGE DEFAULT EVENTS AND RELATIONSHIP TO CREDIT STANDARDS (a)

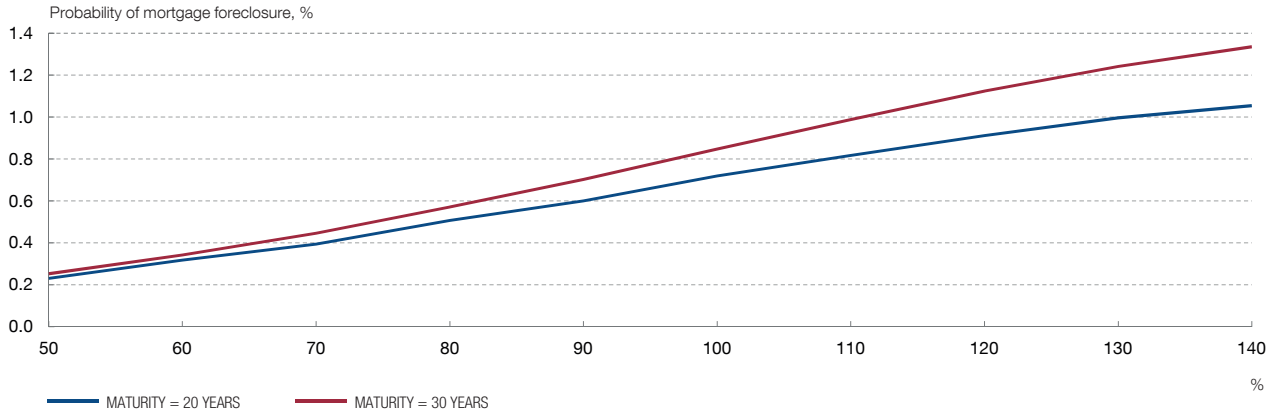
1 LEVERAGE RATIOS AND PROBABILITY OF MORTGAGE FORECLOSURE



2 INTERACTION BETWEEN LSTI AND LTV AND PROBABILITY OF MORTGAGE NON-PERFORMANCE (b)



3 INTERACTION BETWEEN MATURITY AND LTP AND PROBABILITY OF MORTGAGE FORECLOSURE (c)



SOURCE: Galán and Lamas (2019).

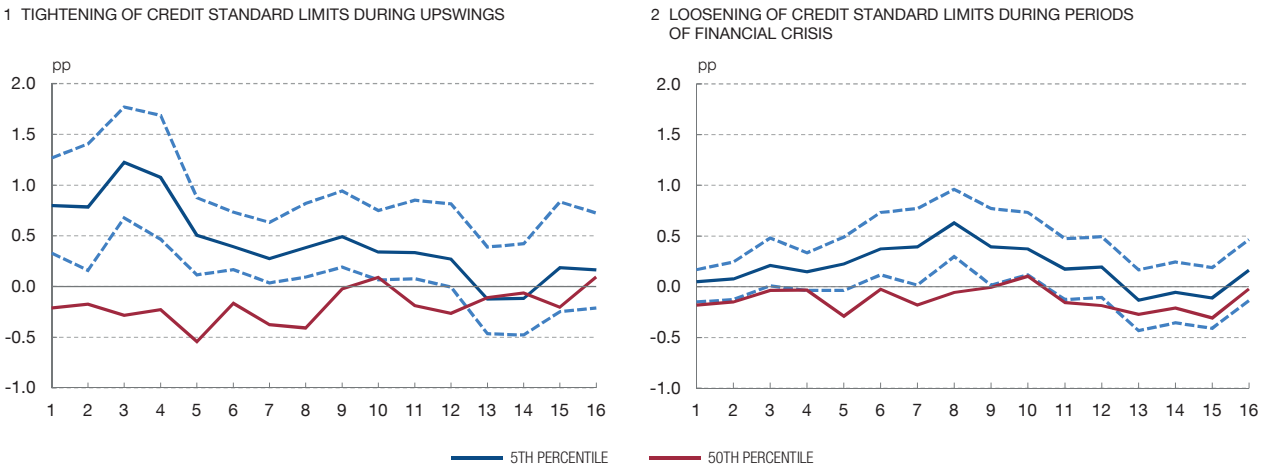
a The probability of a stress event occurring (mortgage foreclosure or non-performance) is estimated for loans with identical characteristics, in which the LTV, LTP, maturity or LST value varies, depending on the chart. Except where the LTV ratio is over 80%, the confidence intervals of these estimates are narrow, and therefore the changes in probability are statistically significant.
b The LSTI ratio is plotted on the horizontal axis.
c The LTP ratio is plotted on the horizontal axis.

risks in the real estate sector. In particular, they find that loans are riskier when all of these ratios are higher and the maturity is longer. Moreover, the analysis of the interactions between these loan characteristics indicates non-linear effects on risk. This suggests the need to combine the various metrics indicated, and to consider the effects in different phases of the financial cycle, for a more consistent analysis of real estate sector risks (see Chart 2).

The estimated effects of setting limits on credit standards in terms of the future GDP growth distribution function (Galán (2020)) likewise suggest that their activation or tightening during normal or expansionary periods would have positive effects for the GDP decline that would arise in the event of a downturn (5th percentile) that exceed

Chart 3

IMPACT OF CREDIT STANDARD LIMITS ON THE 5TH AND 50TH PERCENTILES OF THE GDP GROWTH DISTRIBUTION OVER TIME HORIZONS OF BETWEEN 1 AND 16 QUARTERS (a)



SOURCE: Galán (2020).

a The solid blue and red lines represent the estimated impact on the 5th and 50th percentile of the conditional distribution of GDP growth, respectively. The dotted blue lines represent the confidence band at 95% obtained through bootstrapping.

the estimated adverse impact under normal economic conditions (50th percentile). Unlike in the case of capital tools, the positive impact is identified almost immediately following implementation of the measures and their effects are longer lasting. Also, the effects of deactivating or easing these limits during periods of financial crisis are virtually non-existent (see Chart 3).

3.3 Sectoral concentration limits

There is very little empirical evidence on the impact of sectoral concentration limits, given their scant use in a macroprudential setting and the difficulty in distinguishing the various effects. However, as a sectoral instrument, it seems logical to expect similarities between these effects and those indicated for the SCCyB, but the potential spillover effects to other sectors need to be analysed carefully. Given that concentration is defined as a ratio relative to CET1, it could be equated to a far more demanding capital tool.[6]

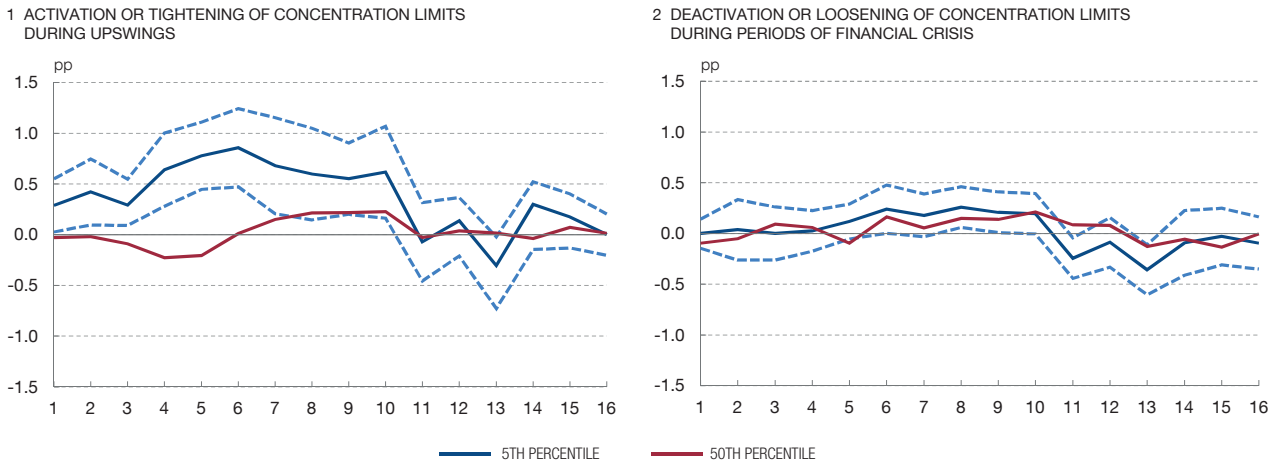
The quantile regression methodology, mentioned in previous sub-sections, can be used to quantify the impact of implementing sectoral concentration tools[7] on

6 Trucharte (2021) also conducts a counterfactual backward-looking exercise based on the last financial crisis to calculate the capital increase that would have been required of banks had the concentration limit been set at average historical levels.

7 These instruments were activated on microprudential rather than macroprudential grounds, and therefore this evidence should be interpreted with caution.

Chart 4

IMPACT OF THE TIGHTENING AND LOOSENING OF CONCENTRATION LIMITS ON THE 5TH AND 50TH PERCENTILES OF THE GDP GROWTH DISTRIBUTION OVER TIME HORIZONS OF BETWEEN 1 AND 16 QUARTERS (a)



SOURCE: Galán (2020).

a The solid blue and red lines represent the estimated impact on the 5th and 50th percentile of the conditional distribution of GDP growth, respectively. The dotted blue lines represent the confidence band at 95% obtained through bootstrapping.

the GDP growth distribution (Galán 2020). As with the CCyB, the results show the activation or tightening of these limits having positive effects on the left-hand tail of the GDP growth distribution (a smaller GDP decline in the event of severe recessions), which outweigh the negative effects on the median distribution (a slight decline in growth in normal times). These effects would be significant immediately after activation and would show strong persistence between one and two years thereafter. Deactivating or loosening the limits on concentration during periods of systemic crisis would have no significant effect on the GDP growth distribution (see Chart 4).

4 A proposal for the practical functioning of macroprudential instruments

As discussed above, designing a framework for macroprudential decision-making is an enormously complex task. In addition to the difficulty of defining and quantifying their objective, the instruments available interact with each other, with other microprudential regulatory requirements and with other macroeconomic and microeconomic policies. Further, little experience has yet been obtained on their functioning and effectiveness, either by those responsible for their application[8] or by theoretical and empirical researchers.

8 European legislation has provided for the application of macroprudential measures since 2014 or 2016 (depending on the tool).

The ideal approach would consist of a process with two distinct phases. In the first phase, the causes (frictions) underlying the emergence and development of systemic risk would be identified. In the second stage, the most appropriate instrument for each case would be selected, using duly calibrated and estimated theoretical and empirical models. Given that this is a very new field, this approach can only be developed over a medium-term horizon. Nonetheless, the experience obtained to date allows for some preliminary reflections, based on a compilation of potential systemic risk situations. Specifically, analysing how these situations would affect banks and determining the channels through which the effects of macroprudential tools are transmitted can provide an indication of the best strategy in each case. Evidently, this exercise must take into account both the spillover effects of activating each specific instrument[9] and the possible leakages that may diminish their effectiveness.[10] The potential distributional effects of each of the tools must also be factored into decisions, since it is very important that the cost of the measures is not borne exclusively by one group or segment.[11] Naturally, this list of situations will never be exhaustive, but it provides a good starting point for drawing up an operational framework. It should also be borne in mind that the situations actually arising may differ considerably from those described here. Therefore, it must be ensured that supervisory authorities are able to make flexible use of the tools available.

4.1 Possible practical application and sequencing of the tools

As commented above, the credit cycle is a central element of the time dimension of systemic risk. High and sustained credit risk growth increases the probability of subsequent systemic financial crises arising (see Martínez-Miera and Suárez (2012)). Consequently, most of the financial system vulnerabilities analysed here are associated with credit developments. However, situations may arise that heighten or mitigate the risks. For instance, if credit growth runs in step with asset revaluation (particularly for real estate property), both the probability of a systemic financial crisis and its effective cost rise significantly.

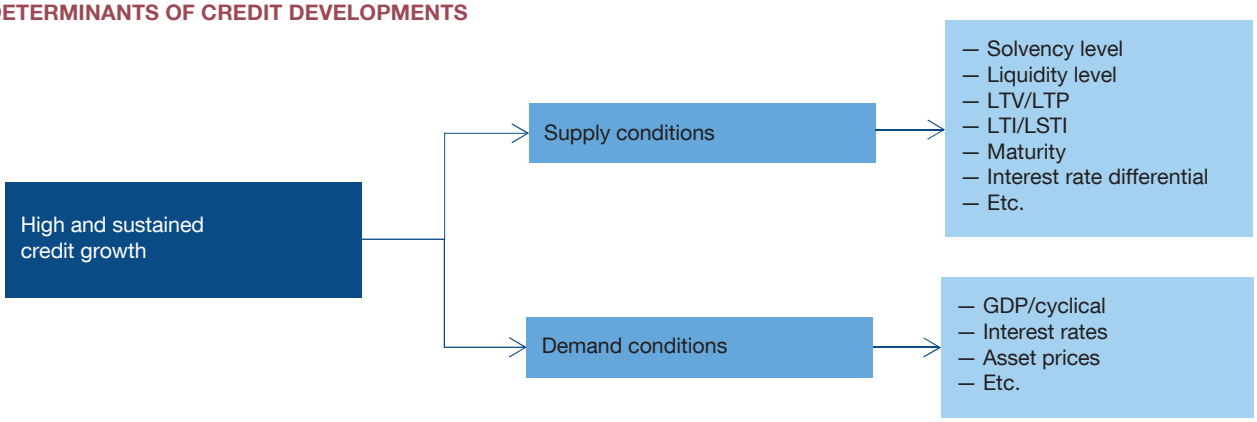
Conversely, as Dell'Ariccia et al. (2016) show, not all credit expansions lead to financial crises, particularly when those expansions are prompted by improved economic fundamentals (demand conditions). Accordingly, developments in credit standards will have to be assessed, since this is a key part of obtaining information

9 For example, Tzur-Ilan (2017) shows that limits imposed on some characteristics of mortgage loans can drive up unsecured consumer lending.

10 Aiyar et al. (2014) found that the Bank of England's heightened capital requirements for supervised institutions in the United Kingdom lowered the credit supply from these banks; however, unsupervised institutions, which were not subject to the increased capital requirements, expanded their supply of credit, offsetting nearly a third of the initial reduction.

11 For further information on banks' capacity to differentially pass-through to customers measures that affect them as a whole, see Jiménez et al. (2020).

Figure 1
DETERMINANTS OF CREDIT DEVELOPMENTS



SOURCE: Banco de España.

on loan supply conditions and borrowers' creditworthiness and ability to pay. Consequently, any high and sustained credit growth that is detected as part of financial cycle analysis should prompt careful study of whether this has been accompanied by an easing of lending standards, since this could determine whether the credit expansion is driven by supply-side or demand-side developments (see Figure 1).

4.1.1 Credit expansion with easing of credit standards

In a situation of easing credit standards, banks or the financial system as a whole endogenously generate an expansionary financial cycle or amplify an existing one. According to the evidence presented in the foregoing section, capital-based macroprudential tools should be applied in the early stages of credit expansion. Further, since this is a cyclical risk, the most suitable tool would be the CCyB[12] (see Figure 2). It should be phased in, at a pace adapted to developments in the financial sector, as envisaged in prudential legislation. Should the cycle stabilise, no additional measures would be required. However, the empirical evidence available also shows that this buffer tempers credit growth only very slightly and therefore, in all probability, the excessive credit growth will persist.[13]

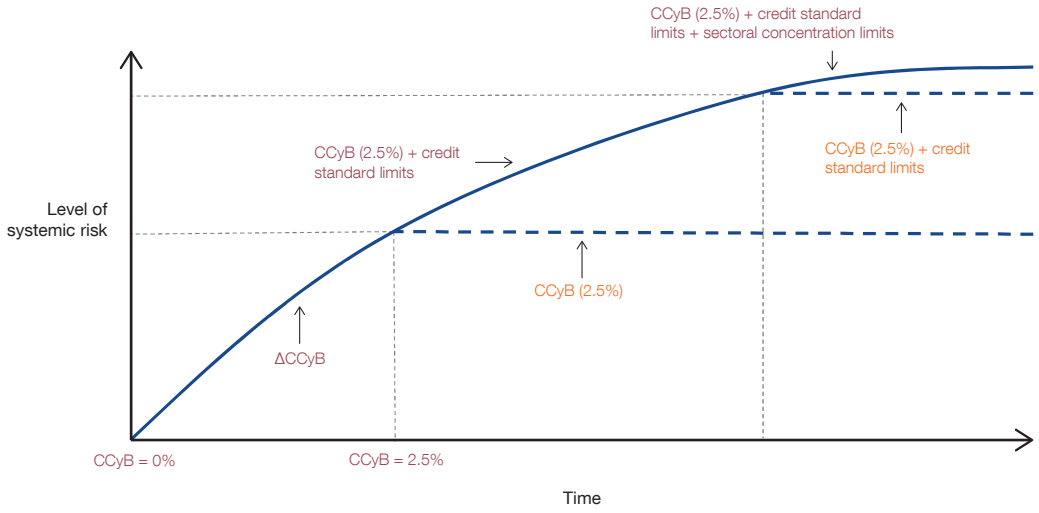
Consequently, if systemic risk build-up continues, borrower-based macroprudential instruments (BBI) would have to be activated. In principle, the decision to restrict one characteristic or another, and how to calibrate the degree of restriction, will depend

12 Assuming credit growth is widespread across portfolios. As discussed below, if the growth were in one or several specific portfolios, the SCCyB would be the more appropriate macroprudential tool.

13 As has been emphasised, part of this tool's effectiveness comes into play when the systemic risk materialises; hence, it must be activated in good time.

Figure 2

SEQUENCE OF ACTIVATION OF MACROPRUDENTIAL TOOLS IN RESPONSE TO A BUILD-UP OF SYSTEMIC RISK ASSOCIATED WITH AN EASING OF CREDIT STANDARDS



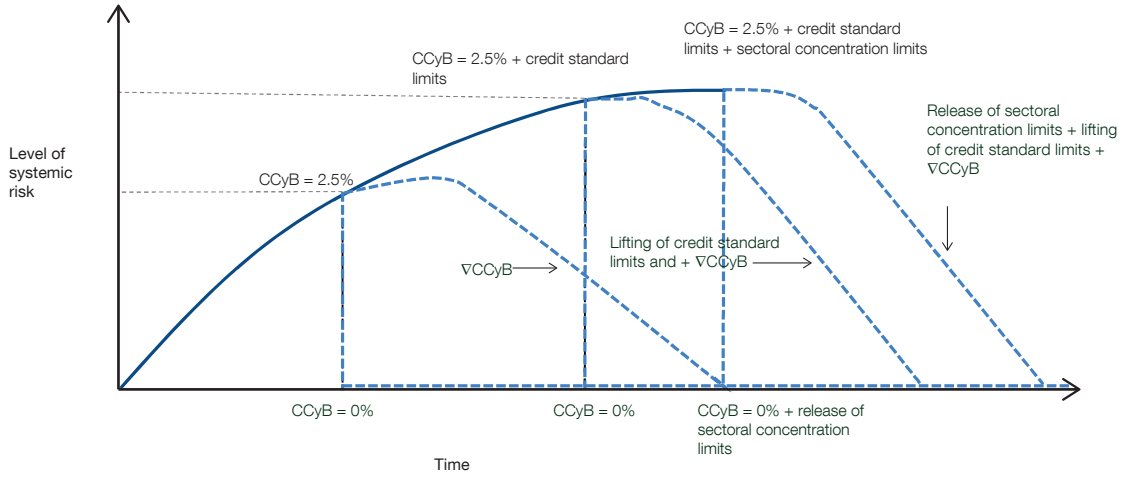
SOURCE: Banco de España.

on which dimension of lending is easing. However, experience appears to show that when just one dimension is limited, others fill the space; therefore, several dimensions will typically have to be acted on simultaneously. Further, there is also some evidence that credit can be transferred from some portfolios to others; for instance, from secured to unsecured credit. Consequently, transaction-side limits may have to be followed up with borrower-based limits. The empirical evidence suggests that, when activated, these tools have a fairly immediate effect on the growth of new lending. However, depending on the average maturity of the portfolios, they may take time to affect the volume of existing credit, which is the magnitude that represents the system's true vulnerability. Therefore, in more exceptional circumstances, particularly when banks are highly leveraged, introducing limits on the sectoral concentration of exposures should also be considered. Logically, in practice this sequencing will depend on the specific analysis of the situation and the course of the systemic risk, which may advise changes both in the order of use and the intensity of the limits.

As Figure 3 shows, the deactivation of these instruments will depend on how the systemic risk develops: it may dissipate progressively or it may materialise and prompt a financial crisis. If the risk dissipates, it seems reasonable to think that the tools should be deactivated in reverse order of their activation. Thus, in the initial phase, if activating the CCyB suffices to control the credit cycle, the additional tools will not have been activated and the buffer may be progressively released. Similarly, if the situation is brought under control after limits have been imposed on lending standards or concentration, these would be deactivated first, followed by gradual

Figure 3

SEQUENCE OF DEACTIVATION OF MACROPRUDENTIAL TOOLS IN RESPONSE TO THE MITIGATION OR MATERIALISATION OF SYSTEMIC RISK ASSOCIATED WITH AN EASING OF CREDIT STANDARDS



SOURCE: Banco de España.

release of the CCyB. If the systemic risk materialises, however, the CCyB should be released immediately and in full, since, on the empirical evidence, this would ease the credit supply constraints and, therefore, the potential decline in GDP. The sectoral concentration limits should also be deactivated immediately. Note that, since concentration is defined in terms of credit volume as a percentage of CET1, this ratio could rise abruptly if the systemic risk materialises. This is because CET1, the denominator of the ratio, will decline as banks absorb losses, forcing them to deleverage if the limit is not deactivated. By contrast, as explained in the previous section, eliminating the limits on loan terms and conditions has little effect on credit or GDP, since banks tend to tighten credit standards in such situations.

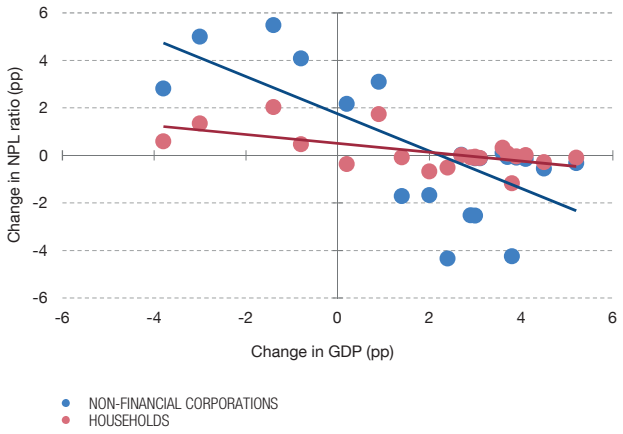
4.1.2 Credit expansion without easing of credit standards

One might be tempted to think that if lending standards remain unchanged, macroprudential tools do not need to be activated. However, deeper analysis can help temper that conclusion. In the event, for example, of an upswing (positive output gap) and agents are accordingly increasing their debt, macroprudential policy could play an important role during the subsequent economic downturn in preventing credit constraints. Indeed, the empirical evidence shows that both households (see, for example, Casado and Villanueva (2018)) and firms (see, for example, Jiménez et al. (2014)) fall into arrears when their income declines significantly and, in the case of individuals, when they become unemployed. This is precisely what happens to a relatively broad set of agents when the economy moves into recession (see Chart 5.1).

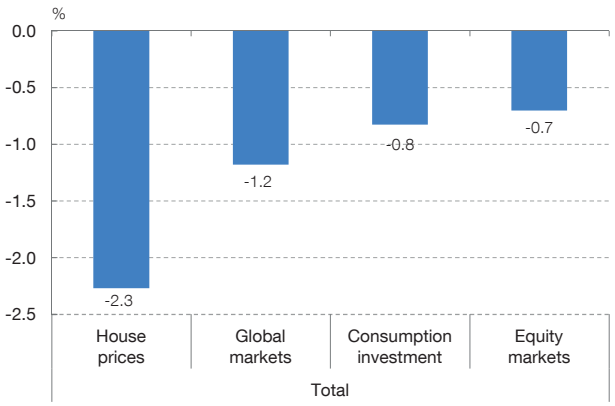
Chart 5

RELATIONSHIP BETWEEN MACROECONOMIC PERFORMANCE, CREDIT QUALITY AND BANKING SECTOR SOLVENCY

1 RELATIONSHIP BETWEEN CHANGE IN THE NPL RATIO AND CHANGE IN GDP



2 SENSITIVITY OF BANK SOLVENCY TO MACROECONOMIC SHOCKS (a)



SOURCE: Banco de España.

a The results are presented in terms of the difference in the CET1 capital ratio (FL) at the end of the analysis horizon in each of the adverse scenarios compared with the level attained under the baseline scenario (coinciding with that designed for the 2018 EU-wide stress tests coordinated by the EBA). Only the scenarios associated with the 1st percentile of the distribution of these four sets of shocks are included. The shocks considered include: (i) impact on international trade; (ii) declining confidence of national economic agents in Spain, with reduced consumption and business investment; (iii) downward adjustments in equity prices, and (iv) house price adjustments. For each of these, shocks are applied in line with historical periods of very high stress (1st percentile of the distribution). The endogenous response of the other Spanish macroeconomic variables is calculated based on the Banco de España's macroeconomic models. For a full analysis of these shocks, see Chapter 2 of Banco de España (2019).

If, when faced with the type of shock that can lead to recession, credit institutions lack a sufficient capital buffer to absorb those losses (see Chart 5.2), they may react by reducing the supply of credit. If several banks are affected, a credit crunch could ensue which would exacerbate the economic recession (see Bentolila, Jansen and Jiménez (2018)).

The optimal macroprudential tool in this circumstance would be countercyclical and be aimed at shoring up the banks' loss-absorbing capacity. The CCyB has precisely these characteristics. On the evidence presented in the foregoing section, building up the buffer during business cycle upturns would have little near-term impact on the credit cycle or GDP. However, its deactivation during economic downturns could help to fend off credit constraints in the economy. If the recession did not ultimately materialise, the buffer could be gradually deactivated. Evidently this strategy is not without risk, since activating the instrument prematurely could slow the post-recession economic recovery, while tardy activation could exacerbate the slowdown. However, on the empirical evidence presented in the above section, it appears preferable to act too early rather than too late.

Note that a similar case could be made in the event of an upswing with a positive output gap but no credit growth. Given that the course of the economic cycle would

lead to a recession down the line, losses would materialise on banks' accounts, although they would be smaller. The recommendation would only differ in that the CCyB activation percentages should be lower. Moreover, in this (and the previous) case, it would seem logical that these percentages should be determined depending on the voluntary buffers that banks have built up, since these buffers, if they are high, could play the same role. Activating the CCyB has the advantage of ensuring that banks retain these resources until the systemic risk materialises and that they are put to macroprudential use, regardless of each bank's individual circumstances and constraints, thus preventing, for example, any stigmatisation effects if just one bank uses them.

Higher credit growth may also have resulted from interest rates standing at very low levels for an extended period of time. Evidently, the lower the interest rates, the greater the demand for credit; however, the so-called credit channel of monetary policy suggests that banks will also expand their balance sheets and, therefore, the supply of credit (Bernanke and Gertler (1995)). There is also empirical and theoretical evidence that banks may react to such situations by taking greater risks (risk-taking channel) (see for example, Jiménez et al. (2014) and Martínez-Miera and Repullo (2017)) Any, not necessarily cyclical, materialisation of these risks could entail losses for the banks. In consequence, an instrument that shores up banks' capital would again be the optimal macroprudential instrument. However, this reduction in nominal interest rates may be more persistent if, for example, it results from a reduction in equilibrium real interest rates. In this case, the systemic risk buffer could be more appropriate. It stands to reason that this instrument should be progressively deactivated when banks' risk-taking begins to moderate, or deactivated entirely if the risks materialise.

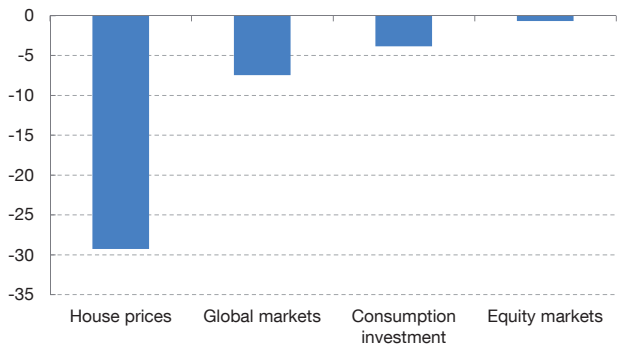
4.1.3 Credit expansion in certain sectors

Credit expansion may also stem from significant increases in collateral valuations (specifically of real estate assets), possibly outstripping their long-run equilibrium value. Indeed, house prices have on occasions been used as an indicator of the financial cycle as an alternative to credit developments (Claessens, Kose and Terrones (2011)). To assess whether macroprudential policy action is needed in this situation, it must be borne in mind that, first, such credit expansions normally run in step with an easing of some lending standards (particularly conditions relating to agents' ability to pay). And second, the empirical evidence shows that the greater the house price overvaluation, the larger the eventual correction in situations of stress (see, for example, Galán and Rodríguez-Moreno (2020)) and, therefore, the greater the potential future losses for banks (see Chart 6). These losses can materialise at banks through both direct and indirect channels. Of the direct channels, probably the most important is when reductions in collateral value force banks to scale up residential mortgage loan provisions; in addition, the value of the foreclosed

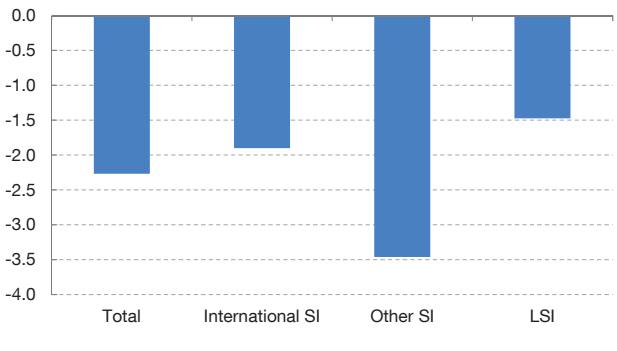
Chart 6

RELATIONSHIP BETWEEN HOUSE PRICES WITH MACROECONOMIC SHOCKS AND BANKING SECTOR SOLVENCY

1 IMPACT OF MACROECONOMIC SHOCKS ON HOUSE PRICE DEVELOPMENTS (a) (c)



2 IMPACT OF SHOCKS IN HOUSE PRICE RATE OF CHANGE ON BANKING SECTOR SEGMENTS (b) (c)



SOURCE: Banco de España.

a For house prices, the impact of applying additional shocks to the variables indicated in the horizontal axis are presented, with respect to the level reached by these under the baseline scenario of the 2018 EBA stress test. For instance, if the shock is applied directly to house prices, their cumulative growth in 2018-2020 is nearly 30 pp less than under the baseline scenario, while a shock to global trade would lead to an adjustment in that same growth of approximately 7 pp. The shocks are calibrated at the 1st percentile of the historical distribution of shocks in house prices, global trade, consumption and investment in Spain and equity prices in Spain.

b For a very severe house price shock (1st percentile of the distribution), the endogenous response of the other Spanish macroeconomic variables is calculated based on the Banco de España's macroeconomic models. For this stressed macroeconomic scenario, the difference is calculated between the CET1 capital ratio (FL) at the end of the 2018-2020 analysis horizon and the level that this ratio would attain under the baseline scenario of the 2018 EU-wide stress tests coordinated by the EBA. The results are shown both for the overall banking sector and for each type of institution: significant institutions (SI), with and without material international activity, and less significant institutions.

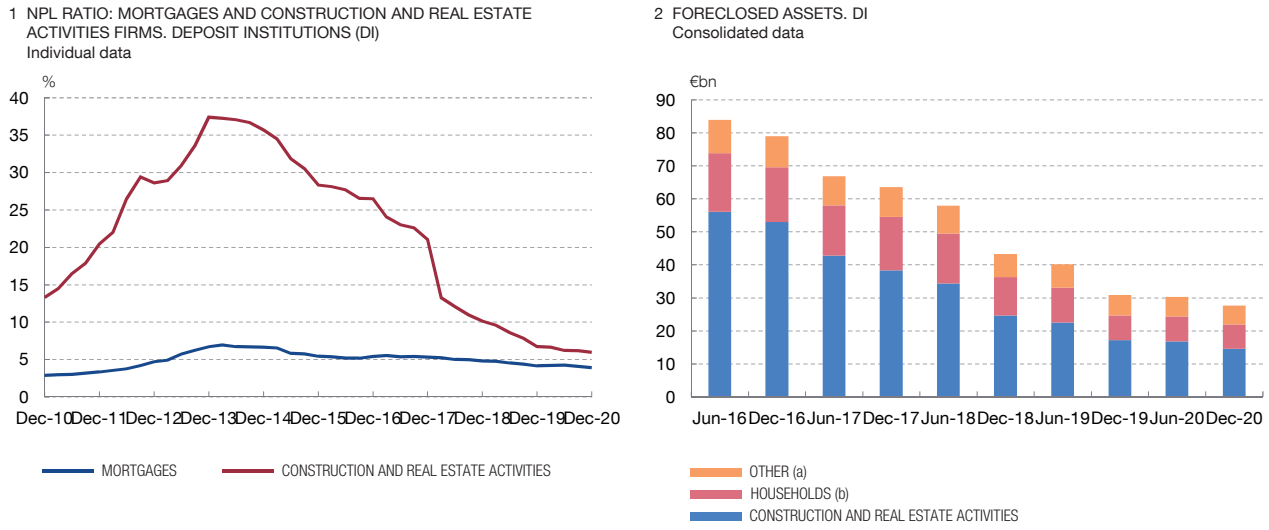
c For a full analysis of these shocks, see Chapter 2 of Banco de España (2019).

properties arising from defaulted mortgage loans will also decline. Among the indirect channels, falling house prices will erode household wealth, which will naturally depress consumption and investment. Likewise, activity in the residential construction sector will decline, having an impact on employment. Further, firms and sole proprietors that obtain financing using housing as collateral could see their credit flow reduced. All of which will have a negative impact on banks' income statements.

Accordingly, it seems advisable for banks to have sufficient capital to absorb these potential losses without affecting the flow of financing to the rest of the economy. This recommendation would stand even if credit were not expanding, although in all likelihood the capital required to absorb the losses would be lower. It seems reasonable to think that the optimal macroprudential instrument in this case would be the CCyB. However, some important caveats, set out below, mean specific analysis of each situation is warranted. Admittedly, this vulnerability is clearly cyclical, does not necessarily affect a specific credit portfolio and can generate losses in credit institutions' business lines. Yet if the credit growth is confined to the mortgage portfolio, the SCCyB for that specific portfolio could be activated prior to activating the general CCyB, with a view to prompting a change in their relative cost prices without affecting the other sectors. If this fails to mitigate the systemic risk,

Chart 7

BANKING SECTOR TROUBLED ASSETS LINKED TO REAL ESTATE EXPOSURES



SOURCE: Banco de España.

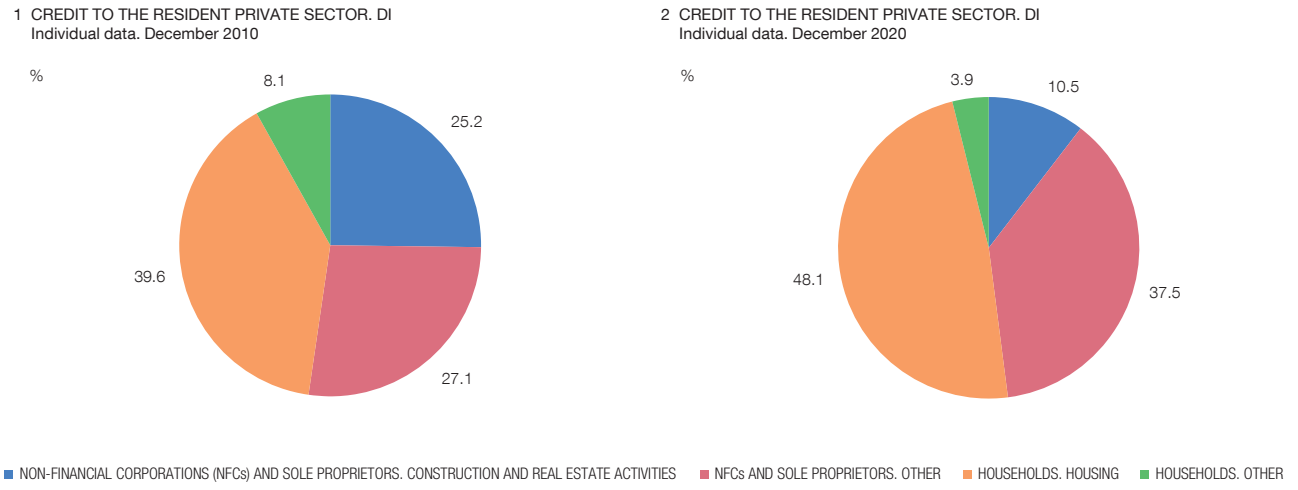
a Includes, primarily, capital instruments, financing for holding entities and other real estate assets foreclosed or received in lieu of payment of debts.
b Arising from loans for house purchase.

consideration should be given to activating the borrower-based macroprudential tools, such as LTV or LTP limits. This would reduce the losses for banks in the event of default. The difficulty with LTV or LTP limits is that they would have to be tightened as the estimated house price overvaluation intensified. This could shift credit towards other portfolios, such as consumer loans, which, besides, tend not to be secured. As a result, other types of instruments, such as LTI/LSTI or DTI/DSTI limits, should be activated to ensure that borrowers have sufficient resources to meet their financial obligations. If this also proves insufficient, limits on the sectoral concentration of exposures would have to be introduced to act directly on the mortgage loan portfolio.

In the particular case of risk concentration in real estate sector portfolios, it is also very important to consider whether this concentration is running in step with activity growth in the sector itself. If so, the activation of macroprudential tools must take into account the housing production processes. It seems reasonable that limits on credit terms and conditions or sectoral concentration should be activated for builders and property developers prior to being activated for households (house purchasers). This would make for more preventive action and would avoid a truncation of the housing production and sale chain that could lead to homes being left unfinished. It should not be forgotten that firms, unlike households, have limited liability and, consequently, their probability of default is far higher (see Chart 7). Moreover, the value of an unfinished home is much lower than that of a finished one.

Chart 8

BANK CREDIT IN SPAIN BY SEGMENT OF THE NON-FINANCIAL PRIVATE SECTOR



SOURCE: Banco de España.

In any event, we must bear in mind that house prices can outstrip their fundamentals for reasons far removed from the macroprudential sphere, such as supply-side constraints or tax aspects, which these tools will not correct. In this connection, He (2014) shows that tax measures can be particularly suitable for modulating house price developments.

Still on the subject of sectoral issues, as with the mortgage portfolio, when one or more credit portfolios begin to present far stronger growth than is warranted by their fundamentals, several distinct elements are worth considering, particularly if restraint is evident in other portfolios (see Chart 8). In these circumstances, it may not be appropriate to use aggregate macroprudential instruments. Indeed, if the portfolio in excessive growth also offers the highest short-term returns (disregarding the risks it is generating), imposing higher costs or restrictions at the aggregate level could divert even more financing towards that portfolio, thus building up greater systemic risk. Accordingly, it would appear far more effective to use sectoral instruments that are able to alter the relative costs of each of the portfolios or to limit those exposures, which would consequently help financing flow towards other credit portfolios (BCBS (2019b)).

However, this crowding-out effect can go too far and the other portfolios must therefore be continuously monitored. Here, the question may arise of how many sectors need to show exuberance for aggregate instruments – which seem the most natural from the macroprudential standpoint – to be introduced. This decision will, of course, depend on the weight of the affected portfolios. In any event, the step from sectoral instruments to aggregate instruments should never entail reducing the intensity of the use of sectoral instruments in the portfolios concerned. Assuming

that the portfolio exuberance is wholly cyclical, i.e. there have been no structural changes in the economy warranting permanent portfolio rebalancing, the sequencing of macroprudential instruments would be the same as when the credit exuberance is aggregate, both in their activation and their deactivation. Put differently, in Figure 3 an initial phase could be envisaged in which the aggregate systemic risk is very low, but in which there is a build-up of risks in one or more sectors for which the SCCyB would be activated prior to the general CCyB. According to the circular pending approval in Spain, the combination of both instruments would allow a capital buffer to be amassed of up to 5 pp if the systemic risk continues to build up.

4.1.4 Credit expansion and overindebtedness

So far, we have analysed situations of high and sustained growth in credit to the non-financial private sector when agents start out with sustainable levels of debt. However, the credit growth cycle may begin when agents are already overindebted. The policy recommendations in this case will necessarily differ. If it is households or non-financial corporations that are overindebted, the priority would be to prevent them from increasing their debt. To this end, the most effective measures would be limits on credit terms and conditions; specifically, establishing LTI/LSTI limits or shortening loan maturities. However, to avoid harming households and firms that are not excessively leveraged, these would need to be combined with limits on DTI/DSTI ratios. This would not obviate the need to activate instruments to shore up banks' capital, since indebtedness and debt burden are two important determinants of financial defaults in general, both for households and firms. However, they could always be activated secondarily. Further, it would have to be determined whether this overindebtedness is persistent, in which case the most appropriate tool would be the systemic risk buffer. The advantage of this buffer is that it can be applied in a sufficiently granular manner so as to act directly on the main source of risk.

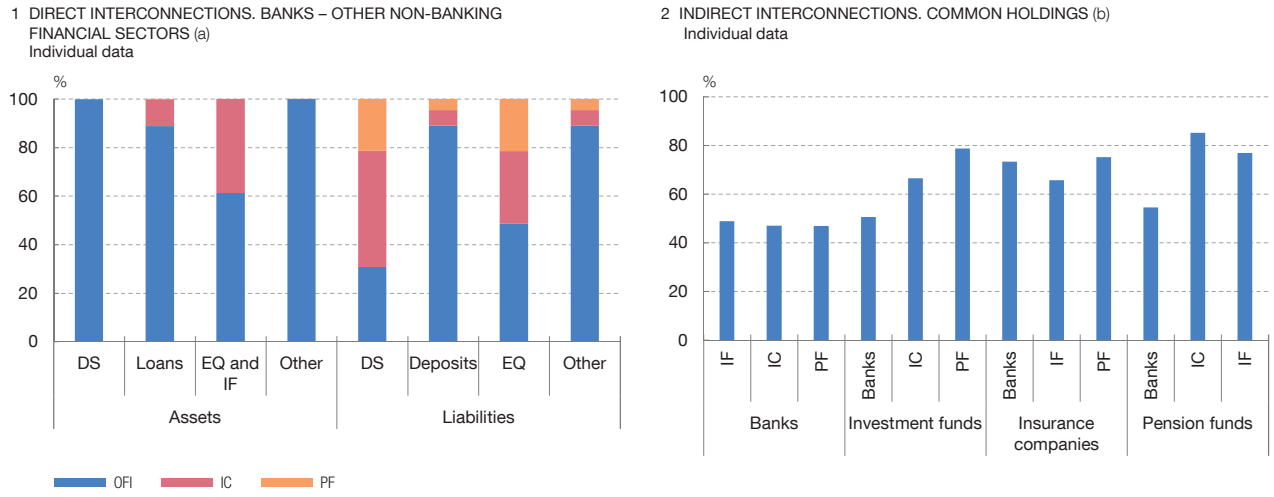
When banks themselves present excessive leverage, the general recommendation is more straightforward: their solvency levels need to be increased. Different instruments could be used, depending on whether the situation is considered cyclical or more persistent. Another aspect that would have to be taken into consideration is which banks are affected: all banks, many small banks, or just a few large banks. If the problem is cyclical, the best option is the CCyB. If the problem is more permanent, the systemic risk buffer should be selected.

4.2 Some further considerations on the cross-sectional dimension of systemic risks

Systemic risk may arise without an increase necessarily occurring in the overall debt of the economy and, in particular, that of the non-financial private sector. As set out

Chart 9

INTERCONNECTIONS BETWEEN TYPES OF INTERMEDIARIES IN THE SPANISH FINANCIAL SYSTEM



SOURCES: Banco de España (Chart 9.1) and Securities Holdings Statistics by Sector (Chart 9.2).

a The stacked bars indicate the share of each instrument relative to the banking sector's total exposure to the corresponding non-banking financial sector. The abbreviations DS, EQ and IF denote debt securities, equity instruments and investment fund units. The other financial institutions (OFI) category includes investment funds, special lending institutions and other financial intermediaries (broker-dealers, securitisation special purpose vehicles, venture capital firms, central counterparties and asset management companies, including Sareb, and other entities). The abbreviations IC and PF denote insurance companies and pension funds.

b The share of common holdings in the marketable securities portfolio of each sector is shown. "Common holdings" means ownership of identical securities issued by the same issuer. The abbreviations IF, IC and PF denote investment funds, insurance companies and pension funds. For example, the common holdings between banks and investment funds represent 49% of the banks' overall securities holdings (first column in the chart) and 51% of the investment funds' overall holdings (fourth column). The market value (or fair value) of the holdings is used.

in the introduction, systemic risk also has a cross-sectional dimension, whose presence, accumulation and development should be mitigated with the appropriate macroprudential instruments.

One such situation may be the outcome of certain banks being systemic in nature, or of their systemicity becoming a fact or increasing. Indeed, difficulties at systemic banks may entail disruptions for the entire financial system and can also be key to bringing about contagion situations (Bluhma and Krahnen (2014)), which have to be mitigated. As previously discussed, there is one regulatory macroprudential instrument that does in fact address this risk: the (global or national) systemically important institution buffer. Accordingly, an appropriate calibration of the buffer reflecting banks' degree of systemicity would be the first line of defence against this risk.[14]

The cross-sectional dimension of systemic risk also comes about when interconnections between institutions go beyond what the framework for systemic banks encompasses. Such interrelatedness can be direct or indirect (see Chart 9)

14 A description of the calculation of these scores can be found in Banco de España (2017).

and, depending on its nature, certain macroprudential instruments may be preferable to others. Aggregate capital instruments may be used (such as the systemic risk buffer) or, in extreme situations, the banking sector's exposure to the rest of the financial system may be quantitatively constrained by the activation of the instrument setting limits on concentration. Logically, the analysis of risks in the rest of the financial system will determine the intensity with which these instruments have to be activated.

To conclude the analysis of the cross-sectional dimension of systemic risk, we should review – albeit briefly – the problems surrounding international interconnections. In a financially globalised world, as at present, the risks or spillover effects of decisions taken by other countries may impact the national economy most significantly, in particular the financial sector. This is all the more important when global banks intermediate a sizeable portion of credit on national territory or, as in Spain's case, when national banks locate a significant portion of their operations in other countries.[15] This is why regular monitoring of these risk factors must continue as part of the ongoing assessment of the micro- and macroprudential measures in place, in order to analyse whether they are proving effective in terms of risk prevention and mitigation.

5 The future challenges for macroprudential policy

The new macroprudential instruments available to the Banco de España complement those already in place, allowing it to address a broad range of financial stability risks that have proven significant in view of past international experience and that of Spain. Despite their different specific objectives, the ultimate aim of all these instruments continues to be to help preserve financial stability, which provides for a positive and sustainable contribution of the financial system to the real economy.

Adding to the challenges proper to the operationalisation of the new instruments, fresh risks and areas of attention for macroprudential policy continue constantly to arise. These must be duly addressed, given their implications for financial stability.

5.1 Lessons on the effective functioning of the instruments during the COVID-19 crisis

The economic crisis triggered by the COVID-19 pandemic is affecting most of the world's financial systems. As a result, it is testing the effectiveness of the regulatory reforms introduced in response to the last financial crisis, including macroprudential

15 The empirical evidence prior to the COVID-19 crisis suggests that the internationalisation model that has characterised Spanish banks, based on the independent management of these subsidiaries, especially in terms of funding and risk analysis, has contributed to restricting the transmission to the rest of the world of the financial conditions of the international banks in the country (Argimón et al. (2018)).

policy. The specific characteristics of this crisis (it is exogenous to the global financial system and, in principle, temporary) have required a swift and forceful response by national and international authorities (including those in the banking regulation area), whose effects should also be analysed.

Admittedly, the full effects and consequences of the COVID-19 crisis have still to be seen and may prove persistent. But some initial and preliminary lessons may be drawn for banking regulation on the basis of the experience to date (Castro and Estrada (2021)). Some of these lessons are particularly relevant for macroprudential policy and may be analysed in due course as part of the assessment exercises covering the effects of the reforms implemented by the pertinent agencies and authorities, bearing in mind the empirical evidence.

As regards macroprudential capital buffers, the COVID-19 crisis has accentuated the advantages of releasable buffers, such as the CCyB, with a view to making them more readily usable by banks at times of stress to absorb losses when these materialise, maintaining the flow of credit to the economy. Further, the crisis has signalled the need for buffers to stand ready to respond to risks, both endogenous and exogenous. Another notable aspect is the importance of the regulatory authorities maintaining regular, active and coordinated communication.

Depending on the empirical evidence gathered, we might also assess whether it is necessary to address some other aspect of the current design of capital buffers. In particular, taking a medium-term view, we might analyse the balance between structural and releasable capital buffers, and whether the latter need be set up even without systemic risk associated with excessive credit growth developing (e.g. in Figure 3 a positive level for releasable buffers might be taken as a starting point). And there is also the possibility of introducing mechanisms that allow the cyclical adjustment of liquidity buffers and that respond to different risk situations.

5.2 The non-bank financial sector: interrelations and regulatory perimeter

Under certain scenarios, an expansionary financial cycle might arise owing to the activity of non-bank financial institutions, or the activation of macroprudential instruments for banks might shift activity towards them, limiting the effectiveness of the measures. If these institutions are directly and significantly interconnected with banks (cross-positions on institutions' balance sheets, either via loans, fixed-income securities, equities or derivatives), tensions may pass through and be amplified via the banking system. Another possibility is the existence of indirect interconnections with non-bank financial institutions (e.g. owing to the similarity between the balance sheets of non-bank financial institutions and those of banks). In that case, the main risk arises from a potential price correction of assets in which there are common positions if events were to materialise triggering discount sales.

In these situations, the first step sees the regulators and supervisors of non-bank financial institutions use the micro- and macroprudential mechanisms and instruments available to them to prevent and mitigate risks at their source. It might moreover be necessary to jointly assess the need for other types of macroprudential measures not geared to specific sectors or institutions, but rather to address systemic risks arising in financial markets and operations (normally associated with procyclical interconnections and effects) in which different types of bank and non-bank financial agents interact.[16] Finally, there might be an assessment of the suitability of the current buffers available to the banking sector, such as the systemic risk buffer, in order to cater for potential residual risks caused by direct and indirect interconnections with the non-bank financial sector, in the event sufficiently material risks were identified that were not already covered by current regulatory requirements.

In any event, the emergence of new actors in financial markets – some motivated by the far-reaching technological changes under way in the sector, as is the case with so-called Bigtech – calls for systematic monitoring and analysis of the effects of the regulatory measures on different sectors and their interrelations (interdependencies, interconnections and possible spillovers), and of the regulatory perimeter of the entire financial system. For the proper functioning of the system, having regard to the different types of activity performed by financial services providers, it is essential to ensure that market participants operate under the principle of regulatory neutrality when they are assuming identical risks.

5.3 New risks with macroprudential implications: new technologies and climate change

In addition to the emergence of new actors in financial markets, the application of new technologies to financial activity is also giving rise to new risks and vulnerabilities. These include those derived from cyber-attacks and from dependence on technological services concentrated in third parties. The pandemic, for its part, has accelerated the digitalisation of certain financial activities and has seen an increase in remote working. That further increases the significance of these risks and the need for appropriate mechanisms to prevent and mitigate them.

Of particular importance for macroprudential policy is the potential of these risks to cause events with a systemic impact, should they materialise (Bank of England (2018) and European Systemic Risk Board (2020b)). That would affect core functions of financial systems, depending, for instance, on amplifying factors (system complexity) or mitigating factors (contingency plans).[17] Given their significance,

16 See, for example, the report by the European Systemic Risk Board (2020a) on the macroprudential use of margins and haircuts in derivatives markets and securities financing transactions.

17 See, for example, Ros (2020).

these factors are already receiving due attention from the pertinent authorities and agencies (see, for example, Basel Committee on Banking Supervision (2018b) and European Banking Authority (2019)). Monitoring of the cross-sectoral transmission of these risks will in any case be necessary here, bearing in mind that many of the connections and possibilities of contagion that are generated may go beyond the banking regulatory perimeter.

Other risks of clear macroprudential significance are those arising from climate change, since by their nature they affect the economy and the financial system as a whole. In this case, the main risk factors are well-known and include: the physical risks that the rise in temperature or extreme weather conditions may cause; the so-called "transition risks", linked to the regulatory and technological changes geared to preventing or mitigating climate change, with a view to creating a more sustainable economy; and the changes in demand (changes in bank customers' behaviour and preferences), prompted by greater environmental awareness.

Given, first, the potential systemic impact of climate change-related risks and, second, the possible contribution of the banking sector to smoothing the transition to a more sustainable economy, in this area macroprudential supervision has a clear role. One specific task involves assessing and quantifying the risks arising from this transition, both for individual banks and for the entire financial system. It will be necessary here to have appropriate data and methodologies, such as the stress tests required of the financial system, which allow the impact of different scenarios to be evaluated. Various initiatives are also under way with regard to climate change and its impact in respect of financial stability. Examples include the Network for Greening the Financial System (NGFS) and the G20 Sustainable Finance Study Group.[18] The BCBS, meantime, has published a report compiling the regulatory and supervisory initiatives adopted by its members in relation to the risks associated with climate change (Basel Committee on Banking Supervision (2020)) and continues to pursue the matter through a high-level group. At the European level, the European Commission, the European Banking Authority and the ECB have set various initiatives in train within their fields of competence.

In short, the Banco de España, as the designated authority for macroprudential policy decision-making in relation to credit institutions, has broadened the range of instruments available to it to fulfil its remit to prevent and mitigate systemic risk. This is a complex task. And a major analytical and research drive will be required in the coming years, given that the subject matter is new to the world stage, if it is to be comprehensively and reliably addressed. Indeed, significant challenges most likely requiring new developments continue to emerge. For the time being, certain scenarios are being considered which, on the basis of the experience at hand, may prove useful for steering discussions.

18 G20 Sustainable Finance Study Group (2018).

REFERENCES

Afanasieff, T. S., F. L. C. A. Carvalho, E. C. de Castro, R. L. P. Coelho and J. Gregório (2015). *Implementing loan-to-value ratios: The case of auto loans in Brazil (2010-11),* Working Papers, no 380, Banco Central do Brasil.

Aiyar, S., C. W. Calomiris and T. Wieladek (2014). "Does Macro-Prudential Regulation Leak? Evidence from a UK Policy Experiment", *Journal of Money, Credit and Banking,* Supplement to vol. 46(1), pp. 181-214.

Aizenman, J., and Y. Jinjarak (2009). "Current account patterns and national real estate markets", *Journal of Urban Economics,* vol. 66(2), pp. 75-89.

Akinci, O., and A. Queralto (2014). *Banks, Capital Flows and Financial Crises,* Board of Governors of the Federal Reserve System, International Finance Discussion Papers no 1121.

Argimón, I., C. Bonner, R. Correa, P. Duijm, J. Frost, J. de Haan, L. de Haan and V. Stevunovs (2018). "Financial Institutions' Business Models and the Global Transmission of Monetary Policy", *Journal of International Money and Finance,* vol. 90(C), pp. 99-117.

Aron, J., and J. Muellbauer (2016). "Modelling and forecasting mortgage delinquency and foreclosure in the UK", *Journal of Urban Economics,* 94, 32-53.

Banco de España (2017). "Identification of Systemic Institutions", Box 3.1, *Financial Stability Report,* May, pp. 65-66.

Banco de España (2019). *Financial Stability Report,* Spring.

Bank of England (2018). "Could a cyber attack cause a systemic impact in the financial sector?", *Quarterly Bulletin,* Topical article, Q4.

Basel Committee on Banking Supervision (2018a). *Towards a sectoral application of the countercyclical capital buffer: A literature review,* Working Paper, 32, March.

Basel Committee on Banking Supervision (2018b). *Implications of fintech developments for banks and bank supervisors,* Sound Practices, February.

Basel Committee on Banking Supervision (2019a). *Guiding principles for the operationalisation of a sectoral countercyclical capital buffer,* November.

Basel Committee on Banking Supervision (2019b). *Towards a sectoral application of the countercyclical capital buffer,* Working Paper, 36, April.

Basel Committee on Banking Supervision (2020). *Climate-related financial risks: a survey on current initiatives,* April.

Basten, C., and C. Koch (2017). *The countercyclical capital buffer,* mimeo.

Bedayo, M., Á. Estrada and J. Saurina (2020). "Bank capital, lending booms, and busts: Evidence from Spain over the last 150 years", *Latin American Journal of Central Banking,* 1.

Bentolila, S., M. Jansen and G. Jiménez (2018). "When credit dries up: Job losses in the great recession», *Journal of the European Economic Association,* vol. 16(3), June, pp. 650-695.

Bernanke, B., and M. Gertler (1995). "Inside the black box: The credit channel of monetary policy transmission", *Journal of Economic Perspectives,* vol. 9, no 4, Fall.

Bluhma, M., and J. P. Krahnen (2014). "Systemic risk in an interconnected banking system with endogenous asset markets", *Journal of Financial Stability,* vol. 13, August, pp. 75-94.

Campbell, J. Y., and J. F. Cocco (2015). "A Model of mortgage default", *The Journal of Finance,* 70, pp. 1495-1554.

Casado, J. M., and E. Villanueva (2018). "Spanish household debt defaults: results of the Spanish Survey of Household Finances (2002-2014)", *Financial Stability Review,* no 35, November, Banco de España.

Castro, C., and Á. Estrada (2021). "Financial stability and banking regulation in the context of the Covid-19: some early policy reflections", *The Euro in 2021 - A Yearbook on the European Monetary Union,* Fundación de Estudios Financieros and Fundación ICO.

Castro, C., Á. Estrada and J. Martínez (2014). "The countercyclical capital buffer in Spain: an exploratory analysis of key guiding indicators", *Financial Stability Review,* November, Banco de España.

Castro C., Á. Estrada and J. Martínez (2016). *The countercyclical capital buffer in Spain: an analysis of key guiding indicators,* Working Papers, no 1601, Banco de España.

Cerutti, E., S. Claessens and L. Laeven (2017). "The use and effectiveness of macroprudential policies: New evidence", *Journal of Financial Stability,* 28, pp. 203-224.

Claessens, S., S. Ghosh and R. Mihet (2013). "Macro-prudential policies to mitigate financial system vulnerabilities", *Journal of International Money and Finance,* 39, pp. 153-185.

Claessens, S., M. A. Kose and M. E. Terrones (2011). *How do business and financial cycles interact?,* IMF Working Paper, WP/11/88.

Crowe, C., G. Dell'Ariccia, D. Igan and P. Rabal (2013). "How to deal with real estate booms: Lessons from country experiences", *Journal of Financial Stability,* 9(3), pp. 300-319.

Dell'Ariccia, G., D. Igan, L. Laeven and H. Tong (2016). "Credit Booms and Macrofinancial Stability", *Economic Policy,* vol. 31(86), pp. 299-355.

Estrada, Á., and J. Mencía (2021). "El cuadro de mandos de la política macroprudencial", *ICE, Revista de Economía,* no 918, January-February.

European Banking Authority (2019). *EBA Guidelines on ICT and security risk management,* Final report, November.

European Central Bank (2009). *Financial Stability Review,* December, pp. 134-142.

European Systemic Risk Board (2020a). *Mitigating the procyclicality of margins and haircuts in derivatives markets and securities financing transactions,* January.

European Systemic Risk Board (2020b). *Systemic cyber risk,* February.

Ferrari, S., M. Pirovano and P. Rovira Kaltwasser (2017). *The impact of sectoral macroprudential capital requirements on mortgage lending: Evidence from the Belgian risk weight add-on,* mimeo.

Freixas, X., L. Laeven and J. L. Peydró (2015). *Systemic risk, crises and macroprudential regulation,* Cambridge, The MIT press.

G20 Sustainable Finance Study Group (2018). *Synthesis Report,* July, G20 Argentina.

Galán, J. (2020). "The benefits are at the tail: uncovering the impact of macroprudential policy on growth-at-risk", *Journal of Financial Stability,* online version.

Galán J., and M. Lamas (2019). *Beyond the LTV ratio: new macroprudential lessons from Spain,* Working Papers, no 1931, Banco de España.

Galán, J., and M. Rodríguez-Moreno (2020). "At-risk measures and financial stability", *Financial Stability Review,* no 39, Autumn, Banco de España.

Hartmann, P. (2015). *Real estate markets and macroprudential policy in Europe,* ECB Working Paper Series, no 1796, May.

He, D. (2014). "The effects of macroprudential policies on housing market risks: evidence from Hong Kong", *Financial Stability Review,* April, Banque de France, pp. 105-120.

Huremovic, K., G. Jiménez, E. Moral-Benito, J. L. Peydró and F. Vega-Redondo (2020). *Production and financial networks in interplay: crisis evidence from supplier-customer and credit registers,* Working Paper, no 1191, Barcelona Graduate School of Economics.

Iyer, R., and J. L. Peydró (2011). "Interbank Contagion at Work: Evidence from a Natural Experiment", *The Review of Financial Studies,* vol. 24(4), pp. 1337-1377.

Janus, T., and D. Riera-Crichton (2016). *Banking Crises, External Crises and Gross Capital Flows,* Working Paper, no 273, Federal Reserve Bank of Dallas.

Jiménez, G., D. Martínez-Miera and J. L. Peydró (2020). *Who truly bears (Bank) taxes? Evidence from only shifting statutory incidence,* Working Papers, no 2040, Banco de España.

Jiménez, G., S. Ongena, J. L. Peydró and J. Saurina (2014). "Hazardous Times for Monetary Policy: What do Twenty-Three Million Bank Loans Say About the Effects of Monetary Policy on Credit Risk-Taking?" *Econometrica,* vol. 82(2), March, pp. 463-505.

Jiménez, G., S. Ongena, J. L. Peydró and J. Saurina (2017). "Macroprudential Policy, Countercyclical Bank Capital Buffers and Credit Supply: Evidence from the Spanish Dynamic Provisioning Experiments", *Journal of Political Economy,* vol. 125(6), pp.2126-2177.

Lane, P. R., and P. McQuade (2014). "Domestic Credit Growth and International Capital Flows", *Scandinavian Journal of Economics,* vol. 116, pp. 218-252.

Martínez-Miera, D., and R. Repullo (2017). "Search for Yield", *Econometrica,* vol. 85(2), March, pp. 351-378.

Martínez-Miera, D., and J. Suárez (2012). *A macroeconomic model of endogenous systemic risk taking,* CEPR Discussion Paper no 9134, September.

Martins, B., and R. Schechtman (2014). *Bank capital requirements and loan pricing: Loan-level evidence from a macro prudential within-sector policy,* mimeo.

Poghosyan, T. (2019). *How effective is macroprudential policy? Evidence from lending restriction measures in EU countries,* IMF working paper, 19/45.

Reinhart, C., and K. Rogoff (2008). "Is the 2007 U.S. subprime crisis so different? An international comparison», *American Economic Review,* Papers and Proceedings, 98(2), pp. 339-344.

Reinhart, C., and K. Rogoff (2009). *This Time Is Different: Eight Centuries of Financial Folly,* Princeton, NJ, Princeton University Press.

Richter, B., M. Schularik and I. Shim (2019). "The Costs of Macroprudential Policy", *Journal of International Economics,* 118, pp. 263-282.

Ros, G. (2020). *The making of a cyber crash: a conceptual model for systemic risk in the financial sector,* ESRB Occasional Paper Series, no 16, May.

Taleb, N. N., and C. Sandis (2014). "The skin in the game heuristic for protection against tail events", *Review of Behavioural Economics,* no 1(1), pp. 115-135.

Tinbergen, J. (1956). *Economic Policy, Principles and design,* Books (Jan Tinbergen), North-Holland.

Trucharte, C. (2021). "Nuevas herramientas macroprudenciales para las entidades de crédito", *ICE, Revista de Economía,* no 918, January-February.

Tzur-Ilan, N. (2017). *The Effect of Credit Constraints on Housing Choices: The Case of LTV limit,* Bank of Israel Discussion Paper 2017/3.

Implications for financial market infrastructures of a wholesale central bank digital currency based on distributed ledger technology

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IMPLICATIONS FOR FINANCIAL MARKET INFRASTRUCTURES OF A WHOLESALE CENTRAL BANK DIGITAL CURRENCY BASED ON DISTRIBUTED LEDGER TECHNOLOGY

Abstract

An ongoing debate is raging about the possible issuance of a sovereign digital currency by national central banks. This article focuses on one part of this debate, specifically the impact that the issuance of a wholesale central bank digital currency based on distributed ledger technology (DLT)[1] could have on financial market infrastructures (FMIs). A sovereign digital currency issued within the network could harness the potential of DLT as an exchange mechanism that, by its very design, mitigates liquidity and credit risks. The article identifies the main areas where this would affect the existing FMIs, classified according to the potential significance of this impact compared with the services these infrastructures currently provide, to allow them to offer enhanced services that would be difficult to achieve with present technology.

1 Introduction

The debate on the advisability of the issuance of a digital currency by national central banks, generally known as a sovereign or central bank digital currency (CBDC) has recently intensified. This is a broad debate that covers the issuance both of a retail and a wholesale central bank digital currency. Issuance of a retail CBDC, as a supplement to cash and deposits, and accessible to all kinds of users, poses a huge challenge for national central banks. They would face a complex process, with a high number of potential users and a multitude of aspects and implications across a broad range of spheres. In addition, to assess a retail CBDC issuance it is essential to consider the specific characteristics of each region and their cash use patterns (to date, in most countries, the only way that individuals have access to central bank money). In this respect, the Eurosystem has begun to study the possibility of issuing a digital euro,[2] as part of its commitment to supply the public with a risk-free means of payment that meets their needs.

This debate also encompasses the possible issuance of a wholesale central bank digital currency (WCBDC), confined to a limited group of financial counterparties. This is a more limited debate: it may share some aspects, such as the technology issues, but it is less complex and has more limited implications. Indeed, there are

1 A database of which there are multiple identical copies distributed among several participants and which are updated in a synchronised manner by consensus of the parties.

2 ECB (2020c).

currently numerous digital currency initiatives developing, and many of the parties concerned are wondering what role central banks should play in these developments.

The potential issuance of a WCBDC would have implications for the direct competences of the Eurosystem, in terms of its responsibility for monetary policy, for the purposes of supervision of financial institutions and, lastly and possibly most directly, as regards its responsibility for promoting the smooth operation of payment systems.[3] This analysis aims to identify precisely those aspects of a WCBDC that would affect the existing FMIs and, therefore, concentrates on this third competence. It is important to note, in this respect, that FMIs are constantly evolving, on account of developments in technology that entail efficiency gains for these infrastructures.

Recently, some new private initiatives aim to offer wholesale means of payment based on tokens, that is, units of value issued and backed by private institutions (wholesale stablecoins),[4] as opposed to other projects that have public sector backing. In this respect, the European Commission's legislative initiative to create a pilot regime for FMIs based on DLT, as part of the Digital Finance Package,[5] deserves a special mention. This initiative expressly advises that – whenever possible within the DLT infrastructures – payments should be made in central bank money (potentially a WCBDC).

When we refer to the issuance of a new WCBDC, it is important to note that bank reserves held at central banks already constitute a form of WCBDC.[6] Moreover, TARGET[7] services already operate electronically with this wholesale central bank currency. Accordingly, this article seeks to analyse the specific case of issuance of a WCBDC within a DLT network. Distributed technology is certainly not a necessary condition for the existence of a WCBDC, but the combination would offer a series of advantages that would be difficult to achieve with FMIs' current technology. Wholesale interbank transactions are a use case that would allow all the potential of distributed technology to be harnessed, to operate a network of participants with different interests but which share information. In addition, a WCBDC issued directly within the distributed network seems to be the most appropriate solution for exchanges inside the network, as it would provide a perfectly liquid and credit risk-free payment solution (the CBDC represents a claim on a central bank deposit and is, therefore, a risk-free asset).

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3 One of the Banco de España's functions is to promote the smooth operation and stability of the financial system and, specifically, of the payment systems (including TARGET2).

4 Digital assets designed to minimise their price volatility relative to a "stable" asset or basket of assets, maintaining price stability. They may be collateralised (backed by legal tender or other cryptocurrencies to ensure their stability) or algorithmic (based on algorithms and smart contracts that administer the supply of the tokens issued to ensure their stability). See Arner et al. (2020).

5 https://ec.europa.eu/info/publications/200924-digital-finance-proposals_en.

6 A centralised WCBDC based on entries in accounts open at the central bank.

7 Trans-European Automated Real-time Gross settlement Express Transfer system (see Annex).

In general, having all the necessary instruments to carry out exchanges within a single network or platform – i.e. end-to-end transactions – provides added value to any infrastructure. To perform this kind of end-to-end transactions within a DLT network, all participants must have access to a liquid and safe asset with which to settle transactions. This does not mean that it is technically impossible to deploy an alternative without a WCBDC issued within the network;[8] in that case, clearing and settlement would be carried out through the distributed network, but there would have to be an external link, as these settlements would be backed by funds held in a fiduciary account open in the conventional infrastructure. This option is, a priori, more complex and is not credit risk-free, whereas credit risk is mitigated if the WCBDC is issued within the network. In addition, a WCBDC mitigates the potential liquidity risk present in the private initiatives in the event of a possible unexpected surge in demand.

2 Role of the Eurosystem's existing FMIs

A financial market infrastructure is a multilateral system among participating institutions, including the operator of the system, used for the purposes of clearing, settling or recording payments, securities, derivatives or other financial transactions.[9] The Eurosystem is the monetary authority of the euro area, comprising the European Central Bank (ECB) and the national central banks of the Member States whose currency is the euro. Its primary objective is to maintain price stability. Within the Eurosystem, the TARGET services play a key role. Developed and managed by the Eurosystem, they ensure the free flow of cash, securities and collateral across Europe. All these transactions are settled – finally and irrevocably – in central bank money. The TARGET services comprise: TARGET2 (the real-time gross settlement (RTGS) system), TARGET2-Securities (the securities settlement platform) and TIPS (the instant payment settlement service).

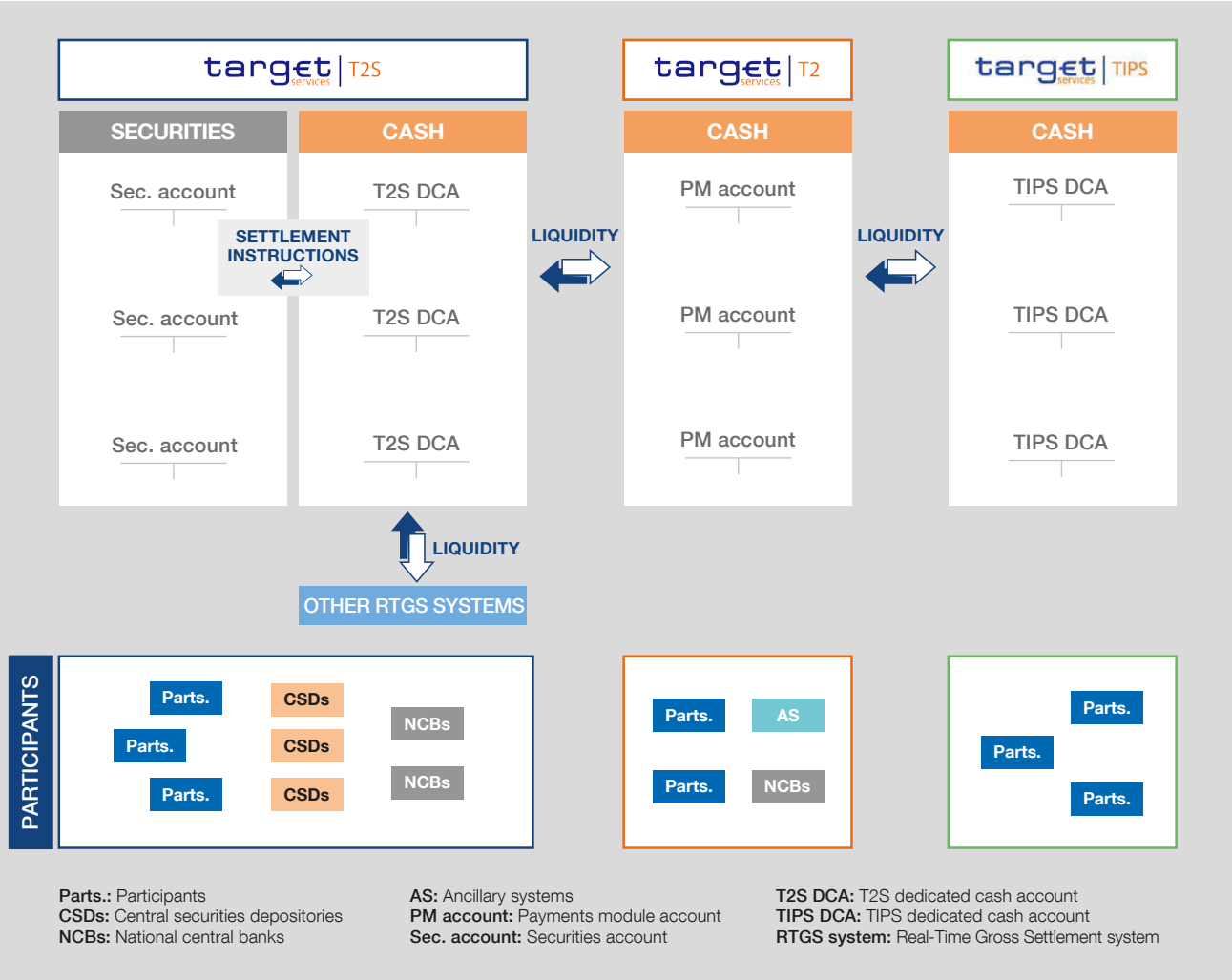
TARGET2 is a payment system managed by the Eurosystem that allows for the exchange of transactions between the participating financial institutions. It is a single shared platform (SSP) that offers the same level of service to all participants. From a legal standpoint, TARGET2 comprises the different national components of the euro area countries (or of other European Union countries whose central banks have decided to join the system). Thus, TARGET2-BE is a payment system managed by the Banco de España[10] and the Spanish component of the TARGET2 large-value payment system in euro. In general terms, transactions are settled one-by-one (gross) and in real time, i.e. as soon as they enter the system. If there are queued

8 Project Helvetia.

9 Committee on Payment and Settlement Systems and Technical Committee of the International Organization of Securities Commissions (2012).

10 Article 8 of Law 41/1999 of 12 November 1999 on payment and securities settlement systems (Spanish version only).

Figure 1
TARGET SERVICES AND PARTICIPANTS



SOURCE: Devised by authors.

transactions owing to a lack of funds, the system activates certain liquidity optimisation routines that allow them to be netted, thus settling transactions that would otherwise have remained in the queue awaiting funds. The platform permits execution of euro area monetary policy and processes both interbank and customer transactions (generally large-value transactions) through the cash accounts opened by the participating institutions.

TARGET2-Securities (T2S) is a pan-European single platform, owned by the Eurosystem, which provides for centralised settlement in central bank money of securities transactions in euro or in other currencies (multi-currency settlement). By grouping securities accounts and cash accounts together on one platform, it is able to provide an integrated, neutral and borderless settlement service. T2S offers central securities depositories (CSDs) a shared, technical solution for settlement of securities transactions. The CSDs maintain their business and contractual relations

with their participants and continue to provide securities custody and administration services (such as managing corporate actions), as well as other added-value services. T2S offers real-time gross settlement of securities (for delivery free of payment and delivery versus payment), together with night-time batch settlement, using sophisticated algorithms. It also includes various optimisation routines, which are used to improve system liquidity and increase settlement efficiency (auto-collateralisation, prioritisation and partial settlement of instructions, settlement algorithms, optimisation and recycling of unmatched transactions, en bloc settlement instruction chains, etc.), and the domain responsible for liquidity management in the dedicated cash accounts.

TARGET Instant Payment Settlement (TIPS)[11] is a Eurosystem service that enables payment service providers to offer instant credit transfers in the retail sphere around the clock. TIPS was developed as an extension of TARGET2 and has been used to settle payments in central bank money since November 2018. At present, TIPS only settles payments in euro, but as from May 2022 it will start to settle instant payments in Swedish kronor.

The Eurosystem participates in a series of initiatives that primarily seek to promote efficiency and innovation and, ultimately, to achieve greater integration of Europe's financial markets. Consistent with this strategy, the Eurosystem is investigating ways to improve its FMIs, to allow them to continue to meet market needs, anticipate cybersecurity challenges and keep up to date with advances in technology.

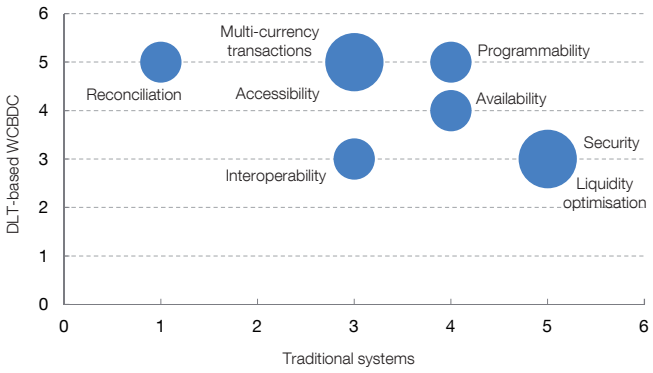
In addition to these services, other projects are being developed. T2-T2S consolidation is a project to replace TARGET2 with a new real-time gross settlement system to enhance optimised liquidity management across all TARGET services. The Eurosystem Collateral Management System (ECMS) will be a single, standardised and harmonised system to manage assets used as collateral in Eurosystem credit operations.

3 Possible improvements within existing FMIs

Among the possible improvements, introducing a WCBDC issued within a DLT network entails a different framework which could potentially optimise the services offered by existing FMIs. Below we analyse the implications that such issuance could have, taking as reference the systems described in the previous section. The aspects identified are classified according to their greater or lesser potential impact for today's payment and securities settlement systems. The aim is to determine whether such a change is essential in order for certain improvements to be achieved (i.e. they would be difficult to achieve at the existing FMIs), or whether, on the

11 https://www.ecb.europa.eu/paym/target/tips/html/index.en.html.

Chart 1
AREAS OF IMPACT IDENTIFIED



SOURCE: Devised by authors.

contrary, these are areas where the existing FMIs already offer satisfactory services, or have sufficient potential to do so.

i) **Reconciliation of transactions** entails a high cost for institutions, both in terms of time and resources. Currently, external data sources must be used which are managed on a centralised basis and must be integrated into the institutions' own systems in order to make the reconciliation. DLT networks can simplify these processes,[12] since as they operate with a single database shared by all the participants, the data used will be complete, real-time and identical. This means that **reconciliation would be more efficient,** to the point that it may be made in real time or may even become unnecessary.[13] In any event, although issuing a WCBDC within a DLT network could accelerate the innovation process, integration processes with institutions' internal systems would be required.

   Complementary technologies, such as artificial intelligence (AI), may also contribute to achieving large-scale efficiency gains for automation of reconciliation processes in the existing systems.[14] These technologies are compatible with – but not exclusive to – DLT networks.

12 World Bank Group (2017)

13 Project Ubin Phase 3. See Deloitte 2018.

14 At present, FMI participating institutions' data management systems must include reconciliation rules for all the data on account statements and entries in accounts that are sent from a centralised platform. Using AI-based IT solutions and algorithms based on historical data patterns, these reconciliation processes could be fully automated.

ii) Efficiency, transparency and traceability gains for multi-currency international transactions[15] is precisely the area where most initiatives have emerged in recent years, both in the private sphere and involving central banks and authorities. Multi-currency international transactions have traditionally been manual processes, involving high costs and difficulties to trace the transactions and to ascertain their exact amount and the actual date of availability of funds at destination. These initiatives[16] have demonstrated the technical viability of DLT networks for such transactions, and also their ability to improve the user experience, speed up the transactions, reduce their complexity and their cost and enhance their transparency.[17] DLT networks would also improve data integrity and allow for the transaction status to be known in real time.[18] Lastly, they would represent an opportunity to lower the counterparty risk, as transactions could be settled directly in central bank money, and also to lower cross-border transaction costs. Accordingly, in general, the **potential issuance of a WCBDC integrated into a DLT network could enhance the efficiency, transparency and traceability of multi-currency transactions.**

iii) Regarding the number of direct participants in the TARGET services, aside from the regulatory and strategic considerations, there is currently a barrier to entry given the access requirements and the high connection costs that only banks with a high volume of activity can assume. **A decentralised platform could lower these barriers and enable direct access to settlement services to a larger number of participants.** This would make it possible to lower the "tiering",[19] or in other words, to reduce the number of indirect participants that settle through direct participants (which are institutions that hold a payments module account, a T2S dedicated cash account or a TIPS dedicated cash account[20] with a Eurosystem central bank).[21] This could mitigate the associated risks

15 CLS (Continuous Linked Settlement) is currently the world leader in multi-currency transaction settlement. It provides a payment versus payment (PvP) settlement service, thus mitigating settlement risk, and optimises the use of liquidity by means of a multilateral position netting system. However, it has certain limitations, in that transactions are only settled within a two-hour window and there is a window of only five hours for allocation of funds, both very distant from availability 24/7.

16 Among others, Project Inthanon-LionRock, launched by the Hong Kong Monetary Authority and the Bank of Thailand. See Bank of Thailand and Hong Kong Monetary Authority (2020).

17 Project Jasper Phases 1 and 2. See Payments Canada, Bank of Canada and R3 (2017).

18 Project Ubin Phase 1. See Deloitte (2017).

19 In a payment system, "tiering" refers to the proportion of institutions that participate indirectly in the system through access to accounts held by direct system participants, which offer settlement services. Tiering is limited in TARGET2 and amounts to around 6% in terms of value and 21% in terms of volume.

20 The following may be direct participants in TARGET2: credit institutions established in the European Union or the European Economic Area (EEA), including when they act through a branch established in the European Union or the EEA; credit institutions established outside the EEA, provided they act through a branch established in the European Union or the EEA; and the ECB and the national central banks of the EU Member States.

21 Guideline of the European Central Bank of 5 December 2012 on a Trans-European Automated Real-time Gross settlement Express Transfer system (TARGET2).

(credit, liquidity, operational and legal risk) both for the direct and the indirect participants.

iv) In large-value payments, most traffic is channelled through real-time gross settlement (RTGS) systems. These are generally specialised electronic fund transfer systems that transfer money and securities from one bank to another in real time (i.e. there is no waiting period, with transactions being settled as soon as they are processed) and on a gross basis (i.e. they are processed one-to-one, with no need for prior netting). Once processed, payments are final and irrevocable. However, these systems have limitations as regards to availability, largely imposed by technical restrictions. There are indications of a possible shift in traffic in large-value payments from these systems to instant payment platforms,[22] which provide for transfers of funds between users in real time, around the clock. In the not-too-distant future, the need for availability 24/7 could extend to all other settlement platforms.[23]

By integrating a WCBDC into a DLT network, RTGS systems could operate 24/7. These are highly resilient infrastructures that do not depend on a single validating authority. In addition, as they are decentralised,[24] maintenance tasks being performed on one part of the network would not halt operations on the rest of the network. Although there are operational hurdles to achieving availability 24/7 with existing technology, it would certainly be possible to increase the present level of availability. However, it is important to note that some TARGET service users have reported technical limitations on their ability to further increase availability. This casts **doubt over the real need to extend the availability of these services in the wholesale sphere.**

v) **Interoperability between wholesale payment and securities settlement systems** in the different economic areas worldwide is possibly one aspect where there is most room for improvement. However, this is not necessarily owing to technology-related reasons,[25] but may be for

22 This is already happening in the Netherlands, where credit institutions used to use an application to direct critical customer payments to TARGET2. Many of them no longer do so, and now direct such payments towards instant payment solutions. This has not yet happened in Spain, although it is true that as a result of the pandemic, the fall in the volume of customer payments is above the EU average.

23 In addition to availability, there are other factors that make instant payments more convenient: substantially lower costs than for T2 transfers, the increased limit for instant transfers (the SCT Inst scheme) that may encourage inter-company payments, real-time payments to customers, flexibility for making payments outside regular working hours and an improved user experience.

24 Although in the case of a wholesale system, there would be fewer participants than in a retail system.

25 Some of the technology-related reasons are: the use of different technical standards, differences in the development and implementation of APIs, the existence of legacy IT systems that cannot be easily adapted to the new requirements, and limited operating hours. An ongoing international initiative led by the FSB with the participation of the CPMI seeks to improve cross-border payments; see Committee on Payments and Market Infrastructures (2020).

strategic or cost-benefit reasons. In consequence, the volumes currently settled through multi-currency interoperable systems are quite low. Issuing a WCBDC integrated into a DLT platform could be an appropriate way to address some of these aspects, as the experience of central banks and authorities has shown, both in terms of connecting DLT systems with centralised systems and interconnecting different DLT platforms.[26]

As to the possibility of connecting different **securities settlement platforms to RTGS systems,** the conceptual analysis and experiments carried out[27] have shown that delivery versus payment (DvP) securities settlement is possible between different DLT platforms and even through connections with centralised platforms.[28] Indeed, in Europe, there is already an interconnection between RTGS systems (e.g. TARGET2 and Kronos2[29]) and a securities settlement platform (TARGET2-Securities).

Securities settlement services on the TARGET platform are currently connected to two RTGS systems,[30] and connections to a larger number of infrastructures would be technically possible. The securities are held and administered by Central Securities Depositories (CSDs), which perform this service on behalf of others by providing or holding securities accounts. In the case of transactions settled between participants of different CSDs (inter-CSD settlements), these services have evolved, with the integration of the national securities settlement services in Europe into a single infrastructure. As a result, securities settlement at the pan-European level is harmonised and simple, with a significant cut in costs and in central bank money. The TARGET services also permit settlement of transactions of external CSDs, that is, CSDs that are not direct platform participants,[31] even if there is no direct connection with other securities settlement platforms.

Accordingly, in general **the introduction of a WCBDC, either alone or as part of a DLT network, would not per se resolve the problem of international interconnectivity.** There are, however, other alternatives that could be studied in this respect.[32]

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26 Project Ubin Phase 4. See Accenture (2019).

27 Project Stella, an ECB/BOJ joint research project.

28 Project Stella Phase 3. See ECB and Bank of Japan (2018 and 2020).

29 Danmarks Nationalbank's real-time gross settlement system for payments in Danish kroner and collateral management system.

30 TARGET2 and Kronos2.

31 For this purpose, a T2S participating CSD must register the external CSD as its participant and configure the necessary statistical data (i.e. links and the corresponding accounts). T2S thus provides the tools for interoperability between different securities settlement systems worldwide, even if the platforms are not directly interconnected.

32 There are some examples of system interconnectivity with no need for a WCBDC or for DLT technology, for instance, in the European sphere, the technical interconnection between RTGS systems (e.g. TARGET2 and

vi) Recently, discussions abound on the different applications of programmable money, and how this could enhance the efficiency of the institutions connected to FMIs (contributing to complete automatic processing of transactions), to make payment systems more efficient. If this were introduced into a distributed network, it would grant access, through the use of smart contracts, to automatic execution of operations such as payment of interest. Essentially, these contracts are based on an IT protocol that automatically verifies and executes the underlying agreement, with no need for intermediaries. Although this level of **programmability** does not exist in today's RTGS systems, in general terms **automatic execution of operations could be achieved using other technologies,** specifically an application programming interface (API)[33] that connects external participants to the system. This could, however, entail greater exposure to these participants.[34]

vii) Regarding **liquidity optimisation routines,** although some conceptual tests and experiments using DLT networks in which central banks and authorities have participated have shown that they are technically viable,[35] they are not new, as the TARGET services have used such routines for years.[36] As for execution times at the existing FMIs,[37] there may be room for improvement, but there appears to be no urgent need to reduce these times for the services they currently provide. In consequence, **it seems that neither liquidity optimisation routines nor a possible improvement in execution times are determinant in the case for issuance of a WCBDC on a DLT platform.**

viii) **As regards the security, resilience and integrity of the FMIs, the TARGET services currently enjoy a high level of security.** The large

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Kronos2) and a securities settlement platform (TARGET2-Securities). In addition, in May 2022 the Swedish instant payment settlement service (RIX-INST) is expected to be connected to the TIPS platform for the settlement of instant payments in Swedish kronor, and a project for instant settlement of multi-currency (EUR-SEK) payments is at the research stage. Lastly, the euroSIC system processes all cross-border payments in euro from/to Switzerland, channelled through the Swiss Euro Clearing Bank, which acts as a link between the Swiss RTGS system and TARGET2.

One example outside Europe is the East African Payment System (EAPS), which connects the RTGS systems of Kenya, Uganda, Tanzania, Rwanda and Burundi. In this system, each national central bank holds an account at the other central banks and payments are settled in the local currencies of the participating countries.

33 A set of definitions and protocols used to develop and integrate software from different applications.

34 The "trigger solution", which would allow the settlement of smart contract-based transactions to be integrated into conventional payment systems, as in the case of TARGET2. See Deutsche Bundesbank (2020).

35 More specifically, Project Ubin Phase 2, in which the Monetary Authority of Singapore and 11 financial institutions have demonstrated that it is possible to implement measures of this kind in different types of DLT networks to perform RTGS functions. See Accenture (2017).

36 In addition, various initiatives are under way to design more advanced mathematical models to formulate algorithms that may be applied to the existing FMIs. In the case of securities settlement, T2S has a broad range of tools to optimise liquidity and securities settlement: auto-collateralisation, advanced settlement algorithms, optimisation and recycling of unmatched transactions, partial settlement of transactions and prioritisation of instructions.

37 See Annex.

volume of investment in this sphere[38] is acting as a major boost to security and to alignment with the stricter standards required to date. However, business continuity and contingency mechanisms in centralised systems require high investment and entail high maintenance costs.

Despite the numerous conceptual tests and experiments carried out, there are no published details on the cost that a DLT infrastructure of the size of the existing FMIs would entail, and no production-level experience that allows us to assess the investment required. In consequence, although DLT networks are intrinsically highly resilient – decentralised database technology which thus eliminates the risk of the single point of compromise – to date this does not appear sufficient, from a security standpoint, to warrant either a radical change in technology in the TARGET services, or the issuance of a WCBDC associated with that technology.

4 Final considerations

An overall analysis of the different areas that would be affected by the potential issuance of a WCBDC as part of a DLT network reveals that the gains identified do not, a priori, appear to warrant such a substantial change in FMIs in the short term. Especially considering that these infrastructures are currently undergoing changes, with a view to making gains in terms of innovation, efficiency and cyber resilience.

The proliferation of private initiatives and the interest shown in some jurisdictions could be a result of strategic positioning in light of the technological revolution in which we are immersed. However, it is difficult to imagine there will be a radical change in technology. Rather, we foresee a scenario in which the FMIs will gradually evolve, incorporating new functionalities and offering new possibilities to their participants, adopting solutions based on new technologies such as the DLT networks and with APIs playing a key role. In consequence, the Eurosystem as a whole should anticipate and lead the changes in payment systems, without losing sight of the private initiatives that have emerged and of the importance of time-to-market.

38 Cyber security enhancements: software integrity (recovery), data integrity (recovery), security testing (TIBER-EU, penetration testing) and security services (Security Operations Center, Incident Detection and Response).

REFERENCES

Accenture (2017). *Project Ubin Phase 2. Re-imagining Interbank Real-Time Gross Settlement System Using Distributed Ledger Technologies*, November.

Accenture (2019). *Jasper-Ubin Design Paper. Enabling Cross-Border High Value Transfer Using Distributed Ledger Technologies*.

Advisory Group on Market Infrastructures for Securities and Collateral (2017). *The potential impact of DLTs on securities post-trading harmonisation and on the wider EU financial market integration*, ECB, September.

Arner, D., R. Auer and J. Frost (2020). "Stablecoins: risks, potential and regulation", *Financial Stability Review,* Issue 39, Banco de España.

Auer, R., G. Cornelli and J. Frost (2020). "Rise of the central bank digital currencies: drivers, approaches and technologies", *Working Papers* No 880, BIS.

Ayuso. J. and C. Conesa (2020): "An introduction to the current debate on central bank digital currency (CBDC)", *Occasional Papers* No 2005, Banco de España.

Bank for International Settlements (2020). "Central banks and payments in the digital area", BIS *Annual Economic Report 2020,* pp. 67-95.

Bank for International Settlements, SIX Group AG and Swiss National Bank (2020). Project Helvetia.

Bank of Canada (2017-2019). Project Jasper.

Bank of Thailand and Hong Kong Monetary Authority (2020). *Inthanon-LionRock. Leveraging Distributed Ledger Technology to Increase Efficiency in Cross-Border Payments.*

Bullmann, D., J. Klemm and A. Pinna (2019). "In search for stability in crypto-assets: are stablecoins the solution?", *Occasional Paper Series* No 230, ECB, August.

Committee on Payment and Settlement Systems. Technical Committee of the International Organization of Securities Commissions (2012). *Principles for financial market infrastructures,* April.

Committee on Payments and Market Infrastructures (2019). *Wholesale digital tokens*, December.

Committee on Payments and Market Infrastructures (2020). *Enhancing cross-border payments: building blocks of a global roadmap.* Stage 2 report to the G20, July.

Deloitte (2017). *The future is here. Project Ubin: SGD on Distributed Ledger.*

Deloitte (2018). *Delivery versus Payment on Distributed Ledger Technologies - Project Ubin.*

De Nederlandsche Bank (2020). "Central Bank Digital Currency. Objectives, preconditions and design choices", *Occasional Studies,* Vol. 20-01, April.

Deutsche Bundesbank (2020). *Money in programmable applications: Cross-sector perspectives from the German economy,* December.

European Central Bank (2020a). *TARGET Annual Report 2019,* May.

European Central Bank (2020b). *TARGET2-Securities (T2S) Annual Report 2019,* May.

European Central Bank (2020c). Report on a digital euro, October.

European Central Bank and Bank of Japan (2018). *STELLA – a joint research project of the European Central Bank and the Bank of Japan. Securities settlement systems: delivery-versus-payment in a distributed ledger environment,* March.

European Central Bank and Bank of Japan (2020). *STELLA – joint research project of the European Central Bank and the Bank of Japan. Balancing confidentiality and auditability in a distributed ledger environment,* February.

Kumhof, M. and C. Noone (2018). "Central bank digital currencies – design principles and balance sheet implications", *Staff Working Paper* No 725, Bank of England.

Lagarde, C. (2020). Speech by Christine Lagarde, President of the ECB, at the Deutsche Bundesbank online conference on banking and payments in the digital world.

Monetary Authority of Singapore (2016-2020). Project Ubin.

Niepelt, D. (2020). Reserves for All? Central Bank Digital Currency, Deposits, and Their (Non)-Equivalence, Study Center Gerzensee, University of Bern, CEPR, CESIfo.

Payments Canada, Bank of Canada and R3 (2017). *Project Jasper: A Canadian Experiment with Distributed Ledger Technology for Domestic Interbank Payments Settlement.*

Pfister, C. (2019). "Central Bank Digital Currency: One, Two or None?", *Working Paper* No 732, Banque de France.

Pinna, A. and W. Ruttenberg (2016). "Distributed ledger technologies in securities post-trading", *Occasional Paper Series,* No 172, ECB, April.

Ponce, J. (2020). "Digitalization, retail payments and Central Bank Digital Currency", *Financial Stability Review,* Issue 39, Banco de España.

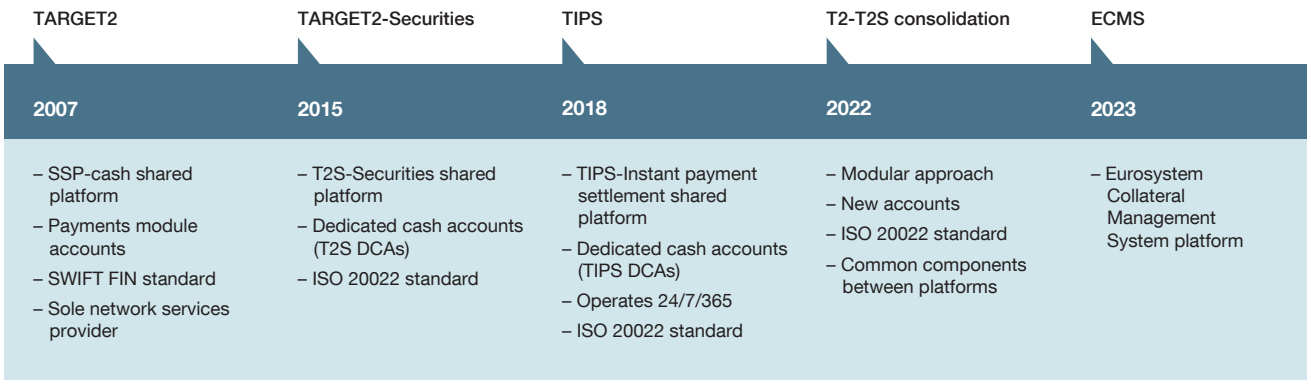
Romero Ugarte, J. L. (2018). "Distributed ledger technology (DLT): introduction", Analytical Articles, *Economic Bulletin* 4/2018, Banco de España.

Shabsigh, G., T. Khiaonarong and H. Leinonen (2020). "Distributed Ledger Technology Experiments in Payments and Settlements", *FinTech Notes* No 20/01, IMF.

World Bank Group (2017). "Distributed Ledger Technology (DLT) and Blockchain", *FinTech Note* No 1.

World Economic Forum (2020). "Central Bank Digital Currency Policy-Maker Toolkit", *Insight Report,* January.

Figure A.1
TARGET SERVICES TIMELINE



SOURCE: Devised by authors.

TARGET2

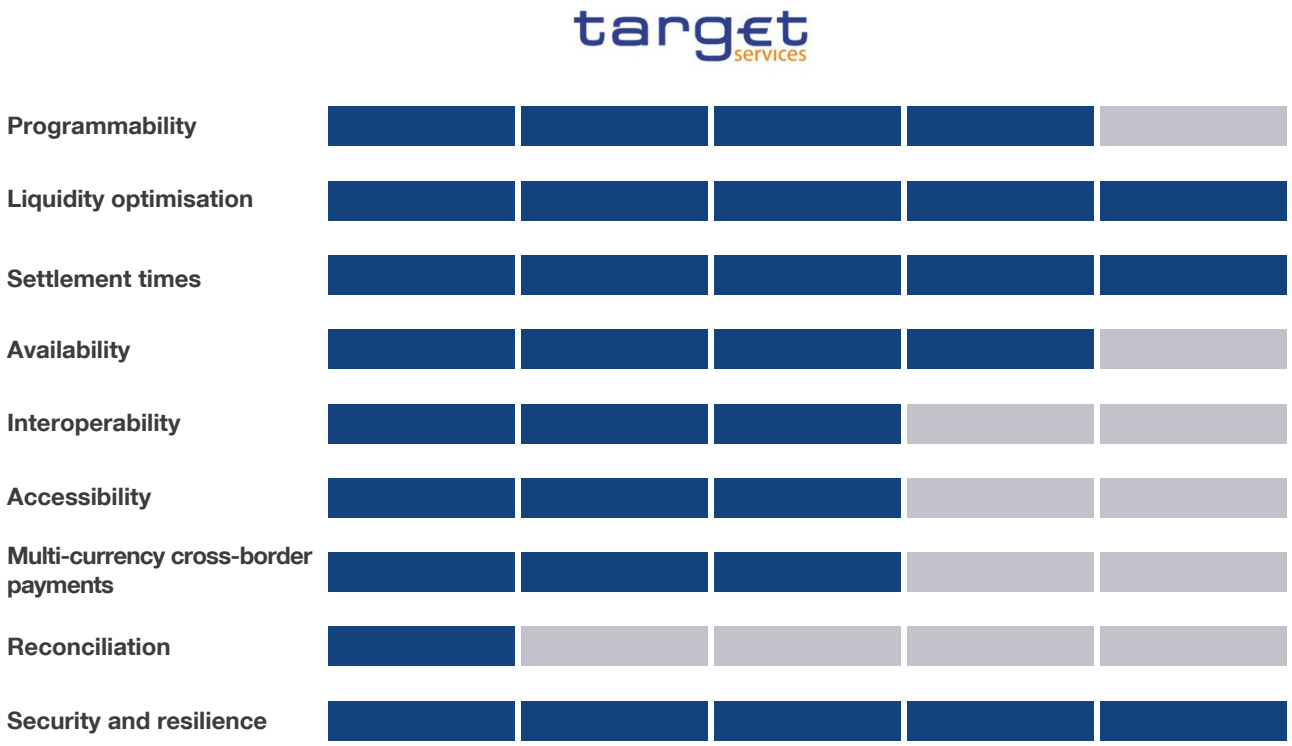
According to data published by the ECB (2020a), TARGET2 processes 88% of the value and 62% of the volume settled by large-value payment systems in euro. When settling transactions, participants can use priority options to optimise their liquidity management. They can also reserve liquidity and establish bilateral or multilateral limits with other participants. Moreover, various algorithms are used to resolve payment queues swiftly and efficiently and with significant liquidity savings.

The number of non-settled payments in TARGET2 is very low; this reflects the fact that liquidity is appropriately distributed across all TARGET2 participants. Overall, non-settled payments in TARGET2 in 2019 amounted to 0.1% of the total daily volume. There are various reasons for non-settled payments: insufficient funds in the account to be debited, transaction errors by participants, or breach of the limits established on the liquidity position between one or more participants.

Liquidity levels in TARGET2 cash accounts are very high. This contributes to the smooth operation of the payment systems, as it reduces the use of intraday credit and facilitates early payment settlement.

In 2019, all payments settled in the TARGET2 payments module were processed in under five minutes. On the peak day for payments settled (525,075 payments in total), 50% of the transactions were settled within 26 seconds and 90% within 39 seconds.

Figure A.2
TARGET SERVICES



SOURCE: Devised by authors.

The technical architecture of the business continuity model follows the concept of "four sites in two regions". In addition, cyber resilience enhancements are constantly being made, in accordance with the strictest standards. TARGET2 uses the SWIFT FIN standard for customer and interbank payments. From November 2022, with the launch of the T2-T2S consolidation project, the ISO 20022 standard will be used.

TARGET2-Securities

According to the T2S Annual Report, in 2019 T2S settled a daily average of 606,938 transactions, with a daily average of €1,106.13 billion. At the end of the day, all instructions that have not been settled remain in the system for future settlement.

One of the indicators used to measure the efficiency of the T2S platform's settlement system is the platform settlement efficiency indicator (PSEI). It measures the platform's ability to settle transactions and is calculated at the end of each business day. In 2019 the indicator stood at 97.63% in terms of value and at 96.93% in terms of volume as a proportion of total transactions.

One example of a liquidity optimisation routine is auto-collateralisation, which is a credit operation that is triggered when a participant does not have sufficient funds to purchase certain securities. It is an automatic process aimed at facilitating smooth real-time DvP securities settlement with central bank money. In 2019 the daily average value of auto-collateralisation on the T2S platform amounted to €103.91 billion.

T2S uses the ISO 20022 messaging standard for its communications with users (CSDs, central banks and directly connected participants).

TIPS

TIPS uses the ISO 20022 messaging standard. TIPS is based on the SEPA Instant Credit Transfer (SCT Inst) scheme, which is the pan-European scheme defined by the European Payments Council (EPC) for instant payments. It processes transactions in real time, 24/7, with a maximum amount per transaction of €100,000. The maximum end-to-end processing time is 10 seconds, i.e. the funds will be available in the payee's payment account within 10 seconds (99% of instant payments processed by TIPS are processed within 5 seconds).

Cyber risk as a threat to financial stability

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Abstract

Information systems play a critical role in the functioning of financial institutions. While supporting their services and enabling their strategies, underlying vulnerabilities could pose an important source of risk: cyber risk. This may impair financial institutions' operational capabilities and even threaten their viability. Furthermore, the high level of interconnection and interdependence between the elements of the financial system allows for the contagion of cyber risk among them. Consequently, the materialization of cyber risk in its most extreme form could threaten the stability of the financial system.

To address this topic, the article first introduces cyber incidents and their estimated costs, focusing on the financial system. Cyber risk is then considered, together with the main vulnerabilities and threats to cyber security affecting financial institutions. This is followed by a justification of the potential systemic effect of cyber risk on the financial system, supported by the use of theoretical models. Moreover, highlights of the current regulatory framework on cyber risk for financial institutions operating in Spain are also presented. Finally, recommended future lines of work for the improvement of the management of cyber risk in the financial system are discussed.

1 Introduction

Perhaps the most notorious cyber incidents to date are the WannaCry and NotPetya *ransomware*[1] cyber-attacks. The WannaCry attack in May 2017 affected computer systems in more than 150 countries,[2] while the NotPetya attack in June 2017 is possibly the most destructive cyber-attack ever seen, with an estimated cost of US$10bn according to a US White House assessment.[3] Although not aimed at the financial sector, these attacks affected banks, ATM networks and card payment systems.

Indeed, multiple organizations of different sizes across different sectors have recently been targeted by ransomware attacks. Notably, in the last half of 2020, two of the most relevant Spanish insurers.[4,5] The attack suffered by one of them impacted

1 A cyber-attack designed to block access to an information system and/or the information it stores until a sum of money is paid.

2 Reuters: Cyber-attack hits 200,000 in at least 150 countries: Europol - See news article.

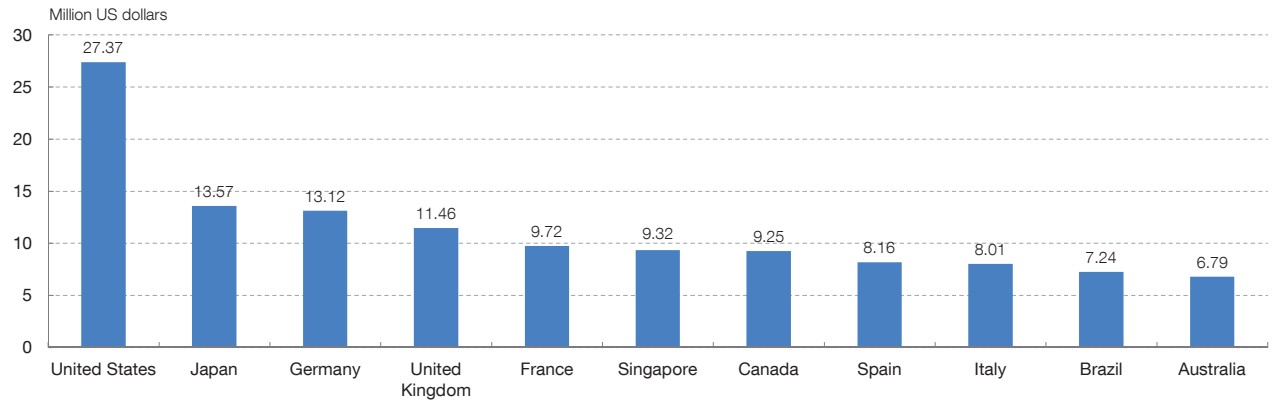
3 Wired: The Untold Story of NotPetya, the Most Devastating Cyberattack in History - See news article.

4 Spanish National Cybersecurity Institute (INCIBE): Mapfre suffers from ransomware cyberattack - See highlight.

5 *El País:* How a ransomware attack impacted one of the biggest Spanish insurers - See news article in Spanish.

Chart 1

ESTIMATED AVERAGE ANNUAL COST OF CYBER-ATTACKS IN LARGE ORGANIZATIONS (a) PER COUNTRY



SOURCE: *Ninth Annual Cost of Cybercrime Study,* conducted by Accenture and Ponemon Institute (2019).

a In the context of the study, large organizations are those with a number of employees greater than 5,000.

90% of its information systems while for the other, it took more than six weeks to recover the functionality of its systems.

The financial sector has long been a key target for cyber criminals looking for financial gain (and not only). For many years, the majority of financial institutions has traditionally been targeted through *phishing*[6] and banking *malware*[7] – in addition to other cyber threats[8] –, and still are.

Despite the fact that **the total cost of cyber incidents is notoriously hard to establish,** it seems clear that their impact on organizations, industries and the society as a whole is substantial. Chart 1 illustrates the estimated average annual cost of cyber-attacks for large organizations according to a study[9] conducted in 355 companies across eleven countries. In the case of Spain, it reaches the value of $8.16M.

Chart 2 illustrates that the financial sector suffers the highest average costs of cyber-attacks compared to other sectors.

According to the same study, large organizations belonging to the financial services industry have to afford the highest costs of cyber-attacks per organization, with an estimation of $18,37 M, while the banking industry follows closely, with $17,84 M.

6 Any fraudulent attempt to obtain sensitive information or data, such as usernames, passwords and credit card details, by disguising as a trustworthy entity in an electronic communication.

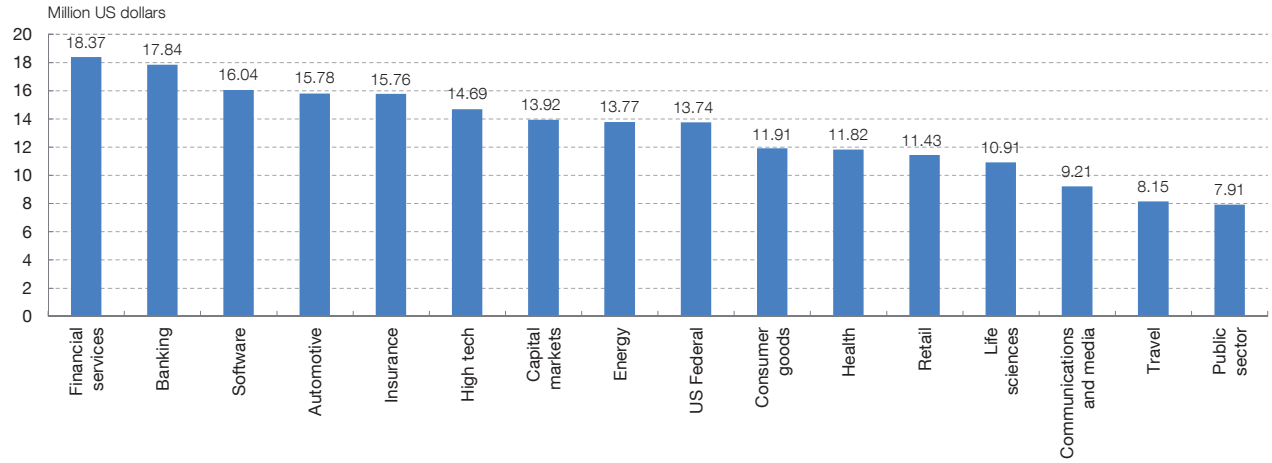
7 Any software intentionally designed to cause damage to information systems.

8 Additional examples of cyber incidents affecting financial institutions can be found at the compilation performed by the Carnegie Mellon Cyber Policy Initiative, available here.

9 See Accenture and Ponemon Institute (2019).

Chart 2

ESTIMATED AVERAGE ANNUAL COST OF CYBER-ATTACKS IN LARGE ORGANIZATIONS PER INDUSTRY



SOURCE: *Ninth Annual Cost of Cybercrime Study,* conducted by Accenture and Ponemon Institute (2019).

Insurance industry organizations are in the fifth position, with an estimation of $15,76 M, while those belonging to capital markets category have to face $13,92 M costs on average per year.

The volume, severity and sophistication of cyber-attacks on institutions are on the rise. During 2019, 67% of financial institutions experienced an increase in the number of cyber-attacks; 26% of the attacks had the aim of being purely destructive, which represented a 160% increase compared to the previous year.[10] Furthermore, 79% of cybersecurity directors of the world's leading financial institutions claim that cyber criminals have become more sophisticated.

But **cyber incidents can also happen without the intervention of malicious threat actors.** A notable example of this occurred in April 2018 at a Spanish owned British bank, after the migration of its IT platform.[11] After three years of planning and testing, the bank migrated its data and operations to a single new IT platform. Despite the successful migration of customer and financial data, infrastructure and software issues led to significant levels of instability in the new platform. These issues ultimately led to disruption in the bank's online and mobile banking services as well as its call centres and branches.

Banco de España is Spain's national authority responsible for prudential supervision of credit institutions, within the framework of the Single Supervisory Mechanism,

10 See VMware (2019).

11 The report of an independent review by Slaughter and May, commissioned by the bank, can be found here.

and other supervisory tasks and, as a central bank, seeks to promote the proper functioning and stability of the Spanish financial system and of the national payment systems, without prejudice to the functions of the ECB. In this context, **cyber risk is an emerging area of interest for** the fulfilment of its mandate. In addition, the recent transposition into the Spanish legal framework of the Directive (UE) 2016/1148 on network and information systems security (known as NIS Directive) appoints **Banco de España** as a national competent authority for credit institutions.[12]

There is an increasing interest in understanding the potential impact of cyber risk on financial stability and improving the resilience of the financial system in the event of a systemic cyber event. This article introduces the problem of cyber risk from the perspective of the financial sector at both the individual institutions and system-wide level. In the absence of previous events, the potential effect of cyber risk on financial stability is justified supported by the use of models. An analysis of the characteristics of the regulatory framework for the cyber risk affecting the financial sector in Spain is made in order to address the missing elements required to safeguard financial stability against this type of risk.

2 Cyber risk and financial institutions

Data is paramount for financial institutions to provide their services. Financial institutions'[13] data rely on the proper and reliable functioning of information systems. These systems form the backbone of almost all their processes and distribution channels as well as supporting the automated controls environment that assure information integrity. They also bring new opportunities to improve traditional businesses and generate new ones.

Information systems represent material proportions of institutions' costs, investments and intangible assets.[14] Their importance to financial institutions' operations means they also become sources of fragility should these systems fail or the data become unreliable. They are therefore, attractive targets for malicious actors and pose additional risks to the institutions.

As illustrated in previous examples, **cyber incidents are events that compromise the security of information systems and the information they hold,** regardless of

12 According to the Royal Decree 43/2021, published on the 26th of January 2021, which develops the Spanish legislation transposing Directive (UE) 2016/1148 on network and information systems security (known as NIS Directive). Available here.

13 In the context of this article the concept of financial institution covers, among others, financial intermediaries, markets and market infrastructures.

14 By June 2020, the European Parliament voted to allow banks to include the value of their software systems in the calculation of their reserves – something worth tens of billions of euros for the sector – as part of the adjustments in response to the COVID-19 pandemic. The European Banking Authority has been charged with finding a common method of valuation. Available here.

Table 1

SECURITY PROPERTIES GIVING RISE TO CYBER RISK AS DEFINED IN THE CYBER LEXICON DEVELOPED BY THE FINANCIAL STABILITY BOARD (FSB) (a) AND EXAMPLES OF CYBER INCIDENTS RELATED TO THEIR COMPROMISE

Definition of the security properties giving rise to cyber risk	Examples of cyber incidents related to their compromise
Confidentiality: information is neither made available nor disclosed to unauthorized individuals, entities, processes or systems	Financial institution's clients accessing the financial positions of other clients
Integrity: accuracy and completeness	Data stored and processed by information systems are incomplete, inaccurate or inconsistent across different systems
Availability: being accessible and usable on demand by an authorized entity	Disruption of online banking services as a consequence of a information system failure
Authenticity: an entity is what it claims to be	Illegitimate replication of online banking services for the performing of phishing campaigns
Accountability: ensures that the actions of an entity may be traced uniquely to that entity	Inability to identify the originator of a transaction
Non-repudiation: ability to prove the occurrence of a claimed event or action and its originating entities	A customer of a financial institution orders a transaction that is not carried out. The customer cannot prove that his order was received by the institution
Reliability: consistent intended behavior and results	Information system instability as a consequence of a technological platform migration

SOURCE: Authors' elaboration.

a See Financial Stability Board (2018).

whether they originate from intentional attacks – cyber-attacks – or not. **Cyber risk can be defined as the combination of the probability of cyber incidents occurring and their impact.** A definition of the security properties giving rise to cyber risk is provided in Table 1, being confidentiality, integrity and availability the primary ones.

Technology is obviously crucial when it comes to cyber risk; however, this risk is not only about information systems, **but also processes and people.** It is not possible to deploy and rely on technology and maintain a reasonably guarded security posture without competent people and suitable support processes, encompassing management systems, best practices and governance frameworks, including IT audit.

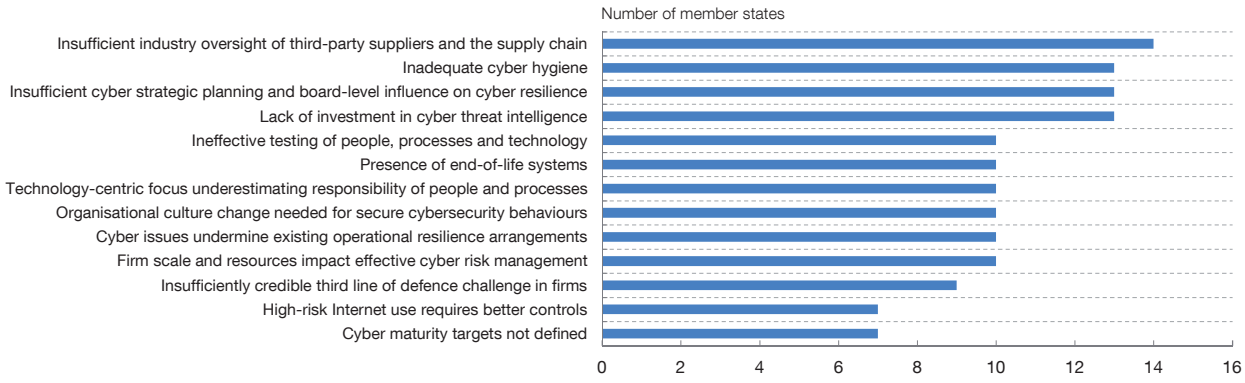
Although cyber risk can be viewed as a subset of operational risk,[15] it differs in material ways from more traditional sources of operational risk.

Cyber risk related assets – namely people, processes and technology – can present (and they inevitably do) weaknesses, susceptibilities or flaws, which are known as vulnerabilities. **Cyber risk materialises in cyber incidents through the exploitation of these vulnerabilities.**

15 Operational risk encompasses the risk of financial losses stemming from inadequate or failed internal processes, people and systems or from external events.

Chart 3

PREVALENCE OF COMMON CYBER VULNERABILITIES IN 14 EU MEMBER STATES FINANCIAL INSTITUTIONS



SOURCE: European Systemic Cyber Group, *Report on the systemic characteristics of cyber risk.*

Chart 3 shows a set of thirteen common cyber security vulnerabilities in European financial institutions belonging to 14[16] EU member states ranked according to their frequency of occurrence[17] across them. The information was gathered as part of the European Systemic Cyber Group's work (ESCG).[18]

Of particular concern is that **human actors with malicious intent can cause cyber risk materialize.** These actors are typically grouped into (i) hostile nation-states – whose capabilities are increasingly sophisticated when compared to other actors –, (ii) terrorist groups moving into the cyber arena, (iii) cybercrime organizations – generally interested in making profit through cyber-attacks –, (iv) hacktivists – motivated by political demands –, (v) disgruntled employees that exploit their privileged access to organization's IT resources, and (vi) individual malicious intruders, known as hackers.

Threats to cyber security have a fast paced evolving nature. No wonder, then, a plethora of public and private organizations issue cyber threats assessment reports to track their evolution relatively frequently.[19] According to these reports, the financial sector is usually among the most exposed to these threats. Notably,

16 Belgium, Germany, Hungary, Ireland, Italy, Lithuania, Malta, The Netherlands, Poland, Romania, Slovenia, Spain, Sweden and the United Kingdom (at the time member state of the EU).

17 This, however, does not imply the severity of the vulnerabilities or mean that a particular vulnerability has materialised in the jurisdiction concerned, only that it has been noted to exist.

18 The European Systemic Cyber Group (ESCG) is an experts group established by the European Systemic Risk Board (ESRB) in 2017 to investigate systemic cyber risk and examine whether and how a cyber-incident could cause a systemic crisis. Since 2020 the ESCG is arranged as a joint ESRB-Bank of England working group.

19 A reference for the reader could be those issued by ENISA, the European Union Agency for Cybersecurity, available here, and by the CCN-CERT, one of the Spanish national governmental agencies on cybersecurity, available here.

financial institutions fall under the interest of different kinds of malicious threat actors that have been identified to date and **threats to the cyber security of financial institutions have a specific profile**.[20]

Financial institutions have **complex and interdependent supply chains** that offer a broad, target-rich attack surface that adversaries can undermine. Despite the fact that attackers have been conducting supply chain attacks for years, in December 2020 an unprecedented sophisticated global scale cyber-attack[21] leveraging SolarWinds Orion IT software was unveiled.[22]

Credentials and identity theft compromise and abuse have traditionally been cornerstones for targeted attacks and fraud. As a consequence of the COVID-19 pandemic, financial institutions have been forced to rapidly adjust their operations to enable massive and swift telework deployment. From the point of view of technology, this has implied an expansion of the attack surface, potentially increasing vulnerabilities further.

Data theft is also among the traditional threats to the financial institutions. Recently, threat actors are often going beyond theft to include data destruction and disruption. A new wave of cyber-attacks sees data no longer simply being copied, but also destroyed — or changed — breeding distrust.[23]

As technology advances, both cyber-defenders and adversaries are exploring means of using new tools. An example, on the threat actor side is the use of *deepfake*[24] technologies to increase the effectiveness of their campaigns. **Disinformation and misinformation campaigns** are of particular concern in this regard. Notably, multiple United States entities, including the NASDAQ, Securities Exchange Commission and FINRA have warned of spikes in market manipulation in the wake of the COVID-19 pandemic. Often, market manipulation involves elements of disinformation or misinformation directed at influencing unsuspected investors to aid criminal actors' objectives. Malicious actors can take advantage of high market volatility which could further undermine market confidence.

It is important to note that **not every cyber incident is the result of an intentional attack,** such as those originating from natural disasters disrupting IT infrastructure or accidental actions of authorized IT systems users. In fact, some of the biggest data breaches have been caused by poor IT systems configuration.

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20 According to the SecurityHQ white paper "Financial Sector Threat Landscape 2020". Available here.

21 Reuters: SolarWinds hack was 'largest and most sophisticated attack' ever: Microsoft president news article.

22 The first statement made about its detection is available here.

23 Indeed, destructive and disruptive malware attacks are on the rise and cross-sector targeting and threat groups leveraging ransomware are targeting multiple related parties at once globally.

24 An artificial intelligence technique that allows to edit fake videos of people who are apparently real, using unsupervised learning algorithms and existing videos or images.

The high level of interconnectedness of information systems enables cyber incidents to be more widespread in their impact than many other shocks. Additionally, the high level of automation of information systems enables cyber incidents to spread rapidly, making human intervention difficult. Thus cyber risk has the potential to materialize and propagate at a significantly quicker pace than other types of risk.

Regardless of whether they originate from intentional attacks or not, **cyber incidents typically result in business disruption, information loss, equipment damage or even in revenue loss.** Given the dependence of financial institutions on information technology, the performance of economic functions[25] by financial institutions could be affected by cyber incidents.

Finally, **the scale and complexity of organizations' IT infrastructure makes impossible their absolute protection and elimination of cyber risk.** Consequently, cyber incidents may have a high degree of inevitability. In fact, cyber incidents have the potential to impair the operational capabilities of financial institutions to a point that compromises their viability.

3 Cyber risk can threaten financial stability

Initially, it may seem that cyber risk is only a threat to the soundness of financial institutions individually. On the contrary, **the interdependence of the information systems supporting the financial system further enables cyber incidents to spread to organizations not initially affected.** In the worst cases, an incident can spread widely across sectors and even beyond geographical borders.

Assessing the potential impact of cyber risk on financial stability[26] is a complex task since there are no historical examples from which to draw lessons or conclusions. However, the lack of examples cannot be considered proof that cyber risk cannot impact financial stability.

In its 2017 report: *Cybersecurity and Financial Stability: Risks and Resilience,* the U.S. Office of Financial Research (OFR) identifies **three potential ways in which cyber incidents can threaten financial stability: lack of substitutability, loss of confidence and loss of data integrity.** Lack of substitutability can be seen from a financial system perspective (e.g. a clearing house) or from a technological perspective (e.g. a main cloud service provider).[27]

25 See Financial Stability Board (2013).

26 For the purpose of this article the definition for financial stability used is the one published by the ECB here: "Financial stability can be defined as a condition in which the financial system – which comprises financial intermediaries, markets and market infrastructures – is capable of withstanding shocks and the unravelling of financial imbalances. This mitigates the prospect of disruptions in the financial intermediation process that are severe enough to adversely impact real economic activity."

27 See Healey et. al (2018a).

In its 2020 report, the ESCG built upon those potential ways a cyber incident could threaten financial stability and defined a set of **characteristics**[28] **that make the financial system vulnerable to cyber risk:** a high degree of interdependence, the absence of a clear view of those dependencies, a high level of reliance on data and the relevance of confidence.

The **high degree of interdependence** can come in the form of dependencies between different components of the system (e.g. between financial institutions or between them and market infrastructures) but also between components of the system and those from outside the system (e.g. software or communication services providers). A cyber incident in a particular component could spread to others that depend on it regardless of whether they are part of the financial system or not.

There is a **lack of understanding around the concentration and dependency of relationships between components** of the financial system, and also those components from outside the system. This hinders the ability to fully understand how, for example, an impact on a certain service provider can spread within the financial system.

High reliance on data makes any impact on the confidentiality, integrity or availability of data (the three main information security focus points) susceptible to wide-spread consequences in the system; for instance, unavailability or tampering of trading prices can stop a market from operating.

Confidence is key in the financial system and can become crucial in a financial crisis, as we have seen in the past; it takes time to build it but can be destroyed in minutes. Cyber incidents and the uncertainty that may come with them can quickly erode confidence and have a widespread impact on the system. For example, a cyber incident that corrupts account balance data of a bank, even for a short period of time, will have a sizeable impact on the confidence in the institution.

In order **to assess the potential impact a single component might have on the whole system** the FSB has established three criteria[29] that can be applied both in the financial and technological domains: size, substitutability and interconnectedness.

Size is an intuitive criterion: a cyber-incident in a component of the system that represents a significant percentage of it can affect the whole system.

The **lack of substitutability** of certain core components of the financial system, like critical financial market infrastructures (e.g. clearing and payment systems), generate

28 See European Systemic Cyber Group (2020).

29 See International Monetary Fund/Bank for International Settlements/Financial Stability Board (2009).

single points of failure. It is more likely that a cyber-incident affecting one of such components can lead to a system-wide impact.

Interconnectedness between components of the financial system is a key criterion when assessing the potential propagation a cyber-incident might have through the system. Notably, information technology has substantially increased the level of interconnectedness between components of the financial system (and of them with external elements), both technically and financially.

Taking into account the characteristics of cyber risk, previously discussed in this article, and the aforementioned characteristics of the financial system, it is possible to begin understanding how the **crystallisation of cyber risk can have a considerable impact at a system-wide level.** However, this doesn't imply that a cyber-incident, even if it has a sizeable impact and a system-wide reach, has the potential to compromise financial stability.

In order to make this link, and in the absence of previous financial stability crises originated by cyber incidents, a deeper analysis of how these characteristics interact is needed. Both qualitative and quantitative approaches are useful tools to have a better understanding of the potential impact of cyber risk on financial stability.

Quantitative models can provide numerical estimations of cyber risk impacts but they require sufficient data from previous events in order to be accurate. The Federal Reserve Bank of New York (FRBNY) published a report featuring a quantitative approach to the impact of a cyber-incident.[30] The report adds a valuable approach to existing literature by providing a detailed description of the economic impact a cyber-attack can have in the U.S. wholesale payments network.

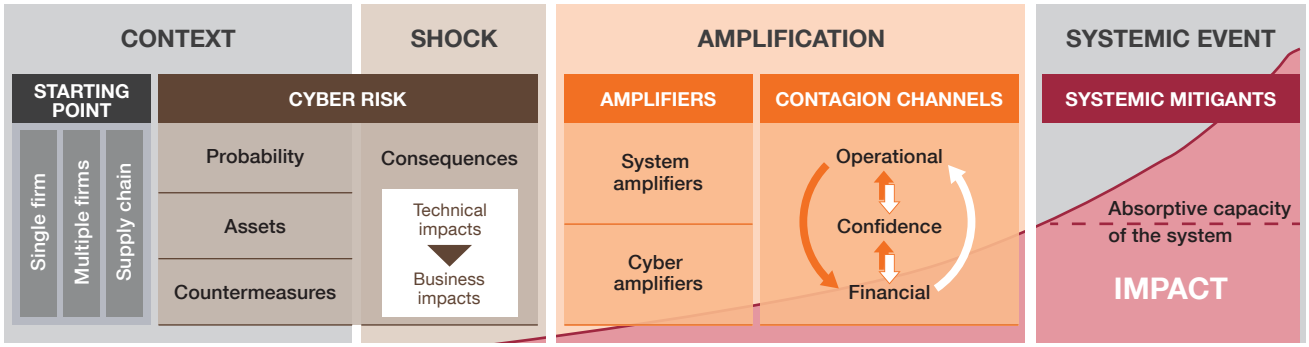
Using real wholesale payments data from 2018, the report estimates that a cyber-attack impacting any of the five most active US banks could lead to the impairment,[31] on average, of 38% of the payment network. The forgone payment activity could be up to 2.7 times the daily United States GDP; and up to a 30% higher if the cyber incident occurs on certain dates with higher payment volumes.

This model provides actual cost estimations of the impact that a cyber-incident with system-wide effects can have, demonstrating their potential negative effects to financial stability. However, it does not focus on the mechanisms that allow a cyber-incident to become amplified to the point in which it begins having a significant impact.

30 See Eisenbach et al. (2020).

31 Impairment of an institution is defined in Eisenbach et al. (2020) as the point at which "the counterfactual end-of-day reserve balance is more than two standard deviations below its average, over a 30 day window."

Figure 1
A MODEL FOR THE PROPAGATION OF CYBER INCIDENT EFFECTS IN THE FINANCIAL SYSTEM



SOURCE: Authors' elaboration. Adapted from the model presented in Ross (2020).

Qualitative approaches on the other hand give us a better understanding of the factors and mechanisms that come into play when cyber risk crystallises and how these mechanisms and factors can amplify its effects to the point in which it may threaten financial stability. Analysing each step of this process and how different elements come into play during the amplification of a cyber-incident, helps us identifying system vulnerabilities relevant to cyber security (in contrast with those at a single institution level) as well as potential mitigants that could help prevent financial stability issues arising from a cyber-incident.

A conceptual model is a more appropriate tool to explore how cyber risk and the financial system can interact in such a way that financial stability is affected. Following a similar approach as previous works,[32] the ESCG developed a conceptual model[33] **to analyse the evolution of cyber incident effects from its inception, considering three contagion channels that spread its effects: operational, confidence and financial.**

The model, based on the FSB's approach to macro-financial implications of operational and cyber risk, **divides the analysis of the evolution of a cyber-incident to its final outcome in four phases: context, shock, amplification and systemic event,** as shown in Figure 1.

The **context phase** analyses the risks that can crystallise and lead to a cyber-incident and provides the complete context under which a cyber-incident arises. This analysis includes not only the threat classification of the crystallised risks (localisation, motivation and agent) but also the assets affected (financial and non-financial), the capacity of the organisation to mitigate cyber risk as well as the starting

32 See Kaffenberger and Kopp (2019), and Healey et al. (2018b).
33 See Ross (2020).

point, i.e. single institution hit by an incident, multiple financial institutions hit simultaneously or via the supply chain.

In the **shock phase** the immediate impacts of the cyber incident are assessed. This phase does not take into account the likelihood of the shock and focuses instead on the technological and business impacts generated by the loss of one or more of the cyber security properties mentioned before (confidentiality, integrity and availability being the primary ones) as a result of the cyber incident.

The **amplification phase** makes use of two concepts: **amplifiers** that can increase the impact or likelihood of the shock (distinguishing between system amplifiers and cyber specific amplifiers), and **contagion channels** through which the shock can be transmitted (confidence, financial and operational). These two concepts are brought together to explore how the affected financial institutions interact with their systems and how the initial shock propagates.

The last phase of the model, **systemic event phase,** evaluates the point at which a cyber-incident becomes systemic; that is the point at which the system is no longer able to absorb the shock. To identify this point, an upper impact tolerance threshold for the financial system has to be defined (i.e. the point at which the aggregate impact becomes too great for the system to bear). The model also introduces a lower impact threshold, below which individual institutions, the services they provide, and the economic functions they support, should operate within. The gap between both represents the absorptive capacity of the system, the coping capacity within the system to absorb shocks.

In order to better illustrate how a cyber-incident can impact the financial system, the abovementioned model can be applied against a hypothetical scenario developed by the ESCG.[34] The scenario is based on the destruction or alteration of value-related data (e.g. account balances) as a result of a cyber-attack to the account data and payment software of a large bank. Figure 2 details the development of the incident through the phases of the model.

The application of ESCG's conceptual model to this scenario suggests **there are potential mitigants that could help reduce the impact of the incident.** The main contagion channels in this scenario are financial and confidence. Public concern about their savings can easily extend to customers of all banks, while uncertainty about the problem and its solution erodes confidence not only within the public, but also within other market participants and authorities. At the same time, the financial impact spreads from the bank to its counterparties, causing liquidity problems.

34 See European Systemic Cyber Group (2020).

Figure 2

APPLICATION OF ESCG'S CONCEPTUAL MODEL TO A HYPOTHETICAL SCENARIO

Propagation of the effects of the destruction or alteration of value-related data (e.g. account balances) as a result of a cyber attack to the account data and payment software of a large bank			
Context phase	Using malicious software and infiltrating the IT systems management supply chain, threat actors gain access to certain IT systems of a bank. For several months, undetected, they have performed reconnaissance tasks while gaining access to critical systems as well as to backup and restoration processes. The attackers then initiate the execution of a massive set of fraudulent payments, covering their tracks by deleting the account balance data of a large number of accounts as well as payment-related processes and software		
Shock phase	Unsure of what the problem is, the bank suspends its payment operations. Short-term solutions (e.g. manual workarounds) are deployed, but their viability depends on how long they will have to be used. Concerns are raised about the reliability of the live data as it becomes clear that the incident affects the bank's subsidiaries in other countries via their shared IT systems. The incident is communicated to the National Competent Authority of the countries impacted		
Amplification phase	Unaware of the full extent of the attack, of the possible impacts in the backup and restoration procedures and of the time that will be required to resume services, the bank initially assumes that activity could be resumed before manual workarounds become unviable. As time goes by, critical activities exceed their maximum tolerable downtime thresholds and the bank begins to set up alternative platforms to operate. Contagion between the following different channels begins:		
Operational to operational contagion	Operational to financial contagion	Operational to confidence contagion	Confidence to confidence contagion
Appears when it becomes evident that restoration will not be possible as the attackers were able to alter backup and recovery procedures. The interdependencies between account balances, payment systems and treasury procedures impacts treasury services, and by the end of the first day the bank's receipts and payments are pending	Follows when institutional customers of the bank do not receive expected payments. Customers are also unable to use funds from their deposits. The bank's management starts considering the possibility that data will not be recovered in a short period of time or even that the data may have been permanently lost The bank's financial position starts to deteriorate as it cannot perform payment, clearing or settlement services A more severe scenario could have been created if the attackers had hindered the capacity of the bank to receive emergency liquidity from the central bank by incapacitating its collateral framework, thus triggering default management procedures or even the intervention of resolution authorities	Arises as customer are increasingly unable to withdraw funds (both at ATMs and branches). Customers seek to understand the impact of the problem and how long it will last, as they try to ascertain whether their money is safe	Could occur in a more severe scenario if the attackers claim responsibility for the incident and threaten to repeat it in other banks. This claim, added to the existing concern, could have a larger impact if the use of social media to spread rumours amplifies the erosion of confidence in the financial system
Systemic event phase	Although some data could be recovered in the short term, it becomes apparent that full data recovery will require a semi-manual process, which will take a considerable amount of time. As a result of this, the bank notifies authorities, markets and its customers of the situation. While the bank and its counterparties begin to report liquidity problems, disruptions begin in the payment, clearing and settlement systems of the country. While financial institutions request help from authorities, loss of confidence spirals as customers try to move their funds out of the bank, but the unreliable balances make it almost impossible. Fear that this event has impacted other banks spreads, increasing concerns across the financial sector. The authorities consider different actions like establishing a communication strategy to offer reassurance to the public. The lack of previous experience dealing with similar crisis adds to the uncertainty experienced by authorities, market participants and customers		

SOURCE: Authors' elaboration. Adapted from European Systemic Cyber Group (2020).

As the scenario progresses, a better understanding of its impact and spread develops. It is therefore possible to reflect on how some of the events could have been prevented or mitigated. Would a critical data backup provided by the authorities have allowed the bank to restore data and resume operations faster? How could the impact on liquidity have been mitigated? What would have been the impact of a social media campaign spreading false rumours? How could financial institutions

and authorities increase or keep market and public confidence during the incident? Raising these kind of questions and seeking answers to them can be helpful in shaping effective policies to mitigate the impact of cyber risk.

The conclusion drawn by the ESCG from the application of the conceptual model to different scenarios[35] (both real and hypothetical) is that **in order to have a significant impact on financial stability, a cyber-incident must:**

- Be of **intentional nature,** a cyber-attack, with a clear intention to cause damage.
- Be **carried out by actors with sophisticated capabilities.**
- Have a **specific alignment of amplifiers and lack of effective mitigants.**
- Create actual or anticipated **losses** that **cannot be absorbed, which erode trust** in and within the financial system.

ESCG's conclusions add on to a growing consensus considering that cyber risk has the potential to have a significant impact on financial stability. However, how to predict and measure the impact are still subject of analysis. Whether agreeing with the same specific factors defined by the ESCG or defining new ones, it becomes evident that, **given a set of specific concurrent factors, cyber risk can threaten financial stability.**

This convergence of factors should not be considered proof of the low probability of this kind of cyber incident happening. Unintentional cyber incidents have the potential to impair an institution. If combined with an impact in the confidence channel due to, for example, a malicious social media campaign, there remains the possibility of a financial stability impact. Furthermore, an increase in the capabilities of threat actors, due to black-market propagation of sophisticated tools, combined with increasingly complex IT systems, creates a rapidly evolving technological risk landscape where the probability of high-impact events increases.

4 Cyber risk regulatory framework for Spanish financial institutions

Regulators have been working for years on implementing strategies to address cyber risk. In the past decade, supervisory best practices and tools have been established **focused on single institutions soundness.** Regulatory frameworks have been developed to identify, evaluate and mitigate cyber risks for financial institutions, but also to help them prepare to respond to cyber incidents.

35 See European Systemic Cyber Group (2020).

Traditionally, European regulators have addressed cyber risk with a fragmented approach, including dispositions on Information Technology as part of different sectorial regulations (e.g. the Payment Services Directive, PSD2,[36] which has dispositions on cyber risk but only covers payment service providers).

The following is a brief outline of three of the most important European regulations for the financial system defining obligations in order to enhance cyber security: the directive on the security of network and information systems (NIS Directive), the General Data Protection Regulation (GDPR) and the revised Payment Services Directive (PSD2).

The NIS Directive[37] (NISD) is the first piece of EU-wide legislation purely focused on cyber security. It pursues the objective of improving the security of networks and information systems underlying either digital services providers or essential services operators, which includes the most relevant institutions of the financial sector. It aims to improve cyber security capabilities at national level, and to enhance cooperation in order to facilitate and improve cyber incident response activities. To do so, it mandates the development of a National Cyber Security Strategy[38] and the designation of a Single Point of Contact, National Competent Authorities and Computer Security Incident Response Teams (CSIRTs).

The **General Data Protection Regulation**[39] (GDPR) entered into effect in May 2018, **setting new and unprecedented data privacy and security standards.** Financial institutions are affected by this regulation so long as they target or collect data related to people in the European Union or offer services to them. Among other provisions, GDPR requires the handling of personal data securely, by implementing "appropriate technical and organizational measures" and envisages fines that can be up to four percent of the offending organization's global profits.

The revised Payment Services Directive (PSD2), transposed to the Spanish regulatory framework in November 2018, updates the previous payment services directive. The main goals pursued with this update are **fostering innovation and competition in the European payments market while improving the security of transactions and data.** This regulation poses new challenges for institutions regarding cyber risk given that, while including several cyber security technical requirement (e.g. strong costumer authentication[40] or transaction and device

36 See *Payment services (PSD2) - Directive (EU) 2015/2366.*

37 See Directive on security of network and information systems (NISD) - Directive (EU) 2016/1148.

38 The last version of the Spanish National Cybersecurity Strategy is available here (only in Spanish).

39 See *General Data Protection Regulation (GDPR) - Regulation (EU) 2016/679.*

40 "An authentication based on the use of two or more elements categorised as knowledge (something only the user knows), possession (something only the user possesses) and inherence (something the user is) that are independent, in that the breach of one does not compromise the reliability of the others, and is designed in such a way as to protect the confidentiality of the authentication data", PSD2, Article 4(30).

monitoring), it also increases their attack surface by requiring them to develop an external access interface to payment accounts for third parties.

Looking at the regulation issued by the three European Supervisory Authorities (ESAs) fragmentation is also present. The banking sector, as spearhead of technology adoption in the financial system, has a more developed and extensive regulatory framework on cyber risk. Examples of this are several guidelines and regulatory technical standards issued by the European Banking Authority (EBA) in the last years[41] (e.g. the EBA Guidelines on ICT and security risk management). Also ESMA and EIOPA[42] have recently published guidelines dealing with aspects of cyber risk (e.g. EIOPA Guidelines on information and communication technology security and governance[43] or ESMA Guidelines on outsourcing to cloud service providers[44]).

In Spain, banks are subject to a wide range of national and European Union regulations. When it comes to cyber risk, banks have requirements coming from: (i) different regulations for specific activities (e.g. PSD2 for the payment services they provide); (ii) regulation with a wider scope for the banking sector (e.g. the EBA Guidelines on ICT and security risk management); or (iii) more general regulation that covers different sectors (e.g. the General Data Protection Regulation, GDPR, and its local adoption[45] in relation to personal data or the Network Information Security Directive and it local transposition[46]).

Regulatory fragmentation poses several problems, both for authorities and financial institutions. For authorities, for example, fragmentation makes it difficult to have a clear overview of the whole financial sector regulatory framework, what regulations are in place and affect different financial institutions, etc. This also may hinder authorities' coordination capabilities when responding to a cyber-incident since it will be difficult for them to know other authorities that should be involved, their responsibilities, points of contact, requirements for financial institutions, etc.

Fragmentation can become a problem for those financial institutions who are subject to different regulations. For example, a bank that is victim of a cyber-attack affecting personal information of its payment services clients will have to report the event to different authorities, both national and European (including data protection agencies, law enforcement, local Computer Emergency Response Teams – CERT –, local supervisors and the ECB) to comply with its obligations under different regulations (e.g. PSD2 for the payment service perspective or GDPR from the personal data

41 See *EBA Guidelines on ICT and security risk management* (EBA/GL/2019/04).

42 The European Insurance and Occupational Pensions Authority (EIOPA) and the European Securities and Markets Authority (ESMA).

43 See *EIOPA Guidelines on information and communication technology security and governance.*

44 See *ESMA Guidelines on outsourcing to cloud service providers.*

45 See Ley Orgánica 3/2018, de protección de datos personales y garantía de los derechos digitales.

46 See Real Decreto 43/2021, de 26 de enero, por el que se desarrolla el Real Decreto-ley 12/2018, de 7 de septiembre, de seguridad de las redes y sistemas de información.

perspective). That reporting will also have to be done taking into account different requirements (i.e. thresholds, formats, timeframes) making compliance even more burdensome in a moment where efforts should be focused on managing the incident.

Being aware of this and of other burdens that regulatory fragmentation may pose to both authorities and financial institutions, **regulators are in the process of increasing the level of harmonization in cyber risk regulation.** Initiatives like the Digital Operational Resilience Act[47] (DORA) or the Revised Directive on Security of Network and Information Systems[48] (NIS2) are clear examples of how regulators are trying to address the issue.

In addition, authorities are sponsoring initiatives to better understand cyber vulnerabilities in the financial sector and interdependencies between financial institutions. They are also paying attention to contagion risk, trying to understand how impacts derived from a cyber-incident could spread among multiple institutions, affecting financial stability.

5 Reducing the impact of cyber risk on financial stability

Cyber risk requires a concurrent approach from both micro- and macro-prudential angles. The risk arising from the aggregate impact of cyber risk at individual institutions makes **microprudential policies an essential tool in reducing the potential threat to financial stability.** Cyber risk is not a novelty in microprudential regulation and there are already policies that deal with this risk from different angles.

By contrast, **macroprudential policies,** which are typically aimed at mitigating and preventing cyclical or structural systemic risks to financial stability, **have not focused on cyber risk to date.** This can be partially explained by the fact that cyber risk has only been seen as a type of operational risk and has therefore been managed from a microprudential perspective. Another reason could be that no actual cyber incident has had a profound system-wide impact on financial stability yet.

Existing macroprudential tools may not prove effective for dealing with issues derived from a cyber-incident as macroprudential policies are basically conceived to be deployed in a preventive manner. For example, capital buffers or liquidity tools may not be the right levers in preventing a systemic event if a G-SIB loses its account balance data due to a cyber-incident. Similarly, such tools may prove to be ineffective if a critical financial market infrastructure suffers a cyber-incident that forces it to cease operations for a prolonged period.

47 See legislative proposal for an EU regulatory framework on digital operational resilience for the financial sector – Digital Operational Resilience Act (DORA).

48 See proposal for directive on measures for high common level of cybersecurity across the Union - Network and Information Systems (NIS 2 Directive).

Cyber risk can also crystallise at a speed and scale that might render existing instruments unsuitable for competent authorities. The uncertainty of the origin, intent and impact of a cyber-incident can make authorities' reactions insufficient and inadequate when dealing with system-wide confidence.

In order to lessen the potential impact of cyber risk on financial stability and improve the financial system resilience, authorities will have to act. We believe that **legislative improvements should be introduced, both at micro- and macro-prudential levels,** to:

— Improve coordination between authorities during cyber incidents.

— Gain a better understanding of cyber risk's potential impact on financial stability.

— Enhance preparation and foster information sharing both at institutions and authorities level.

— Reduce the aggregated impact of cyber risk at individual level.

— Increase regulatory harmonization.

Improving coordination between authorities is key when dealing with the impact of a risk that has such a rapid crystallisation ability and diverse manifestation like cyber risk.[49] To achieve this, a common coordination framework will be required. At the base of this framework should lie a common lexicon and taxonomy with agreed threshold and classification criteria.

While the lexicon will ensure that information is interpreted adequately by all authorities, the taxonomy will allow incidents to be classified homogeneously across all jurisdictions, reducing potential discrepancies. Among other key elements of a coordination framework we could mention common information sharing formats, secure communication channels or well identified points of contact for all involved authorities.

The complexity of the financial system requires a deeper level of understanding in order to build on the work done in creating and analysing different cyber risk scenarios.[50] To better understand cyber risk's potential impact on financial stability we must first have a clear view on the financial sector's interdependencies,[51] both at technical and operational level.

49 See Oliver Wyman and Depository Trust and Clearing Corporation (2018).

50 See Boer and Vázquez (2017), and Kaffenberger and Kopp (2019).

51 See Ross (2020).

Creating a sectorial map of these interdependencies is a complex task that authorities may want to approach on a bottom-up basis, beginning with simpler maps at national level that are then aggregated and analysed at European level. This approach would allow national authorities to have a clear view on their jurisdictions dependencies, while at the same time European authorities would achieve an overarching view.

Improved quantitative and qualitative models would be another paramount tool to improve our understanding of cyber risk's potential impact and how interdependencies, amplifiers and mitigants interact in a cyber-incident.[52]

Authorities not only have to develop adequate instruments to deal with a cyber-incident (e.g. common coordination framework, common taxonomy and lexicon, interdependencies maps or predefined actions plans for certain scenarios); they also have to be sure that they can use them efficiently and build up their capabilities and those of the financial institutions.

Preparation of the financial sector can be driven by authorities by establishing periodical cyber exercises in local jurisdictions and at cross-national level. Although there are crisis exercises performed in the financial sector, they still are a fragmented effort since they usually have a limited scope (e.g. Financial Market Infrastructures, single jurisdictions, individual financial institutions or not considering certain aspects of a cyber-crisis). Also, there is not a comparable level of maturity among jurisdictions. Periodical cross-national cyber exercises may encourage countries to conduct regular exercises within their jurisdiction.

Information sharing, as a cornerstone of coordination, is crucial to enable a collective system-wide response to cyber risk.[53] Authorities and regulations are increasingly focused on information sharing,[54] alongside other organisational initiatives that focus on information sharing like the Financial Services Information Sharing and Analysis Center (FS-ISAC[55]) or the UK's Cross Market Operational Resilience Group.

Trust is a key element when it comes to information sharing. Financial institutions may not be inclined to share confidential details about cyber incidents with its competitors or supervisors. To foster information sharing between financial institutions and authorities, obstacles to it (e.g. limitations imposed by regulations or national security agencies, lack of trust between parties or confidentiality and liability concerns) must be overcome.

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52 See Ross (2020), Kaffenberger and Kopp (2019), and Healey et al. (2018b).

53 See Oliver Wyman and Depository Trust and Clearing Corporation (2018).

54 See World Bank (2020), and Basel Committee on Banking Supervision (2018).

55 See FS-ISAC web page.

Authorities should help build a trust network that fosters information sharing across the financial sector. To do so, it is our opinion that encouraging voluntary sharing is the best option, whether it is between financial institutions, between authorities or between financial institutions and authorities. All parties should agree a common set of rules and formats to share information and an open dialogue must be established to discuss what barriers are identified and how they can be overcome (e.g. changes in legislation, setting up secure information sharing mechanisms or creating public-private collaboration forums).

As mentioned earlier in this article, there are already **microprudential policies** that deal with cyber risk, and their **evolution is crucial** to better reflect expectations from regulators and guidance from international bodies[56] and to adapt to new technologies and circumstances.[57]

The first three regulatory principles presented in Kashyap and Wetherilt (2019) show how microprudential policies can be a catalyst for improving individual institutions' risk management: (i) insist that firms operate with the presumption that a successful high-impact attack is inevitable; (ii) insist that firms plan for prolonged and system-wide disruption, with particular attention to resourcing for response and recovery; and (iii) aim for a two-way dialogue between firms and supervisors as part of a wider collaborative approach to recovery objectives.

All these lines of action must follow an overarching principle of **regulatory harmonization.** Regulatory fragmentation will not only hinder the aforementioned improvements suggested, it has a clear negative impact on coordinating, gaining a clear overview of the financial system, sharing information or understanding the aggregated impact of individual risks. It is paramount that further legislative improvements are aligned, with recent efforts to enhance regulatory harmonization like the European Commission initiatives DORA and NIS2. This means focusing on regulatory initiatives with a wider scope rather than on specific aspects or activities of the financial sector.

6 Conclusions

Information systems are a key resource for developing and supporting **financial services** as well as enabling financial institutions' strategies. This important role along with some features of the financial system (i.e. interdependencies and the difficulty in achieving a clear view on them, reliance on data and on confidence) make cyber risk a potential threat to financial stability.

56 See G7 (2016), and Crisanto and Prenio (2017).

57 See Kopp et al. (2017).

The financial sector is a traditional victim of cyber-attacks. Studies show that the average annual cost related to these malicious cyber incidents is particularly high in this sector. A closer look onto malicious cyber incidents reveals new attacks discovered every month, with an increasing severity and sophistication.

Cyber risk is different to other forms of operational risk. While directly linked with technology, persons and processes play also a vital role in it and they all present the vulnerabilities that give rise to cyber risk. These vulnerabilities are exploited by cyber threats, sometimes specifically tailored for the financial sector, including, among others, data thefts, identity thefts, supply chain attacks and data encryption. Even if a cyber-incident at individual institutions does not pose a risk to the whole system, it can impair the institution's capabilities and even compromise their viability.

The financial sector is highly reliant on data and confidence; it also features a high degree of interdependence between its components and there is no clear view on those dependencies. These intrinsic characteristics make **the financial sector particularly vulnerable to cyber risk and confers this risk the potential to impact financial stability.** In order to assess the potential impact of cyber risk, quantitative and qualitative models are being developed, each with different advantages and disadvantages.

One of these models is the conceptual model developed by the ESCG, based on the FSB's approach to macro-financial implications of operational and cyber risk. The model can be applied to real and hypothetical scenarios to understand how a cyber-incident can spread and evolve to become a systemic event and which mitigants could help reduce its impact. The ESCG concluded from the application of the model that in order to threaten financial stability, a cyber-incident would require a specific convergence of factors.

Both microprudential and macroprudential policies are paramount to reduce the potential impact of cyber risk on financial stability. While cyber risk has been under the microprudential policies' focus for some time, this has not been the case for macroprudential policies, which remain to be further developed in several areas. One possible explanation could be the lack of actual cases of a cyber-incident impacting financial stability since the introduction of macroprudential tools in financial regulation. In addition, the characteristics of cyber risk may render existing macroprudential tools ineffective when applied to issues stemming from cyber-incidents.

Cyber risk is becoming an increasingly important area of attention for authorities with capacity to issue regulation for the financial sector[58] **or**

58 Financial institutions may also be affected by cyber security regulations issued by non-financial authorities at both national and supra-national levels.

influence in it. The effort carried out ranges from high level principles issued by fora like the G7[59] or the Basel Committee on Banking Supervision (BCBS),[60] European initiatives like Digital Operational Resilience Act[61] (DORA) and the Revised Directive on Security of Network and Information Systems[62] (NIS2) to more detailed guidelines like those issued by the European Banking Authority (EBA). Even though the current regulatory framework for cyber risk still lacks a harmonized approach, through initiatives like DORA or NIS2, authorities aim to reduce the regulatory fragmentation affecting cyber risk.

Given the intrinsic characteristics of the financial sector and cyber risk as well the current status of regulation and policies, we are of the opinion that **additional efforts should be made to lessen the impact of cyber incidents on financial stability.** Despite authorities increasing attention on cyber risk, we think that there is still room for legislative improvements in order to:

- Enhance coordination between authorities during cyber incidents.
- Gain a better understanding of cyber risk's potential impact on financial stability.
- Enhance preparation and foster information sharing both at institutions' and authorities' level.
- Reduce the aggregated impact of cyber risk at individual level.
- Increase regulatory harmonization.

59 See G7 (2016) and G7 (2018).

60 See Basel Committee on Banking Supervision (2018).

61 See legislative proposal for an EU regulatory framework on digital operational resilience for the financial sector – Digital Operational Resilience Act (DORA).

62 See proposal for directive on measures for high common level of cybersecurity across the Union - Network and Information Systems (NIS 2 Directive).

REFERENCES

Accenture and Ponemon Institute (2019). *Ninth Annual Cost of Cybercrime Study.*

Basel Committee on Banking Supervision (2018). *Cyber-resilience: Range of practices,* Bank for International Settlements.

Boer, M., and J. Vázquez (2017). *Cyber Security & Financial Stability: How cyber-attacks could materially impact the global financial system,* Institute of International Finance, Washington, DC.

Crisanto, J., and J. Prenio (2017). «Regulatory approaches to enhance banks' cyber-security frameworks», *FSI Insights on policy implementation,* No. 2, Financial Stability Institute, Bank for International Settlements.

Eisenbach, T. M., A. Kovner, and M. J. Lee (2020). *Cyber Risk and the U.S. Financial System: A Pre-Mortem Analysis,* Federal Reserve Bank of New York Staff Reports, Report No. 909.

European Central Bank (2016). *Stocktake of IT risk supervision practices*.

European Systemic Cyber Group (2020). *Systemic cyber risk,* European Systemic Risk Board.

Financial Stability Board (2013). *Guidance on Identification of Critical Functions and Critical Shared Services.*

Financial Stability Board (2018). *Cyber Lexicon*.

G7 (2016). *Fundamental Elements of Cybersecurity for the Financial Sector,* G7 Cyber Expert Group.

G7 (2018). *Fundamental Elements for Third Party Cyber Risk Management in the Financial Sector,* G7 Finance Ministers and Central Bank Governors.

Goh, J., H. Kang, Z. X. Koh, J. W. Lim, C. W. Ng, G. Sher and C. Yao (2020). *Cyber Risk Surveillance: A Case Study of Singapore,* Working Paper No. 20/28, International Monetary Fund.

Healey, J., P. Mosser, K. Rosen and A. Tache (2018a). *The Future of Financial Stability and Cyber Risk,* Cybersecurity project at Brookings, the Brookings Institution, Washington, DC.

Healey, J., P. Mosser, K. Rosen and A. Wortman (2018b). *The Ties That Bind: A Framework to Assess the Linkage Between Cyber Risks and Financial Stability,* Project on Cyber Risk to Financial Stability, School of International and Public Affairs, Columbia University, New York.

International Monetary Fund/Bank for International Settlements/Financial Stability Board (2009). *Guidance to Assess the Systemic Importance of Financial Institutions, Markets and Instruments: Initial Considerations,* Report to the G-20 Finance Ministers and Central Bank Governors.

Kaffenberger, L., and E. Kopp (2019). *Cyber Risk Scenarios, the Financial System, and Systemic Risk Assessment,* Cyber Policy Initiative Working Paper Series, "Cybersecurity and the Financial System", No. 4, Carnegie Endowment for International Peace, Washington, DC.

Kashyap, A., and A. Wetherilt (2019). «Some Principles for Regulating Cyber Risk», *AEA Papers and Proceedings,* 109, pp. 482-487, American Economic Association.

Kopp, E., L. Kaffenberger and C. Wilson (2017). *Cyber Risk, Market Failures, and Financial Stability,* Working Paper No. 17/185, International Monetary Fund.

Office of Financial Research (2017). *Cybersecurity and Financial Stability: Risks and Resilience,* Viewpoint February.

Oliver Wyman and Depository Trust and Clearing Corporation (2018). *Large-scale cyber-attacks on the financial system. A case for better coordinated response and recovery strategies,* white paper.

Ross, G. (2020). *The making of a cyber crash: a conceptual model for systemic risk in the financial sector,* Occasional Paper Series, No. 16, May, European Systemic Risk Board.

VMware (2019). *2020 Cybersecurity Outlook Report,* March, VMware Carbon Black Threat Analysis Unit.

World Bank (2020). *Financial Sector's Cybersecurity: A Regulatory Digest,* July, Financial Sector Advisory Center, World Bank Group.

The design of macroeconomic scenarios for climate change stress tests

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Abstract

The challenges of climate change affect all aspects of the economy, including financial stability, which may be affected both by the physical risks (associated with the climate change process itself) and the transition risks (associated with initiatives to curb the climate change process). This article presents a model designed to produce macroeconomic scenarios, chiefly related to transition risks, to serve as a basis for stress tests to verify that all the components of the financial system are prepared for possible adverse events of this type. In particular, these scenarios are based on a hypothetical rise in the price of CO_2 emission allowances, over a 2-5 year horizon. The model simulates the impact of this shock on the Spanish economy, paying particular attention to sectoral asymmetries arising from the intensity with which different types of energy are used in each industry, the interdependencies summarised in the input-output tables for the Spanish economy and the general equilibrium effects in terms of relative price changes and sectoral reallocation.

1 Introduction

The challenges of climate change affect all aspects of the economy, including financial stability. Both the physical risks and the transition risks may have asymmetric effects that reveal a special vulnerability in certain sectors or firms, so that under the most pessimistic scenarios, some financial institutions[1] may find themselves in difficulty if they are poorly diversified in these newly relevant dimensions. Bank stress tests attempt to anticipate the possible emergence of this type of problem. To carry out such tests, quantitative tools are required to simulate the effects of shocks and their transmission throughout the economy and financial system. This article presents one of the elements being prepared for these climate change stress tests: a sectoral model capable of generating macroeconomic scenarios to serve as the starting point of the exercise. As the model is still under development and the current objective is merely to begin to communicate the preparation process for these scenarios, this article only addresses the main features of the model and the type of results it can generate. In particular, no details are provided (for the time being) about the effects of the simulated shock on specific sectors.

Physical risks are those associated with the process of climate change. These include, inter alia, rising temperatures, ice melt and sea level rises, a higher frequency

1 These include not only banks, but also other financial intermediaries, such as insurance companies and investment funds, which are closely linked to banks in Spain. In principle, the scenarios generated by this model may be used to analyse the effects of the shock on all of them.

and intensity of adverse atmospheric phenomena, progressive degradation of environmental variables, such as air and water quality, deforestation and biodiversity loss.[2] These risks are already beginning to materialise, causing significant damage (to capital goods and real estate, for example), reductions in productivity and ad hoc disruptions to production chains. They can be expected to continue increasing for decades, so that the most adverse effects will be concentrated in the long run.

Transition risks, on the other hand, are those associated with initiatives to stop the climate change process: raising the cost of emission allowances, new taxes and subsidies to accelerate reductions in greenhouse gas emissions, new regulations requiring changes in agents' behaviour to obtain these results, technological changes that increase the rate at which capital is depreciated when replaced by less polluting options, or even consumer preference changes prompting a producer response, etc. In the political sphere, the development of climate change legislation also affects financial institutions: for example, the European Commission's "Action Plan: Financing Sustainable Growth" seeks to redirect capital flows towards sustainable investment, and the Taxonomy Regulation, also approved by the European Commission, defines the criteria for classifying economic activity environmentally. Legislative developments may also affect financial institutions' asset portfolios, including the EU Green Bond Standard, which will potentially have an impact on asset valuations, the inclusion of environmental aspects in the European Central Bank's (ECB) bank stress tests, and, more generally the ECB's mandate review.[3] In the case of physical risks, the greatest danger is that actions end up being insufficient to change the current course of climate change and avert the most pessimistic scenarios in the long term. This extended time frame should mitigate the implicit risks to financial stability, allowing institutions to adapt their exposure to different firms and sectors smoothly over time; even so, given the potential extent of these risks, they will also need to be evaluated quantitatively. In the case of transition risks, however, there is a greater probability of observing potentially sizeable effects within more limited time periods, especially if a disorderly transition amplifies the short-term costs.[4]

The model presented in this article is designed to produce macroeconomic scenarios, chiefly relating to transition risks, to serve as the basis for stress tests to verify that every part of the financial system is prepared for possible adverse events of this type. In particular, these scenarios will be based on a hypothetical rise in the price of CO_2 emission allowances, within a horizon of 2 to 5 years. The model simulates the impact of this shock on the Spanish economy, paying particular attention to sectoral asymmetries arising from the intensity with which different types of energy are used in each industry, the interdependencies summarised in the input-output

2 Various European and international bodies have published evidence on the long-term physical impact of climate change. See OECD (2015), G20 (2016), ECB (2019) and European Commission (2020).

3 See ECB (2021).

4 See Bank of England (2018), ESRB (2016) and ECB (2019).

tables for the Spanish economy, and the general equilibrium effects in terms of relative price changes and sectoral reallocation.[5]

Section 2 details the main characteristics of the model in question, while Section 3 discusses the preliminary simulation results and Section 4 presents sensitivity exercises for these results. Lastly, Section 5 sets out the conclusions.

2 A sectoral general equilibrium model of the Spanish economy

The banking sector stress tests take as their starting point macroeconomic scenarios designed to reflect the possible behaviour of the economy in the event that large negative shocks materialise. In later stages, the aggregate variables these scenarios provide are used to estimate their effect on bank loan portfolios and balance sheets. The scenarios are usually prepared using traditional macroeconomic models, such as the Quarterly Macroeconometric Model of the Banco de España (MTBE),[6] which summarises the historical relationships between the main variables of the Spanish economy, e.g. between firms' investment and the demand or interest rates they face, or between household consumption and real disposable income or the unemployment rate. That model is a general one, capable of simulating a large variety of possible shocks. However, it does not contain the necessary ingredients to prepare a scenario that adequately reflects the transition risks. This requires a detailed sectoral breakdown and specific details of the energy use and emissions intensity in each industry.

To fill these gaps, a new macroeconomic model has, in recent months, begun to be designed specifically to generate these scenarios. The model is still not complete, but, as in the case of the MTBE, it probably never will be; instead it will be subject to a constant process of renewal and enhancement to adapt it to events and needs as they arise. The main features of this model are outlined below. Within the next few months, the Banco de España will publish an occasional paper providing more technical details of the specification of the current version of the model.[7]

Inspired by previous developments in the literature,[8] the model is a general equilibrium one in which agents adjust their decisions according to those of all the other agents. In particular, prices and quantities are optimally adjusted, following the prescriptions derived from the optimisation problem described for the various model agents (inter

5 The current model features very rich heterogeneity as regards sectors and input-output table links. However, the current version does not have capital or financial frictions, nor is the banking sector explicitly modelled, which could be an additional feedback channel. This extension is left for the future. Also, the model focuses on cross-sector heterogeneity, since it is especially relevant to explaining the different impact of transition risks. There may be other levels of intra-sectoral or geographical heterogeneity that are also relevant (as found, for example, by Bolton and Kacperczyk (2020)), but they are not reflected in this model and are not explored in this article.

6 See Arencibia, Hurtado, De Luis and Ortega (2017).

7 See Aguilar, González and Hurtado (2021).

8 See, for example, Bouakez, Rachedi and Santoro (2020).

Table 1
SECTORS CONSIDERED BY THE MODEL

Non-energy sectors	
1 Crop and animal production	27 Other wholesale trade
2 Forestry and logging	28 Other retail trade
3 Fishing and aquaculture	29 Land transport
4 Mining and quarrying	30 Water transport
5 Manufacture of food, beverages and tobacco products	31 Air transport
6 Manufacture of textiles, wearing apparel, leather	32 Warehousing & support activities for transportation
7 Manufacture of wood and wood products, except furniture	33 Postal and courier activities
8 Manufacture of paper and paper products	34 Accommodation and food service activities
9 Printing and reproduction	35 Publishing activities
10 Manufacture of chemicals and chemical products	36 Motion picture, video, television, music and radio
11 Manufacture of pharmaceutical products	37 Telecommunications
12 Manufacture of rubber and plastic products	38 Computer programming and information services
13 Manufacture of other non-metallic mineral products	39 Financial services, except insurance and pensions
14 Manufacture of basic metals	40 Insurance and pension funding
15 Manufacture of fabric. metal products, exc. mach. & equip.	41 Auxiliary activities to financial services
16 Manufacture of computer, electronic and optical products	42 Real estate activities
17 Manufacture of electrical equipment	43 Legal and accounting activities
18 Manufacture of machinery and equipment	44 Architectural and engineering activities
19 Manufacture of motor vehicles	45 Advertising
20 Manufacture of other transport equipment	46 Other professional services
21 Manufacture of furniture; other manufacturing	47 Administrative services
22 Repair and installation of machinery and equipment	48 Public administration and social security
23 Water collection, treatment and supply	49 Education
24 Sewerage & waste collection, treatment & disp. activities	50 Health
25 Construction	51 Other service activities
26 Wholesale and retail trade and repair of motor vehicles	
Energy sectors	
52 Manufacture of coke and refined petroleum products	53 Electricity, gas, steam and air conditioning supply

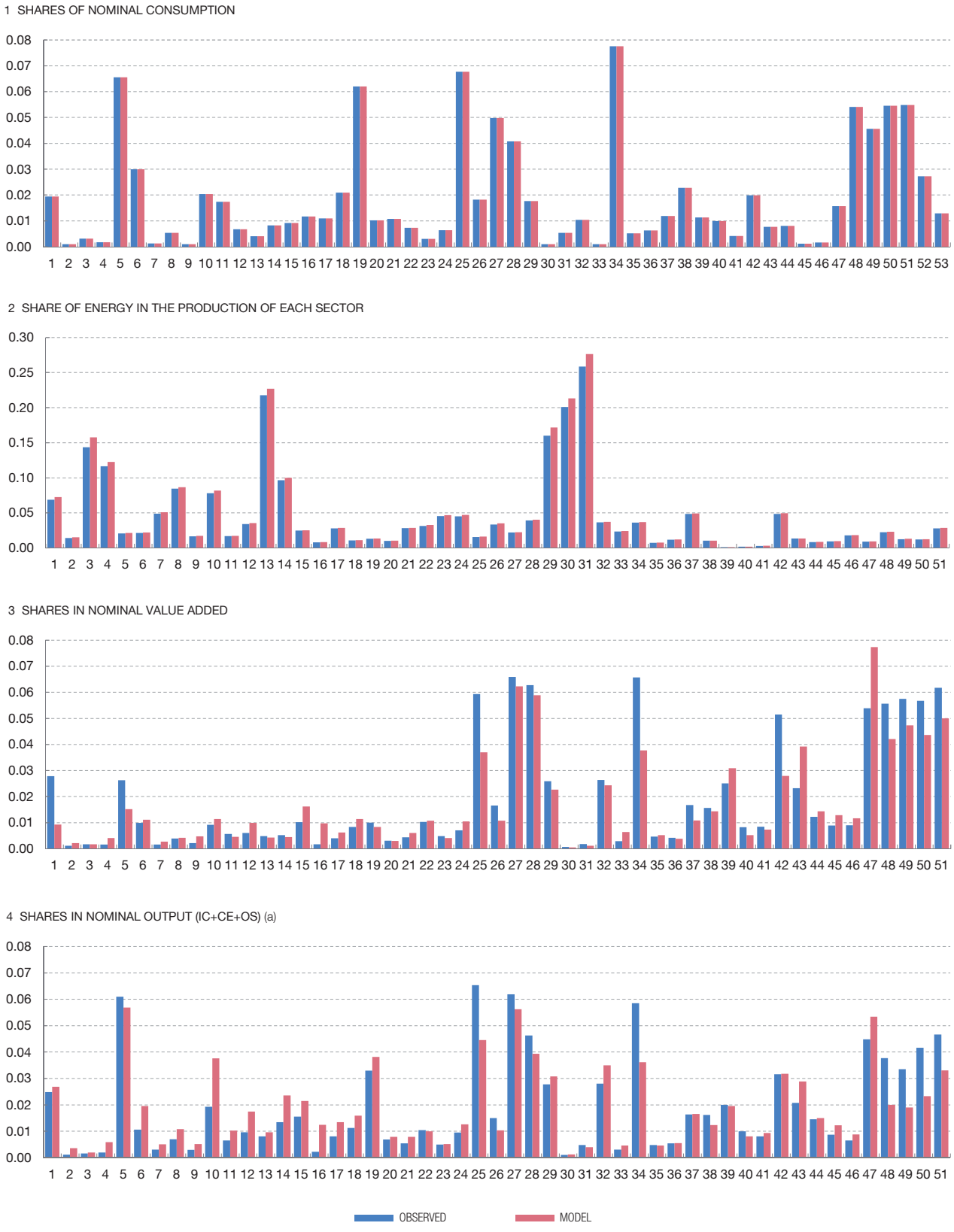
SOURCE: Devised by the authors

alia, consumers, producers and retailers). This is the main reason for the difficulty of computing the model equilibrium: it is necessary to find the set of prices and quantities for all sectors that simultaneously ensures that all agents are at their optimal point and that all the aggregate constraints of the economy are satisfied (the supply of each product coincides with its demand, the labour firms demand is equal to the supply by households, etc.).

One of the main features of the model is its detailed sectoral breakdown. Given that the risks associated with climate change have a very marked asymmetric component in this respect, it is essential for the model to be capable of capturing the different share of energy in the production functions of the various industries, and the interrelations between them. Table 1 sets out the sectoral breakdown currently used by the model:

Chart 1

MODEL CALIBRATION: SECTORAL DATA ADJUSTMENT



SOURCE: Authors' calculations, based on Eurostat data.

a IC stands for intermediate consumption, CE for compensation of employees and OS for operating surplus.

51 non-energy sectors and two energy production sectors ("fuels" and "electricity"). Chart 1 shows how the model calibration precisely replicates the share of each sector in household consumption and reasonably approximately (but not exactly, owing to the simplifications involved in the stylised form of the aggregator and production functions) the share of energy in the inputs of the various non-energy sectors, and the relative size of the various industries in terms of value-added and output.

The two energy sectors differ as regards the amount of emission allowances associated with each, and also in the way in which the simplified specifications of the model relate to the more complex real world structures.

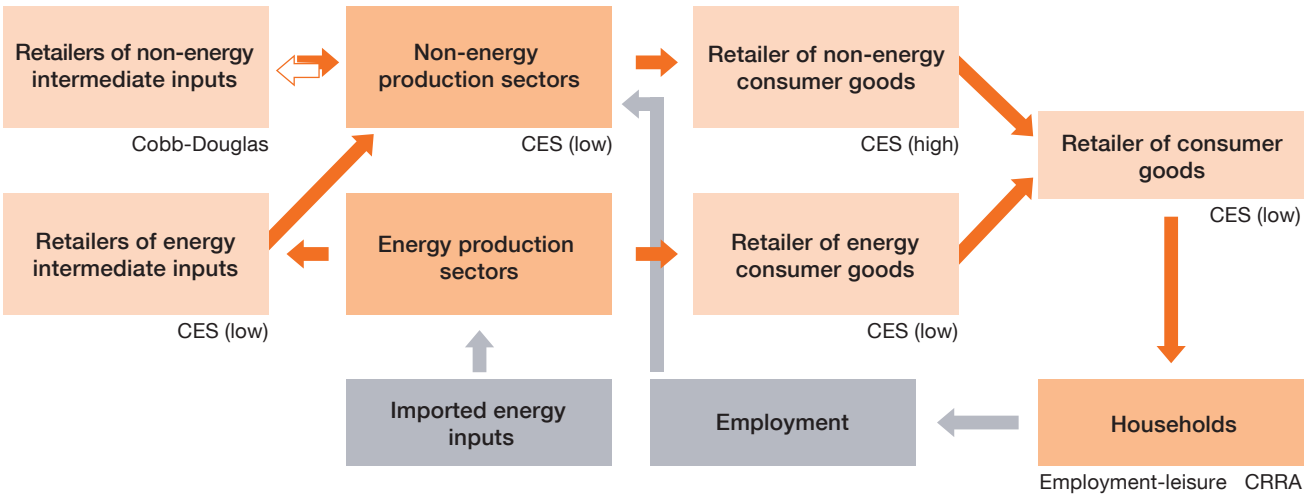
In the case of fuels, their production does not generate a large amount of emissions, but their use does; it is the agents who use the fuels that have to acquire the associated emission allowances, while the fuel producer receives a price that does not include the amount corresponding to such allowances. Electricity, in contrast, generates emissions when it is produced, but not necessarily when it is used. Thus, electricity users do not need to acquire emission allowances, but simply pay a price to electricity producers, who are responsible for obtaining the necessary emission allowances to be able to produce that electricity.

In contrast to these real-world idiosyncrasies, in the simplified structure of the model both sectors function in the same way: energy users pay a gross price that includes the electricity or fuel itself along with the necessary emission allowances to produce or consume it, and energy producers receive a net price from which the cost of these emission allowances has already been deducted. The fitting of the model to the data resolves this divergence between the real-world and model structures: the fuel price in the real world corresponds to its net price in the model, while the electricity price in the real world corresponds to its gross price in the model.

The difference between the gross price and the net price in the model is generated by a tax rate associated with the emissions, which is calibrated with the data available for the Spanish economy in the input-output tables and in the industry CO_2 atmospheric emission accounts published by the INE (National Statistics Institute). For electricity, the tax rate is obtained from the relationship between the value of the emission allowances used by the electricity production sector and the sectors' aggregate revenues, net of these allowances. In the case of fuels, the tax rate is estimated by means of the relationship between the value of the emission allowances used by all sectors, other than the electricity sector, and the sector's aggregate revenues, net of the allowances it uses. The result is a much higher tax rate associated with fuels than with electricity, corresponding to the higher level of emissions generated by the production and use of the former.

Figure 1 summarises the structure of the model very succinctly. In the lower right-hand corner, households choose optimally between consumption and leisure in order to maximise a utility function with constant relative risk aversion; that choice

Figure 1
SUMMARY REPRESENTATION OF THE MODEL STRUCTURE



SOURCE: Devised by the authors.

will depend on the level of consumption and the relationship between the aggregate price and wages. On the right-hand side of the figure, these households purchase a homogeneous good from the consumption retailer, who combines energy and non-energy consumer goods by means of an aggregator function with constant elasticity of substitution. Each of these two consumer goods is obtained, in turn, from a retailer who aggregates the different kinds of energy and non-energy goods by means of the corresponding CES (constant elasticity of substitution) aggregator function. And on the left-hand side, there are another 51 retailers of non-energy intermediate products with a Cobb-Douglas aggregator function (equivalent to a CES function with unit elasticity), and 51 retailers of energy intermediate products with a CES aggregator function, who combine the different products in order to sell the basket of energy or non-energy intermediate products used by each of the non-energy production sectors. In addition to these two baskets of intermediate products, the non-energy producers also use employment, combining the three elements by means of a nested CES production function. The energy producers in the model use a much simpler technology: the only input they use is basic energy products, imported at an international price that does not depend on actions taken in the domestic economy (in particular, this price should not change when the tax rate associated with emissions is raised in the simulation).

The different aggregator and production functions contain numerous parameters that allow the degree of substitution between goods to be controlled. In general, almost all of them are calibrated at values smaller than one, indicating that some – albeit limited – substitution between goods is to be expected in response to the simulated shock. This is true for substitution between fuels and electricity, both in the case of consumer goods and in that of intermediate products. The value of these elasticity of substitution

parameters must be adjusted to the simulation horizon: a rise in the price of emission allowances would not be expected to lead to significant substitution between fuels and electricity in the road transport sector within a 3-year period, but could be expected to within 15 years. Among the various non-energy intermediate products, substitution is one-for-one (Cobb-Douglas aggregator), which means that the quantities react proportionately to the relative-price changes, so that the nominal weight of the different sectors in the basket of intermediate products acquired by each non-energy producer remains constant.[9] The only elasticity of substitution calibrated with a value greater than one is that of the retailer of non-energy consumer goods: households may substantially adjust how they distribute their consumption among the different categories of non-energy goods when their relative prices change.

In total, 159 agents interact with one another in the model:

— 1 representative household.

— 51 non-energy producers, who use employment, a basket of different energy intermediate products and a basket of different non-energy intermediate products.

— 2 energy producers, who use imported basic energy products.

— 1 consumption aggregator, who combines two products (energy and non-energy products).

— 1 energy consumption aggregator, who combines two products (fuels and electricity).

— 1 non-energy consumption aggregator, who combines 51 products (those produced by each of the non-energy sectors).

— 51 energy intermediate product aggregators, each of which combines 2 energy products (fuels and electricity).

— 51 non-energy intermediate product aggregators, each of which combines 51 non-energy products.

Computing the model equilibrium requires finding the 159 prices and the almost 3,000 quantities that simultaneously satisfy the optimality conditions of all these agents and the economy's aggregate constraints.

9 This level of substitution may be too high for simulations with a short time horizon, so that in future it may be desirable to replace these Cobb-Douglas aggregators with aggregators with a constant elasticity of substitution of less than one. However, given the large number of variables in this block of the model, the computational complexity of the exercise would increase substantially. The result would be a (non-homogeneous) widening of the sectoral differences in the simulation (greater impact in almost all sectors that already have especially negative effects).

3 A simple simulation exercise

The model described in the previous section can be used to estimate the effects of a rise in the price of CO_2 emission allowances. The results will take into account the Spanish economy's production structure (summarised in the input-output tables) and the general equilibrium effects in terms of relative price changes and sectoral reallocation in production and consumption alike.

In the simulation exercise presented below, the results of which are still very provisional, the shock consists of a substantial increase in the tax rate that represents the cost of CO_2 emission allowances in the model. The price of these allowances increased approximately fivefold between summer 2017 and summer 2019, largely as a result of regulatory changes designed to reduce excess supply in the market and generate greater incentives to reduce emissions, by means of reductions in the amounts supplied in allowance auctions and the launch of the Market Stability Reserve (MSR) which began to operate in January 2019. As an example of a possible intensification of these transition risks, the simulation estimates the impact of a further increase of similar magnitude, from €33 per tonne of CO_2 emitted (the market price at the beginning of 2021) to €165 per tonne.

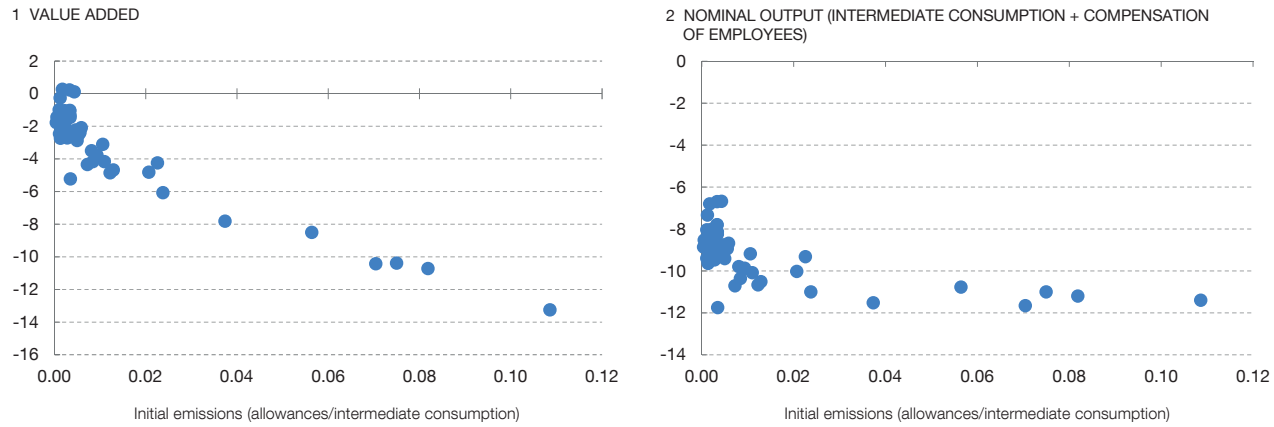
Under a relatively standard calibration, this shock gives rise in the model to a sharp reduction in the use of energy in consumption and production alike. This reduction is greater in the case of fuels, the use of which is reduced by 34%, than in that of electricity (down 19%), which is less emissions intensive.

The aggregate effects of the shock are negative: employment falls by 2.3% and real GDP by 3%. However the cross-sector dispersion is high: some sectors suffer much more severe falls than the average, while a few are even favoured. In general, the sectors most prejudiced by the increase in emission costs are the most energy-intensive ones, but significant non-linear second-round effects are observed in the simulation. Thus, there are sectors with relatively similar emission shares that are affected very differently, depending on the other sectors with which they are most interrelated. A sector that generates limited emissions may be strongly affected if it uses many intermediate products from energy-intensive sectors (their costs increase) or if a significant portion of its sales are to such sectors (their demand falls). Calibration of the model with input-output table data for Spain ensures that these relationships are realistically captured.

Chart 2 shows the relationship between the level of emissions of each non-energy sector and the impact of the simulation, in terms of real value-added and output. The energy sectors, which are not shown in these charts, are clearly the ones most affected. Since the results are still preliminary and will be revised in future, the chart does not indicate which observations correspond to which sectors.

Chart 2

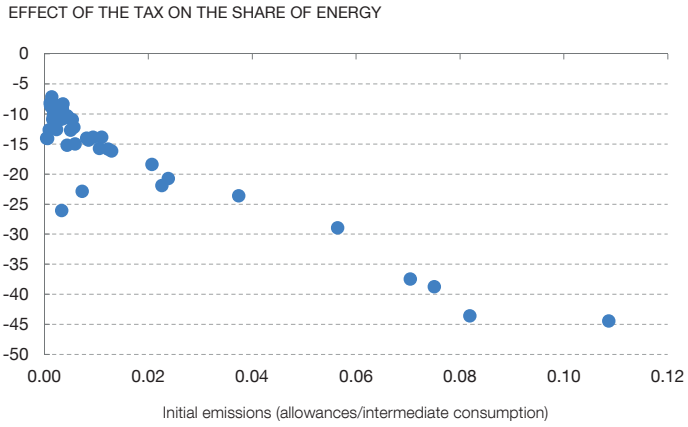
EFFECT ON THE VARIOUS SECTORS OF THE INCREASE IN THE COST OF EMISSIONS



SOURCE: Authors' calculations, based on Eurostat data.

Chart 3

EFFECT OF THE INCREASE IN THE COST OF EMISSIONS ON ENERGY INTENSITY



SOURCE: Authors' calculations, based on Eurostat data.

In response to the shock, all the productive sectors substantially reduce the amount of energy they use, but the effect is strongest in the most polluting sectors, which not only reduce their output to a greater extent, but also make larger cuts to the share of energy in the set of intermediate products they use. This result is illustrated in Chart 3.

Aggregate household consumption also falls considerably. This decline in consumption is seen in practically every sector (see Chart 4), but the fall is most marked in those products that become relatively more expensive in response to the shock.

Overall, the simulation generates the results expected, in the sense that the sectors most prejudiced by the increase in the price of emission allowances are those with the highest emissions, but it also has interesting non-linear effects, associated with the interrelations between sectors reflected in the input-output matrix.

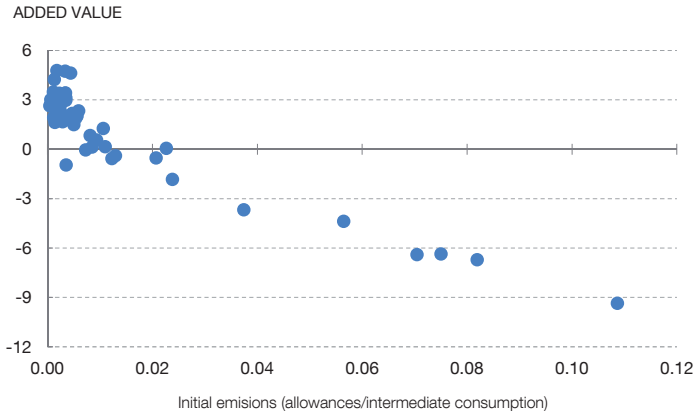
4 Sensitivity of the results to changes in some parameters

Especially as regards their quantification, the results of the simulation presented in the previous section depend crucially on the broad set of parameters with which the model is calibrated and the structures represented therein. This section presents two sensitivity exercises around the baseline simulation: first, the way in which the emission-cost increase is implemented is changed; and second, the parameters that regulate the degree of product substitution in firms' production functions and in consumers' utility function are modified.

In the version of the model used in the previous section, agents are refunded the cost of emission allowances through lump-sum transfers to households, a simple way of approximating any real-world mechanism in which the allocation of emission allowances and the effects on household income do not depend on households' future actions. This assumption gives rise to a particularly pessimistic scenario: regulatory changes may also be implemented so that the higher cost of emissions generates an increase in government revenues that allows the negative shock arising from the increase in emission costs to be offset by other tax changes that may partly mitigate its negative effects. Given that the aim of these simulation exercises is to generate macroeconomic scenarios that serve as a starting point for the performance of climate-change stress tests for the banking sector, it is reasonable to use assumptions that amplify the negative effects of the shock. However, this is not necessarily the most likely scenario.

Chart 5 presents the results of an alternative simulation in which the regulatory change is implemented in such a way as to minimise transition costs: the cost of emissions is raised by means of a tax that increases government revenues, allowing other distorting taxes to be reduced (in this case, the tax on household wage income). This affects the household choice between leisure and work, generating a positive supply-side shock (an increase in labour supply) that combines with the negative one (associated directly with the increase in emission costs). Depending on the calibration of the wage elasticity of labour supply, the net result may be, as in this simulation, expansionary: both employment and GDP increase, the negative impact on the sectors that generate most emissions is reduced and a considerable number of industries are benefited by the shock. These industries generate limited emissions and do not heavily depend, either through their purchases or sales, on sectors that generate large emissions, so that they are not significantly affected by the increase in emission costs, although they are benefited by the higher labour supply (and by a

Chart 5
ALTERNATIVE SIMULATION WITH REDUCTION OF TAXES ON LABOUR INCOME



SOURCE: Authors' calculations, based on Eurostat.

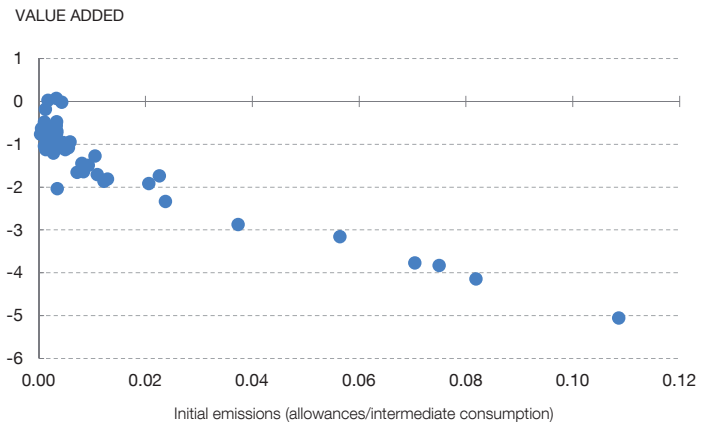
fall in their prices relative to other sectors, which was already present in the simulation in the previous section).

As compared with the fall of 34% and 19% in the use of fuels and electricity under the baseline simulation, this scenario with reduced taxes on employment income generates somewhat lower reductions of 29% and 13%. However the cost in terms of employment and GDP is completely eliminated, which means it is possible to implement a larger increase in emission costs until the same emissions-reduction effects are achieved, without the economic costs at aggregate level (although there are still significant negative effects for some sectors).

A second dimension in which sensitivity exercises need to be performed is that of the elasticities of substitution between goods. As mentioned in the previous section, the sectors most affected by the increase in emission costs are those most dependent on the use of fuels. In the long-term, the elasticity of substitution between types of energy will be higher, allowing these sectors to substitute, to a greater extent, electricity for fuels, or inputs that require less energy for those that use a large amount of energy. In any event, the CO_2 emissions associated with their productive processes will be cut and, therefore, the contractionary effect of the shock reduced. The results of an alternative simulation with a higher elasticity of substitution are shown in Chart 6.

This higher elasticity of substitution reduces the sectoral heterogeneity, giving rise to a more uniform effect across sectors. The sectors that were prejudiced in the baseline simulation are still the ones that decline most in this version with a higher elasticity of substitution, and the sectors benefited are also still the same ones, but

Chart 6
ALTERNATIVE SIMULATION WITH HIGHER ELASTICITY OF SUBSTITUTION



SOURCE: Authors' calculations, based on Eurostat data.

the difference between the former and the latter is significantly reduced. When this scale difference is corrected, the shape of the cloud of dots is similar but not identical to the original: the change in the elasticity of substitution generates moderately non-linear effects which depend on the productive structure and sectoral interrelations.

5 Conclusions

Both climate change and the policies implemented to counter it may have negative effects on the economy, which would be transmitted to financial institutions through their exposure to the firms and sectors most affected. These risks should be assessed with a view to mitigating and preventing their impact on financial stability. For this purpose, various institutions, including the Banco de España, have begun to prepare climate-change stress tests for banks, to identify actions to reduce the probability of the most unfavourable events.

As an initial ingredient, such stress tests require macroeconomic scenarios that capture the effect on the economy of possible adverse shocks. This article has presented a model specifically designed to build such scenarios. The model focuses on the transition risks, associated with the regulatory measures applied to check climate change, as these are the most important ones over relatively short time horizons. And since the effects of these risks are foreseeably highly asymmetric across sectors, the model is highly granular and stresses the interrelations described by the input-output tables for the Spanish economy and the general equilibrium effects in terms of relative-price changes and substitution between intermediate

products in firms' production functions, and between types of consumption in the household utility function. Physical risks (arising from climate change itself) remain for a subsequent development, which will require a different model, more focused on the long term and probably less sectorally disaggregated.

This article has presented a still-preliminary version of this sectoral model for transition risks. In the short term, the focus will be on improving the model to fit other aspects of the observed data and on increasing the flexibility of the options for the parameters defining the elasticity of substitution between goods in the various aggregator, production and consumption functions. Further ahead, the model could be expanded to convert it into an open economy model, with exports and with imports in addition to those of basic energy goods, and to include capital in the production function, enhancing the realism with which the model fits the data and allowing effects on assets used by firms as loan collateral to be incorporated into the simulations.

Even in its current simpler version, the model already quite closely approximates the productive structure of the Spanish economy and allows reasonably realistic simulations to be formulated, in which the sectors most affected by a rise in the price of emissions are those that use energy inputs more intensively, while at the same time reflecting the non-linear effects generated by the interrelations between sectors in a general equilibrium structure.

The model allows certain key factors for designing policies to combat climate change to be identified and, in particular, highlights the importance of designing fiscal instruments and regulatory mechanisms to achieve emission reduction objectives at the lowest possible economic cost. Notwithstanding this, the results of the simulations also show that, even in the best scenarios, risks remain for certain sectors that would be prejudiced by a disorderly transition, even if environmental policies are implemented through tax structures that include compensation to eliminate adverse effects at the aggregate level. The climate change stress tests for banks will attempt to ensure that the financial stability risks associated with these shocks are minimised.

REFERENCES

Adrian, T., N. Boyarchenko and D. Giannone (2019). "Vulnerable Growth", *American Economic Review,* 109(4), pp. 1263-1289.

Aguilar, P., B. González and S. Hurtado (2021). "A sectorial model for carbon tax stress test scenarios», *Working Papers,* Banco de España, forthcoming.

Arencibia, A., S. Hurtado, M. de Luis and E. Ortega (2017). "New version of the Quarterly Model of Banco de España (MTBE)", *Occasional Paper* No 1709, Banco de España

Bank of England (2018). *Transition in thinking: The impact of climate change on the UK banking sector,* Report of the Prudential Regulation Authority, September.

Bolton, P., and M. T. Kacperczyk (2020). "Do Investors Care about Carbon Risk?" National Bureau of Economic Research (NBER), *Working Paper* No 26968.

Bouakez, H., O. Rachedi and E. Santoro (2020). "The Government Spending Multiplier in a Multi-Sector Model", R&R, *American Economic Journal: Macroeconomics.*

European Central Bank (2019). "Climate-related risks to financial stability", special feature B, *Financial Stability Review,* May.

European Central Bank (2021). "Climate change and central banking", speech by Christine Lagarde, President of the ECB, 25 January.

European Commission (2020). *Climate change impacts and adaptation in Europe,* JRC PESETA IV final report.

European Systemic Risk Board. *Too late, too sudden: Transition to a low-carbon economy and systemic risk,* report No 6 of the Advisory Scientific Committee, February.

G20 (2016). *G20 Green Finance Synthesis Report*, G20 Green Finance Study Group, September.

Organisation for Economic Co-operation and Development (2015). *The Economic Consequences of Climate Change,* OECD Publishing, Paris, November.

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