We analyse the determinants of coverage ratios and their components (non-performing loans (NPLs) and loss loan reserves) in a large sample of European banks. We find that bank-specific factors, particularly credit risk variables (including forward-looking indicators) and capitalization, matter the most. Coverage ratios adjust insufficiently as asset quality deteriorates, except in high-NPL banks. Capitalization has a positive effect on coverage ratio, pointing to a complementarity between the two buffers. At the country level, specific macroprudential levers and developing NPL secondary markets enhance coverage ratios. Our findings emphasize the importance of micro oversight and call for more stringent macro policies in high-NPL countries.

JEL codes: G21, G28, M41

—Lucia Alessi, Brunella Bruno, Elena Carletti, Katja Neugebauer and Isabella Wolfskeil
Cover your assets: non-performing loans and coverage ratios in Europe

Lucia Alessi, Brunella Bruno, Elena Carletti, Katja Neugebauer and Isabella Wolfskeil

Joint Research Centre, European Commission; Università Luigi Bocconi; Università Luigi Bocconi, IGIER and CEPR; Banco de Portugal; Università Luigi Bocconi

1. INTRODUCTION

One of the most debated issues in Europe in the last two decades concerns the accumulation of large stocks of non-performing loans (NPLs). Due to the significant GDP contractions experienced during the global financial crisis and the sovereign debt crisis, NPLs originating from European banks reached a peak of almost €1.2 trillion, nearly 8% of GDP, in 2015. Following numerous policy actions put forth to deal with this problem, NPLs gradually decreased to €638 billion in 2019 (EBA, 2019). Unfortunately, NPLs are bound to surge again due to the COVID-19 outbreak, and this time to potentially even higher levels than in the past, depending on the evolution of the pandemic (Ari et al., 2020).

Based on these forecasts, the key question is how the banking system should best prepare itself for the new deterioration in NPL stocks, also in light of the recently introduced IFRS 9 accounting rules which address the need for banks to set aside reserves in
anticipation of future losses, and what public policies could be most effective for this purpose. In this paper, we try to provide some answers to these questions by studying how banks managed their NPLs stocks following the previous crises and what policies turned out to be most effective then.

As is well known, high levels of NPLs are problematic as they may reduce a bank’s ability to lend and impair the monetary policy transmission mechanism, thus reducing output growth (Draghi, 2017; ESRB, 2019). However, what matters even more than the absolute amount of NPLs in a bank’s balance sheet is the level of loss coverage, that is the amount of loan loss reserves (LLRs), as this determines how losses originating from NPLs impact bank capital. To explain the mechanism, each year banks set aside loan loss provisions (LLPs), to form LLRs. These reserves work as a buffer to absorb expected loan losses because, when the loss occurs, banks can draw on these reserves without impairing their capital. Hence, the ‘uncovered’ portion of NPLs represents the real threat to bank balance sheets in terms of financial stability: ceteris paribus, banks with larger volumes of NPLs and lower coverage ratios are more vulnerable to negative shocks affecting borrowers’ credit quality, as they have lower buffers to withstand them, especially in bad times when loan losses are more likely. For these reasons, in the last decade, numerous policy initiatives have been designed to enhance banks coverage policies, with the coverage ratio (i.e., the share of LLRs over NPLs in a bank’s balance sheet) becoming a key prudential tool and supervisory metric for bank soundness (European Central Bank [ECB], 2016, 2017a).

Nevertheless, despite their economic and policy relevance, loan loss coverage policies still vary largely across banks and countries in Europe, with many of the countries with the highest level of NPLs reporting below-average coverage ratios (EBA, 2018). In this paper, we exploit this variation to investigate drivers and dynamics of bank coverage ratios and their components at both the micro (bank) and macro (country) level, using a sample of 441 large and medium-sized banks in Europe over the period 2010–17. The focus on Europe provides an interesting case study, given the high level of NPLs and the substantial bank and country heterogeneity in the region (EBA, 2018). The results also provide interesting insights in light of the current situation in the financial sector in Europe, where questions about optimal provisioning for COVID-19 losses loom large in many countries, in particular as a means to mitigate potential ‘cliff effects’ when the moratoria on loan repayments will expire.2

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1 For example, large institutions have commonly reported lower coverage ratios than small and medium-sized banks. At the country level, the average coverage ratio in Europe is nearly 46%, but it ranges from 24% in Finland to nearly 70% in Hungary (EBA, 2018).

2 In light of the spread of COVID-19, European governments have taken a variety of initiatives to provide economic support and relief measures aimed at addressing the economic consequences of the outbreak on households and businesses. Such measures include moratoria on repayment of loans, loan guarantees as well as other forms of business support targeted at individual firms or specific industries.
Our results point to the following three main conclusions. First, bank-specific factors are the main drivers of coverage ratios. This finding emphasizes the importance of micro prudential oversight as a way to induce banks to increase their coverage ratios. Still, some of the variation in coverage ratios is explained by unobservable, structural bank characteristics that could be better captured by close and customized scrutiny as it occurs in the supervisory dialogue. Among the bank-specific determinants, credit risk-related factors such as reserve policies (the level and change of) NPLs, credit growth, as well as forward-looking measures of credit risk play an important role.

Capitalization also explains coverage policy variation. In particular, higher capital ratios have a positive effect on coverage policies, suggesting some complementary between the two variables. The finding, which holds also when we investigate the causal relationship between capital and coverage ratios more explicitly by exploiting the 2011 EBA capital exercise, confirms the importance of adequate levels of capitalization as a major factor of financial stability (Schularick et al., 2020).

The second conclusion is that variations in NPLs or LLRs affect coverage ratios in a non-trivial manner. In particular, by inspecting the underlying mechanisms, we show that when NPLs increase, banks tend to set aside larger reserves, but in a way that is not sufficient, at least in the short term, to determine higher coverage ratios. The relationship between coverage ratios and asset quality is, however, non-linear, as very high-NPL banks tend to be comparatively better covered as their asset quality worsens. Moreover, by looking at well-reserved banks and risky banks (those with structurally high levels of LLRs and NPLs, respectively), we show that the former tend to have lower coverage ratios than the average bank, while the latter tend to be better covered. These findings altogether emphasize the need to look at reserves or the stock of NPLs only in conjunction with the associated level of coverage, as a comprehensive measure of balance sheet strength.

The third main conclusion concerns the effectiveness of a set of macro policies and policy tools in shaping coverage ratios, although as a less powerful alternative to micro supervision. In particular, we find that more stringent macroprudential policies (especially time-varying/dynamic loan-loss provisioning) are associated with higher coverage ratios. In addition, banks from high-NPL countries exhibit lower NPLs and lower coverage ratios in the presence of a better rule of law. This may suggest that stronger contract enforcement or more efficient courts support NPL resolution and thus decrease the need of large coverage. We also find that tighter capital rules are associated with lower NPLs and coverage ratios, but only in high-NPL countries, which call for a different

3 As it is quite standard, also in supervisory reports, we measure asset quality with the level of NPLs. We are, however, aware that low NPLs do not necessarily translate in high quality of the underlying assets. One reason is that economic booms help loans remain performing. Another reason may also be that NPLs are low because of managerial under-reporting.
calibration of such policies in different jurisdictions. This result is in line with the finding in Gropp et al. (2019) that banks tend to de-risk and deleverage in an attempt to comply with more stringent capital regulation.

Finally, we find higher coverage ratios in banks located in countries where secondary markets for distressed debt are larger, and even more so in banks located in high-NPL countries. This result corroborates the statements by European central authorities about the need to report adequate coverage ratios to make loan disposals more likely and limit actual losses for the seller (Fell et al., 2016; Constânio, 2017).

Our results carry important policy implications, also in light of the current situation. The new IFSR 9 accounting rules require banks to set aside provisions in anticipation of future expected losses in a more timely and prudent manner. In particular, banks must now take into account the potential losses from the deterioration of the individual borrowers’ credit worthiness as well as the general macroeconomic environment. Our analysis suggests that banks have used coverage ratios as a prudential (forward-looking) rather than a backward-looking buffer already in a context where the ‘incurred loss’ model (ILM) was prevalent. We expect this prudent behaviour to be further reinforced under the new accounting rules, although this may not be sufficient to ensure adequate loan loss coverage in the harsh years to come for two reasons. First, the monitoring activity that banks conduct normally on their overall loan portfolios is now more complicated because of the moratoria policies still in place in various countries, which makes the true creditworthiness of individual borrowers more difficult to ascertain. Second, the large uncertainty on the macro scenarios due to the unclear evolution of the pandemic may make the IFSR 9 model outcome excessively variable (e.g. ECB, 2020). Taken together, these considerations stress the need of a tight dialogue between banks and supervisors and the importance of tailored, case-by-case, supervisory interventions as effective policy levers. In addition, as highlighted by our results on the complementarity between capital levels and coverage ratios, capital affects banks’ incentives to provision and report their credit losses adequately. The implication is that bringing coverage ratios to adequate level requires a significant amount of capital, another aspect that needs to be taken into account when designing the police response to the COVID-19 crisis, as suggested by recent research (see, e.g. Schularick et al., 2020).

As shown in our analysis, provisioning policies and coverage ratios also depend on macro-prudential policies, in particular stringent institutional frameworks and developed secondary markets for distressed debt to ensure speedy NPL disposals and proper recoveries. This calls for the need to further reinforce these features to help banks face the expected surge in troubled loans, especially in those countries already affected by high levels of NPLs. Yet, as COVID-induced NPLs are likely to comprise SME loans rather than mortgage loans as in the previous crises, it may be more adequate to manage these loans through debt restructuring and internal workouts rather than disposal once they turn into troubled assets. Regardless of how NPLs will be resolved the need to ensure banks are adequately provisioned is now more important than ever.
Table 1. Correlations between coverage ratio and non-performing loans (NPL/TA), LLRs (LLR/TA) and LLPs (LLP/TA)

|                | NPL/TA | NPL/TA_{t-1} | NPL/TA_{t-2} | LLR/TA | LLR/TA_{t-1} | LLR/TA_{t-2} | LLP/TA | LLP/TA_{t-1} | LLP/TA_{t-2} |
|----------------|--------|---------------|---------------|--------|---------------|---------------|--------|---------------|---------------|
| Coverage ratio | -0.227*| -0.194*       | -0.139*       | 0.019  | 0.061*        | -0.123*       | -0.102*| -0.048*       |
| Coverage ratio_{t-1} | -0.250*| -0.239*       | -0.185*       | -0.023 | 0.034         | 0.079*        | -0.164*| -0.137*       | -0.092*       |
| Coverage ratio_{t-2} | -0.264*| -0.249*       | -0.238*       | -0.073*| -0.023        | 0.044         | -0.183*| -0.172*       | -0.127*       |

*Note: Correlations with an * are significant at the 10% level.*

This paper contributes to the literature on NPLs and provisioning. Despite the increased policy relevance, the empirical evidence on coverage ratios and its determinants remains scarce. Previous works on related topics have focused on explaining either NPLs or provisions, which, however, are rather uncorrelated with coverage ratios (see Table 1). In fact, we find this ratio does not always move in the same direction of each of its component. In particular, unlike previous work on bank provisioning [see Laeven and Majnoni (2003) among others], managerial discretion to, for example, smooth earnings does not explain coverage policy, which instead responds primarily to non-discretionary factors related to expected credit risk. It follows that the coverage ratio is a more comprehensive indicator of balance-sheet strength and that variables that explain NPL or reserve dynamics are not always relevant to explain variation in coverage ratios. Moreover, as we investigate the dynamics of coverage ratio components too, we are able to explore the mechanisms through which banks protect themselves against credit losses in response to shocks. This allows us, for example, to draw some conclusions on whether coverage policies are driven by accounting rather than prudential considerations and which policy measures may help foster loan loss coverage policies.

The remainder of the paper is structured as follows. Section 2 provides background details on the main measures taken to enhance loss coverage for NPLs and the reasons why it is important for banks to build up adequate coverage ratios. Section 3 illustrates the data and provides descriptive statistics for our sample. Sections 4 and 5 empirically investigate the main sources of variation in coverage ratios and their components. We first focus on micro-level factors (Section 4) and then extend the analysis by using macro-level data (Section 5). Section 6 concludes.

4 Previous studies on LLPs discuss the role of discretion (Liu and Ryan, 2006; Bushman and Williams, 2012; Norden and Stoian, 2013; Beatty and Liao, 2014 and literature therein), as well as their timeliness and contribution to procyclical lending (Laeven and Majnoni, 2003; Beatty and Liao, 2011; Nicoletti, 2018; Huizinga and Laeven, 2019). Berger and De Young (1997), Nkusu (2011), Klein (2013) and Beck et al. (2015) among others, study the determinants of NPLs.
2. NPLS AND COVERAGE RATIOS: ECONOMIC IMPORTANCE AND INSTITUTIONAL BACKGROUND

This section describes the supervisory initiatives introduced in recent years to enhance coverage ratios and briefly explains the role of coverage ratios as prudential tools.

2.1. Recent measures to enhance loss coverage for NPLs

NPLs have recently become a key priority for prudential authorities in Europe because of their negative effects on the stability and growth of both individual banks and the banking system as a whole. From a micro perspective, a high stock of NPLs may cast doubts on the quality of a bank’s assets, thus making bank funding more expensive. This may in turn impede lending as banks with poor asset quality may seek to regain adequate capital ratios by deleveraging and cutting back on lending rather than by raising new equity. Finally, high NPL ratios can also distort bank managers’ incentives in that troubled loans may increase moral hazard and favour excessive risk taking because of eroding bank capital (Bruno and Marino, 2019).

From a more macro perspective, a high level of NPLs may also generate negative externalities at the system level, so that banks operating in a high NPL country may be seen in general as weaker relative to banks operating in a country with lower stocks of troubled assets (ESRB, 2019).

NPLs in European banks skyrocketed to unprecedented levels in the wake of the global financial crisis and have decreased only recently thanks in part to the pressure of the European supervisors. According to the EBA, the NPL ratio of European Union (EU) financial institutions has decreased on average from 6% as of mid-2015 to 3% as of mid-2019. Nevertheless, there are still significant discrepancies across banks and countries, with the aggregate level of NPLs in EU banks remaining very high (over 600 billion euros as of June 2019) and the gap versus international peers remaining striking, making EU banks more vulnerable than their international peers to the repercussions of poor asset quality. What is worse, the COVID-19 pandemic and associated economic recession is expected to reignite the NPL problem: according to ECB estimates, in a severe but plausible scenario NPLs in euro area banks could reach €1.4 trillion, well above the levels of the financial and sovereign debt crises (Enria, 2020).

As argued by Constâncio (2017), one of main concerns in dealing with the surge of NPLs has been the absence of common provisioning practices in Europe. This has contributed to the large variation in NPLs and coverage ratios across banks and countries, and has also impeded benchmarking and peer comparison as supervisory practice. To ensure financial stability the need to implement measures aiming to

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5 According to World Bank data, the NPL ratio was 1% in the United States at the end of 2018.
harmonize provisioning practices and enhance loss coverage have grown (ECB, 2019; Stamegna, 2019).

To strengthen the supervisory approach to NPLs, in March 2017, the ECB released guidelines on how to manage and provision for problem loans, complemented with quantitative indicators on the minimum levels of prudential provisions, based on the vintage and the degree of collateralization of the non-performing exposures (ECB, 2018). One year later, in July 2018, the ECB announced the decision to set bank-specific supervisory expectations for the provisioning of NPLs as part of the supervisory dialogue. The aim was to harmonize the degree of loss coverage over the medium term across comparable banks.

Along the same lines, in March 2018, the European Commission adopted a comprehensive package of measures that included a proposal to introduce common minimum coverage levels for newly originated loans that become non-performing. In April 2019, an amendment to the European capital regulatory framework, the ‘prudential backstop’, required banks to have minimum loss coverage for non-performing exposures and to deduct from their own funds [common equity tier (CET) one capital] those not sufficiently covered.

To complete the picture, the accounting standard IFRS 9, introduced in January 2018, changed the impairment recognition by requiring banks, in essence, to make larger and timelier provisions based on the amount of ‘expected losses’ measured by considering also forward-looking information (e.g. forecasts of future economic conditions). Until the introduction of IFRS 9, banks in most European countries accumulated provisions according to a backward-looking approach, reflecting ‘incurred’ credit losses (Cohen and Edwards, 2017). Ideally, under the new accounting standard, provisions would better anticipate deteriorating economic conditions that may affect a borrower’s ability to repay.

In such a way, provisions could be used effectively to cover expected losses, instead of bank capital acting as a buffer against unexpected losses (Laeven and Majnoni, 2003). This is for example what is happening in the COVID-19 crisis, where banks have started accumulating a large amount of provisions in anticipation of future losses on their stocks of loans.

The switch to the new standard has been an important step in reconciling the perspective of accounting standard setters and bank regulators. Losses on NPLs are in fact subjected to both accounting standards and prudential regulation with different perspectives, especially before the IFRS 9 introduction. The former emphasizes transparency of financial statements, the latter emphasizes safety and soundness. From the perspective of the accounting rules, LLPs have an overall detrimental effect on earnings and regulatory

6 There are some exceptions. Notably, Spanish bank regulators introduced a forward-looking provisioning regime in 2000, meant to address procyclicality issues, which led to more timely and higher general provisions (de Lis et al., 2001; Jiménez et al., 2017).
Because these are at the discretion of bank managers, there is potential for banks to provision more or less than necessary as a way to smooth their income and capital, as we will discuss in Section 4.1. On the one hand, this would introduce discretionary modifications to earnings and reduce comparability across firms (Walter, 1991). On the other hand, from a prudential perspective, higher provisioning may reflect a more cautious approach to building up large reserves prior to future losses.

The COVID-19 pandemic and the related economic recession, however, have made the picture more complicated and have drawn policy makers’ attention to potential flaws of the new accounting standard. In particular, given the unusual uncertainty, the economic forecasts which are at the basis of IFRS 9 bank provisioning are likely to be based on a number of critical assumptions. This would make bank provisioning excessively volatile and procyclical, with undesired effects on regulatory capital as well as in terms of transparency and reliability of bank balance sheets. For these reasons, the ECB has recently provided guidance to mitigate volatility in banks’ regulatory capital and financial statements stemming from IFRS 9 accounting practices, by encouraging banks to set provisions based on longer-term macroeconomic forecasts and by taking into account the COVID-related relief measures (ECB, 2020).

2.2. Coverage ratio as a prudential tool

The initiatives illustrated above show that coverage ratios have gained relevance as a key prudential and monitoring tool to shield banks’ balance sheets. Why is it desirable for regulatory and supervisory purposes to promote high loan loss coverage? The answer is that adequate coverage ratios can help banks mitigate most of the concerns associated with high NPLs.

Adequate LLRs, and thus high coverage ratios, for a given level of NPLs, enhance banks’ safety and soundness by protecting bank capital when losses materialize (Wheeler, 2019). Specifically, LLRs are a ‘contra-asset’ account, which reduces the loans by the amount the bank expects to lose when some portion of the loans are not repaid. Periodically, the bank managers decide how much to add to the LLR account and record this amount as an expense item on the profit and loss account through ‘provisions for loan losses’. This allows banks to recognize the estimated loss even before the actual

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7 The actual effect on bank capital of provisioning is hard to determine, because the regulatory implications of provisions vary according to the approach used by banks for calculating capital requirements, and on the nature of bank provisions (namely, general versus specific provisions). See Bruno and Carletti (2017) for a concise discussion on the effects of provisions on bank capital.

8 On the one hand, there is the risk that provisions may be optimistic in some cases, as government support schemes may have lengthened the time it takes for weaker borrowers to default on their payments, thus delaying banks’ (specific) provisioning for problem loans. On the other hand, given that the IFRS 9 provisions must be based on macroeconomic forecasts that are hard to set in these times of pronounced uncertainty, IFRS 9 model outcomes may be excessively variable and procyclical (ECB, 2020).
loss can be determined with accuracy and certainty. To the extent that credit risk is not under-estimated and allowances are adequate to cover for the actual loss, by building adequate coverage ratios banks protect their capital and preserve their capacity to provide credit to the economy (Beatty and Liao, 2011).

High coverage ratios also help to make banks’ balance sheet more transparent. In the traditional banking literature (e.g. Diamond and Dybvig, 1983), loans are illiquid and untraded contracts generating cash flows that are hard to predict. In the absence of a true market price, the loan fair value is approximated through the process of provisioning. The process of accumulating provisions is, in fact, equivalent to reducing the face value of the loan to its present value, taking into account the allowance built up over time (Song, 2002). If loan loss allowances were underestimated, bank assets and capital ratios would be overvalued and balance sheets would be distorted.

Relatedly, because high loan loss coverage corresponds, de facto, to low loan net book value, it follows that reporting high coverage ratios is also a precondition to make the asset disposal more likely and reduce the bid–ask spread between sellers and buyers (Fell et al., 2016). However, anecdotal evidence and market practices show that, on average, coverage ratios in European banks are still inadequate if compared with actual recovery rates or haircuts applied as an effect of NPL resolution. This points to the importance of increasing coverage ratios in order to reduce the negative impact of credit losses on capital.

In sum, coverage ratios are important tools to ensure the safety and soundness of the banking sector, enhance the transparency of banks’ balance sheets and favour the disposal of NPLs. Yet, as we will show below, they show important variation both across banks and countries. Because of this, a number of policy measures have been introduced in recent years aiming at increasing the level of coverage ratios and decreasing their dispersion. In what follow we analyse the determinants of coverage ratios in Europe, as well as of their components, and derive implications as to which policies may be more effective.

3. DATA AND SUMMARY STATISTICS

We collect annual bank-level data from the S&P Global Market Intelligence Platform (S&P Global). The dataset spans the years 2010–7 and covers all EU countries as of
2017. Following Eber and Minoiu (2016), we collect data at the highest consolidation level. To avoid including small banks that could introduce noise, we only keep banks that are being classified as medium-sized and large according to the ECB definition.\textsuperscript{11} Given the purpose of the analysis, we also drop the institutions whose commercial banking business is negligible from the sample.\textsuperscript{12} All variables are winsorized at 2.5\% and 97.5\%. The final sample contains 441 banks, representing around 70\% of banking assets in Europe. Table A1 reports the breakdown of observations and banks in our sample.\textsuperscript{13}

Figures 1–3 explore trends in NPLs, LLRs and coverage ratios in our sample. Figure 1 shows that the evolution of the average coverage ratio over all countries and in high-NPL countries (low-NPL countries) defined as those with NPL/TA above (below) the sample mean.\textsuperscript{14}

\begin{figure}
\centering
\includegraphics[width=\textwidth]{average_coverage_ratios.png}
\caption{Average coverage ratio for all banks, banks from high-NPL countries and banks from low-NPL countries. High-NPL countries (low-NPL countries) are defined as those with NPL/TA above (below) the sample mean. Data are winsorized at 2.5\% and 97.5\% (sample period: 2010–7, Source: authors’ calculations).}
\end{figure}

\textsuperscript{11} The ECB labels as large those institutions with assets greater than 0.5\% of total consolidated assets of EU banks and medium-sized as those with assets between 0.5\% and 0.005\%.

\textsuperscript{12} We delete institutions with a loan-to-asset ratio and a deposit-to-asset ratio smaller than 20\%, those not classified as ‘bank’ or ‘savings bank/thrift/mutual’, as well as those that, although being classified as banks by S&P Global, may operate not in a pure commercial manner because for example of ownership (e.g. government-owned banks) or scope (e.g. asset management companies).

\textsuperscript{13} As it emerges from Table A1, German banks are over-represented in terms of number of institutions in our sample. This is common in the empirical literature on European banks [see Altavilla et al. (2017), among others] and reflects the highly fragmented nature of the German banking system. To check whether this has implications, we have re-run the analysis on a sample excluding German banks. Results, available upon request, remain robust.

\textsuperscript{14} Our definition of high-NPL countries is time-varying, with some countries coming in only for part of the sample. All countries in which the NPL ratio exceeds 10\% in 2016 (in accordance with the definition of the ESRB, 2017) are consistently covered. These countries are the following, in order of descending NPL ratio: Greece, Cyprus, Portugal, Italy, Slovenia, Ireland, Bulgaria, Hungary, Romania and Croatia.
the sovereign debt crisis in 2010–2 and, again, after the introduction of the single supervisory mechanism (SSM) in 2014. Overall, European banks have progressively increased their coverage ratios, partly as a managerial response to asset quality deterioration and partly due to stricter supervisory and market scrutiny.\footnote{This may be due to stricter supervisory and regulatory scrutiny in relation to the ECB’s asset quality exercises, increased market pressure as well as a deterioration of collateral values (Council of the European Commission, 2017).}

Throughout our sample period, high-NPL countries tend to report coverage ratios below the sample average, although the gap has progressively narrowed over time. In fact, most of the time variation in coverage ratios seems to be explained by high-NPL countries, as they have increased from nearly 35\% to 55\% in 2010–7, as opposed to low-NPL countries whose average coverage ratio moved from 45\% to 55\%. Figures 2 and 3 show the dynamics of the components of the coverage ratio for high and low-NPL countries, respectively. By comparing Figure 1 with Figures 2 and 3, it emerges that while the dynamics of LLRs and NPLs are similar, they are different from those of coverage ratios.

Figures 4 and 5 confirm the presence of large cross-sectional variability in asset quality and coverage ratios, respectively, both across countries and within the same country (see also Table A1 for a sample composition in terms of per-country average coverage ratios and their components). Figure 4 shows that countries with higher median NPLs also have a larger dispersion in NPL/TA across banks. By comparing the two figures, no obvious country-level mapping emerges between the quality of bank loans and the level of coverage. This suggests that although differences in asset quality may contribute to
explain heterogeneity in European banks’ coverage ratios, other factors may also play a role.\textsuperscript{16}

Descriptive statistics and correlations for all the variables are shown in Tables 2 and A2, respectively. The average bank in our sample is a traditional commercial bank, whose core business is lending (the average loan to asset ratio is 65\%) and whose main source of funds is customer deposits (the deposits to assets ratio averages 66\%). As far as bank asset quality is concerned, the NPL to total asset ratio averages at about 4\%. The average coverage ratio is 51\%, with large variation across banks (the minimum coverage ratio being 10\% and the maximum 89\%). These numbers are comparable to those reported in aggregate statistics (ECB, 2016; EBA, 2018).

Looking at measures of bank capitalization, the common equity tier 1 (CET 1) regulatory capital ratio is on average 15\%, well above the Basel III minimum requirement of 8.5\% including the capital conservation buffer. The average return on average asset (ROAA) is around zero, confirming that low profitability has been a major source of concerns for European banks and that high NPLs have been an important cause of low profitability in European banks (Altavilla et al., 2018).

Table 2 also shows descriptive statistics for the set of macro variables we consider, namely institutional variables, including the depth of the NPL secondary market, and business/financial cycle indicators. The former include two indices to account for the regulatory and judicial environment, namely the Regulatory Quality index and the...
Figure 4. Boxplots of non-performing loans over total assets (NPL/TA) by country. Countries are ordered by median NPL/TA in ascending order. Data are winsorized at 2.5% and 97.5% by country (sample period: 2010–7, Source: authors’ calculations).

Figure 5. Boxplots of coverage ratios by country. Countries are ordered by median NPL/TA in ascending order. Data are winsorized at 2.5% and 97.5% by country (sample period: 2010–7, Source: authors’ calculations).
Rule of Law index, both published by the World Bank, and a series of macroprudential variables, grouped in a Macroprudential index as in Cerutti et al. (2017) macroprudential policy dataset. The latter include business cycle indicators such as real GDP growth and unemployment rate, variables related to the financial cycle, such as asset price growth (i.e. house and stock prices), and private credit to GDP ratio, as well as the short-term interest rate. A description of these macro variables, together with the relative hypotheses, is given in Section 5.

4. EXPLOITING THE CROSS SECTION OF BANKS: MICRO-LEVEL ANALYSIS

In this section, we analyse the role of the micro bank-specific variables in explaining coverage ratios. We start with illustrating the main specification and testable predictions and then present the results.
4.1. Baseline specification, main variables and testable predictions

To explore the link between coverage ratios and bank-specific characteristics, we first exploit our sample heterogeneity at the micro-level. Looking simultaneously at the coverage ratio and its components, LLRs and non-performing loans (both scaled by total assets), enables us to better understand the mechanisms by which banks set coverage ratios, over and above the accounting identification of impaired loans. Our key dependent variable is the coverage ratio; in addition, we also use its components as additional dependent variables in separate models.\(^{17}\)

We estimate the following regression having LLRs, NPLs and coverage ratios as dependent variables in separate models:

\[
Y_{ikt} = \beta X_{ikt-1} + \mu_i + \gamma_{kt} + \epsilon_{ikt},
\]

where \(i = 1, \ldots, N, k = 1, \ldots, K\) and \(t = 1, \ldots, T\), with \(i\) being the bank, \(k\) being the country and \(t\) being the year. \(Y_{ikt}\) is our dependent variable, which can be coverage ratio or its components, that is LLRs or NPLs over total assets. The vector \(X_{ikt-1}\) includes bank-level variables to account for bank-specific factors that can be relevant in determining the coverage ratio and its components. The equation includes bank and country-year fixed effects (\(\mu_i\) and \(\gamma_{kt}\), respectively).\(^{18}\) In one specification, we replace bank-fixed effects with various time-invariant characteristics, as we explain further below and later in Section 4.2. All explanatory variables (with the exception of the change in NPLs and loan growth) are lagged by 1 year to mitigate concerns about reverse causality. When \(Y_{ikt}\) equals the ratio of LLRs to total assets (NPLs to total assets), we remove the lagged LLRs to total assets (NPLs to total assets) as explanatory variable.

In identifying the bank-specific drivers of banks’ coverage policy, we draw primarily on the literature which examines the determinants of provisioning and NPLs. We group our independent variables in four main categories: credit risk, funding, bank performance and forward looking.

We start with a large set of credit-risk-related variables. In the literature on bank provisioning, these factors are referred to as non-discretionary, as opposed to (discretionary) characteristics accounting for different management objectives [see Beatty and Liao (2014) among others]. Specifically, we include measures of asset quality such as the level of LLRs as well as the level and the change of NPLs (scaled by total assets). \textit{Ceteris paribus},

\(^{17}\) We are aware that across jurisdictions and banks there may be different definition of NPLs (Baudino et al., 2018). A harmonized definition of NPLs was however introduced in 2014 by the EBA, by which non-performing loans are those that satisfy either of the following criteria: (a) exposures that are more than 90 days past due and (b) the debtor is assessed as unlikely to pay its credit obligations in full without realization of collateral. Unfortunately, the breakdown of the NPL aggregate is unavailable for most banks in our sample.

\(^{18}\) The inclusion of bank and country-fixed effects is also important to absorb the variation in coverage ratios due to possibly different definitions of NPLs across banks and jurisdictions.
we expect poorer asset quality to be associated with higher LLRs, as banks with higher NPLs should be more prone to increase loss coverage for the reasons discussed in Section 2. In one specification, in the spirit of Bushman and Williams (2012), we also test whether banks’ coverage policy includes forward-looking considerations, which we model by including next year’s change in non-performing loans, to account for (potential) future losses. We then include variables measuring the relevance of the lending business (the share of gross loans over total assets) as well as the growth of gross loan as other potential factors affecting credit risk and therefore banks’ loss coverage policies (Bouvatier and Lepetit, 2012; Nicoletti, 2018). The idea is that banks that are more willing to invest their funds in loans (rather than, e.g. securities) are more exposed to credit risk (Keeton and Morris, 1987). Also, excessive credit growth may be associated with more risky lending, and hence with higher NPLs in the future (Jiménez and Saurina, 2006; Huizinga and Laeven, 2019). It follows that a larger share of loans to total assets and higher credit growth should favour a more prudent coverage policy and therefore higher coverage ratios. Finally, we control for size, measured by the natural logarithm of total assets, as aggregate statistics show that smaller banks tend to report higher coverage ratios (EBA, 2018). More generally, prior research has shown that size is a relevant determinant of lending and risk taking [see Kishan and Opiela (2000) among others], and, thus, it may also explain banks’ coverage ratios and their components.

To investigate the role played by bank funding structure, we include measures of capitalization, by using the CET 1 capital ratio, and reliance on deposits, proxied by the share of customer deposits to total assets. Capital plays contrasting roles in terms of coverage ratios. Previous studies argue that bank managers may exploit discretion in provisioning not only to smooth income, but also to manage capital [see, among others, Liu and Ryan (2006), Beatty and Liao (2014) and literature therein]. It follows that capital-constrained banks may have an incentive to use provisions to achieve regulatory capital targets (Andries et al., 2017). This occurs because provisions have a mechanical negative effect on banks’ capital, by reducing earnings.

These arguments point to a positive relationship between capitalization and provisioning, as weak banks would have the incentive to hold back on LLPs and under-reserve in order to preserve regulatory capital. In addition, according to the ‘moral hazard’ hypothesis (Keeton and Morris, 1987), undercapitalized banks are more prone to gamble for resurrection and thus increase the riskiness of their loan portfolio compared with stronger banks, also by lending to zombie firms [Schivardi et al. (2018) and literature therein]. Taken together, these theories imply a positive correlation between capital and coverage ratios, through both the effects on reserves and NPL levels.

An alternative view would instead justify the existence of a negative nexus between coverage ratios and regulatory capital as the two balance-sheet items are seen as substitutable buffers against potential losses. In this view, low capitalized banks may have the incentive to increase loan loss coverage to partly compensate for their lack of capital (Norden and Stoian, 2013). Or, to change perspective, better capitalized banks would
be in a more comfortable position to absorb shocks prompted by the deterioration of the loan portfolio. As such, these banks would have less incentive to set high coverage ratios.

The relevance of deposits may also help explain banks’ reserving practices. In line with Calomiris and Kahn (1991), we expect that banks with a larger share of demandable debt, being more exposed to market discipline, have stronger incentives to report high coverage ratios compared with banks that rely less on deposits.19

We then test whether bank performance, as measured in terms of profitability (proxied by the ROAA) and efficiency (proxied by the cost-to-income ratio, i.e. the ratio of operating expenses over operating income) influences coverage ratios. According to the income-smoothing hypothesis [see Liu and Ryan (2006), Beatty and Liao (2014) and literature therein], when earnings are low, provisions are deliberately understated to mitigate the adverse effect of other factors on earnings, in contrast to situations when earnings are high. Conversely, banks can smooth their earnings by drawing from LLRs if actual losses exceed expected losses.20 This results in a systematic under (over)-reserving in banks with low(high) profits. We therefore expect a positive correlation between ROAA and coverage ratios.

As for cost efficiency, in the literature on NPL determinants, a high cost-to-income ratio can be associated with either higher or lower troublesome loans, according to whether the ‘bad management’ prevail over the ‘skimping’ hypothesis (Berger and De Young, 1997). Under the bad management hypothesis, low cost efficiency (i.e. high cost-to-income ratios) is a signal of poor management practices, thus implying lower portfolio quality as a result of poor screening and monitoring. On the contrary, under the skimping hypothesis, high cost-to-income ratios are associated with lower NPLs, as more resources are allocated to the monitoring of credit risk. As a result, when the cost-to-income increases, we then expect higher NPLs and, ceteris paribus, lower coverage ratios if the bad management view prevails, as opposed to when the skimping hypothesis dominates.

Another strand of literature (Ristolainen, 2018) links more directly the effect of bank performance on coverage ratios through banks’ incentives to under-report NPLs or to under-reserve, which would be stronger in less profitable and less efficient banks. Consistent with this view, we expect lower coverage ratios when bank performance worsens.

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19 A positive association between the deposit to asset ratio and coverage ratio is also in line with Drechsler et al. (2018). They argue that deposits effectively behave as term liabilities because banks are able to exert market power. They thus optimally invest into (risky) long-term assets. Hence, any positive correlation between deposits and coverage ratios could reflect some bank assets’ characteristic not directly captured by our variables.

20 As bank profitability and GDP growth tend to be positively related, income smoothing would be implicitly forward-looking in nature and can mitigate pro-cyclicality (Laeven and Majnoni, 2003; Bushman and Williams, 2012).
Finally, we include a number of time-invariant bank characteristics (in the form of dummies) when removing the bank-fixed effects in one specification. These variables include: Significant, to account for the institutions included in the 2014 Comprehensive Assessment exercise; Listed and Saving, Mutual or Thrift, to account for differences across bank owners/business type; International Financial Reporting Standards (IFRS), to control for possible heterogeneity in reporting practices. In addition, we include a set of dummies that capture structural aspects related to banks’ LLR policy, asset quality and lending strategy, size, funding and performance identifying banks that rank in the top decile of the distribution of the following variables: LLR/TA, NPL/TA, gross loans/TA, Log(TA), deposits/TA, CET1 ratio, ROAA and cost-to-income ratio. Based on these reference variables, we classify banks as Well reserved, Risky, Loan-based, Large, Deposit-based, Sound, Profitable and Inefficient.

4.2. Results

From a policy maker’s view point, it is important to understand which factors explain most of the variation in loan loss coverage policy. To gauge these factors, we proceed in steps.

4.2.1. Micro time-varying and invariant variables. As a preliminary analysis, we run our main regression on the coverage ratio by including only fixed effects at the bank and the country-year level. As shown in Table 3, the regression including only bank-fixed effects has an adjusted $r$-squared of 0.8, while the one with bank and country-year fixed effects has an adjusted $r$-squared of 0.82. These results show that most of the variation of the coverage ratio is explained by time-invariant bank characteristics and that the additional fixed effects only mildly improve the statistical fit. In terms of policy implications, it follows that bank characteristics matter more than country specificities in explaining bank loan loss coverage policies, and that therefore policy makers concerned about coverage ratios should first and foremost strengthen microprudential oversight.

We then analyse which of the (time-varying and time-invariant) bank characteristics help explain variations in the coverage ratio and its components. Columns 1–3 of Table 4 present the results for the baseline investigation on the main micro drivers of NPLs, LLRs and coverage ratios, respectively, where bank-fixed effects are replaced by the time-invariant characteristics described in Section 4.1.

We find that among the structural components, significant banks tend to report lower coverage ratios, as also found in Ristolainen (2018), possibly because of too-big-too fail motives. At the same time, listed banks show significantly higher coverage ratios, perhaps as an effect of closer investor scrutiny for these banks than for unlisted banks.

21 The dummies are time invariant since they are constructed based on average values for the entire length of the sample.
Turning to the dummy variables used to identify the time-invariant component of our main baseline variables, we find that well reserved and risky banks report lower and higher coverage ratios than the average bank, respectively. This evidence suggests that considering LLRs and NPLs separately can be misleading, supporting the argument that the NPL stock should be looked at only in conjunction with the associated degree of coverage (Constâncio, 2017). We also find that loan-based and sound (well capitalized) banks tend to have lower coverage ratios. The latter result points to a substitution effect between capitalization and loan loss coverage for banks with high capital levels, as suggested in Norden and Stoian (2013).

Interestingly, Table 4 also shows that the large set of bank characteristics included in the analysis explains the variation of NPLs and LLRs well (the adjusted $r$-squared in Columns 1 and 2 is above 0.9), but it seems to be less powerful in explaining the variation in the coverage ratio (the adjusted $r$-squared in Column 3 is 0.56). This finding indicates again that looking at only the dynamics of loan loss reserving and NPLs is not sufficient to fully understand the dynamics of coverage ratios. It also suggests that there may be omitted variables which explain the way banks set their coverage ratio. These variables plausibly pertain to the individual bank’s managerial sphere and are, therefore, unobservable (from a modeler’s point of view) or are hard to identify.

As a next step we include bank-fixed effects to account for bank-specific time invariant characteristics, including unobservable ones. In Table 4, Columns 4–6 present the results for our baseline specification, results are broadly consistent with those without bank-fixed effects. Among the time-varying variables, credit risk variables are important to explain coverage policy. We find in particular that the relationship between the level and the change of NPLs and coverage ratio is negative (Column 6), while, as in Huizinga and Laeven (2019), there is a strong positive relationship between asset quality and LLRs (Column 5). This means that although banks tend to react to higher NPLs by increasing LLRs, such an increase does not seem adequate to compensate for the larger amount of NPLs. As a result, when the loan portfolio quality deteriorates, coverage ratios reduce.

### Table 3. Preliminary analysis

|                | (1) Coverage ratio | (2) Coverage ratio | (3) Coverage ratio |
|----------------|-------------------|-------------------|-------------------|
| Constant       | 0.507***          | 0.507***          | 0.507***          |
| Observations   | 1845              | 1845              | 1845              |
| Number of banks| 441               | 441               | 441               |
| Adjusted $R^2$ | 0.803             | 0.215             | 0.826             |
| FE bank        | Yes               | No                | Yes               |
| FE country-year| No                | Yes               | Yes               |

Notes: The dependent variable is the coverage ratio. Only the constant and fixed effects at the bank and the country-year level are included.
Table 4. Micro-level regressions: without bank FE and baseline

|                      | Without bank-fixed effects | Baseline |                      |                      |                      |                      |
|----------------------|-----------------------------|----------|----------------------|----------------------|----------------------|----------------------|
|                      | (1)                         | (2)      | Baseline             | (3)                  | (4)                  | (5)                  |
|                      | NPLs/TA                     | LLRs/TA  | Coverage ratio       | NPLs/TA              | LLRs/TA              | Coverage ratio       |
| LLR/TA\(_{t-1}\)     | 1.231***                    | 13.754***|                      | 1.056***             | 5.717***             |                      |
|                      | (0.077)                     | (0.973)  |                      | (0.126)              | (0.581)              |                      |
| NPL/TA\(_{t-1}\)     | 0.337***                    | -5.806***|                      |                      | 0.295***             | -2.717***            |
|                      | (0.023)                     | (0.494)  |                      |                      | (0.035)              | (0.347)              |
| DELTA (NPL/TA)       | 0.309***                    | -1.100***|                      |                      | 0.295***             | -1.405***            |
|                      | (0.042)                     | (0.415)  |                      |                      | (0.039)              | (0.267)              |
| Gross loans/TA\(_{t-1}\) | 0.021***                    | 0.001    | -0.099**             | 0.025*               | 0.010                | -0.122               |
|                      | (0.005)                     | (0.002)  | (0.046)              | (0.015)              | (0.007)              | (0.084)              |
| Gross loan growth    | -0.033***                   | 0.001    | 0.091                | -0.021*              | 0.008**              | 0.183***             |
|                      | (0.010)                     | (0.004)  | (0.062)              | (0.011)              | (0.004)              | (0.040)              |
| log (total assets)\(_{t-1}\) | -0.003***                   | 0.000    | -0.002               | 0.001                | -0.001               | 0.052                |
|                      | (0.001)                     | (0.000)  | (0.008)              | (0.008)              | (0.002)              | (0.033)              |
| Deposits/TA\(_{t-1}\) | -0.009                      | 0.002    | -0.026               | -0.026               | 0.003                | 0.061                |
|                      | (0.006)                     | (0.003)  | (0.049)              | (0.016)              | (0.005)              | (0.072)              |
| CET1\(_{t-1}\)       | -0.035*                     | 0.000    | 0.329*               | 0.019                | 0.011                | 0.306*               |
|                      | (0.019)                     | (0.009)  | (0.170)              | (0.021)              | (0.009)              | (0.160)              |
| ROAA\(_{t-1}\)       | -0.985***                   | -0.021   | -1.066               | -0.635***            | -0.273***            | -0.885               |
|                      | (0.201)                     | (0.097)  | (1.206)              | (0.205)              | (0.088)              | (0.666)              |
| Cost-to-income ratio\(_{t-1}\) | -0.017**                    | 0.000    | -0.061               | -0.021***            | -0.002               | -0.068**             |
|                      | (0.007)                     | (0.003)  | (0.050)              | (0.007)              | (0.003)              | (0.034)              |
| Significant          | 0.004                       | -0.001   | -0.045*              |                      |                      |                      |
|                      | (0.003)                     | (0.001)  | (0.023)              |                      |                      |                      |
| Listed               | -0.002                      | 0.000    | 0.044***             |                      |                      |                      |
|                      | (0.002)                     | (0.001)  | (0.016)              |                      |                      |                      |
| Savings mutual or thrift | -0.003                     | 0.000    | 0.015                |                      |                      |                      |
|                      | (0.002)                     | (0.001)  | (0.015)              |                      |                      |                      |
| IFRS                 | 0.066                       | -0.002   | -0.034               |                      |                      |                      |
|                      | (0.004)                     | (0.001)  | (0.025)              |                      |                      |                      |
| Well reserved        | 0.004                       | 0.018*** | -0.086***            |                      |                      |                      |
|                      | (0.005)                     | (0.002)  | (0.022)              |                      |                      |                      |
| Risky                | 0.046***                    | -0.009***| 0.107***             |                      |                      |                      |
|                      | (0.005)                     | (0.003)  | (0.024)              |                      |                      |                      |
| Loan-based           | 0.000                       | -0.001   | -0.026*              |                      |                      |                      |
|                      | (0.002)                     | (0.001)  | (0.016)              |                      |                      |                      |
| Large                | 0.002                       | 0.001    | 0.019                |                      |                      |                      |
|                      | (0.003)                     | (0.001)  | (0.024)              |                      |                      |                      |
| Deposit-based        | 0.004**                     | -0.001   | -0.020               |                      |                      |                      |
|                      | (0.002)                     | (0.001)  | (0.023)              |                      |                      |                      |
| Sound                | 0.004*                      | -0.002*  | -0.050**             |                      |                      |                      |
|                      | (0.002)                     | (0.001)  | (0.021)              |                      |                      |                      |
| Profitable           | -0.004                      | 0.004**  | 0.020                |                      |                      |                      |
|                      | (0.004)                     | (0.002)  | (0.027)              |                      |                      |                      |
| Inefficient          | -0.002                      | -0.002   | -0.009               |                      |                      |                      |
|                      | (0.003)                     | (0.001)  | (0.020)              |                      |                      |                      |
| Observations         | 1845                        | 1845     | 1845                 | 1845                 | 1845                 | 1845                 |
| Number of banks      | 441                         | 441      | 441                  | 441                  | 441                  | 441                  |
| Adjusted R-squared   | 0.922                       | 0.93     | 0.561                | 0.956                | 0.968                | 0.853                |

(continued)
We find that higher credit growth is associated with larger LLRs and higher coverage ratios, despite the negative relationship between credit expansion and NPLs. This last result suggests that, in line with Jiménez and Saurina (2006) and Huizinga and Laeven (2019), when the loan portfolio expands, banks prudently enhance their loan loss coverage by anticipating higher (potential) future losses, independent of the impact higher credit growth has on the NPL/TA ratio in the short run.

Among the variables capturing bank funding structure, capital is positively related to coverage ratios, although only at the 10% level, but not with the individual components. This suggest that capital and coverage ratios are not substitute approaches to deal with loan losses, except perhaps for banks with extremely high capital as shown in Column 3 of the table. In Appendix B, we investigate the causal relationship between capital and coverage policies by exploiting the 2011 EBA capital exercise, which created an exogenous increase in capital on a subsample of European banks. We then analyse the differential response in terms of coverage policies between these banks and those not subjected to the capital exercise. We find evidence of a statistically significant positive effect of capital on coverage ratios across various matched samples and different time horizons. This finding supports the view (see, e.g. Schularick et al., 2020) that adequate LLRs require high level of capital and that, without additional capital, European banks might not be up to the task in supporting a strong recovery in COVID times.

Concerning bank performance, profitability explains only the dynamics of the individual components but not coverage ratios directly, while the degree of efficiency, as captured by the level of the cost-to-income ratio, is negatively correlated with both NPLs and coverage ratios. Overall, these results provide some support to the view that lower performance increases banks’ incentives to under-report NPLs and to under-reserve, as found in Ristolainen (2018).

As robustness check (see Table A3), we replace our asset quality indicator with the NPLs to total loans ratio, the ROAA with the return on average equity (ROAE), the CET1 ratio with the Tier 1 ratio. Results remain consistent with the baseline specification.

### Table 4. Continued

| Without bank-fixed effects | Baseline |
|---------------------------|----------|
| (1) | (2) | (3) | (4) | (5) | (6) |
| NPLs/TA | LLRs/TA | Coverage ratio | NPLs/TA | LLRs/TA | Coverage ratio |
| Adjusted within $R^2$-squared | 0.778 | 0.802 | 0.441 | 0.319 | 0.520 | 0.157 |
| FE bank | No | No | No | Yes | Yes | Yes |
| FE country-year | Yes | Yes | Yes | Yes | Yes | Yes |

**Notes:** The dependent variables are the coverage ratio, LLRs/TA and NPLs/TA at the bank level. In columns 1–3, bank-fixed effects are removed and replaced with bank-specific time invariant characteristics. In columns 4 and 5, bank-fixed effects are introduced. Country-year dummies are included in each regression. Robust standard errors are clustered at the bank-level and reported in parentheses. Significance at the 1%, 5% and 10% level is denoted by ***, ** and *, respectively.
4.2.2. Forward-looking variables and high-NPL banks. Next, we extend our baseline specification to account for the forward-looking behaviour of banks and investigate the behaviour of high-NPL banks. Results are shown in Table 5. Columns 1 and 2 report results from a specification where we add the change in NPLs at \(t+1\), to account for (potential) future losses, to the baseline. We find a strong positive association between...
this forward-looking measure of asset quality and coverage ratios. This finding reinforces the interpretation of our results on credit growth, suggesting that coverage ratios work more as a prudential (forward-looking) buffer than merely (and backward-looking) a booking account.

Columns 3 and 4 in Table 5 explore the differential behaviour of banks with the highest levels of NPLs. On the one hand, we expect that banks with high NPLs should face higher expected losses and should therefore be more in need of setting up higher coverage ratios to protect their balance sheets. On the other hand, because provisions to loan-loss reserves would further reduce earnings and capital, high-NPL banks may have more incentives to under-provision for potential losses when asset quality further deteriorates, or when profits and capital decrease relative to banks with lower NPL ratios (Ristolainen, 2018). To exploit the large discrepancies among NPLs ratios, we focus on banks in the top decile of the NPL/TA ratio distribution by including \textit{High NPL} dummy and its interaction with the share of NPLs to total assets, CET1 ratio and ROAA. Note that this \textit{High NPL} dummy variable is now time-varying, in contrast with the dummy variable \textit{Risky} used before representing banks with structurally high NPLs levels during the whole sample.

Results in Columns 3 and 4 show that while higher NPLs are in general associated with reduced coverage ratios, in high-NPL banks, this correlation is significantly less negative, pointing to a non-linear relationship between asset quality and coverage ratios. While banks are generally unable (or unwilling) to adjust their loan-losses at the same pace as asset quality deteriorates, banks facing a very high level of credit risk try to restore an adequate level of coverage. This finding may be driven by particularly strong supervisory pressure or peer effects. The result confirms the one found for banks with structurally high levels of NPLs in Table 4.

Turning to capitalization, we uncover a positive association between the level of capital and LLRs in high-NPL banks, but with no differential effect on coverage ratios. As for the nexus between profitability and coverage ratio, we find a significant and negative correlation, suggesting that high-NPL banks tend relatively more to use their profits in other ways than to increase reserves and coverage ratios, consistent with a pro-cyclical behaviour of bank provisioning (Huizinga and Laeven, 2019).

5. EXPLORING MACRO-LEVEL DATA

In this section, we exploit the richness of country characteristics to better explain the variation in coverage ratios across countries. We replace the country-year-fixed effects with a large set of time varying macro variables related to institutional/governance rules and macroprudential policy to analyse their role as potential drivers of banks’ coverage.
choices. In doing this, we also consider separately the specificities of high-NPL countries and the role of a secondary market where NPLs can be sold.

5.1. Specification and variables

We estimate the following regression having LLRs, NPLs and coverage ratios as dependent variables in separate models:

\[ Y_{ikt} = \beta_1 X_{ikt-1} + \beta_2 Z_{ikt-1} + \mu_i + \delta_t + \epsilon_{ikt}, \]

where \( X_{ikt-1} \) includes lagged bank-level variables as illustrated in Section 4 and \( Z_{ikt-1} \) comprises the lagged time-varying macro-level factors capturing three dimensions: regulatory quality, rule of law and macroprudential stringency. Table 2 reports aggregate statistics for all the macrovariables included in the analysis. We saturate the specification with bank- and year-fixed effects (\( \mu_i \) and \( \delta_t \), respectively).

In the spirit of Andries et al. (2017), we include Regulatory Quality as a measure of the government’s ability to formulate and implement policies and regulations. To capture the quality of the judicial system, we include an index of Rule of Law capturing agents’ confidence in rules, quality of contract enforcement, property rights and courts. Both variables are published by the World Bank, based on an annual survey. We expect better regulatory quality as represented by higher values of Regulatory Quality to be associated with more prudent coverage policy and thus higher coverage ratios. We also expect more stringent (higher) Rule of Law to be associated with lower coverage needs, as for example banks may recover NPLs more quickly and efficiently when the legal and judicial framework is strengthened.

To analyse the role played by macroprudential policy, we include the 2018 update of the country-specific prudential measures as derived from the Cerutti et al. (2017) macroprudential policy dataset. We start with the broadest index available in the dataset, the so-called Macroprudential Index. This covers three borrower-targeted and nine financial-institution-targeted instruments, therefore taking on values between 0 and 12, where 0 means that none of the instruments are in place and 12 means that all of them are in place. Hence, the higher the index, the more stringent the implementation of macroprudential measures in the respective country. We then replace the index by some of its subcomponents. Based on anecdotal evidence in Walter (1991) and prior research on the effects of macro factors on banks provisioning [Jiménez et al. (2017) and Andries et al. (2017), among others], we focus on those ones that are more likely to affect banks’ coverage ratios, namely: Dynamic loan-loss provisioning as a measure of provisioning policies, Capital Surcharges on Systemically Important Financial Institutions (SIFI) as a measure of capital buffers, Levy/Tax on Financial Institutions (FI) and Loan-to-Value (LTV) Ratio Caps capturing the limits to borrowing.

We also control for the business and financial cycle by including a broad range of macroeconomic and financial variables derived from the literature on NPL
determinants (Nkusu, 2011; Klein, 2013; Beck et al., 2015) and provisioning procyclicality (Laevan and Majnoni, 2003; Beatty and Liao, 2014). In particular, Real GDP growth and the Unemployment rate are used as indicators of general macroeconomic performance. House Price change and Stock Price change help explain differences in asset quality, for example via wealth effects among borrowers or via a decreased value of collateral. Private Sector Credit-to-GDP captures the aggregate debt burden of households and businesses. Finally, we control for short-term interest rates as monetary policy may also influence asset quality and loan loss coverage policy.

In the first specification, we include the high-NPL country dummy, to account for banks from countries with an above sample average level of NPLs. All things being equal, banks from countries affected by high levels of NPLs may behave differently from the average sample bank. Most of these countries have in fact weaker institutional frameworks and as such banks may face more impediments in resolving NPLs (Aiyar et al., 2015; ECB, 2016). This may delay NPLs disposals and induce distortions in banks’ provision policies.

Over the last years, high-NPL countries have been under particularly close scrutiny from national and supranational authorities, and banks from these countries have been required to undertake specific efforts to strengthen their balance sheets. It follows that we expect any regulatory intervention in these countries to lead to a relatively stronger reaction by banks located in these countries. To investigate whether this is the case, we interact the high-NPL country dummy with all our proxies for country governance and policy.

Finally, in the second specification, we exploit bank heterogeneity to investigate whether particular macro variables or policies affect a specific type of bank. In particular, given its relevance in affecting banks’ coverage policies, we focus on well capitalized banks by including a time-varying High-CET1-Bank dummy, which identifies banks in the upper decile of the distribution of the CET1 ratio, and its interactions with macro variables. The analysis allows us to derive useful policy insights, which go beyond estimating the average effect of the macro determinants for all banks within a country.

5.2. Results

Table 6 shows the results of our investigation on the role that quality and stringency of the institutional and regulatory framework play on banks’ coverage policy. For sake of space, all the bank-specific variables and the set of macro variables which capture the

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23 The definition of high-NPL country is the one introduced in Section 3, that is a time-varying definition (see footnote 13 for details).

24 In fact, the policies and practices in jurisdictions not afflicted by high NPLs ‘are not expected to be as prescriptive or coordinated as those in jurisdictions currently reacting to high levels of NPLs’ (ECB, 2016).
|                          | (1) NPLs/TA | (2) LLRs/TA | (3) Coverage ratio | (4) NPLs/TA | (5) LLRs/TA | (6) Coverage ratio |
|--------------------------|-------------|-------------|--------------------|-------------|-------------|--------------------|
| Regulatory quality       | 0.008       | −0.004*     | −0.014             | 0.004       | −0.003      | −0.017             |
| Rule of law              | −0.015      | 0.004       | 0.014              | −0.014      | 0.006       | 0.029              |
| Macroprudential index    | 0.001       | 0.001*      | 0.012**            | −0.0109***  | 0.006       | 0.069**            |
| Dynamic loan-loss provisioning |            |             |                    | (0.006)     | (0.004)     | (0.027)            |
| Capital surcharges on SIFI | 0.000      | 0.001       | 0.004              | 0.003       | 0.002       | 0.020*             |
| Levy/tax on financial institutions | 0.003       | 0.002       | 0.029              | (0.002)     | (0.001)     | (0.011)            |
| Loan-to-value ratio caps | 0.002       | 0.001       | −0.006             | 0.003       | 0.002       | (0.013)            |
| High NPL country dummy   | 0.033***    | 0.005*      | −0.006             | 0.022***    | 0.004*      | −0.034*            |
| High NPL country * regulatory quality |            |             |                    | (0.005)     | (0.003)     | (0.020)            |
| High NPL country * rule of law | −0.012**    | −0.001      | −0.040*            | −0.018***   | −0.001      | −0.065***          |
| High NPL country * macroprudential index | −0.002       | 0.000       | −0.005             | 0.007       | 0.003       | (0.025)            |
| High NPL country * dynamic LLP |            |             |                    | 0.007       | 0.002       | −0.057*            |
| High NPL country * cap. sur (SIFI) |            |             |                    | −0.007***   | 0.001       | −0.026***          |

(continued)
|                                | (1) NPLs/TA | (2) LLRs/TA | (3) Coverage ratio | (4) NPLs/TA | (5) LLRs/TA | (6) Coverage ratio |
|--------------------------------|-------------|-------------|--------------------|-------------|-------------|--------------------|
| High NPL country * levy on FI | 0.000       | 0.001       | −0.007             |             |             |                    |
|                                | (0.004)     | (0.001)     | (0.012)            |             |             |                    |
| High NPL country * LTV caps   | 0.009**     | 0.001       | 0.020              |             |             |                    |
|                                | (0.004)     | (0.002)     | (0.013)            |             |             |                    |
| Observations                  | 1845        | 1845        | 1845               | 1845        | 1845        | 1845               |
| Number of banks               | 441         | 441         | 441                | 441         | 441         | 441                |
| Adjusted R-squared            | 0.954       | 0.962       | 0.86               | 0.956       | 0.963       | 0.861              |
| Adjusted within R-squared     | 0.550       | 0.668       | 0.228              | 0.569       | 0.675       | 0.233              |
| Bank control variables        | Yes         | Yes         | Yes                | Yes         | Yes         | Yes                |
| Business and financial cycle control variables | Yes         | Yes         | Yes                | Yes         | Yes         | Yes                |
| FE bank                       | Yes         | Yes         | Yes                | Yes         | Yes         | Yes                |
| FE year                       | Yes         | Yes         | Yes                | Yes         | Yes         | Yes                |

Notes: The dependent variables are the coverage ratio, LLRs/TA and NPLs/TA at the bank level. High-NPL countries are defined as countries with NPL/TA above the sample mean. Bank, business cycle and financial cycle controls as well as bank and time dummies are included in each regression. Robust standard errors are clustered at the bank level and reported in parentheses. Significance at the 1%, 5% and 10% level is denoted by ***, ** and *, respectively.
economic and financial cycle are included in the analysis, but not explicitly reported in the table.

Among all the macro variables considered, only the macroprudential index is positively associated with both reserves and coverage ratios (Columns 2 and 3). Among the components of this index, dynamic loan-loss provisioning is associated with lower NPLs and higher coverage ratios (see Columns 4 and 6). This indicates that when measures to address pro-cyclical provisioning are in place, banks are better able to increase coverage ratios. We also find evidence that taxation on financial institutions is associated with higher coverage ratios (Column 6), plausibly because of the possibility of higher deductions associated with larger provisions (Andries et al., 2017).

Interestingly, in countries most affected by NPL issues, stricter rule of law is associated with lower NPLs, indicating that better quality enforcement or more efficient courts are relatively more beneficial for NPL accumulation presumably as they entail a quicker recovery phase (Columns 1 and 4). In line with this, stricter rule of law is also related to lower coverage ratio (Columns 3 and 6), perhaps because of lower reserve needs when recoveries are higher.

Among the various macroprudential measures, capital surcharges for systemically important institutions have the strongest impact in high-NPL countries and are associated with lower NPLs and coverage ratios (Columns 4 and 6). This finding is in line with previous research on stricter capital regulation which finds that when banks comply with stricter capital rules deleveraging and de-risking strategies are more likely (Gropp et al., 2019). This mechanism is likely to hold in high-NPL countries where banks presumably have a higher incentive to retain earnings to comply with the new rules rather than to increase provisioning.

Table 7 shows results from regressions where we exploit bank heterogeneity in a micro–macro context by including interactions between the $High-CET1-Bank$ dummy and the macro variables. Unlike the average bank in our sample, the interaction terms show that highly capitalized banks tend to increase coverage ratios when regulatory quality is reinforced but react negatively in response to macroprudential index, which has instead a positive coefficient when standing alone (Column 3). We read these results together with the one on the complementarity between capital and coverage ratios in Section 4 as suggesting that, contrary to the average bank, highly capitalized banks tend to shape their coverage policy independently from additional macroprudential rules. Consistent with this finding, none of the specific macroprudential policy measures under analysis seems to be able to affect the coverage ratios of highly capitalized banks (Column 6).

As a final comment, it is important to note that although the bank-specific variables are not included in Tables 6 and 7 for sake of space, they remain the most important

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25 Although at different rates, the majority of EA countries ‘acknowledge tax deductions for LLPs, write-offs and collateral sales’ (ECB, 2016, 2017b).
determinants of coverage ratios. This is evident in Table A4 where we carry out a Shapley decomposition to analyse variance explained by the micro and macro determinants we use in our regressions.

### Table 7. Micro-macro regressions: focus on highly capitalized banks

|                      | (1)       | (2)       | (3)       | (4)       | (5)       | (6)       |
|----------------------|-----------|-----------|-----------|-----------|-----------|-----------|
|                      | NPLs/TA   | LLRs/TA   | Coverage  | NPLs/TA   | LLRs/TA   | Coverage  |
| Regulatory quality   | 0.011*    | -0.005**  | -0.012    | 0.012*    | -0.003    | 0.000     |
|                      | (0.006)   | (0.002)   | (0.034)   | (0.007)   | (0.003)   | (0.036)   |
| Rule of law          | -0.016*   | 0.005     | -0.015    | -0.018*   | 0.004     | -0.019    |
|                      | (0.009)   | (0.003)   | (0.032)   | (0.009)   | (0.003)   | (0.032)   |
| Macroprudential index| 0.000     | 0.001**   | 0.011**   | -0.014**  | 0.008***  | 0.038*    |
|                      | (0.001)   | (0.000)   | (0.005)   | (0.007)   | (0.003)   | (0.023)   |
| Dynamic loan-loss provisioning | -0.002 | 0.002 | 0.011 | 0.000 | 0.000 | 0.000 |
| Capital surcharges on SIFI banks | (0.003) | (0.001) | (0.013) | (0.003) | (0.001) | (0.010) |
| Levy/tax on financial institutions | 0.003 | 0.002 | 0.016 | 0.003 | 0.002 | 0.016 |
| Loan-to-value ratio caps | 0.004 | 0.001 | 0.005 | 0.004 | 0.001 | 0.005 |
| High CET1 bank dummy | 0.030*** | -0.002 | -0.049 | 0.036*** | -0.009 | -0.13 |
|                      | (0.010)   | (0.012)   | (0.085)   | (0.013)   | (0.015)   | (0.097)   |
| High CET1 bank * Reg. quality | -0.009 | 0.002 | 0.129** | -0.012 | -0.007 | 0.093 |
|                      | (0.010)   | (0.005)   | (0.064)   | (0.014)   | (0.005)   | (0.069)   |
| High CET1 bank * rule of law | -0.007 | 0.001 | -0.056 | -0.008 | 0.014** | 0.003 |
|                      | (0.008)   | (0.005)   | (0.054)   | (0.012)   | (0.006)   | (0.063)   |
| High CET1 bank * macropru. index | -0.001 | -0.001 | -0.019** | -0.012 | 0.015 | 0.103 |
|                      | (0.002)   | (0.001)   | (0.008)   | (0.011)   | (0.010)   | (0.069)   |
| High CET1 bank * dynamic LLP | -0.002 | -0.002 | -0.005 | -0.002 | -0.003 | -0.005 |
|                      | (0.003)   | (0.002)   | (0.027)   | (0.004)   | (0.002)   | (0.027)   |
| High CET1 bank * capital surcharges | 0.000 | 0.002** | -0.009 | 0.000 | 0.002** | -0.009 |
| High CET1 bank * levy on FI | -0.002 | -0.003 | -0.005 | -0.002 | -0.003 | -0.005 |
|                      | (0.004)   | (0.002)   | (0.027)   | (0.003)   | (0.001)   | (0.027)   |
| High CET1 bank * LTV caps | -0.009** | -0.002* | -0.023 | -0.009** | -0.002* | -0.023 |
|                      | (0.003)   | (0.001)   | (0.027)   | (0.003)   | (0.001)   | (0.027)   |
| Observations         | 1845      | 1845      | 1845      | 1845      | 1845      | 1845      |
| Number of banks      | 441       | 441       | 441       | 441       | 441       | 441       |
| Adjusted R-squared   | 0.948     | 0.961     | 0.855     | 0.949     | 0.962     | 0.854     |
| Adjusted within R-squared | 0.487   | 0.663     | 0.199     | 0.495     | 0.672     | 0.196     |
| Bank control variables | Yes | Yes | Yes | Yes | Yes | Yes |
| Business and financial cycle control variables | Yes | Yes | Yes | Yes | Yes | Yes |
| FE bank              | Yes       | Yes       | Yes       | Yes       | Yes       | Yes       |
| FE year              | Yes       | Yes       | Yes       | Yes       | Yes       | Yes       |

Notes: The dependent variables are the coverage ratio, LLRs/TA and NPLs/TA at the bank level. High CET1 bank is a time varying dummy variable that accounts for banks in the top decile of the annual CET1 ratio distribution, bank, business cycle and financial cycle controls as well as bank and time dummies are included in each regression. Robust standard errors are clustered at the bank-level and reported in parentheses. Significance at the 1%, 5% and 10% level is denoted by ***, ** and *, respectively.
5.3. Extension: NPL secondary market and coverage policy

One of the responses most often cited by banks as an impediment to the NPL resolution is the lack of a market to sell NPLs (EBA, 2019). Although relatively underdeveloped in relation to the high NPL stock in some jurisdictions in Europe, NPLs transactions have progressively increased over the last years, varying from 11 billion euros in 2010 to nearly 100 billion euros as of end 2017, according to PwC reports. Transactions are concentrated in a few countries, that is Ireland, Germany, Spain and United Kingdom, and more recently, Italy (the largest market place since 2016). Figure 6 shows the value of NPL transactions by country in 2010–7.

The market for distressed assets is clearly a market for lemons à la Akerlof, being characterized by high information asymmetries and large bid–ask spreads between sellers and buyers (Fell et al., 2016). High coverage ratios can help make the disposal of loans more likely by reducing the bid–ask spread and the loss a bank takes as a consequence of the NPL sale (see also the discussion in Section 2). We therefore expect deeper markets to be associated with higher coverage ratios as a pre-condition to access the market (see also the discussion in Section 2).

To test this hypothesis, in Table 8, we expand our micro–macro baseline regression to account for the relevance of the NPL secondary market in a given country. We first include the variable NPL Secondary Market Transactions/TA to measure the share of NPL

Figure 6. NPL secondary market transaction data (2010–6, €billion, Source: PwC).

26 The dataset also includes transactions for Portugal (2011), France (2012), Belgium (2013) and The Netherlands (2013, 2014, 2015, 2016) but for more limited amounts.
|                                | (1) NPLs/TA | (2) LLR/TA | (3) Coverage ratio | (4) NPLs/TA | (5) LLR/TA | (6) Coverage ratio | (7) NPLs/TA | (8) LLR/TA | (9) Coverage ratio |
|--------------------------------|-------------|------------|--------------------|-------------|------------|--------------------|-------------|------------|--------------------|
| NPL secondary market transactions/TA | -0.007      | 0.160**    | -0.295             | (0.144)     | (0.069)    | (0.472)            |             |            |                    |
| Medium NPL secondary Mkt         |             |            | 0.000 (0.002)      | 0.001 (0.002) | 0.010 (0.008) | 0.002 (0.002) | 0.002 (0.001) | 0.006 (0.144) |                    |
| Large NPL secondary Mkt          |             |            | 0.005** (0.002)   | 0.002*** (0.001) | 0.021*** (0.008) | 0.004** (0.002) | 0.001* (0.001) | 0.012 (0.009) |                    |
| High NPL country                |             |            | 0.012*** (0.002)  | 0.001 (0.001) | 0.000 (0.001) | 0.000 (0.002) | 0.001 (0.001) | -0.053*** (0.002) |                    |
| High NPL country * medium NPL secondary Mkt |             |            | 0.001 (0.002) | 0.000 (0.001) | 0.007 (0.001) |                    |             |            |                    |
| High NPL country * large NPL secondary Mkt |             |            | 0.003 (0.002) | 0.002** (0.001) | 0.018** (0.009) |                    |             |            |                    |
| Observations                    | 1845        | 1845       | 1845               | 1845        | 1845       | 1845               | 1845        | 1845       | 1845               |
| Number of banks                 | 441         | 441        | 441                | 441         | 441        | 441                | 441         | 441        | 441                |
| Adjusted $R^2$                   | 0.947       | 0.961      | 0.854              | 0.948       | 0.961      | 0.854              | 0.953       | 0.962      | 0.860              |
| Adjusted within $R^2$           | 0.482       | 0.663      | 0.193              | 0.487       | 0.660      | 0.196              | 0.535       | 0.665      | 0.227              |
| Bank control variables          | Yes         | Yes        | Yes                | Yes         | Yes        | Yes                | Yes         | Yes        | Yes                |
| Business and financial cycle control variables | Yes         | Yes        | Yes                | Yes         | Yes        | Yes                | Yes         | Yes        | Yes                |
| FE bank                         | Yes         | Yes        | Yes                | Yes         | Yes        | Yes                | Yes         | Yes        | Yes                |
| FE year                         | Yes         | Yes        | Yes                | Yes         | Yes        | Yes                | Yes         | Yes        | Yes                |

Notes: NPL secondary market transaction/TA measures the share of NPL transactions over the total banking assets at the country level. The dependent variables are the coverage ratio, LLRs/TA and NPLs/TA at the bank level. Bank, business cycle and financial cycle controls, as well as bank and time dummies are included in each regression. Robust standard errors are clustered at the bank-level and reported in parentheses. Significance at the 1%, 5% and 10% level is denoted by ***, ** and *, respectively.
transactions over the total banking assets at the country level to proxy the degree of development of the market (Columns 1–3). Because the volume of trades is concentrated only in some countries, we also include two categorical variables to account for Medium and Large NPL Secondary Market, by splitting the sample into terciles (based on the share of NPL transactions over the total banking assets at country level). We use the lowest tercile as the reference category and test whether the other categories are associated with higher coverage ratios. We find that while LLRs are higher when transactions increase and, more generally, in medium sized and large marketplace (Columns 2 and 5), coverage ratios are significantly higher only in countries where the NPL secondary market is large (Column 6).

As a next step, we interact our measures of medium and large NPL secondary markets with the high-NPL country dummy. In line with official statistics, we find that banks from high-NPL countries report lower coverage ratios on average. We find, however, relatively larger reserves and higher coverage ratios in banks from high-NPL countries that are featured by very active marketplaces (Columns 8 and 9). This is not surprising, as banks from high-NPL countries are more affected by information asymmetries (see Fell et al., 2016) and therefore may need to set higher coverage ratios to access the market.

6. CONCLUSIONS

This paper explores micro and macro determinants of coverage ratio, an indicator of bank balance sheet strength that has gained increasing importance in Europe in the last few years.

Our analysis derives a number of important findings for policy. Bank-specific factors, and among them credit risk (including forward-looking) variables and capitalization, explain most of the variation in coverage ratios. A deterioration in asset quality is associated with higher coverage ratios, but the relation is not linear, becoming less negative when banks hold very large stock of troubled assets. Overall, capitalization and coverage ratio appear to be complementary tools, in that banks with high levels of capital tend to cover more their loan portfolios.

More stringent macroprudential policy is also associated with higher coverage ratios and interventions on time-varying/dynamic loan-loss provisioning are generally the most effective tools to increase coverage ratios. Structural factors such as the degree of development of NPL secondary markets also explain coverage ratio variation, where larger markets are associated with higher coverage ratios.

High-NPL banks as well as banks from high-NPL countries behave differently from banks less affected by credit risk issues. Coverage policies in banks from more risky countries are especially sensitive to changes in the rule of law, capital rules and development of the NPL secondary market.

Our results are relevant for the current debate on NPLs and coverage policies. We uncover that variables that are traditionally important in explaining NPLs dynamics are not equally useful to explain variation in loan loss coverage. Bank-specific factors explain
most of the variation in banks’ coverage ratios, implying that microprudential supervision would be more effective in steering banks’ loan loss coverage than macro policies. In terms of macro policies, some specific macroprudential levers, as well as developing loan secondary markets, seem to be effective in shaping banks’ coverage. Because of the large discrepancies in asset quality across banks and countries, specific actions for high-NPL banks and high-NPL countries are recommended.

CONFLICT OF INTEREST STATEMENT

L.A., B.B., K.N. and I.W. have nothing to disclose. E.C. was a member of the Advisory Scientific Committee of the European Systemic Risk Board since 2015 and an independent member of the Board of Directors of UniCredit Spa since February 2019.

APPENDIX A: ADDITIONAL TABLES

Table A1. Sample composition and average coverage ratio, LLR/TA and NPL/TA ratios by country

| Country code | Number of observations | Number of banks | Avg. coverage ratio (%) | Avg. LLR/TA (%) | Avg. NPL/TA (%) |
|--------------|------------------------|----------------|-------------------------|-----------------|-----------------|
| AT           | 68                     | 19             | 53                      | 2               | 4               |
| BE           | 20                     | 4              | 47                      | 1               | 2               |
| BG           | 11                     | 3              | 32                      | 5               | 13              |
| CY           | 8                      | 2              | 41                      | 9               | 20              |
| CZ           | 20                     | 4              | 63                      | 3               | 4               |
| DE           | 939                    | 232            | 54                      | 1               | 2               |
| DK           | 48                     | 9              | 55                      | 4               | 7               |
| ES           | 74                     | 17             | 56                      | 2               | 5               |
| FI           | 15                     | 6              | 34                      | 0               | 1               |
| FR           | 67                     | 18             | 63                      | 1               | 2               |
| GB           | 128                    | 30             | 36                      | 1               | 4               |
| GR           | 24                     | 5              | 42                      | 9               | 21              |
| HR           | 8                      | 2              | 57                      | 6               | 11              |
| HU           | 9                      | 3              | 66                      | 9               | 16              |
| IE           | 13                     | 3              | 36                      | 6               | 16              |
| IT           | 252                    | 48             | 44                      | 5               | 10              |
| LT           | 4                      | 2              | 27                      | 1               | 4               |
| LU           | 10                     | 2              | 32                      | 1               | 4               |
| LV           | 8                      | 3              | 54                      | 2               | 4               |
| MT           | 9                      | 3              | 27                      | 1               | 4               |
| NL           | 31                     | 6              | 31                      | 1               | 4               |
| PL           | 32                     | 6              | 59                      | 3               | 6               |
| PT           | 20                     | 5              | 54                      | 5               | 10              |
| RO           | 8                      | 2              | 56                      | 4               | 8               |
| SE           | 4                      | 2              | 72                      | 1               | 1               |
| SI           | 9                      | 3              | 66                      | 6               | 9               |
| SK           | 6                      | 2              | 65                      | 3               | 4               |
| Total        | 1845                   | 441            |                         |                 |                 |
### Table A2. Correlation matrix of the independent and dependent variables in our baseline (micro and micro-macro) analyses

| Cov. ratio | LLR/TA | NPL/TA | DELTA (NPL/TA) | Gross loans/TA | Gross loan growth | log (TA) | Dep/TA | CET1 | ROAA | Cost-to-inc. ratio | Reg. Quality | Rule of law | Macro-pru. index | Dyn. LLP | Cap. Sur (SIFI) | Levy/tax on FI | LTV ratio sec. mkt | NPL sec. mkt |
|------------|--------|--------|----------------|----------------|------------------|----------|--------|------|------|-------------------|--------------|-------------|----------------|----------|---------------|--------------|-----------------|-------------|
| Cov. ratio | 1      |        |                |                |                  |          |        |      |      |                   |              |             |                |          |               |              |                 |             |
| LLR/TA     | 0.019  | 1      |                |                |                  |          |        |      |      |                   |              |             |                |          |               |              |                 |             |
| NPL/TA     | 0.019  | 0.938  | 1              |                |                  |          |        |      |      |                   |              |             |                |          |               |              |                 |             |
| DELTA (NPL/TA) | -0.227* | 0.065* | 0.259* | 0.342* | 0.019 | 0.065* | 0.259* | 0.342* | 0.019 | 0.065* | 0.259* | 0.342* | 0.019 | 0.065* | 0.259* | 0.342* | 0.019 |
| Gross loans/TA | -0.116* | 0.118* | -0.192* | -0.236* | -0.163* | 0.056* | 0.218* | -0.498* | 1     |        |                  |              |             |                |          |               |              |                 |             |
| Gross loan growth | -0.011* | 0.116* | 0.209* | 0.222* | 0.067* | 1      |        |        |      |      |                   |              |             |                |          |               |              |                 |             |
| log (Total Assets) | 0.019 | 0.116* | 0.259* | 0.342* | 0.019 | 0.065* | 0.259* | 0.342* | 0.019 | 0.065* | 0.259* | 0.342* | 0.019 | 0.065* | 0.259* | 0.342* | 0.019 |
| Dep./TA    | 0.118* | 0.116* | 0.259* | 0.342* | 0.019 | 0.065* | 0.259* | 0.342* | 0.019 | 0.065* | 0.259* | 0.342* | 0.019 | 0.065* | 0.259* | 0.342* | 0.019 |
| CET1       | 0.096* | 0.019 | -0.145* | -0.167* | -0.126* | 0.158* | 0.050* | -0.177* | 0.186* | 1     |                   |              |             |                |          |               |              |                 |             |
| ROAA       | 0.128* | 0.027 | 0.103* | -0.096* | -0.008 | 0.029 | -0.106* | -0.082* | 0.135* | -0.181* | -0.411* | 1     |                   |              |             |                |          |               |              |                 |             |
| Cost-to-income ratio | 0.033* | 0.095* | 0.063* | 0.201* | -0.049* | 0.088* | -0.156* | 0.294* | 0.160* | -0.005 | 0.159* | 1     |                   |              |             |                |          |               |              |                 |             |
| Regulatory quality | 0.033* | 0.095* | 0.063* | 0.201* | -0.049* | 0.088* | -0.156* | 0.294* | 0.160* | -0.005 | 0.159* | 1     |                   |              |             |                |          |               |              |                 |             |
| Rule of law | 0.033* | 0.095* | 0.063* | 0.201* | -0.049* | 0.088* | -0.156* | 0.294* | 0.160* | -0.005 | 0.159* | 1     |                   |              |             |                |          |               |              |                 |             |
| Macro-pru. index | 0.232* | 0.018 | -0.059* | -0.170* | -0.014 | 0.005* | -0.156* | 0.133* | 0.191* | 0.110* | 0.031 | -0.084* | -0.166* | 1     |                   |              |             |                |          |               |              |                 |             |
| Dynamic LLP | 0.023 | 0.087* | 0.064* | -0.033 | 0.008 | 0.015 | 0.106* | -0.013 | -0.006* | 0.100* | -0.127* | -0.214* | -0.186* | 0.098* | 1     |                   |              |             |                |          |               |              |                 |             |
| Cap. Sur (SIFI) | 0.121* | 0.014 | 0.015 | 0.114* | 0.112* | 0.181* | 0.233* | 0.092* | 0.070* | 0.170* | 0.006 | 0.684* | -0.136* | 1     |                   |              |             |                |          |               |              |                 |             |
| Levy/tax on FI | 0.264* | -0.229* | -0.249* | -0.227* | -0.015* | 0.003 | -0.224* | 0.204* | 0.119* | 0.073* | 0.223* | 0.269* | 0.281* | 0.098* | 1     |                   |              |             |                |          |               |              |                 |             |
| LTV ratio caps | -0.006 | 0.434* | 0.398* | -0.014 | 0.001 | -0.033 | 0.115* | -0.196* | -0.029 | 0.178* | -0.183* | -0.478* | -0.415* | 0.394* | 0.212* | 0.103* | -0.082* | 1     |                   |              |             |                |          |               |              |                 |             |
| NPL sec. mkt | -0.085* | 0.275* | 0.295* | -0.052* | 0.070* | -0.045* | 0.074* | -0.067* | 0.004 | 0.022 | -0.019 | -0.165* | -0.223* | 0.085* | 0.023 | 0.048* | -0.005 | 0.260* | 1     |                   |              |             |                |          |               |              |                 |             |

*Note: Correlations with an * are significant at the 10% level.*
Table A3. Micro-level regressions: robustness

|                         | (1) NPLs/TA | (2) LLRs/TA | Coverage ratio |
|-------------------------|-------------|-------------|---------------|
| LLR/TA_{t-1}           | 1.035***    |             | 4.807***      |
|                         | (0.125)     |             | (0.515)       |
| NPL/gross loans_{t-1}  | 0.211***    |             | -1.739***     |
|                         | (0.027)     |             | (0.199)       |
| DELTA (NPL/GL)         | 0.173***    |             | -1.078***     |
|                         | (0.025)     |             | (0.156)       |
| Gross loans/TA_{t-1}   | 0.025*      | 0.026***    | -0.266***     |
|                         | (0.015)     | (0.006)     | (0.090)       |
| Gross loan growth      | -0.020*     | 0.017****   | 0.136***      |
|                         | (0.011)     | (0.003)     | (0.043)       |
| log (total assets)_{t-1} | 0.001     | 0.003       | 0.033         |
|                         | (0.008)     | (0.002)     | (0.035)       |
| Deposits/TA_{t-1}      | -0.023      | 0.005       | 0.058         |
|                         | (0.015)     | (0.005)     | (0.073)       |
| Tier 1 capital_{t-1}   | 0.023       | 0.014       | 0.227         |
|                         | (0.023)     | (0.010)     | (0.167)       |
| ROAE_{t-1}             | -0.055***   | -0.021***   | -0.115**      |
|                         | (0.016)     | (0.006)     | (0.051)       |
| Cost-to-income ratio_{t-1} | -0.021*** | 0.001       | -0.085**      |
|                         | (0.007)     | (0.003)     | (0.033)       |
| Observations           | 1842        | 1842        | 1842          |
| Number of banks        | 441         | 441         | 441           |
| Adjusted R-squared     | 0.956       | 0.966       | 0.853         |
| Adjusted within R-squared | 0.321   | 0.491       | 0.153         |
| FE bank                | Yes         | Yes         | Yes           |
| FE country-year        | Yes         | Yes         | Yes           |

Notes: The dependent variables are the coverage ratio, LLRs/TA and NPLs/TA at the bank level. Within the explanatory variables, NPL/TA is replaced with NPLs over gross loans (NPL/GL), the CET1 ratio is replaced by the Tier 1 Capital ratio and ROAA is replaced with the ROAE. Robust standard errors are clustered at the bank-level and reported in parentheses. Significance at the 1%, 5% and 10% level is denoted by ***, ** and *, respectively.
APPENDIX B: CAPITAL AND COVERAGE RATIO FOLLOWING THE 2011 EBA EXERCISE

In this section, we investigate more explicitly the role played by capitalization in shaping banks coverage policy. As discussed in Section 4.1, the role of capitalization on loan loss coverage is not easy to anticipate. On the one hand, because loan loss reserving is a costly strategy, better capitalized banks should be in the best position to accumulate LLRs and therefore report higher coverage ratios. On the other hand, though, banks may see coverage ratios and capital substitute rather than complementary buffers: LLRs are suited to absorb the expected losses emerging losses from the lending business. The larger these reserves the lower the need for banks to set high capital buffers to absorb unexpected credit losses.

The results from the micro-level analysis (Tables 4 and 5) show a positive relationship between capitalization and coverage ratios, pointing to the following mechanism: when capital ratios increase, banks are more prone to set up higher coverage ratios. To establish a more credible causal link between capitalization and loan loss

### Table A4. Shapley decomposition

| Panel A | Variable                     | Value | In percentage (%) |
|---------|------------------------------|-------|-------------------|
|         | LLR/TA<sub>t-1</sub>        | 0.199 | 38.71             |
|         | NPL/TA<sub>t-1</sub>        | 0.187 | 36.48             |
|         | DELTA (NPL/TA)              | 0.006 | 1.23              |
|         | Gross loans/TA<sub>t-1</sub>| 0.012 | 2.40              |
|         | Gross loan growth           | 0.004 | 0.69              |
|         | log (Total Assets)<sub>t-1</sub> | 0.009 | 1.74              |
|         | Deposits/TA<sub>t-1</sub>   | 0.004 | 0.77              |
|         | CET1<sub>t-1</sub>          | 0.001 | 0.28              |
|         | ROAA<sub>t-1</sub>          | 0.003 | 0.55              |
|         | Cost-to-income ratio<sub>t-1</sub> | 0.001 | 0.16              |
|         | Group: Macro                | 0.087 | 16.99             |
|         | Total                       | 0.513 | 100.00            |

| Panel B | Variable                     | Value | In percentage (%) |
|---------|------------------------------|-------|-------------------|
|         | Regulatory quality           | 0.003 | 0.65              |
|         | Rule of law                  | 0.006 | 1.18              |
|         | Macropudential index         | 0.027 | 5.25              |
|         | Business and financial cycle |       |                   |
|         | GDP growth<sub>t-1</sub>     | 0.003 | 0.53              |
|         | Unemployment<sub>t-1</sub>   | 0.002 | 0.41              |
|         | House price change y-o-y<sub>t-1</sub> | 0.009 | 1.73              |
|         | Stock price change y-o-y<sub>t-1</sub> | 0.001 | 0.23              |
|         | Private credit to GDP<sub>t-1</sub> | 0.025 | 4.91              |
|         | Short-term interest rate<sub>t-1</sub> | 0.005 | 1.06              |
|         | Group: micro                 | 0.431 | 84.05             |
|         | Total                        | 0.513 | 100.00            |
coverage, in the spirit of Gropp et al. (2019), we employ the 2011 capital exercise conducted by the EBA as a quasi-experiment to identify how banks adjust their coverage ratios in response to higher capital requirements. Unlike Gropp et al. (2019), we are not interested in understanding how selected banks adjusted their balance sheet to achieve the capital target, but how these banks set their coverage policy, once the capital target has been achieved (i.e. since 2012 onwards).

Several factors justify the use of the EBA capital exercise as a way to identify empirically how an exogenous shock to regulatory capital can affect bank loan loss coverage strategy. First, the capital exercise (that was announced on end of October 2011) required a subset of European banks (treated banks) to reach and maintain a 9% core tier 1 capital ratio by the end of June 2012. This change constituted an economically significant increase in capital requirements compared with the previously required 5%. Second, since only a subset of European banks was selected, we can use the set of non-selected banks as a control group and implement a difference-in-difference strategy. Third, although banks were selected on the basis of an observable non-random characteristic (i.e., asset size), the country-specific selection criterion enables us to employ a number of matching strategies to rule out the possibility of the results being driven by size or other characteristics.\(^{27}\) Fourth, the selection criterion was not strategically manipulable, because banks were identified for the exercise on the basis of their total assets at the end of 2010, that is a year before the capital exercise.

We use a difference-in-differences approach to determine if banks adjust their coverage ratios in response to a change in capitalization. The underlying assumption of difference-in-differences models is that banks in the treated and control groups would continue following a similar trend in the absence of treatment. Given that the treated banks were not chosen randomly, we implement three matching strategies to allow a comparison of more similar banks. Banks are matched using the bias-corrected Abadie and Imbens (2011) matching estimator on seven pretreatment characteristics: total assets, deposits as a share of total assets, gross loans as a share of total assets, the tier 1 capital ratio, the coverage ratio, NPLs as a share of total assets and LLRs as a share of total assets. These matching covariates capture potential differences in size, business models and funding structure, asset quality and loan loss coverage strategies prior to the capital exercise.

We implement the following different matching strategies. The within-country matching strategy matches one noncapital exercise bank to each capital exercise bank (CEB) in the same country based on the seven matching covariates. This strategy

\(^{27}\) The EBA used a country-specific selection rule and included banks ‘in descending order of their market shares by total assets in each member state, such that the exercise covered “50% of the national banking sectors in each EU Member State” (EBA, 2011).
addresses concerns that our results are driven by time varying cross-country differences that we cannot control for. The within-region matching strategy matches two control banks with each treated bank in the same geographic region (GIIPS or non-GIIPS) on the basis of the seven matching covariates. The GIIPS countries are Greece, Ireland, Italy, Portugal and Spain.

Finally, the full sample matching strategy matches four control banks to each treated bank based on the seven matching covariates and independently on the bank location.

Table B1 provides pretreatment mean comparisons for bank characteristics of CEBs and matched control group banks (control) as of 2010. We test for differences in means using a t-test. Significance at the 1%, 5% and 10% level is denoted by ***, ** and *, respectively.

We estimate the following regression having LLRs, NPLs and coverage ratios as dependent variables in separate models:

| Number of banks | Total assets | CET1 | Tier1 | Dep/TA | GL/TA | Cov | NPL/TA | LLR/TA |
|-----------------|-------------|------|-------|--------|-------|-----|--------|--------|
| A: Unmatched    |             |      |       |        |       |     |        |        |
| CEB 41          | 507.027     | 0.095| 0.111 | 0.432  | 0.568 | 0.42| 0.06   | 0.021  |
| Control 98      | 53.031      | 0.107| 0.114 | 0.572  | 0.661 | 0.423| 0.063  | 0.021  |
| Δ               | 453.996***  | −0.013* | −0.003 | −0.140*** | −0.093** | −0.003 | −0.003 | 0.001  |
| B: Within country matching 1:1 | | | | | | | |
| CEB 41          | 507.027     | 0.095| 0.111 | 0.432  | 0.568 | 0.42| 0.06   | 0.021  |
| Control 21      | 127.927     | 0.097| 0.106 | 0.577  | 0.643 | 0.411| 0.072  | 0.024  |
| Δ               | 379.099**   | −0.003 | 0.005 | −0.145** | −0.074 | 0.01 | −0.012 | −0.003 |
| C: Within region matching 1:2 | | | | | | | |
| CEB 36          | 84.912      | 0.1  | 0.109 | 0.524  | 0.648 | 0.423| 0.062  | 0.023  |
| Control 56      | 76.983      | 0.101| 0.109 | 0.529  | 0.639 | 0.419| 0.066  | 0.022  |
| Δ               | 422.115***  | −0.005 | 0.002 | −0.092* | −0.079* | −0.003 | −0.002 | −0.001 |
| D: Full Sample matching 1:4 | | | | | | | |
| CEB 56          | 76.983      | 0.101| 0.109 | 0.529  | 0.639 | 0.419| 0.066  | 0.022  |
| Control 98      | 53.031      | 0.107| 0.114 | 0.572  | 0.661 | 0.423| 0.063  | 0.021  |
| Δ               | 430.044***  | −0.006 | 0.002 | −0.097** | −0.070* | 0.002 | −0.006 | −0.001 |

Notes: This table provides pretreatment mean comparisons for bank characteristics of CEBs and matched control group banks (control) as of 2010. We test for differences in means using a t-test. Significance at the 1%, 5% and 10% level is denoted by ***, ** and *, respectively.

28 The GIIPS countries are Greece, Ireland, Italy, Portugal and Spain.
where $i = 1, \ldots, N$, $k = 1, \ldots, K$ and $t = 1, \ldots, T$, with $i$ being the bank, $k$ being the country and $t$ being the year. $EBA_i \times \text{Post}_t$ is an interaction term between two dummy variables; $EBA_i$ is equal to 1 if bank $i$ took part in the 2011 EBA capital exercise and zero otherwise, and $\text{Post}_t$ is equal to 1 in years 2012–3, 2012–5 or 2012–7, depending on the specification, and zero otherwise. The vector $X_{ikt}$ includes the same bank-level control variables as in Section 4. Finally, the equation includes bank and country-year fixed effects ($\gamma_{kt}$, respectively).

Table B2 reports the estimation results for the coverage ratio and its components from the period before to the period after the capital exercise. In Columns 1–3 we define Post as the years 2012–5, and zero otherwise. In columns 4–6 Post is a dummy variable equal to one in years 2013–7, and zero otherwise. In columns 7–9 Post is a dummy variable equal to one in years 2013–7, and zero otherwise.

Robust standard errors are clustered at the bank-level and reported in parentheses. Significance at the 1%, 5% and 10% level is denoted by ***, ** and *, respectively.

\[ T_{ikt} = \beta_1 EBA_i \times \text{Post}_t + \beta_2 X_{ikt} + \mu_i + \gamma_{kt} + \epsilon_{ikt}, \quad (B1) \]
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