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Centre for Studies in Economics and Finance

WORKING PAPER NO. 513

How Do Banks Respond to Non-Performing Loans?

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November 2018
This version July 2021

University of Naples Federico II   **University of Salerno**   **Bocconi University, Milan**

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How Do Banks Respond to Non-Performing Loans?

Brunella Bruno[*] **and Immacolata Marino**[**]

Abstract
We exploit the first European Central Bank's Asset Quality Review as a quasi-experiment to investigate the effect on banks' balance sheets of a shock to Non-Performing Loans (NPLs). We found that the banks included in the review with higher unexpected changes to their NPLs, deleveraged and reduced their lending more than non-reviewed banks. The effect is non-linear and is stronger among reviewed banks located in high-NPL countries. The banks affected the most were undercapitalised and unprofitable, suggesting that NPLs influence the credit supply via a capital/profitability channel.

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[*] Università Bocconi. Address: Department of Finance, Università Bocconi, Via Roentgen 1, 20136 Milan (Italy). Phone: +39 0258365954. E-mail: brunella.bruno@unibocconi.it (*Corresponding author*)

[**] Università di Napoli Federico II and CSEF. Department of Economics and Statistics, Università di Napoli Federico II, Via Cinthia, Monte S.Angelo, 80126 Naples (Italy). Phone: +39 081675020. E-mail: immacolata.marino@unina.it.

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1 Introduction

Non-performing loans (NPLs), that is loans that are either more than 90 days past their repayment date or loans that are unlikely to be repaid in full, have for long been considered a microprudential issue.[1] However, the surge in bad loans throughout Europe in the wake of the global financial and euro debt crises, made the problem relevant for policy makers, who were concerned that high levels of NPLs would increase systemic risk and impair core functions, such as the supply of credit to the real economy (ESRB, 2019). In 2015, NPLs in Europe peaked at over €1 trillion, nearly 9% of GDP, according to the European Banking Authority (EBA). Since then, several policy actions have been implemented to try to resolve the issue. Nevertheless, the average NPL ratio in the euro area is above pre-crisis levels and is twice the average ratio in US banks. Also, the COVID-19 pandemic and associated economic recession are expected to exacerbate the NPL problem, making it once again a policy priority (see, e.g., Ari et al., 2020; Enria, 2020).

In this paper, we study how banks adjust their balance sheets in response to a deterioration in asset quality. Do they shrink their assets in response to higher NPLs? Do they reduce lending or do they change the asset mix at the expense of the loan portfolio?

These are important questions, but, despite their policy relevance, the existing research has been unable to establish a credible causal link between asset quality deterioration and an adverse effect on lending. For example, the causality between asset quality and bank behavior could run from the bank's credit supply to its stock of NPLs, rather than in the other direction, since a reduced supply of credit could trigger defaults, which, in turn, would increase the volume of NPLs.

This paper provides evidence that banks react to higher NPLs by deleveraging and reducing their lending. To study how banks respond to changes in their NPLs, we use micro level bank data for the euro area during the period 2010-2015. The euro area provides an

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[1]We use the terms NPLs, impaired loans, troubled loans, problem loans and non-performing exposures interchangeably, although we are aware that across jurisdictions and banks these terms can mean different things (BCBS, 2017).

interesting laboratory, given the high level of NPLs in the region and the large discrepancies across countries, for example, a NPL ratio ranging from 1% in Germany to 40% in Greece (EBA, 2019).

To identify an exogenous variation in NPLs, we employ the first Asset Quality Review (AQR) conducted by the European Central Bank (ECB) as a quasi-experiment. The AQR was an unprecedented initiative, implemented in 2014, and applied to a subset of European banks, as a preliminary action before the introduction of the single supervisor. There are several factors that suggest that the AQR is appropriate to identify empirically how an exogenous shock to NPLs can affect bank behaviour. First, the consistent application in the reviewed banks of a new, harmonized definition of non-performing exposures and the credit file scrutiny, resulted in an increase in NPLs of nearly €140 billion (+18.4%) (ECB, 2014). Second, we find large variation among the reviewed banks related to the NPL adjustments required by the ECB. For example, the share of debtors reclassified as non-performing, ranges from 0 to over 40% of the total debtors originally classified by the reviewed banks as performing. This is significant since those banks with larger changes to their NPLs (i.e., more affected by the review) should react more profoundly than banks with few or no changes to their NPLs. Third, since only a subset of European banks was reviewed, we can use the set of non-reviewed banks as a control group. Fourth, although our sample of reviewed banks was selected on the basis of an observable non-random characteristic (i.e., asset size), this was not strategically manipulable around the threshold in order to avoid the treatment, because the banks were identified for review on the basis of their Total Assets (TA) at end 2012, i.e., a year before the AQR.

We show that the shock to NPLs induced by the AQR led the reviewed banks to reduce their asset growth by 1.65 percentage points more than non-AQR banks and to reduce their lending growth by 1.5 percentage points more than non-AQR banks. These results are estimated in a triple Difference-in-Differences (DD) framework, in which we compare the effect of the shock to NPLs in reviewed and non-reviewed banks, conditional on the magnitude of the shock (i.e., the change in NPLs).

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We exploit the discrepancy in asset quality across European countries by splitting our bank sample into banks from high-NPL and low-NPL countries. We show that the reaction to increased NPLs is non-linear and is more pronounced in banks in high-NPL countries. This result is unaffected by differences in economic and credit demand conditions between high-NPL and low-NPL countries.

We are also interested in the most prevalent mechanism (channel) through which NPLs affect banks' behaviour. We address this question by investigating the reactions of less profitable and less capitalised banks. Since problem loans have a negative impact on bank profits and bank capital, we expect weaker banks to be more likely to adjust their balance sheets in response to a shock to NPLs. Undercapitalised banks could restore their capital position by reducing lending rather than issuing equity in line with, e.g., Gropp et al.'s (2019) findings, but could, in principle, lend more rather than less, in line with a search-for yield/gamble for resurrection type logic discussed in other studies (see, e.g., Altavilla et al. 2017). We find that undercapitalised and unprofitable banks, located in high-NPL countries, respond to a shock to NPLs by deleveraging and cutting back lending, supporting the existence of a capital/profitability channel.

We conducted several tests to check the robustness of our results. First, we demonstrate that the NPL shock induced by the AQR is exogenous to reviewed banks and not a function of other factors, such as the bank's financial conditions or the country's fiscal position.

Second, we address concerns that the treated banks may differ from the untreated banks. Since selection into the AQR was based on bank asset size, we implement a number of matching strategies to rule out the possibility of the results being driven by size or other (size related or not) balance sheet characteristics. Also, in the baseline specification, our identification strategy includes country, year and bank-size fixed effects, as well as several time-varying bank characteristics. This allows us to control for time-varying unobserved differences at the country and year levels (e.g., business cycle, variation in demand for credit) and for heterogeneity induced by bank size.

Third, our findings are robust, also, to the exclusion of banks with a capital shortfall, and are not driven solely by the changes in provisions required by the AQR. This rejects the possibility that our results are explained by major outcomes of the Comprehensive Assessment (CA) (i.e., the stress test results and the adjustments to provisions).

Fourth, we restrict our analysis to the group of AQR banks to better capture cross-sectional variation in exposure to the review. This test not only addresses issues related to comparing (potentially) different banks; it also allows us to use the official NPL adjustments, as reported by the ECB, as an alternative NPL shock measure. The baseline results are confirmed across all specifications.

Our paper makes several contributions. We contribute to the NPL literature by establishing a credible causal chain from low asset quality to the way the banks adjust their balance sheets. Most work on NPLs is either descriptive or focuses on the micro (Berger and DeYoung, 1997) and macro (Nkusu, 2011; Klein, 2013; Beck et al., 2015) determinants, rather than the consequences, of problem loans. Much of the evidence showing that NPLs impair lending channels is related to the Japanese crisis which occurred more than twenty years ago (Peek and Rosengren, 2005; Caballero et al., 2008). More recent research on the effects of NPLs finds a negative correlation between NPLs and lending or economic growth (Balgova et al., 2016), but is unable to establish a causal nexus from the former to the latter.

Conceptually, we build on the large literature on the effect of regulation and supervision on banks' behaviour. Gropp et al. (2019) use the 2011 EBA capital exercise to show that the treated banks increased their capital ratios more than the untreated banks, by reducing lending rather than increasing equity. Exploiting the same EBA capital exercise, Blattner et al. (2019) find evidence of reduced lending and misallocation in weak Portuguese banks. Jimenez et al. (2017) measure the impact of dynamic provisioning, a time-varying macroprudential tool, on the supply of credit of Spanish banks and the associated spillovers on real activity across the cycle. Acharya et al. (2018) and Cortés et al. (2020) study the credit supply effects of stress tests on US banks and show that stress tested institutions reduced their lending.

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Our study is related more to the recent stream of work in this body of research, which exploits different institutional features associated with the introduction of the single supervisor in Europe. Fiordelisi et al. (2017) investigated whether, in the period prior to the AQR, banks that expected to come under the ECB supervision acted differently from smaller banks which would remain under the national supervisor. They found that the former reduced their lending more than the latter, possibly to strenghten their balance sheets in view of the ECB's review. Abbassi et al. (2020) found that after the AQR was announced, the reviewed banks temporarily reduced their shares of riskier assets, but that after the review they partly reloaded with risky securities. Eber and Minoiu (2016) found that banks adjusted to the introduction of the single supervisor by reducing their leverage, and that securities were adjusted more radically than loans.

In contrast, the main objective of the present analysis is to assess the effect of the shock to NPLs induced by the AQR, rather than the effect of the AQR *per se*. This distinction is important since not all of the reviewed banks were required to make adjustments to their NPLs. The average NPL adjustment was 1.92 percentage points, and ranged from -4.47 to 13.84 percentage points. This makes our work close to the spirit of Accornero et al.'s (2017) study of the causal nexus of NPLs and lending in Italian banks after the 2014 AQR. Accornero et al. found that lending was not affected by the NPL ratio level, but rather by the emergence of new NPLs, due to the associated increase in provisions.

Finally, our paper has some relevant policy implications. The findings suggest that micro prudential measures to restore profitability and capital adequacy are important to revive bank lending if NPLs surge, consistent with recent research on the policy responses to the COVID-19 crisis (see, e.g., Schularick et al., 2020). However, because the effect of a shock to asset quality tends to be harsher in high-risk countries, more comprehensive measures to resolve NPLs are also needed. These actions may prove helpful to contrast the effect of surging NPLs during negative macro shocks, especially in those countries most affected by NPL problems.

2 Institutional background and data

2.1 The 2014 AQR

We start by providing some background information on the objective and institutional details of the AQR. In combination with the stress test, the AQR is a pillar of the CAs conducted periodically by the ECB since 2013. The first CA occurred between November 2013 and October 2014, in preparation for the implementation of the Single Supervisory Mechanism (SSM). The AQR (the first step in the CA) started in November 2013, with a process of portfolio selection, and concluded in July 2014, with the adjustments to balance sheet items and risk-weights based on the findings of the AQR. The supervisory authorities used these results for their stress test exercise (the second step in the CA) to check banks' shock-absorption capacity under stress. The final CA results were published at end October 2014, along with the required supervisory measures. On 4 November, 2014, the ECB assumed supervisory responsibility for the euro area banks. Figure 1 depicts a timeline of these events, and defines the before and after periods used in our econometric analysis.

The ECB 2014 AQR is the largest supervisory review undertaken so far.[2] It involved over 6,000 experts, who carried out detailed asset-level reviews of more than 800 specific portfolios, representing 57% of the banks' risk-weighted assets, and resulting in an examination of more than 119,000 borrowers. The exercise included 130 institutions, accounting for about 85% of the euro area banking system and selected according to the significance criteria published in December 2012 when the SSM was approved. These criteria were related, primarily, to asset size and a threshold of €30 billion.[3] On 23 October, 2013, the ECB announced details of the AQR and published the list of banks that would be subject to review. The banks were included on the basis of their asset size one year before the start of the exercise (i.e.,

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[2]The scope of subsequent reviews was much more limited, involving 9 banks in 2015 (including 5 Greek institutions), 4 banks in 2016 and 6 banks in 2019 (including 6 Bulgarian institutions).

[3]The asset-related criteria included: (i) rank among the 3 largest credit institutions in the home country (rank condition); and (ii) ratio of bank's assets to national GDP above 20%, provided that the assets also exceeded €5 billion.

TA at year-end 2012, taken at the highest level of consolidation at or above the significance thresholds).[4]

The objective of the AQR was to enhance balance sheet transparency and comparability across banks in preparation for the operational start of the SSM in late 2014. It focused on the asset side of the banks' balance sheets (namely, those elements considered to be the most risky or least transparent) and entailed a point-in-time assessment of the accuracy of asset carrying values at 31 December, 2013. To ensure a satisfactory degree of standardisation, banks were required for the first time to apply the simplified, harmonised definition of Non-Performing Exposure (NPE) introduced by the EBA.[5] This was a major step towards greater transparency and comparability, since European banks and European countries were notorious for the heterogeneity in their definitions of non-performing assets (Baudino et al., 2018). The NPL change was verified through the data integrity validation process, and checked on a file-by-file basis during the credit file review. Any changes to NPL status were projected onto the unsampled portion of the portfolio. In order to maintain consistency and equal treatment across both the AQR and the stress test, central ECB teams conducted independent quality assurance on the work of the banks and the national supervisors.

Because, on average, the banks' internal classifications were less strict than the simplified EBA definition, application of the EBA definition resulted in a €54.6 billion increase in NPL stock (ECB, 2014). The credit file review and projection led to an additional increase of €81.3 billion, to a total increase of €136 billion (from €743 billion to €879 billion, or over 18%). The impact varied according to the debtor's location, with overall increases among locations ranging from 7% to 116%. Over 12% of total debtors, originally reclassified as performing, required reclassification as non-performing. The country average proportion of

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[4]Since TA can fluctuate between two reporting periods, a 10% margin of deviation was applied to the thresholds, which led to the inclusion of institutions with TA of between €27 billion and €30 billion or 18% and 20% of GDP as of year-end 2012 (ECB, 2013).

[5]"NPL" is the accepted abbreviation, although the EBA uses the term "NPE". In this paper, we use these terms interchangeably. The EBA defined any exposure meeting any of the following criteria, as non-performing: every material exposure 90 days past its due date even if not recognised as defaulted or impaired; every impaired exposure; and every exposure that was in default according to capital requirements regulation (i.e. debtor "unlikely to pay").

reclassified debtors ranged from 6% to 32% while the bank level average ranged from 0% to 43%.

2.2 Descriptive statistics

Our main source of bank-level data is ORBIS Bank Focus, a comprehensive commercial database of financial statements provided by Bureau van Dijk (BvD) Electronic Publishing. We start with the full sample of euro area banks, collecting consolidated balance sheet information for 2010-2015.[6] We identify banks subject to the first AQR, based on the results published by the ECB in October 2014 (ECB, 2014).

Figure 2 tracks the evolution of TA, NPLs and the NPL to asset ratio over the entire period of analysis. The upper graph shows that overall total assets increased between 2010 and 2015. Banks first expanded their balance sheets before reducing their assets following the euro sovereign crisis in 2012. The middle graph shows that total NPLs increased during the crisis years, but remained practically constant after 2012 at about 20% above 2010 levels. The dynamics of the two variables are depicted in the lower graph, which shows an increase in the NPL to asset ratio during the euro sovereign crisis and then a decline immediately after 2012.

Our analysis focuses on the period 2010 through 2015. The sample includes 872 banks: 105 AQR and 767 non-AQR. Since the AQR was conducted at the highest level of consolidation, we consider banks classified as: GUO (global ultimate owner), independent companies and single location banks. In the sample of non-AQR banks, we exclude small banks (i.e., with average TA in 2010-2015 below the national median) and banks with a Gross Loans (GL) to TA ratio lower than 10%.

Table 1 presents the descriptive statistics for 2010-2015. The average bank is medium-sized with assets of €12 billion. Also, the average institution is a traditional commercial

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[6]All data are from the ORBIS Bank Focus web interface; they comprise consolidated balance sheets (C1, C2 and U1) of commercial, cooperative and savings banks (using the specialisation variable available in the dataset).

bank whose core business is lending (63% of TA on average) and whose main source of funds is customer deposits (59% of TA on average). Average asset and loan growth rates are 3.5% and 2.9%, respectively, with medians of 3.0% and 2.5%. However, there is considerable cross-section variability, as indicated by the large standard deviation for TA (the median bank is small with TA of less than €1 billion). In the case of asset quality, the average NPL to asset ratio is around 5%, and the average NPL to loan ratio is 8%.

Figure 3 depicts the relationship between the growth of GL (delta log of GL) and the NPL to asset ratio, by country. The initial evidence is of a negative contemporaneous correlation between credit growth and the NPL to asset ratio. Figure 4 depicts the average NPL to asset and loan ratios by country. The horizontal red line corresponds to 10%, a critical level according to the European authorities (ESRB, 2017). We label those countries whose average NPL to loan ratio is above this threshold "high-NPL". The NPL ratio ranges from under 1% (Finland) to nearly 20% (Slovenia), with seven countries at or above the threshold. This shows the importance of the NPL issue in Europe and, also, the significant heterogeneity of asset quality across banks and countries.

In the case of bank soundness, the coverage ratio averages 46%, but with large differences across banks. The Tier 1 regulatory capital ratio average is close to 14%, well above the 8.5% fully loaded capital requirement set by the Basel III regulation. Finally, average Return On Equity (ROE) and Return On Assets (ROA) (3.3% and 0.3%, respectively), confirm that low profitability is a major concern, which, plausibly, is aggravated by the large volume of NPLs. These numbers are comparable to those reported in the aggregate statistics (ECB, 2016).

Table 2 presents summary statistics for banks in the AQR and non-AQR samples. "Diff" is the average difference between the second column (balance sheet items at AQR banks) and the first column (balance sheet items at non-AQR banks). We use the t-statistic to test the statistical significance of the difference.

Although our sample already consists of banks that are larger than the national medians, we observe that AQR banks are bigger than non-AQR banks. The two groups differ, also,

in their business models: their smaller shares of loans and deposits in relation to TA makes AQR banks relatively less oriented to traditional commercial banking compared to non-AQR banks. In economic terms, this difference moderates, since lending is the main business for both groups, 62% for AQR and 66% for non-AQR banks. Also, while there are no significant differences in their loan portfolios and asset quality (proxied respectively by the NPL to total loan and NPL to total asset ratios), AQR banks report higher coverage ratios. AQR banks' capital positions (proxied by the Tier 1 regulatory capital ratio) are weaker. The lower level of capital may also explain why AQR banks are more profitable, on average, in terms of ROE, while there are no significant differences for ROA.

3 Empirical strategy

3.1 Identification

We exploit the 2014 ECB AQR to investigate banks' responses to an exogenous shock to asset quality. We identify treated banks and control banks according to ECB criteria, and define the period 2010 to 2013 as the pre-AQR period and the period 2014 to 2015 as the post-AQR period.

Our main hypothesis is that the change in NPLs induced by the AQR is exogenous in that it stemmed from the first-time application in the reviewed banks of a uniform, stricter definition of NPLs and the succeeding close scrutiny by the ECB, to check balance sheet data accuracy. Among the treated institutions, the intensity of the shock to asset quality was heterogeneous, e.g., because banks already adopting stringent NPL classification criteria were required to make smaller changes than less prudent banks. We exploit this heterogeneity to build two measures of "AQR exposure" where the most affected banks are those with the largest NPL changes.

We measure the shock to asset quality in two ways. In our main specification for the whole sample of treated vis-à-vis untreated banks, we use bank balance sheet data to calculate

the change in NPLs over TA in 2013-2014 ($\triangle NPL$). To better capture the exogenous component of asset quality variation, we restrict the time span to between the first reporting dates immediately before and after the treatment (i.e., year-end 2013 and year-end 2014, see figure 1). Owing to the relatively short time frame, we assume that the change in asset quality is the effect of the ECB review rather than being due to confounding factors such as deterioration in borrowers' credit quality.

We then restrict the analysis to the sample of AQR banks. Focusing solely on the group of reviewed banks has two main advantages. First, it alleviates the identification problem stemming from treated banks being different from untreated banks. Second, it enables us to construct an unbiased measure of exposure to the shock, i.e., the AQR-adjusted NPE ratio ($\triangle NPE$), by using official information contained in the final CA report (ECB, 2014). This should further alleviate concerns that our measure of exposure to the shock is not fully exogenous, but is driven by, e.g., increased borrower defaults or changes in the demand for credit.

The box plot in figure 5 presents the full range of variation (from min to max), the likely range of variation (the IQR), and the median (the diamond) of the two measures of exposure to the shock. Figure 5 shows that both variables display sufficient variation across banks and are comparable in terms of medians. We take advantage of this heterogeneity to identify the differential effect of a shock to NPLs for the AQR banks. Accordingly, we expect a stronger reaction from banks that needed larger NPL adjustments.

A potential concern in our identification strategy is that the NPL adjustments made by the ECB during the review were not exogenous to the reviewed banks. If a particular bank or all the banks from a given country, systematically under-report their NPLs, this is unlikely to be random and is more likely to be a function of a certain bank or country characteristics. For example, weaker (undercapitalised and unprofitable) banks may have a greater incentive to engage in balance sheet window-dressing by under-reporting problem loans (Ristolainen, 2018). A government fiscal position and its ability to support the banking sector, as well as the stringency of the local supervisor, may also explain (non-random) cross-country variety

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in reporting practices.

In table 3 we run several tests to rule out that the NPL shock is driven by these confounding factors. We regress our measures of exposure to the shock ($\triangle NPL$ and $\triangle NPE$) on measures of performance and capital strength, the fiscal position in the bank's country of location, the tolerance of the national supervisor and the bank exposure to sovereign risk, all calculated in the pre-AQR period.

Table 3 reports the results. In columns 1 and 5, we check whether the NPL change in the treated banks is affected by their ROE, banking business profitability (net interest margin) and capitalization (Tier 1 ratio). The results are insignificant. These findings rule out that higher NPL recognition is driven by undercapitalised and unprofitable banks.

In columns 2 and 6, we look at undercapitalised banks in heavily indebted countries (i.e., countries with gross debt as a percentage of GDP in 2013 above the sample average - Belgium, France, Greece, Ireland, Italy and Portugal), since these banks should have greater incentives to under-report NPLs due to the limited ability of their country of location to support the banking industry. Undercapitalised banks are identified by a time-invariant dummy, indicating banks with an average Tier 1 ratio (in the pre-AQR period) below the median of the sample distribution. Next, we interact the LowCap bank and HighDebt country dummies. The coefficients are not significant.

Because of different incentives of centralised versus decentralised supervisors (Carletti et al., 2020), we test, also, whether the size of the NPL adjustment in the reviewed banks is related to the stringency of national supervisor in the pre-review years, i.e., before the introduction of the central supervisor in Europe. Local authorities may choose to be lenient on their domestic banks for a variety of reasons (see, e.g. Bruno and Carletti, 2019). For example, consistent with Granja and Leuz (2020), lenient national supervision may explain under-reporting in the pre-review years, and, therefore, larger NPL adjustments following the AQR. To rule out this possibility, we follow Gropp et al. (2020) and construct a Supervisory Forbearance Power (SFP) index to measure the national regulator's propensity to exert

regulatory forbearance.[7] We expect that the higher the forbearance power, the higher the incentive to under-report. We then interact the SFP index with the LowCap dummy since under-reporting is likely to be higher in weaker banks. Columns 4 and 8 show that the results of this test are also insignificant.

We address concern that the change in NPLs in the reviewed banks was determined by the euro sovereign debt crisis that occurred in the pre-AQR period (2010-2013). In most countries affected by system-wide increases in NPLs, these increases were linked to the severe economic recession that followed the global financial crisis and the European sovereign debt crisis (ESRB, 2019; figure 2). The euro crisis affected banks and countries differently, with the most exposed banks domiciled in peripheral countries (Greece, Ireland, Italy, Portugal, and Spain - the GIIPS) and holding large amounts of domestic government bonds, perhaps as an effect of moral suasion exercised by national governments (see, e.g., Altavilla et al., 2017; Becker and Ivashina, 2018) or as a consequence of risk shifting/carrying trade strategies (Acharya and Steffen, 2015). In table 3 columns 4 and 8 we regress our measures of changes to asset quality on a proxy for bank exposure to sovereign risk, accounting for GIIPS banks with large holdings of government bonds in the pre-AQR years (i.e., the interaction between the GIIPS and the HGov dummies). We find that the NPL change is not explained by large exposure to the sovereign debt crisis.[8]

Another potential concern related to our identification setting is that selection into the AQR was not random, but was based on size, resulting in the AQR banks being larger, on average, than untreated banks (table 2). Also, the cross-country nature of our analysis involves comparison between different size distributions across countries. The theory and existing empirical research indicate that bank size is strongly related to the ability of the

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[7]We combine the official Supervisory Power index and the Supervisory Forbearance Discretion index available in the Bank Regulation and Supervision Database compiled by Barth et al. (2013). The SFP index captures both the degree to which national supervisors have the authority to take specific actions and the degree to which national supervisors may engage in forbearance when confronted with imprudent behaviour (Gropp et al., 2020), with a higher index indicating greater forbearance power.

[8]Unfortunately, we cannot calculate the actual share of domestic sovereign bonds held by the AQR sample banks. However, Gennaioli et al. (2018) found that some 75% of European banks' bond holdings consisted of domestic bonds. Given the home bias of European banks, we use the government bonds to asset ratio as a plausible proxy for exposure to domestic public bonds.

bank to raise funds and make loans (Kashyap and Stein, 1995, and Kishian and Opiela, 2000 among others). Any causal inference would be compromised if large banks behaved differently from small banks even in the absence of a change in NPLs. Moreover, banks with differences in business models may have suffered from or dealt with the European sovereign debt crisis or other crises differently.

We address these concerns in several ways. First, in all the specifications we include country-sizeBin-year fixed effects, which allows us to isolate the "bank size" effect and to account for cross-country differences such as regulatory interventions and business cycles. We assign each bank to its appropriate country size-bin.[9]

As a further check, we implement various matching strategies and estimate the Average Treatment effect on the Treated (ATT) on bank outcomes, using the bias-corrected Abadie and Imbens (2011) matching estimator. The advantage of matching strategies is that they allow comparison of more similar banks (by e.g., size and business models) than in the full sample, although at the cost of a smaller sample size. This approach provides an estimate of the differential effect of the exogenous changes in NPLs across treated and untreated banks. The simplest matching procedure requires that, for every non-reviewed bank, we identify four AQR matches in the same size category and in the same country. The procedure then estimates the mean differences in AQR banks relative to the control group, conditional on matching on the selected characteristics. We then include an additional matching covariate (total customer deposit to total asset ratio) to proxy for funding strategy. Finally, in the full sample matching procedure, we select size and country, customer deposit to asset ratio and

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[9]To compare banks in the same sizeBin, we: 1) defined a sizeBin dummy for each bank, and a threshold level for each country, computed as the median of its banks' TA; 2) assigned a value equal to 1 to the banks' sizeBin dummy if the bank's average total asset value was above the country threshold and 0 otherwise. This resulted in different distributions within each country of AQR dummies and sizeBin dummies. In most cases we have counterfactual observations only above the median (e.g., for Austria 245 out of 440 non-AQR banks have no comparable treated banks; our strategy only compares 195 non-AQR observations with 51 AQR observations). In a few cases, we have counterfactual banks only below the median (e.g., in Belgium 38 out of 54 AQR banks have no comparable untreated banks above the median; our strategy only compares 16 AQR observations with the 23 non-AQR observations below the median). In other cases we have counterfactual observations both above and below the median (e.g., for Luxembourg 39 out of 48 non-AQR banks have 10 comparable treated observations below the median and 9 non-AQR banks also have comparable treated banks above the median).

other bank characteristics as pre-treatment matching covariates to account for the dominant business model (loan to asset ratio and net interest margin), capitalisation (Tier 1 ratio) and profitability (ROE).

An additional potential issue related to the selection criteria, is the discrepancy between the date of the AQR announcement (23 October, 2013) and the AQR cut-off date (31 December, 2013). In principle, banks could have manipulated their balance sheets strategically in preparation for the AQR.[10] We argue that this is less of a concern in our setting where the shock to NPLs is the result of application of stricter classification criteria and closer supervisory scrutiny. Thus, any attempts to "dress up for supervisors" would result in more precise classifications and possibly higher (rather than lower) NPLs. If this were the case, one could consider our measures of changes to asset quality as the lower bound of the shock, in the absence of anticipation of scrutiny.

Table 4 shows the effect of the AQR on NPLs by reporting basic differences in two measures of asset quality (NPL/TA and NPL/GL) between AQR and non-AQR banks, before and after the review. It also reports basic differences in the volume of NPLs and GL (log NPLs and log GL) between the two groups. The DD coefficients show higher NPLs in the treated than in the control group, regardless of the indicator used. Our preferred measure of asset quality (NPL/TA) increased by 24% more in the treated group compared to the control group. Interestingly, while the volume of NPLs (in log) increased by 7%, we did not find any differences in lending volume between the two groups, suggesting that the AQR *per se* had no impact on the supply of bank credit.

The estimates rely on the assumption of parallel trends prior to the AQR. In table 5 we test this assumption parametrically by checking the statistical significance of the interaction term AQR*Year in a model where asset quality is regressed on: a linear trend, the AQR dummy, bank level controls and the interaction term in the sample before the AQR (2010-2013). Table 5 columns 1 and 3 show that the estimated coefficients of the interaction terms

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[10]E.g., Abbassi et al. (2020) exploit the discrepancy between the announcement and the start of the AQR and show that after the announcement, the reviewed banks decreased the share of riskier loans and securities and then, at the end of phase 2 of the AQR, in July 2014, reverted by purchasing riskier securities.

are small and not statistically significant, suggesting that the parallel trend assumption is not rejected. We test also for anticipated effects of the treatment, estimating a model where the AQR dummy is interacted with all the year dummies. Columns 2, 4 and 6 report the estimated coefficients of the leads and lags. These estimates rule out possible anticipated effects of the review, consistent with the parallel trend assumption. Further, the lack of anticipation effects suggests that any other changes in the institutional framework that affected AQR and non-AQR banks differently were not crucial for the NPL patterns.

3.2   Model specification

For each bank-level outcome (growth of loans, growth of assets, growth of securities, change in GL/TA and change in the securities to TA ratio) of bank i in country j at time t, we estimate the following econometric model:

$$y_{ij,t} = \alpha_0 + \beta_3 AQR_{ij} * \triangle NPL_{ij,13-14} * Post_t +$$
$$\beta_2 \triangle NPL_{ij,13-14} * Post_t + \beta_1 AQR_{ij} * Post_t + \tag{1}$$
$$\theta_1 X_{ij,t-1} + \mu_{ijt} + \lambda_{ij} + \epsilon_{ij,t}$$

where the coefficient of interest is β_3 and the interacted term $AQR^* \triangle NPL^*$Post captures the differential effect of AQR exposure, conditional on the intensity of the shock to NPLs. AQR is a dummy equal to 1 for the reviewed banks, $\triangle NPL$ is a time-invariant indicator measuring bank-specific asset quality variation (change in NPL/TA) in 2013-2014, $Post$ is a dummy equal to 1 in 2014-2015 and 0 otherwise, and the indicator variable AQR is absorbed by the bank fixed effects. Standard errors are clustered at the bank level.

To alleviate concerns that the results are determined by factors related to bank size or by country-year specific events, we include bank fixed effects (λ_{ij}) and country-sizeBin-year fixed effects (μ_{ijt}). By comparing banks in the same sizeBin, same country and same year, we mitigate concerns that the results are determined by bank specific factors related to size,

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or by country-year-specific events. Controlling for this set of fixed effects at country level is crucial to isolate unobserved events, which, in a given jurisdiction, in a given year, might play a particular role in determining lending and/or asset composition (e.g., the differential severity of the sovereign debt crisis in 2010-2012), and structural factors that might influence the credit supply. For example, although they belong to the same monetary area, euro countries differ in several respects, including stringency of their institutional frameworks (ECB, 2016) and presence of government interventions to clean up bank balance sheets (Brei et al., 2019). Both factors might affect the way banks resolve NPLs and reactivate their credit channels.

We also include a strong set of lagged time varying controls for the main bank specific factors affecting credit supply in a context of high NPLs. We control for capitalisation by including the Tier 1 regulatory capital ratio. There is ample empirical evidence showing that bank capital is important for the propagation of shocks to the credit supply (see Peek and Rosengren, 1995, Kishian and Opiela, 2000 and Gambacorta and Mistrulli, 2004, among others). We use the Tier 1 ratio rather than a pure (non-risk-based) leverage ratio because, by construction, the former is more sensitive to risk; this helps to motivate a substitution effect between, e.g., (safe) securities and (risky) loans.

To capture the role of the funding structure, we focus on the ratio of customer deposits to TA to gauge the importance of stable sources of funds. The theory predicts that largely inelastic core deposits are stable funding sources, which, historically, have insulated bank funding costs against economic shocks, including exogenous credit risk shocks (Berlin and Mester, 1999). The theory related to matching assets and liabilities maintains also that banks may enjoy synergies if they engage in both deposit taking and lending (Kashyap et al., 2002), and that it is efficient for banks funded mainly by core deposits to invest in loans rather than informationally transparent assets such as marketable securities (Song and Thakor, 2007). The global financial crisis showed that banks that rely more heavily on core deposits are less prone to contract lending than banks that rely on unstable wholesale sources of funding (see, e.g., Ivashina and Scharfstein, 2010).

To control for profitability, we use ROE, which has been shown to work to attract external funds and affect bank risk taking (see, e.g., Altavilla et al., 2019). We also include the coverage ratio, i.e., the share of loan loss reserves in NPLs, because, in principle, by building higher loss coverage, banks protect their capital and, thus, preserve their capacity to provide credit to the economy (Beatty and Liao, 2011).

In addition, we check the one-year lagged measures of our dependent variables on asset composition and check, also, for bank characteristics such as bank size (log of TA) and liquidity (cash and due from banks over TA), which the lending channel literature generally consider to be drivers of the credit supply (see Bruno et al., 2018 for a review of this literature). In this last case, the global financial crisis reinforced the relevance of asset liquidity because, as previous studies show, banks with more illiquid assets hoarded liquidity and reduced their lending more than did liquid banks (Millon Cornett et al., 2011). We elected to use a restrictive measure of liquid assets because securities that are readily marketable in normal times (including government bonds), may turn illiquid during a crisis.

4   Results

4.1   Baseline results

Table 6 reports the estimation results for equation (1) where the interaction AQR*$\triangle NPL$*Post is our key explanatory variable capturing the differential effect of AQR exposure, conditional on the magnitude of the NPL shock.

When we look at the estimated coefficients of the interaction term AQR*Post (where the $\triangle NPL$ ideally is equal to 0), we find that banks under the review with no shock to NPLs increased their loan portfolios more than non reviewed banks, at the expense of securities, with both size and composition effects. The coefficient is positive and significant at the 1% level for a change to the loans and the loan to asset ratio, and is negative (significant at the 5% level) for the change in the securities to TA ratio. This result suggests that, overall,

the AQR and the consequent transition from national supervisors to the SSM had beneficial effects on the credit supply, in line with prior research (e.g., Eber and Minoiu, 2016).

We then look at the coefficient of the AQR*$\triangle NPL$*Post to isolate the impact of the shock to NPLs for the treated versus the untreated banks. We find that the positive effect of AQR on the reviewed banks is mitigated if the $\triangle NPL$ is above 0, since a larger shock to asset quality results in lower asset and lending growth (columns 1 and 2). Lending slows more than asset growth, suggesting that banks react to asset quality deterioration by deleveraging and pruning out risky assets (loans) more than securities. In terms of economic significance, column 1 also implies that a one-standard-deviation increase in the exposure to the shock ($\triangle NPL$=1.10) would lead reviewed banks to reduce lending and asset growth respectively by 1.521 percentage points and 1.65 percentage points.

To alleviate concern that our results are driven by size and other bank characteristics, or by country specific factors, we replicate the analysis on AQR banks and a matched sample of untreated banks. In the spirit of Gropp et al. (2019), we adopt three matching strategies and implement the bias-corrected Abadie and Imbens (2011) matching estimator. Table A1 reports the estimation results for the three matched samples (panels A, B and C) described in section 3.1. The results of our previous tests are confirmed. Regardless of the matching procedure, a shock to asset quality induces AQR banks to reduce lending growth significantly. In two out of the three matched samples (panels B and C) we find also that asset quality deterioration has a marked negative effect on asset growth.

4.2 Exploiting asset quality heterogeneity across countries: High-versus Low-NPL countries

To obtain additional evidence on the effect of asset quality deterioration, we exploit the differences in asset quality across countries. It has been argued (Constâncio, 2017) that, although confined to Europe, the NPL issue show wide differences across countries (see also figures 3 and 5). We split our sample into banks from high-NPL countries (i.e., those with

average NPL/GL above 10% in 2010-2015) and low-NPL countries.[11]

There are several reasons why the responses of these two country groups might vary. For example, most countries affected by high NPL levels have illiquid secondary markets for their troubled loans, or weak institutional frameworks that make foreclosure procedures particularly lengthy and costly (ECB, 2016). This could translate into reduced ability to resolve NPLs and, thus, greater uncertainty in the loan recovery process, which may affect lending decisions (Laeven and Majnoni, 2005). As a result, banks domiciled in high-NPL countries may be tempted to react more radically than those located in countries where problem loans are less of a concern.

Table 7 presents aggregate estimates for the sample of banks in high-NPL countries (panel A) and in countries with normal levels of problematic loans (panel B). In panel A, the coefficients of the triple interaction AQR*$\triangle NPL$*Post in columns 1 and 2 are negative and statistically significant at the 1% and 5% levels respectively, i.e., AQR banks reacted to the shock in NPLs by deleveraging at the expense of their lending business, with no significant differences in the portfolio mixes. In panel B, the coefficients of the triple interaction in columns 1 and 2 are negative, but statistically insignificant. The results suggest that the decline in assets and lending growth, due to a shock to NPLs, is concentrated in banks located in countries already most affected by the problem of NPLs.

4.3   Why NPLs affect the credit supply: Investigating the channels

Why do higher NPLs force banks to deleverage and cut lending? In this sub-section, we address this question by exploring the most common mechanisms causing problem loans to affect asset growth and credit supply. Banking practice and accounting rules suggest that NPLs have a negative impact on profitability and capital. First, high NPLs are commonly associated with lower revenues and higher expenses to provision and work out impaired loans.

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[11]According to the ECB (ESRB, 2017), this is a meaningful threshold for high-NPL countries. For robustness we identify high-NPL countries as those with NPL ratios above the sample mean and median. The results are identical because the sample of high-NPL countries remains unchanged.

Also, credit quality deterioration is often associated with increased funding costs which can impair funding capacity. The combined effect of reduced revenues and/or increased expenses, decreases bank profits and, thus, negatively influences bank capital. Moreover, because problem loans have higher risk-weights than performing loans, ceteris paribus, banks with higher NPLs tend to report lower regulatory capital ratios, as a combined effect of lower capital (the ratio numerators) and higher risk-weighted assets (the ratio denominators).

Against this background, in the banking literature there are two alternative views explaining the lending behavior of capital constrained banks. According to the capital channel thesis, capital constrained banks deleverage and reduce credit supply because shrinking the balance sheet and cutting back on risky assets, such as loans, is less costly than issuing equity or retaining a higher proportion of earnings, especially for very weak banks (Berger and Udell, 1994). Asymmetric information and the lemons problem (Myers and Majluf, 1984; Peek and Rosengren, 1995) also explain why banks prefer to deleverage rather than to issue new equity. Admati et al. (2018), among others, show that, with debt in place, shareholders are biased toward selling assets rather than pure recapitalisation. Recent empirical works confirm that binding capital requirements induce banks to deleverage and reduce assets subject to higher capital charges, in preference to raising new equity (De Jonghe at al., 2016; Gropp et al., 2019; Cortés et al., 2020).

However, from an opposite viewpoint, it is possible that more NPLs induce banks to expand rather than to reduce their credit supply. This may occur if moral hazard concerns arise and a risk taking/reach-for-yield channel is at work (Peek and Rosengren, 2005; Caballero et al., 2008). High leverage and information asymmetries produce agency problems and moral hazard (Jensen and Meckling, 1976). All things being equal, high NPLs aggravate moral hazard by increasing balance sheet opacity and by decreasing profits and capital. In this view, weaker balance sheets are an incentive for borrowers to take risks, e.g., by trying to switch to riskier loans.[12]

We explore these channels by testing how weak (i.e., undercapitalised and unprofitable)

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[12]Reduced (overall) amounts of lending may be combined with credit reallocation from healthy to zombie firms (Blattner et al., 2019).

banks react to a shock to NPLs. For the reasons explained above, we expect these banks to have a greater incentive to adjust their balance sheets in response to a shock to NPLs. We check this by splitting the sample into banks from high-NPL countries based on their capitalisation (Tier 1 ratio) and profitability (ROE) level. We compute the median of the Tier 1 ratio and ROE distribution before the AQR review (2010-2013), and define LowCAP and LowProf banks as those banks below these thresholds. We then re-estimate equation (1) separately for the below median Tier 1 ratio and below median ROE subsamples.

Table 8, panel A and panel B respectively, presents the results for the lower capitalisation (LowCAP) and lower profitability (LowProf) banks. By comparing the results in tables 7 (panel A) and 8 (panels A and B), we observe that the relative decrease in asset and lending growth in response to a shock to asset quality, is driven by undercapitalised and unprofitable banks. The magnitude of the coefficient suggests that the difference in this relative decrease in credit growth is economically meaningful.

Overall, the results in table 8 are consistent with the notion that NPLs affect bank behavior mainly via a capital and (to a lesser extent) a profitability channel.

4.4 Alternative explanations

4.4.1 Controlling for aggregate credit demand

To mitigate concerns that our results are driven by aggregate credit demand, in table A2 we replace country-year fixed effects with GDP growth-country fixed effects. This is important because one of the reasons why high-NPL countries might differ from less risky jurisdictions might be their respective macroeconomic conditions including demand for credit. The economic recessions that followed the global financial crisis and the European sovereign debt crisis were particularly severe in high-NPL jurisdictions (ESRB, 2019). The negative business cycle may have affected credit demand more severely in those countries compared to low-NPL countries.

We use GDP growth to control for credit demand because credit demand tends to decline if macroeconomic conditions worsen (Kashyap and Stein, 2000). As a further robustness check, in table A3, we introduce an alternative proxy, based on survey data, by interacting the measure of credit demand with the respective country dummy. The euro area Bank Lending Survey (BLS) provides quarterly information on European bank perceptions of credit demand conditions during the previous three months. Both tests show that a shock to NPLs has a more negative effect on lending growth in the reviewed banks from high-NPL countries. The magnitude of this effect is similar to the baseline model with country-time fixed effects.

4.4.2 Controlling for changes in provisions and other outcomes of the AQR

We test, also, for whether outcomes of the AQR other than NPL adjustments, are driving our findings. As noted in the institutional section, NPL adjustment was not the only outcome of the AQR and the CA. In addition to the effect on NPLs, a second confirmed outcome of the AQR was the aggregate adjustment of €48 billion to bank asset carrying values as of 31 December, 2013. Over 90% of this amount was represented by the changes in provisions resulting from the NPL adjustments. As argued in previous work (Jimenez et al., 2017; Blattner et al., 2019; Wheeler, 2019), because provisions affect profits and, ultimately, bank capital, provisioning policies may influence the credit supply in several ways. To rule out that our results are driven only by the changes in the provisions required by the AQR, in table A4 we replicate the analysis by replacing our preferred measure of shock to (gross) NPLs with the change in NPLs net of provisions made over 2013-2014.

As in the previous tests, the differential effect of the shock to NPLs in AQR banks, controlling for the change in provisioning, is more marked in banks from riskier countries which reduce their lending and asset growth by more than the non-reviewed banks in the same country group (panel B, columns 1 and 2). All the results of the baseline specification (reported in table A4) are confirmed. This suggests that our findings are not explained *only* by the changes in provisioning induced by the AQR. In fact, as discussed in section 4.3,

NPLs may have a negative impact on bank profitability *also* because they are associated with reduced revenues as well as with increased operating and funding costs.

Another important outcome of the CA was that the reviewed banks were subjected to a stress test in the post-AQR years. Based on the AQR-adjusted balance sheet, bank capital adequacy was analysed to determine sensitivity under certain stressful economic conditions. Taking account of capital buffers, the CA identified a capital shortfall of €25 billion in 25 participating banks with respect to certain thresholds, in a baseline and an adverse scenario. Twelve of the 25 banks covered the shortfall by increasing their capital by a total of €15 billion in 2014; the rest were required to prepare capital plans within two weeks of the announcement of the results in October 2014, and to cover the capital shortfall within nine months (ECB, 2014). All these adjustments occurred in what we define as the post-AQR period (2014-2015).[13]

Because deleveraging is a common strategy to regain capital adequacy (see our discussion on the capital channel motive in Section 4.3), in table A5, we test the sensitivity of our results by excluding from the treated group the 25 banks that the stress test found were undercapitalised.[14]

As in the previous tests, in table A5, the results confirm the significant differential in AQR banks' responses to changes in asset quality. Compared to the control group, treated banks located in high-NPL countries have a greater tendency to reduce lending growth and the share of loans in TA (panel B, columns 1 and 4). In the case of AQR banks from low-NPL countries, the coefficients of asset and lending growth are negative, but statistically

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[13]Banks were required to have an 8% CET1 ratio after accounting for the effect of asset quality review on their year-end 2013 balance sheet and to maintain the 8% ratio at each year-end during the baseline stress test scenario, and a 5.5% CET1 ratio at each year-end under the adverse scenario. The overall capital impact on the 130 banks covered by the CA was €263 billion. This comprises the impact of both the AQR and the stress test. See ECB (2014) and particularly the section on the aggregate outcomes of the CA.

[14]List of banks with capital shortfall (ECB, 2014): Eurobank, Monte dei Paschi di Siena, National Bank of Greece, Banca Carige, Cooperative Central Bank, Banco Comercial Portugues, Bank of Cyprus, Oesterre-ichischer Volksbanken-Verbund, Permanent Tsb, Veneto Banca, Banco Popolare, Banca Popolare di Milano, Banca Popolare di Vicenza, Piraeus Bank, Credito Valtellinese, Dexia, Banca Popolare di Sondrio, Hellenic Bank, Munchener Hypothekenbank, AXA Bank Europe, CRH-Caisse de Refinancement de l'Habitat, Banca Popolare dell'Emilia Romagna, Nova Ljubljanska Banka, Liberbank, Nova Kreditna Banka Maribor.

insignificant. However, these banks tend to increase the share of securities by relatively more compared to non-reviewed banks (panel B, column 5).

4.5 Exploiting heterogeneous shock reactions in AQR banks

We next focus on the sub-sample of AQR banks. Focusing on AQR banks has three main advantages. First, it enables us to alleviate the identification problems stemming from reviewed banks being different from non-reviewed banks, by ruling out that the results are driven by bank size or related characteristics. Second, it allows us to exploit ECB data and measure the intensity of the shock to NPLs triggered by the AQR by using the exact, official "NPE adjustment" (ECB, 2014). This addresses concerns about possible miscalculation of the proxy ($\triangle NPL$) used in our main test. Third, by using the official adjustment recorded by the ECB, we alleviate concern that the change in NPLs is driven by factors unrelated to the supervisory exercise, such as changes in macroeconomic conditions and/or credit demand.

As discussed in section 2, supervisors imposed a number of adjustments on the balance sheets of reviewed banks; NPLs increased by 18%, on average, based on a wide range of adjustment sizes. We exploit this heterogeneity to test whether before-after the AQR, reviewed banks with larger changes to their NPLs reacted differently from those with smaller NPL adjustments. The regression model thus becomes:

$$y_{ij,t} = \alpha_0 + \beta_2 \triangle NPE_{ij,13-14} * Post_t + \theta_1 X_{ij,t-1} + \mu_{ij,t} + \lambda_{ij} + \epsilon_{ij,t} \tag{2}$$

The key explanatory variable is $\triangle NPE$*Post where $\triangle NPE$ is the first difference between the AQR adjusted NPE ratio and the unadjusted NPE ratio (as a percentage) at year-end 2013, and as reported by the ECB. $Post$ is a dummy equal to 1 in the post treatment period (2014-2015). As in the previous tests, we include one-year lagged controls for the bank, and two sets of fixed effects (bank and country-year fixed effects). The interacted term captures the effect of the treatment after its implementation.

Table 9 panel A presents the results of equation (2) for the whole sample of AQR banks. We find that larger adjustments to NPLs have a negative impact on bank lending. The estimated coefficients of the interacted term in columns 1 and 4 are negative and significant at the 10% level. This suggests that a larger shock to the NPLs has both a size and composition effect since, in the post treatment period, banks with more extensive adjustments to their NPLs reduced both lending growth and the share of loans to TA.

Table 9, panels B and C, present the estimation results for the subsample of AQR from high- and low-NPL countries, respectively. The results show a strong negative effect of increased NPLs in both samples. Specifically, table 9 panel B shows a size effect for banks from riskier countries, which reacted to larger NPL adjustments by deleveraging and reducing lending growth. The estimated coefficients of the interaction term in columns 1 and 2 are negative and significant at the 1% and 5% levels, respectively. Panel C shows evidence of a composition effect, with banks from low-NPL countries reacted to the shock on NPLs by reducing the share of resources allocated to their loan portfolios. The coefficient of the change in the share of loans to TA is negative and significant at the 1% level (column 4).

For robustness, in table A6 we augment the analysis by including the change in the coverage ratio, measured as the ECB adjustments to provisions over the NPE adjustments. We do this to rule out that the results are being driven by those banks that although they were found to be underprovisioned were required to make no or very small changes to their NPLs (interestingly, adjustments to provisions do not exactly track adjustments to NPLs). The results of the baseline specification (table 9) are confirmed, suggesting that the negative impact on bank lending induced by larger adjustments to NPLs is independent of the bank's provisioning policy.

Finally, for the restricted sample of AQR banks from high-NPL countries we replicate the analysis of the channels described in Section 4.3. In table 9, we re-estimate equation (2) by including the interacted terms $\triangle NPE$*Post*LowCAP (panel A) and $\triangle NPE$*Post*LowProf (panel B). By comparing tables 9 and 10, in line with previous results, we find that the relative decrease in asset and lending growth is explained by undercapitalised and (to a

lesser extent) unprofitable banks.

5   Conclusions

We exploited the ECB 2014 AQR as a quasi-experiment to investigate the nexus of causality between changes in NPLs and the way banks shape their balance sheets. We show that in response to a shock to their NPLs, AQR banks deleveraged and reduced lending more than non-reviewed banks. The effect on lending is non-linear, and is stronger in reviewed banks from high-NPL countries. Analysis of the sub-sample of AQR banks confirmed that lending contracted more in reviewed banks with larger NPL adjustments. We found size effects for banks from high-NPL countries, and composition effects for banks from less risky jurisdictions.

Overall, our evidence suggests that an increase in NPLs is detrimental to lending by inducing banks to either cut credit growth (size effect) or shift resources at the expense of the loan portfolio (composition effect). The most affected banks are undercapitalised and unprofitable institutions from high-NPL countries.

There are some relevant policy implications. A negative macro shock (such as the COVID-19 pandemic) determining a surge in NPLs threatens the banks' ability to provide credit. To cope with this requires a combination of measures, i.e., micro-prudential initiatives to strengthen bank balance sheets and comprehensive actions to resolve problem loans and return them to more normal levels. All these actions are more urgent in the case of banks from high-NPL countries.

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Figures

Figure 1: AQR timeline and phases
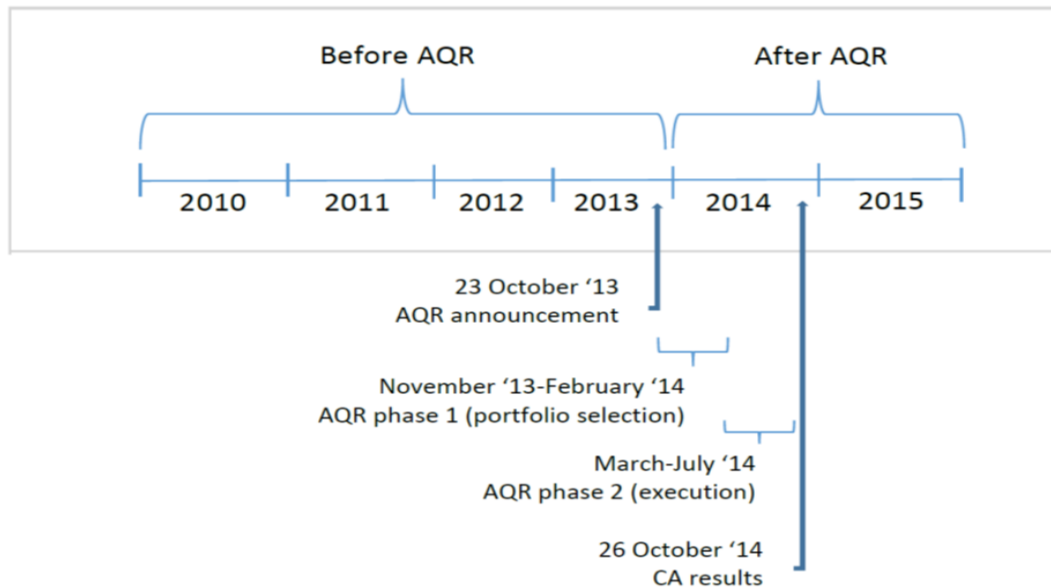
This figure displays the phases of the AQR exercise. On 23 October, 2013, the ECB announced details of the CA and published the list of banks subjected to the review. The banks selected were first subjected to the AQR that started in November 2013 with a process of portfolio selection (phase 1); following the completion of this phase in mid-February 2014, banks were subjected to the review of their asset quality (the so called execution or phase 2). The process ended in July 2014 with the adjustment of risk-weights. Building on these results, supervisory authorities conducted a stress test exercise. As of the end of October 2014, the CA final results were disclosed and recommendations for supervisory measures to be undertaken were released. On 4 November, 2014, the ECB assumed responsibility for the supervision of euro area banks.

Figure 2: Trends in NPLs and total assets
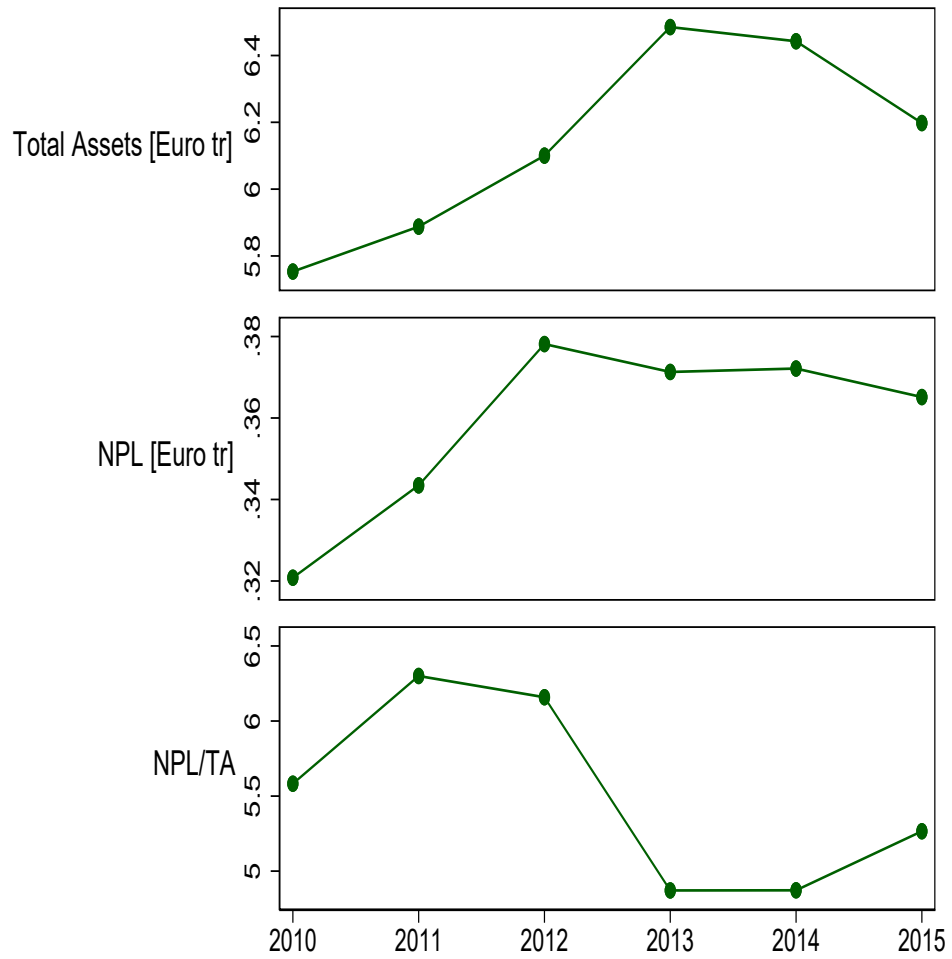
This figure tracks the evolution of TA, NPLs and NPL/TA over 2010-2015.

Figure 3: Growth of gross loans and NPLs (as % of total assets) by country
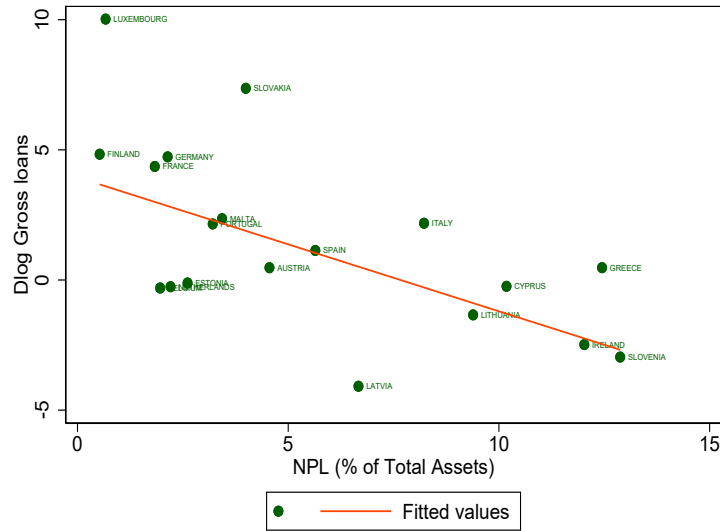
This figure shows the correlation between the growth of gross loans ($\triangle logGL$) and NPL/TA. Each dot represents the country average in 2010-2015.

Figure 4: Heterogeneity of bank-level NPL ratios
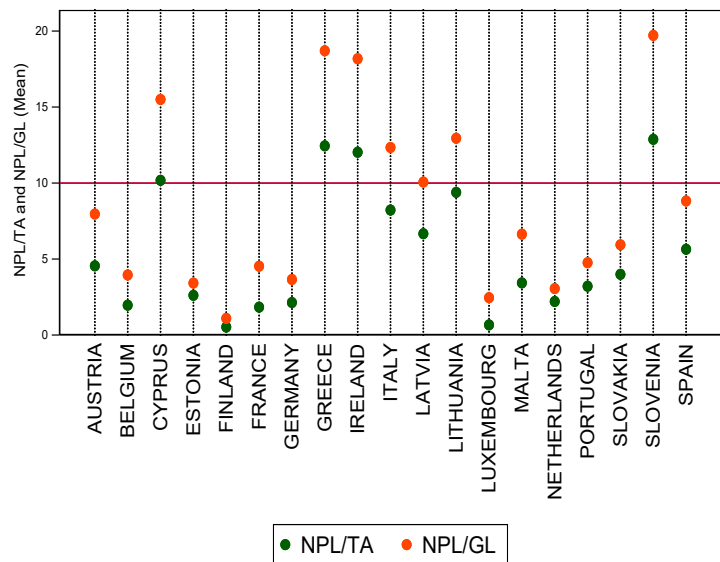
This figure displays the average NPL/TA and NPL/GL of euro area banks by country in 2010-2015. We label as high-NPL countries those with NPL/GL above 10%.

Figure 5: $\triangle NPE$ and $\triangle NPL$ distributions in AQR banks
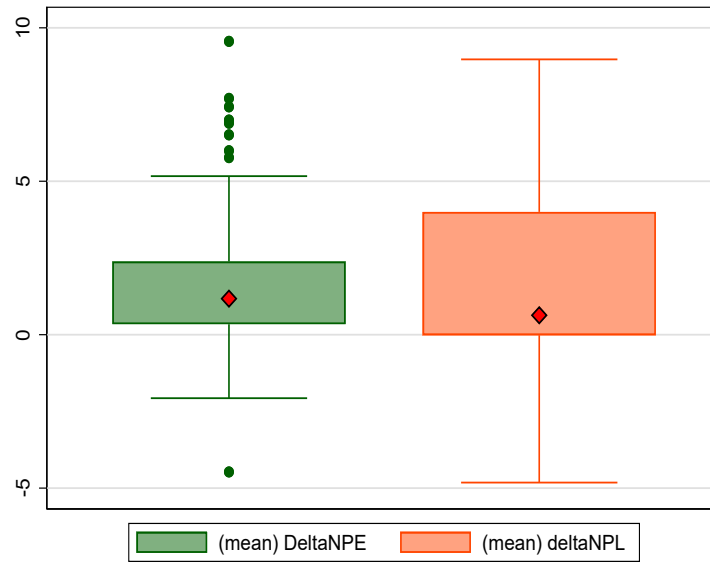
This figure plots the $\triangle NPE$ and $\triangle NPL$ in AQR banks. $\triangle NPE$ is the difference between the "un-adjusted NPE level as of year 2013"and the "AQR-adjusted NPE", as reported in the final report on the comprehensive assessment (ECB, 2014). $\triangle NPL$ is the change in the NPL/TA ratio over 2013-2014 computed from balance sheet information.

Tables

Table 1: Descriptive statistics

	(1) Mean	(2) St.Dev	(3) p10	(4) p50	(5) p90	(6) N
Total assets(Euro MM)	11,722	24,854	423.0	982.5	61,263	3,152
Gross loans/TA	63.25	13.60	42.61	64.52	80.48	3,152
Total customer deposits/TA	58.60	17.83	35.65	58.63	81.25	3,151
Total securities/TA						
Cash and due from banks/TA	1.429	1.100	0.346	1.190	2.915	3,152
Growth rate total assets	3.462	6.137	-4.767	3.058	11.36	3,152
Growth rate gross loans	2.872	5.760	-4.470	2.503	9.698	3,152
Growth rate total securities	8.099	20.89	-15.76	5.199	40.14	3,152
Change in Gross loans/TA	-0.360	5.479	-8.674	-0.126	6.696	3,152
Change in Total securities/TA	6.039	19.38	-14.58	2.162	35.84	3,152
NPL/TA	5.373	4.250	0.797	4.022	12.65	2,895
NPL/GL	8.315	6.303	1.560	6.440	19.57	2,895
Coverage ratio (LLR/NPL)	46.12	17.76	26.23	43.30	68.60	2,892
Tier1 regulatory capital ratio	13.65	3.616	9.420	13.07	19.12	3,025
ROE	3.340	3.242	-1.650	3.050	7.210	3,151
ROA	0.281	0.268	-0.140	0.250	0.610	3,152
Number of Banks	872	872	872	872	872	872

This table provides the summary statistics for all dependent and explanatory variables used in the paper over 2010-2015.

Table 2: AQR vs non-AQR banks in the pre-AQR period

	Non-AQR		AQR		AQR-Non-AQR	
	(1)		(2)		(3)	
	Mean	St.Dev.	Mean	St.Dev.	Diff	T-stat
Total assets(Euro MM)	3084.60	9934.82	57042.50	29050.19	53957.90***	(34.12)
Gross loans/TA	66.24	13.22	61.50	16.23	-4.74***	(-5.05)
Total customer deposits/TA	56.40	16.52	44.62	16.86	-11.78***	(-11.72)
Total securities/TA	23.62	11.30	25.42	12.40	1.80*	(2.47)
Cash and due from banks/TA	1.19	0.94	2.14	1.48	0.94***	(11.32)
Growth rate total assets	4.51	6.07	0.19	7.40	-4.33***	(-10.10)
Growth rate gross loans	3.22	5.72	0.42	6.79	-2.80***	(-7.11)
Growth rate total securities	12.73	23.22	3.56	22.28	-9.17***	(-6.82)
Change in Gross loans/TA	66.24	13.22	61.50	16.23	-4.74***	(-5.05)
Change in Total securities/TA	23.62	11.30	25.42	12.40	1.80*	(2.47)
NPL/TA	5.66	3.85	5.32	4.30	-0.34	(-1.34)
NPL/GL	8.36	5.42	8.35	6.02	-0.01	(-0.03)
Coverage ratio (LLR/NPL)	41.55	16.50	54.93	18.11	13.38***	(12.42)
Tier1 regulatory capital ratio	13.34	3.70	11.84	3.46	-1.50***	(-7.04)
ROE	3.12	2.89	4.28	5.11	1.15***	(4.05)
ROA	0.28	0.25	0.27	0.38	-0.01	(-0.68)
Observations	1437		347		1784	

This table reports the descriptive statistics for banks from the AQR and non-AQR samples over 2010-2013. Diff is the average difference between the second column (balance sheet items at AQR banks) and the first column (balance sheet items at non-AQR banks). We test the statistical significance of the difference using the t-statistic (T-stat). *, **, *** indicate statistically significant at the 1%, 5% and 10% level.

Table 3: Validation test: NPL predictors

Dep.Var.	$\triangle NPL$				$\triangle NPE$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Bank performance and capital strength								
LowROE	-0.062				0.082			
	(0.056)				(0.115)			
LowNIM	0.483				-0.309			
	(0.370)				(0.732)			
LowCAP	-0.004				-0.025			
	(0.014)				(0.031)			
Country fiscal position								
HighDebt*LowCAP		0.956				-2.341		
		(0.609)				(1.507)		
HighDebt		-1.174				1.416		
		(0.966)				(1.612)		
LowCAP		-0.865				1.294		
		(0.616)				(0.881)		
National supervisor forbearance power								
HighSFP*LowCAP			-0.149				-0.356	
			(0.645)				(1.392)	
HighSFP			-0.931				-0.033	
			(1.370)				(2.167)	
LowCAP			-0.386				0.794	
			(0.392)				(0.966)	
Exposure to sovereign risk								
GIIPS*HighSovExp				-0.204				0.344
				(0.505)				(0.846)
GIIPS				0.166				-2.481*
				(0.637)				(1.257)
HighSovExp				-0.324				0.152
				(0.320)				(0.487)
Observations	226	229	229	199	221	224	224	194
Country*Size*Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

This table presents the results from several tests to rule out that the NPL shock is driven by confounding factors. We regress our measures of exposure to the shock ($\triangle NPL$ and $\triangle NPE$) on proxies of bank performance and capital strength (columns 1 and 5), country fiscal position (columns 2 and 6), national supervisor's forbereance power (columns 3 and 7), and exposure to sovereign risk (columns 4 and 8). Regressions are run over 2010-2013. In all specifications we include time-varying bank characteristics (lagged by one period) and country-sizeBin-year FE. *, **, *** indicate statistically significant at the 1%, 5% and 10% level.

Table 4: The effect of AQR on NPLs

	NPL/TA	NPL/GL	LogNPLs	LogGL
AQR-Non-AQR[pre-treatment]	-0.342	-0.012	3.832***	3.663***
AQR-Non-AQR[post-treatment]	0.927***	1.513***	4.155***	3.757***
DD	**1.269***	**1.524**	**0.323**	**0.094**

This table reports basic differences in NPL/TA, NPL/GL, log NPLs and log GL between AQR and non-AQR bank (before and after the AQR exercise). DD is the Difference-in-Difference coefficient.

Table 5: Common trend and anticipation test

	NPL/TA		NPL/GL	
	(1)	(2)	(3)	(4)
	Common Trend Assumption	Leads&Lags	Common Trend Assumption	Leads&Lags
AQR*2010		-1.433***		-0.821
		(0.436)		(0.578)
AQR*2011		-1.643***		-1.189*
		(0.496)		(0.674)
AQR*2012		-0.500		-0.408
		(0.529)		(0.729)
AQR*2014		**1.202**		**1.916**
		(0.558)		(0.834)
AQR*2015		0.609		1.052
		(0.579)		(0.878)
AQR*Year	0.124		-0.029	
	(0.139)		(0.196)	
Observations	1,072	2,895	1,072	2,895
Banks	447		447	
Sample	2010-2012	All	2010-2012	All
P-val leads		3.54e-06		0.0648

This table reports estimates of the effects of the AQR on NPL/TA and NPL/GL. AQR is a dummy equal to 1 for banks included in the 2014 AQR. Regressions in columns 1 and 3 are estimated in pre-AQR years (2010-2013) and include a linear trend as a control. In columns 2 and 4 the p-value refers to the joint statistical significance of the leads effect of the AQR.

Table 6: Shock to NPLs and banks' behavior

	(1) $\triangle logGL$	(2) $\triangle logTA$	(3) $\triangle logSEC$	(4) $\triangle GL$	(5) $\triangle SEC$
AQR*$\triangle NPL$*Post	-1.521**	-1.650*	-2.406	0.245	-0.194
	(0.760)	(0.990)	(3.285)	(0.526)	(2.515)
$\triangle NPL$*Post	0.693**	-0.299	-1.602*	1.003***	-1.781***
	(0.287)	(0.283)	(0.888)	(0.215)	(0.637)
AQR*Post	2.515***	0.808	-3.100	2.381***	-4.762**
	(0.779)	(0.756)	(2.427)	(0.838)	(2.022)
Bank controls					
NPL/TA	-0.720***	-0.556***	-0.652	-0.141	0.396
	(0.099)	(0.125)	(0.423)	(0.108)	(0.356)
CoverageRatio	0.003	-0.004	0.029	-0.011	0.041
	(0.012)	(0.015)	(0.048)	(0.013)	(0.042)
GL/TA	-0.210***	0.244***	-0.713***	-0.519***	-1.103***
	(0.065)	(0.058)	(0.195)	(0.060)	(0.170)
TS/TA	0.089*	0.045	-2.675***	0.020	-3.143***
	(0.048)	(0.055)	(0.181)	(0.051)	(0.160)
Size	-14.530***	-16.247***	-17.505**	0.908	6.475
	(2.802)	(2.751)	(7.667)	(2.128)	(4.326)
Tier1Ratio	0.318***	0.221**	-0.087	0.146	-0.157
	(0.096)	(0.111)	(0.376)	(0.106)	(0.297)
ROE	0.137***	0.191***	0.071	-0.102*	-0.120
	(0.053)	(0.060)	(0.195)	(0.057)	(0.173)
Liquidity	-0.066	-0.415*	-0.465	0.248	-0.330
	(0.197)	(0.228)	(0.706)	(0.222)	(0.620)
CustomerDeposits	0.003	-0.007	0.057	0.016	0.131
	(0.033)	(0.043)	(0.156)	(0.036)	(0.142)
Observations	3,135	3,135	3,135	3,135	3,135
Banks	856	856	856	856	856
Bank FE	Yes	Yes	Yes	Yes	Yes
Country-Size-Year FE	Yes	Yes	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes	Yes	Yes

This table presents the estimates of the change in the log of gross loans, the log of total assets, the log of total securities, the change in the ratio of gross loans to total assets and in the ratio of total securities to total assets. AQR is a dummy equal to 1 for banks included in the 2014 AQR; $\triangle NPL$ is the change in NPL/TA between 2013 and 2014; Post is an indicator variable for the period 2014-2015. In all specifications we include bank fixed effects, time-varying bank characteristics (lagged by one period) and country-sizeBin-year FE. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level.

Table 7: Shock to NPLs and banks' behavior: High- vs. Low-NPL countries

	(1) $\triangle logGL$	(2) $\triangle logTA$	(3) $\triangle logSEC$	(4) $\triangle GL$	(5) $\triangle SEC$
Panel A: High-NPL countries					
AQR*$\triangle NPL$*Post	-3.725***	-2.388**	-3.864	-0.986	-2.104
	(0.839)	(1.055)	(6.340)	(1.256)	(6.012)
$\triangle NPL$*Post	0.847**	-0.593*	-2.567**	1.366***	-2.466***
	(0.328)	(0.356)	(1.157)	(0.220)	(0.800)
AQR*Post	3.742***	-0.805	-8.125	4.040*	-6.970
	(1.399)	(1.697)	(5.579)	(2.138)	(4.913)
Observations	1,413	1,413	1,413	1,413	1,413
Banks	279	279	279	279	279
Panel B: Low-NPL countries					
AQR*$\triangle NPL$*Post	-0.533	-0.650	1.214	-0.112	2.288
	(1.061)	(1.375)	(3.485)	(0.588)	(1.901)
$\triangle NPL$*Post	0.219	0.499	0.629	0.007	-0.388
	(0.359)	(0.421)	(1.083)	(0.268)	(0.907)
AQR*Post	2.959***	2.292**	0.725	1.916**	-1.691
	(1.111)	(1.075)	(2.762)	(0.888)	(1.937)
Observations	1,722	1,722	1,722	1,722	1,722
Banks	577	577	577	577	577
Bank FE	Yes	Yes	Yes	Yes	Yes
Country*Size*Year FE	Yes	Yes	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes	Yes	Yes

This table presents the estimates of the change in the log of gross loans, the log of total assets, the log of total securities, the change in the ratio of gross loans to total assets and in the ratio of total securities to total assets. High-NPL countries are those with average NPL/GL above 10% in the pre-AQR period (2010-2013). AQR is a dummy equal to 1 for banks included in the 2014 AQR; $\triangle NPL$ is the change in NPL/TA between 2013 and 2014; Post is an indicator variable for the period 2014-2015. In all specifications we include bank fixed effects, time-varying bank characteristics (lagged by one period) and country-sizeBin-year FE. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level.

Table 8: Exploring the channel in High-NPL countries

	(1)	(2)	(3)	(4)	(5)
	$\triangle logGL$	$\triangle logTA$	$\triangle logSEC$	$\triangle GL$	$\triangle SEC$
	(1)	(2)	(3)	(4)	(5)
Panel A: LowCap banks					
AQR*$\triangle NPL$*Post	-3.583***	-2.225*	-7.572	-1.482	-6.068
	(0.891)	(1.197)	(6.133)	(1.317)	(6.095)
$\triangle NPL$*Post	0.293	-0.744*	-3.387**	1.251***	-2.839**
	(0.354)	(0.449)	(1.325)	(0.302)	(1.092)
AQR*Post	3.501**	0.222	-2.282	3.739*	-1.500
	(1.606)	(2.014)	(5.596)	(2.235)	(4.838)
Observations	842	842	842	842	842
Number of Banks	167	167	167	167	167
Bank FE	Yes	Yes	Yes	Yes	Yes
Country-Size-Year FE	Yes	Yes	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes	Yes	Yes
Mean	1.350	3.611	14.23	-1.758	13.44
St. Dev.	5.856	7.094	25.58	6.059	24.08
Panel B: LowProf banks					
AQR*$\triangle NPL$*Post	-3.053***	-2.458**	-8.838	-0.567	-6.935
	(0.848)	(1.225)	(6.759)	(1.248)	(6.645)
$\triangle NPL$*Post	0.458	-0.555	-2.898**	1.217***	-2.685**
	(0.469)	(0.532)	(1.422)	(0.307)	(1.182)
AQR*Post	3.003*	0.757	0.661	2.033	0.268
	(1.614)	(2.040)	(6.868)	(2.070)	(6.240)
Observations	673	673	673	673	673
Number of Banks	134	134	134	134	134
Bank FE	Yes	Yes	Yes	Yes	Yes
Country-Year FE	Yes	Yes	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes	Yes	Yes
Mean	0.651	2.773	13.04	-1.536	13.07
St. Dev.	5.494	6.870	25.39	6.076	23.83

This table presents the estimates of the change in the log of gross loans, the log of total assets, the log of total securities, the change in the ratio of gross loans to total assets and in the ratio of total securities to total assets. Panel A and panel B refer to estimates for the lower capitalisation (LowCap) and lower profitability (LowProf) banks, respectively. AQR is a dummy equal to 1 for banks included in the 2014 AQR; $\triangle NPL$ is the change in NPL/TA between 2013 and 2014; Post is an indicator variable for the period 2014-2015. In all specifications we include bank fixed effects, time-varying bank characteristics (lagged by one period) and country-sizeBin-year FE. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level.

Table 9: Shock to NPLs and banks' behavior: AQR banks

	(1) $\triangle logGL$	(2) $\triangle logTA$	(3) $\triangle logSEC$	(4) $\triangle GL$	(5) $\triangle SEC$
Panel A: Whole sample					
$\triangle NPE$*Post	-0.597*	-0.213	0.238	-0.431*	0.245
	(0.313)	(0.418)	(0.907)	(0.227)	(0.680)
Observations	516	516	516	516	516
Banks	102	102	102	102	102
Panel B: High-NPL countries					
$\triangle NPE$*Post	-0.868**	-0.961*	0.018	0.018	0.507
	(0.420)	(0.552)	(1.692)	(0.267)	(1.146)
Observations	176	176	176	176	176
Banks	34	34	34	34	34
Panel C: Low-NPL countries					
$\triangle NPE$*Post	-0.166	0.718*	0.177	-0.810***	-0.457
	(0.396)	(0.394)	(1.140)	(0.295)	(0.931)
Observations	340	340	340	340	340
Banks	68	68	68	68	68
Bank FE	Yes	Yes	Yes	Yes	Yes
Country*Year FE	Yes	Yes	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes	Yes	Yes

This table presents the estimates of the change in the log of gross loans, the log of total assets, the log of total securities, the change in the ratio of gross loans to total assets and in the ratio of total securities to total assets. Regressions are run on the subsample of AQR banks. $\triangle NPE$ is the first difference between the AQR adjusted NPE ratio and the unadjusted NPE ratio (as a percentage) at year-end 2013, and as reported by the ECB; Post is a dummy equal to 1 in the post treatment period (2014-2015). In all specifications we include bank fixed effects, time-varying bank characteristics (lagged by one period) and country-year FE. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level.

Table 10: Exploring the channel in AQR banks from High-NPL countries

	(1) $\triangle logGL$	(2) $\triangle logTA$	(3) $\triangle logSEC$	(4) $\triangle GL$	(5) $\triangle SEC$
Panel A: LowCap banks					
$\triangle NPE$*Post*LowCap	-3.806**	-7.805***	-25.064**	3.286	-19.460**
	(1.809)	(2.294)	(9.404)	(2.395)	(8.971)
Observations	144	144	144	144	144
Banks	25	25	25	25	25
Panel B: LowProf banks					
$\triangle NPE$*Post*LowProf	-3.305**	-2.529	-15.586*	0.155	-13.018*
	(1.350)	(2.096)	(7.998)	(2.041)	(7.340)
Observations	165	165	165	165	165
Banks	30	30	30	30	30
Bank FE	Yes	Yes	Yes	Yes	Yes
Country*Year FE	Yes	Yes	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes	Yes	Yes

This table presents the estimates of the change in the log of gross loans, the log of total assets, the log of total securities, the change in the ratio of gross loans to total assets and in the ratio of total securities to total assets. Regressions are run on the subsample of AQR banks. Panel A and panel B refer to estimates for the lower capitalisation (LowCap) and lower profitability (LowProf) banks, respectively. $\triangle NPE$ is the first difference between the AQR adjusted NPE ratio and the unadjusted NPE ratio (as a percentage) at year-end 2013, and as reported by the ECB; Post is a dummy equal to 1 in the post treatment period (2014-2015). In all specifications we include bank fixed effects, time-varying bank characteristics (lagged by one period) and country-year FE. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level.

Table A1: Shock to NPLs and banks' behavior: Matching

	(1) $\triangle logGL$	(2) $\triangle logTA$	(3) $\triangle logSEC$	(4) $\triangle GL$	(5) $\triangle SEC$
Panel A: Full matching					
AQR*$\triangle NPL$*Post	-1.678***	-0.845	0.058	-0.714	1.447
	(0.522)	(0.713)	(2.956)	(0.581)	(2.616)
$\triangle NPL$*Post	1.496***	-0.180	-1.461	1.857***	-1.967**
	(0.357)	(0.458)	(1.391)	(0.397)	(0.978)
AQR*Post	1.282	-0.544	-3.651	2.444**	-3.400
	(0.923)	(1.063)	(4.028)	(1.049)	(3.740)
Observations	704	704	704	704	704
Banks	127	127	127	127	127
Panel B: Within size, funding structure and country					
AQR*$\triangle NPL$*Post	-1.588*	-1.889**	-2.647	0.618	-0.286
	(0.821)	(0.942)	(4.370)	(1.146)	(3.781)
$\triangle NPL$*Post	1.253*	0.834	1.392	0.473	-0.016
	(0.703)	(0.743)	(3.527)	(1.051)	(2.941)
AQR*Post	2.734**	-1.110	-9.578**	4.902***	-9.436**
	(1.179)	(1.373)	(4.730)	(1.334)	(4.293)
Observations	563	563	563	563	563
Banks	101	101	101	101	101
Panel C: Within size and country					
AQR*$\triangle NPL$*Post	-2.543**	-2.983***	-7.279	1.198	-3.413
	(1.059)	(0.972)	(4.707)	(1.638)	(4.188)
$\triangle NPL$*Post	2.238**	1.985**	6.291	-0.138	3.323
	(0.978)	(0.794)	(4.045)	(1.596)	(3.560)
AQR*Post	2.898**	-0.933	-10.691**	5.091***	-10.859**
	(1.390)	(1.465)	(5.165)	(1.525)	(4.883)
Observations	546	546	546	546	546
Banks	97	97	97	97	97
Bank FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes	Yes	Yes

This table reports the results from three matching strategies. The full sample procedure includes 82 AQR banks and 42 non-AQR banks, and matches the AQR to non-AQR banks based on 6 pretreatment covariates: size and country, customer deposit to total asset ratio, loan to total asset ratio, Tier 1 ratio, net interest margin and ROE. In all specifications we include bank fixed effects, time-varying bank characteristics (lagged by one period) and year FE. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level.

Table A2: Shock to NPLs and banks' behavior: Controlling for GDP growth

	(1) $\triangle logGL$	(2) $\triangle logTA$	(3) $\triangle logSEC$	(4) $\triangle GL$	(5) $\triangle SEC$
		Panel A: Whole sample			
AQR*$\triangle NPL$*Post	-1.633**	-1.696*	-2.960	-0.003	-0.709
	(0.744)	(0.965)	(3.285)	(0.532)	(2.576)
$\triangle NPL$*Post	0.617**	-0.401	-1.771*	1.026***	-1.813***
	(0.289)	(0.329)	(0.974)	(0.229)	(0.660)
AQR*Post	2.508***	1.047	-1.400	2.393***	-3.027
	(0.761)	(0.698)	(2.317)	(0.806)	(2.064)
Observations	3,032	3,032	3,032	3,032	3,032
Banks	832	832	832	832	832
		Panel B: High-NPL countries			
AQR*$\triangle NPL$*Post	-3.734***	-2.243**	-7.583	-1.759	-5.949
	(1.133)	(1.119)	(6.064)	(1.460)	(6.109)
$\triangle NPL$*Post	0.792**	-0.681*	-2.654**	1.398***	-2.455***
	(0.334)	(0.405)	(1.235)	(0.248)	(0.827)
AQR*Post	3.559**	-0.600	-1.303	4.456**	-0.490
	(1.712)	(1.689)	(5.455)	(2.167)	(5.498)
Observations	1,349	1,349	1,349	1,349	1,349
Banks	263	263	263	263	263
		Panel C: Low-NPL countries			
AQR*$\triangle NPL$*Post	-0.599	-0.842	1.109	-0.041	2.719
	(1.069)	(1.352)	(3.486)	(0.550)	(1.893)
$\triangle NPL$*Post	0.094	0.413	0.459	-0.031	-0.508
	(0.365)	(0.405)	(1.018)	(0.273)	(0.883)
AQR*Post	2.838***	2.155**	0.406	2.168***	-1.028
	(1.080)	(1.036)	(2.730)	(0.834)	(1.940)
Bank FE	Yes	Yes	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes	Yes	Yes
GDPgrowth*Country FE	Yes	Yes	Yes	Yes	Yes

This table presents the estimates of the change in the log of gross loans, the log of total assets, the log of total securities, the change in the ratio of gross loans to total assets and in the ratio of total securities to total assets. High-NPL countries are those with average NPL/GL above 10% in the pre-AQR period (2010-2013). AQR is a dummy equal to 1 for banks included in the 2014 AQR; $\triangle NPL$ is the change in NPL/TA between 2013 and 2014; Post is an indicator variable for the period 2014-2015. In all specifications we include bank fixed effects, time-varying bank characteristics (lagged by one period) and GDPgrowth-country FE. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level.

Table A3: Shock to NPLs and banks' behavior: Controlling for credit demand

	(1) $\triangle logGL$	(2) $\triangle logTA$	(3) $\triangle logSEC$	(4) $\triangle GL$	(5) $\triangle SEC$
			Panel A: Whole sample		
AQR*$\triangle NPL$*Post	-1.538**	-1.540*	-2.919	0.015	-0.797
	(0.719)	(0.925)	(3.224)	(0.530)	(2.548)
$\triangle NPL$*Post	0.616**	-0.415	-1.775*	1.038***	-1.813***
	(0.289)	(0.331)	(0.984)	(0.230)	(0.663)
AQR*Post	2.120***	0.256	-2.485	2.349***	-3.523*
	(0.764)	(0.758)	(2.272)	(0.798)	(1.970)
Observations	3,087	3,087	3,087	3,087	3,087
Banks	848	848	848	848	848
			Panel B: High-NPL countries		
AQR*$\triangle NPL$*Post	-2.372**	-1.030	-5.902	-1.218	-5.453
	(1.193)	(1.199)	(5.670)	(1.346)	(5.642)
$\triangle NPL$*Post	0.747**	-0.724*	-2.727**	1.392***	-2.492***
	(0.336)	(0.408)	(1.242)	(0.248)	(0.826)
AQR*Post	1.027	-2.834	-4.761	3.524*	-1.694
	(1.772)	(1.803)	(4.664)	(1.865)	(4.374)
Observations	1,393	1,393	1,393	1,393	1,393
Banks	277	277	277	277	277
			Panel C: Low-NPL countries		
AQR*$\triangle NPL$*Post	-0.346	-0.690	0.916	0.009	2.251
	(1.014)	(1.312)	(3.424)	(0.549)	(1.918)
$\triangle NPL$*Post	0.041	0.370	0.493	-0.023	-0.394
	(0.367)	(0.409)	(1.034)	(0.272)	(0.899)
AQR*Post	3.400***	2.358**	0.546	2.137**	-1.648
	(1.019)	(1.017)	(2.761)	(0.881)	(2.007)
Observations	1,694	1,694	1,694	1,694	1,694
Banks	571	571	571	571	571
Bank FE	Yes	Yes	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes	Yes	Yes
CreditDemand*Country FE	Yes	Yes	Yes	Yes	Yes

This table presents the estimates of the change in the log of gross loans, the log of total assets, the log of total securities, the change in the ratio of gross loans to total assets and in the ratio of total securities to total assets. High-NPL countries are those with average NPL/GL above 10% in the pre-AQR period (2010-2013). AQR is a dummy equal to 1 for banks included in the 2014 AQR; $\triangle NPL$ is the change in NPL/TA between 2013 and 2014; Post is an indicator variable for the period 2014-2015. In all specifications we include bank fixed effects, time-varying bank characteristics (lagged by one period) and CreditDemand-country FE. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level.

Table A4: Shock to NPLs net of provisions and banks' behavior

	(1) $\triangle logGL$	(2) $\triangle logTA$	(3) $\triangle logSEC$	(4) $\triangle GL$	(5) $\triangle SEC$
	Panel A: Whole sample				
AQR*$\triangle NetNPL$*Post	-1.730**	-1.787*	-3.390	-0.403	-0.228
	(0.771)	(0.985)	(3.334)	(0.930)	(2.564)
$\triangle NetNPL$*Post	0.529	-0.460	-2.220*	1.179***	-2.259***
	(0.348)	(0.371)	(1.155)	(0.296)	(0.857)
AQR*Post	2.354***	0.675	-3.082	2.424***	-4.631**
	(0.806)	(0.779)	(2.539)	(0.830)	(2.148)
Observations	3,135	3,135	3,135	3,135	3,135
Banks	856	856	856	856	856
	Panel B: High-NPL countries				
AQR*$\triangle NetNPL$*Post	-3.815**	-4.343***	-11.345	0.036	-6.537
	(1.855)	(1.280)	(9.090)	(2.003)	(8.949)
$\triangle NetNPL$*Post	0.637	-0.837*	-3.443**	1.615***	-3.105***
	(0.430)	(0.459)	(1.476)	(0.305)	(1.061)
AQR*Post	2.135	-0.621	-5.180	2.805	-4.962
	(1.437)	(1.456)	(5.135)	(1.985)	(4.812)
Observations	1,413	1,413	1,413	1,413	1,413
Banks	279	279	279	279	279
	Panel C: Low-NPL countries				
AQR*$\triangle NetNPL$*Post	-1.205	-1.098	-1.389	-0.811	1.073
	(0.939)	(1.166)	(4.056)	(0.535)	(2.454)
$\triangle NetNPL$*Post	0.251	0.526	0.658	0.095	-0.491
	(0.408)	(0.463)	(1.294)	(0.325)	(1.050)
AQR*Post	2.929***	2.318**	0.262	1.829**	-2.114
	(1.061)	(1.016)	(2.614)	(0.883)	(1.858)
Observations	1,722	1,722	1,722	1,722	1,722
Banks	577	577	577	577	577
Bank FE	Yes	Yes	Yes	Yes	Yes
Country*Size*Year FE	Yes	Yes	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes	Yes	Yes

This table presents the estimates of the change in the log of gross loans, the log of total assets, the log of total securities, the change in the ratio of gross loans to total assets and in the ratio of total securities to total assets. High-NPL countries are those with average NPL/GL above 10% in the pre-AQR period (2010-2013). AQR is a dummy equal to 1 for banks included in the 2014 AQR; $\triangle NetNPL$ is the change in NPL/TA net of provisions made over 2013-2014; Post is an indicator variable for the period 2014-2015. In all specifications we include bank fixed effects, time-varying bank characteristics (lagged by one period) and country-sizeBin-year FE. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level.

Table A5: Shock to NPLs and banks' behavior: Excluding AQR banks with capital shortfall

	(1) $\triangle logGL$	(2) $\triangle logTA$	(3) $\triangle logSEC$	(4) $\triangle GL$	(5) $\triangle SEC$
	Panel A: Whole sample				
AQR*$\triangle NPL$*Post	-1.316	-0.619	3.556	-0.484	4.562**
	(0.851)	(1.079)	(2.780)	(0.570)	(1.853)
$\triangle NPL$*Post	0.837***	-0.453	-2.593**	1.316***	-2.533***
	(0.324)	(0.336)	(1.148)	(0.238)	(0.836)
AQR*Post	2.135**	-0.747	-8.760***	4.440***	-6.528***
	(1.029)	(1.068)	(2.938)	(1.279)	(2.420)
Observations	2,367	2,367	2,367	2,367	2,367
Banks	816	816	816	816	816
	Panel B: High-NPL countries				
AQR*$\triangle NPL$*Post	-3.022**	-0.067	13.387	-3.682*	12.653
	(1.241)	(1.548)	(9.550)	(2.045)	(8.582)
$\triangle NPL$*Post	0.813**	-0.630*	-2.835**	1.423***	-2.615***
	(0.346)	(0.367)	(1.225)	(0.243)	(0.870)
AQR*Post	2.632*	-3.769*	-21.735**	7.586***	-16.182**
	(1.419)	(2.250)	(8.754)	(2.719)	(7.447)
Observations	1,115	1,115	1,115	1,115	1,115
Banks	262	262	262	262	262
	Panel C: Low-NPL countries				
AQR*$\triangle NPL$*Post	-1.354	-1.656	4.864	0.215	6.647*
	(1.396)	(1.486)	(4.605)	(1.184)	(3.830)
$\triangle NPL$*Post	0.710	1.503**	-1.422	-0.600	-3.186
	(0.946)	(0.682)	(3.353)	(0.904)	(3.314)
AQR*Post	2.495	0.620	-6.516*	4.251***	-4.745
	(1.615)	(1.506)	(3.797)	(1.479)	(3.044)
Observations	1,252	1,252	1,252	1,252	1,252
Banks	554	554	554	554	554
Bank FE	Yes	Yes	Yes	Yes	Yes
Country*Size*Year FE	Yes	Yes	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes	Yes	Yes

This table presents the estimates of the change in the log of gross loans, the log of total assets, the log of total securities, the change in the ratio of gross loans to total assets and in the ratio of total securities to total assets. We exclude from the whole sample, the 25 banks that the stress test found were undercapitalised. High-NPL countries are those with average NPL/GL above 10% in the pre-AQR period (2010-2013). AQR is a dummy equal to 1 for banks included in the 2014 AQR; $\triangle NPL$ is the change in NPL/TA between 2013 and 2014; Post is an indicator variable for the period 2014-2015. In all specifications we include bank fixed effects, time-varying bank characteristics (lagged by one period) and country-sizeBin-year FE. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level.

Table A6: Shock to NPLs and banks' behavior: AQR banks

	(1) $\triangle logGL$	(2) $\triangle logTA$	(3) $\triangle logSEC$	(4) $\triangle GL$	(5) $\triangle SEC$
Panel A: Whole sample					
$\triangle NPE$*Post	-0.552*	-0.185	0.135	-0.422*	0.138
	(0.307)	(0.423)	(0.918)	(0.231)	(0.675)
$\triangle Cov$*Post	-0.183	-0.115	0.423	-0.036	0.434
	(0.149)	(0.160)	(0.578)	(0.113)	(0.495)
Observations	516	516	516	516	516
Banks	102	102	102	102	102
Panel B: High-NPL countries					
$\triangle NPE$*Post	-0.798*	-0.914*	-0.101	0.009	0.343
	(0.395)	(0.536)	(1.722)	(0.283)	(1.181)
$\triangle Cov$*Post	-0.323	-0.218	0.547	0.044	0.757
	(0.243)	(0.241)	(1.736)	(0.328)	(1.559)
Observations	176	176	176	176	176
Banks	34	34	34	34	34
Panel C: Low-NPL countries					
$\triangle NPE$*Post	-0.134	0.728*	0.086	-0.788***	-0.556
	(0.375)	(0.400)	(1.183)	(0.285)	(0.962)
$\triangle Cov$*Post	-0.189	-0.060	0.548	-0.133	0.595
	(0.174)	(0.187)	(0.575)	(0.131)	(0.451)
Observations	340	340	340	340	340
Banks	68	68	68	68	68
Bank FE	Yes	Yes	Yes	Yes	Yes
Country*Year FE	Yes	Yes	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes	Yes	Yes

This table presents the estimates of the change in the log of gross loans, the log of total assets, the log of total securities, the change in the ratio of gross loans to total assets and in the ratio of total securities to total assets. $\triangle NPE$ is the first difference between the AQR adjusted NPE ratio and the unadjusted NPE ratio (as a percentage) at year-end 2013, and as reported by the ECB; Post is a dummy equal to 1 in the post treatment period (2014-2015); $\triangle Cov$ is the change in the coverage ratio measured as the adjustments to provisions over the NPE adjustments, as reported by the ECB. In all specifications we include bank fixed effects, time-varying bank characteristics (lagged by one period) and country-year FE. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level.