

Capital Ratios and Stress Testing: The In-Comprehensive SSM-ent

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Abstract

The widest EU stress testing exercise took place in mid 2014 in close collaboration between the EU regulators. An analysis of the results revealed that impairments and risk exposure were the main factors behind the decreases in the participating banks' capital position. Still, the assessment of the results was incomprehensive in that, aside from size and country, no analysis was conducted in regard to which type of banks were most predisposed to the highest contraction in capital ratios. Our analysis reveals that the banks' ex-ante balance-sheet position can provide a solid understanding of the variation in capital during the tests. These results are important to policymakers and risk managers in gauging the interplay between capital and leverage ratios for future stress tests.

JEL classification: G21 G29

Keywords: Stress Test, Basel, Capital

1. Introduction

After the events of the recent financial crises, stress testing has become one of the hottest topics in risk management, in particular under the umbrella of regulation. However, stress testing is not a new topic. It became mandatory for banks to develop (micro) stress scenarios as early as 1996 when the concept of stress testing was introduced by the Basel Committee on Banking Regulation (BCBS) as part of the amendments to the 1988 Basel I Accord. With the arrival of Basel II in 2004, stress testing quickly became a vital component of the newly introduced Pillar 2 requirements and its offsprings the Internal Capital Adequacy Assessment Process (ICAAP) and the Supervisory Review and Evaluation Process (SREP). The supervisory pillar, as it became known, sought to measure extreme risks which were not captured under the Pillar 1 minimum capital requirements.

In 2007, the perspective shifted from being internally focused when national and international regulators saw the value in using stress testing as an instrument for macro-prudential policy. Macro tests provided to regulators a representation of the impact of stress on the collective behavior of institutions. BCBS (2008) and BCBS (2009) soon followed as part of the updates which became known as Basel 2.5. Unfortunately, the realizations came too late to prevent another global financial crisis as stress testing was still mostly conducted at business line level and missed out on the most relevant scenarios¹. Nonetheless, the regulatory amendments were subsequently incorporated into

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¹Such as those related to complex structured products, securitization risk etc...

the Basel III package which first appeared in 2010. The revised sections of the package related to capital (BCBS (2010a)) and liquidity (BCBS (2010b)) both factored in stress testing namely as part of exposure calculations and the liquidity coverage ratio.

However, regulators quickly became knowledgeable of the fact that allowing banks to conduct their own stress tests would lead to many inconsistencies across the banking sector. On the other hand, constructing a single test (or series of tests) for an entire supervisory jurisdiction would require aggregation tools to analyse the data, a matter heavily dependent on enforcing sector-wide guidelines for reporting and accounting.

Notwithstanding the amount of effort it would take, international regulators soon embarked on the (second) option of putting together stress testing guidelines for their jurisdictions. In the U.S., the Fed still conducts a series of exercises which started in 2009². What was first known as the Supervisory Capital Assessment (SCAP) then changed to the Comprehensive Capital Analysis and Review (CCAR). The latter's objective is to assess whether large banks operating in the U.S. have sufficient capital to withstand global economic shocks. According to the last set of results that was released in March 2014, a few major U.S. domiciled banks received objections on their capital plans on the basis of their stress tests. This triggered major obstructions to their business plans especially regarding dividend distributions. In addition, U.S. banks abide by the Dodd-Frank Act Stress Testing (DFAST) legislation, seen as complementary to CCAR, which uses a distinct testing methodology. The FED's role is therefore to manage the two efforts in order to avoid duplication and minimize regulatory oversight (FED (2014)).

Arguably a bigger challenge was raised by European regulators in order to conduct a pan-European stress test. The Committee of European Banking Supervisors (CEBS) and its offspring, the European Banking Authority (EBA), administered a series of annual tests between 2009 and 2011. These tests, slowly became more and more developed, engulfing more banks at each run. However, the EBA stopped its stress tests during the course of the Euro crisis before re-assuming this mandate with the emergence of the European Central Bank (ECB) as the new European banking supervisor under the Single Supervisory Mechanism (SSM) which was approved by the European Parliament (ECRS (2013)) in September 2013.

In preparation for the ECB to assume its new role on November 4th 2014, the new stress tests were announced at the beginning of that year. The EBA was responsible for devising the stress test methodology, scenarios and disclosure templates which were used by the ECB when performing their own stress test³ as part of their comprehensive assessment (CA).

The ECB tests revealed capital shortfalls of 24.6 billion across 25⁴ EU banks. The breakdown by the EBA and ECB of the common equity tier 1 (CET1) shortfall into the ratio's contributing factors pointed to two sides of the same coin with impairment and loan losses designated, respectively, as the main culprits. Nonetheless, both institutions did not undertake any analysis of what other bank-specific factors were associated with the shortfalls.

Our analysis seeks to fill this gap by analyzing which balance-sheet factors were mostly associated with the outcome of the stress test. By doing so, we emphasize the role of capital and leverage

²With the exception of 2010.

³At the same time, the EBA conducted its own test which overlapped to a great extent with the sample chosen by the ECB. Certain countries such as the UK featured under the EBA test but not the ECB as they did not fall under the SSM. However the most important difference between the two tests was at the consolidation level. Also, while the EBA test excluded subsidiaries from other EU or non-EU countries, banking groups from European countries outside the Euro-zone were included.

⁴24 in the case of the EBA.

ratios in the stress tests, thereby consolidating evidence as to the essential teaming between the two ratios for the purpose of guaranteeing financial stability (Taylor (2014)).

Section 1 gives an overview of the ECB stress tests. Section 2 describes the data and methodology used for our analysis. Section 3 presents our results, followed by a series of robustness tests in section 4. We conclude with a summary of our main findings and underline the importance this has on policymakers and risk managers.

2. ECB Comprehensive Assessment (CA)

2.1. Overview

We start by the definition of a stress test as stated in the ECB (2014) report⁵:

“The stress test is a forward-looking exercise that provides insight into the ability of a bank to withstand pre-defined adverse economic conditions. It should be noted that the stress test is not a forecast of future events, but rather a prudential gauge of participating banks’ resilience under severe but plausible macro-economic conditions”.

Stress tests are normally of two types: sensitivity or scenario-based. In particular, with respect to the latter, the scenarios themselves can be portfolio/internally-driven (following an internal vulnerability assessment of the bank or institution) or event/externally-driven. In the case of event-driven scenarios, these can either be judgment-based (hypothetical), or related to historical episodes of stress⁶ (historical) or even a combination of both (hybrid).

In the case of the ECB exercise, the stress test was purely hypothetical, relying on a baseline and adverse scenarios covering the period 2014-2016, and based on end of 2013 balance-sheet data. The baseline scenario was considered the most plausible scenario, as opposed to a formal forecast, as seen by the European Commission (EC) for the designated period. In contrast, the adverse scenario was meant to capture the prevailing market view of current risks⁷ as identified by the European Systemic Risk Board (ESRB). For these scenarios, banks were required to remain above a minimum of 8% and 5.5% CET1⁸, respectively. In order to maintain simplicity and cross-bank consistency as well as to ensure that banks’ CET1 ratios would not benefit from deleveraging action which normally accompanies downturns, the ECB imposed a condition of static balance-sheets on most banks⁹. More detail on the nature and specification of these tests can be found in EC (2014) and ESRB (2014).

The test was comprehensive in that it covered 19 participating countries from across the Eurozone. The assessment was conducted at “the highest level of consolidation in participating Member States” which included 130 banks accounting for 81.6% of total SSM banking assets (€22 trillion).

Note that, as per the aforementioned constraints on running a test of this nature, the ECB first had to conduct a harmonization and cleansing of banks’ (800) portfolios, known as the asset

⁵Hereafter, all statistical references will be made to this report except when stated otherwise.

⁶These include Black Monday (1987), the Asian Financial Crisis (1997), LTCM/Russian crisis (1998), Terrorist and dot-com bubble (2001-2002) as well as the subprime crisis (2007-2009) and the more recent Euro crisis (2011-ongoing at the time of writing)

⁷As per the EBA, these include: (i) a hike in global bond yields; (ii) a deterioration of credit quality in countries with weak demand; (iii) stalling policy reforms; and (iv) an inability to maintain affordable market funding.

⁸Capital was defined as per the Capital Requirements Regulation/Directive (CRR/CRD IV) as of 1 January 2014.

⁹A total of 29 banks which had already agreed with the European Commission (Directorate General of Competition, DG COMP) or were undertaking restructuring plans which fell during the scenario timeline were granted permission to conduct the scenario on a dynamic basis.

quality review (AQR), before it could embark on the stress tests. This was reflected in its three-fold statement of purpose which was first to strengthen banks' balance sheets before enhancing transparency and building confidence. We describe the main results from both undertakings in the following subsections.

2.2. Asset Quality Review (AQR)

While the focus of our paper is on the outcome of the stress tests, the sheer intensity of the AQR impact on banks' balance sheets (€48 billion spread across all countries as per Figure 1), begs the question of whether it had any deferred impact on the stress test results.

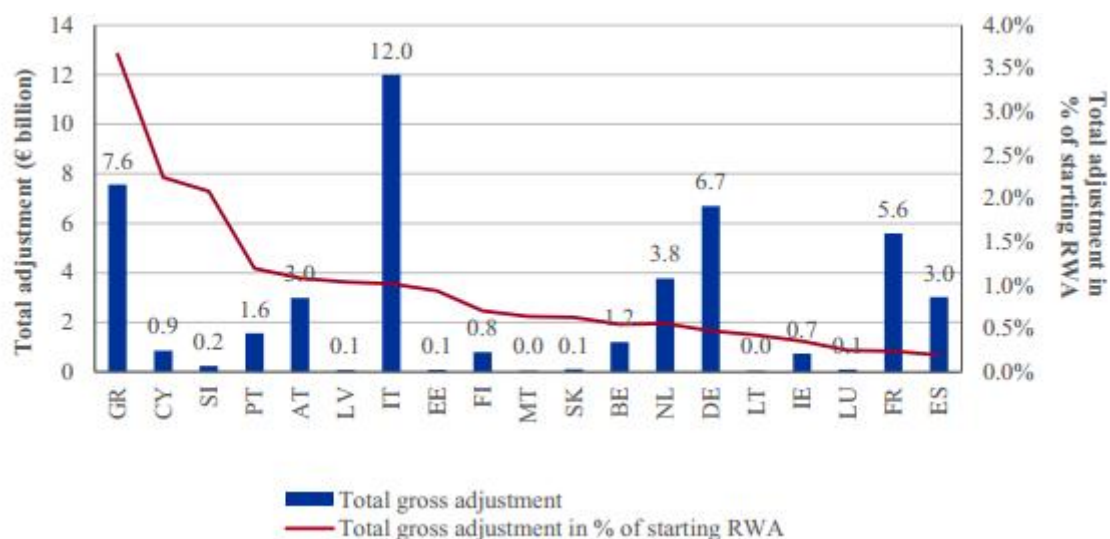


Figure 1: Gross AQR adjustment by country of participating bank (Source: ECB (2014))

Note that while the focus of the stress test was only on the behavior of the capital ratio (CET1), the AQR itself affected both capital and leverage ratios. The latter has recently been the topic of regulatory discussion, especially with the Financial Policy Committee (FPC) at the Bank of England (FPC (2014)), after the BCBS decided to test a minimum requirement of 3% for the leverage ratio over the next few years with a view to phase it out by the beginning of 2018. One interesting result from the review revealed that 14 institutions fell below this minimum threshold even prior to conducting the AQR.

In terms of capital (CET1) and leverage ratios, the main changes driven by the AQR affected both their numerator (capital) as well as their denominators (risk-weighted assets and total assets, respectively). With regards to CET1 capital, the changes were mostly related to the estimation of default probability and loss given default by the banks. These factors, which enter directly into the computation of capital requirements for banks using internal models, were long before seen as the cause behind banks' understatement of capital and divergences amongst banks with similar risk profiles. In fact, the EBA continues to deliver on an important policy agenda in that regard (EBA (2014)). As a result, the AQR brought in many important adjustments with respect to CET1 ratios. According to our calculations based on the data provided by the ECB (see Section 2), the average adjustment across all participating banks was 66 (33) bps for capital (leverage)

ratios. This would indicate that the adjustments linked risk-weighted assets carried twice as much importance during the AQR, due to the repercussions on risk-weights as well as total assets.

Another interesting fact pointed to by the AQR was the €135.9 billion in changes to non-performing exposure (NPE), primarily due to the differences in the definition of forbearance across banks. As a result, the EBA simplified the definition of NPE in order to apply it consistently across all banks resulting in a harmonized measure.

Moreover, the AQR included a qualitative review of trading books spanning P&L analysis as part of a level 3 asset review and credit valuation adjustments. On level 3 exposures, a review of the “most material” derivative pricing models was conducted. The review required 16 banks to hold an additional €223 million accounting for around 30% of in-scope models.

CVA adjustments in particular received much attention as the AQR showed the need for a €3.1 billion (27%) increase in the reserves banks held against counterparty defaults. The impact was mostly due to PD and LGD underestimations (€1.8 billion), excluded exposures (€1.0 billion), inappropriate exposure profiles (€0.3 billion), as well as the complete absence at some banks of accounting CVA (€0.1 billion). More importantly, the analysis revealed that 50% of participating banks had poor or substandard practices in their CVA calculation, thereby requiring methodological upgrades.

Note that the join-up process between the AQR and the stress test results happened after the latter had taken place using an internally developed tool by the ECB. The impact of the join-up was highly correlated with the magnitude of the AQR findings. However, this leaves the question open as to whether the banks with higher adjustments were impacted more heavily during the stress scenarios. A positive answer to that question could mean that the adjustments were incomplete and the stress test had revealed more pitfalls that should have been addressed. We provide an answer to this question in our empirical section.

2.3. Stress Test

2.3.1. Overall Bank Sample

With regards to the baseline scenario, the average CET1 ratio increased by 0.2% from 11.4% to 11.6%. Nonetheless, 16 banks experienced a shortfall in capital with respect to the 8% hurdle rate. All but one of the banks also failed the adverse scenario.

Across the full sample, the adverse scenario led to an aggregate fall in capital of €215.5 billion (22% of initial capital). This represented only a quarter of the increase in risk-weighted assets. As a result, the median CET1 ratio fell by four percentage points, from 12.4% in 2013 to 8.3% in 2016¹⁰ as shown in Figure 2.

Bear in mind that countries such as Slovenia and Cyprus which experienced the highest falls in CET1 ratios showcased some of the lowest reductions in CET1 according to Figure 3. In contrast, the top three EU economies (Italy, Germany and France) averaged around €30 billion falls in CET1. This apparent contrast, which is brought out by the two figures, is directly linked to the size of the banking sector in the larger economies which accumulated more losses in absolute terms in comparison to smaller economies. Hence, dividing by risk-weighted assets, the ordering of countries as per 2 is re-instated in Figure 3 as shown by the monotonic decrease in the red line.

On the other hand, the ECB reveals that banks which operated a dynamic balance-sheet were impacted less by the baseline scenario. This is in contrast to the behavior of banks under the

¹⁰These become 11.1% and 7.7% using a fully-loaded CET1 ratio.

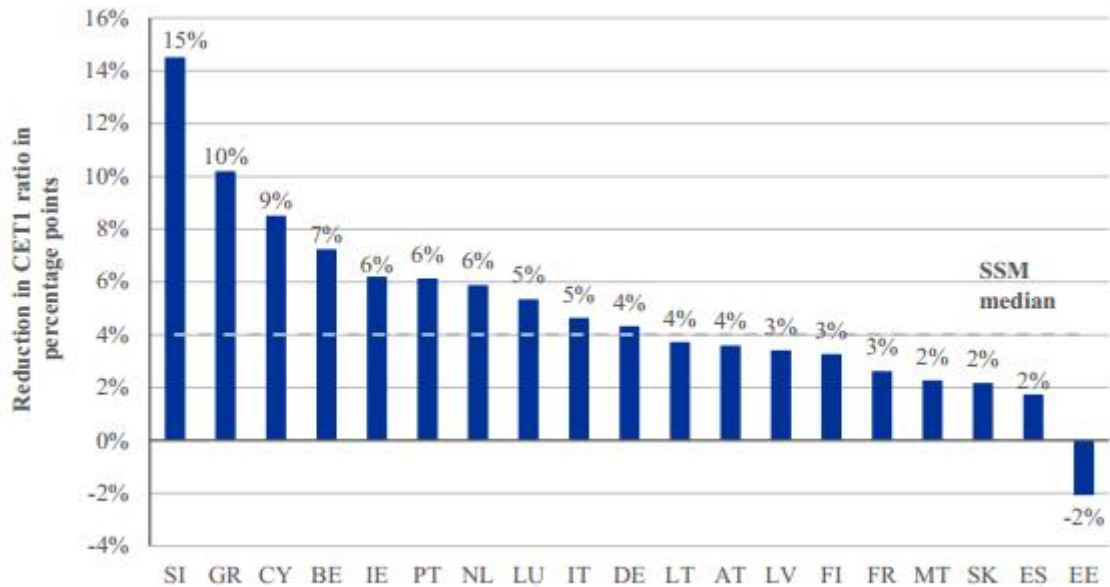


Figure 2: Comprehensive assessment median projected adverse scenario reduction in capital ratio by country of participating bank (Source: ECB (2014))

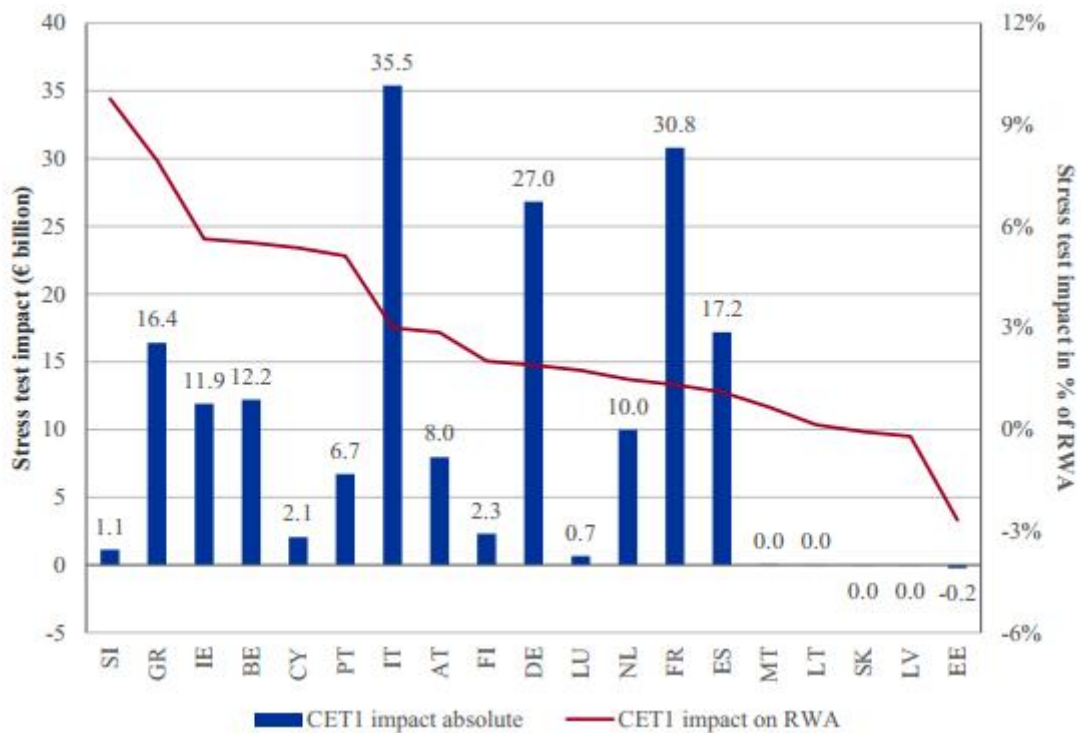


Figure 3: Impact of the stress test on the aggregate CET1 capital by country under the adverse scenario in billion and in percentage of RWA (Source: ECB (2014))

adverse scenario, arguably due to the impact of restructuring on banks' vulnerability during periods of stress.

Finally, in explaining the variation behind the decreases in CET1, the analysis conducted by the ECB pointed to an increase in loan losses as being the main driver. This is aligned with the EBA analysis which focused on impairment and risk exposure.

2.3.2. Banks with Shortfall

The sample of 25 banks which experienced a shortfall during the exercise are listed in Appendix A. On average the loss was almost €1 billion per bank. The distribution across countries, as illustrated in Figure 4, shows a mix between large and small countries (Italy, Greece and Cyprus) in terms of the worse affected.

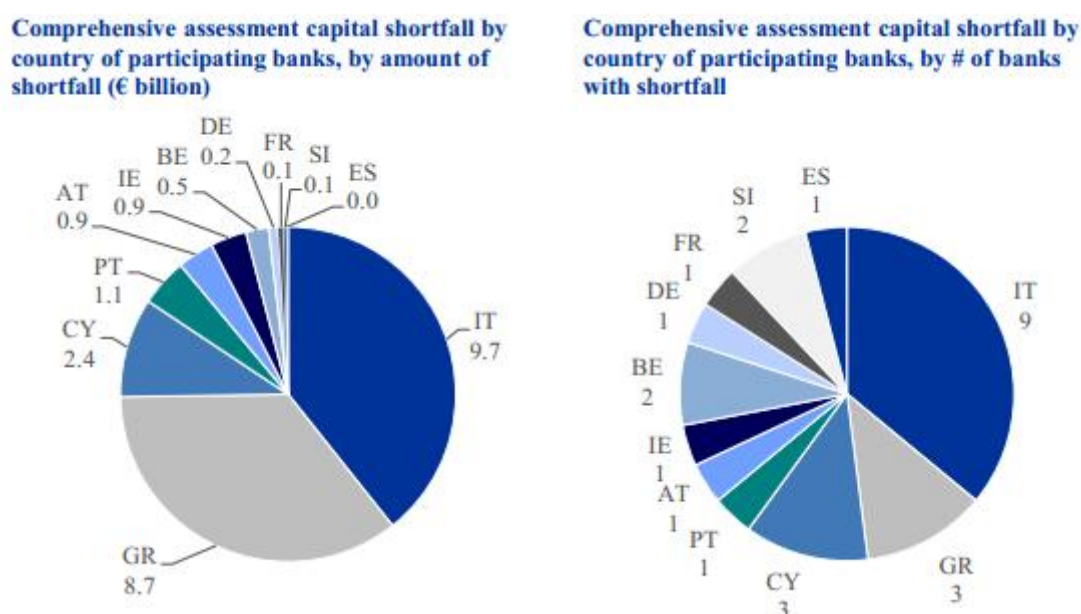


Figure 4: Capital shortfall by country of participating banks (Source: ECB (2014))

2.3.3. The impact of balance-sheet variables on capital shortfall

The ECB study of which ex-ante factors could have impacted how banks performed during the stress scenario is mainly limited to static¹¹ variables such as country (as shown above) and bank size (as shown in Figure 5). According to the ECB results, small to mid-sized banks experienced higher shortfalls. In Appendix B, we show that this result varies depending on the categorization method used for the grouping of banks.

In sum, while the ECB study reveals important facts about the characteristics of banks in relation to the stress test, it remains short of quantifying which underlying factor(s) had more significant impact on the outcome of the stress scenario. As these (dynamic) factors would be more amenable to change than those identified by the ECB, this would allow regulators and risk managers to better withstand future stress exercises. Our aim in this paper is to uncover which factors have proven to be the most determining ones.

¹¹With the exception of banks not subject to the static balance-sheet assumption.

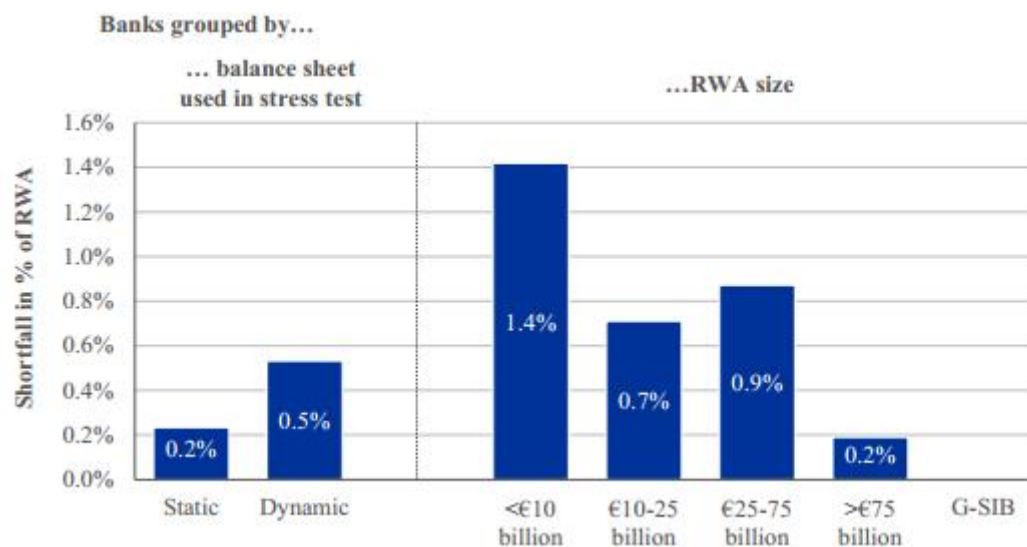


Figure 5: Capital shortfall grouped by bank stress test balance sheet type and RWA size group (Source: ECB (2014))

3. Data and Methodology

3.1. Variable Definitions

We use the data released by the ECB on its external website under the Comprehensive Assessment Disclosure Overview Tool dated 26 of October 2014. The data consists of multiple balance-sheet items spanning 130 banks located across the 19 countries¹² selected for the CA.

The purpose of this exercise is to study the changes to CET1 ratios under different scenarios and attribute these to different ex-ante characteristics of the banks' balance-sheet. As such, our dependent variable ΔCET1 is the change in CET1 in percentage terms between 2013 and 2016 under baseline and adverse scenarios.

The first set of variables we believe can be associated with that change are the 2013 pre-stress levels of CET1 (AQR CAP RATIO¹³) and Leverage ratios (AQR LEV RATIO). This choice is motivated by the effect of capital on banks' risk aversion which directly impacts their performance under stress. Callem and Rob (1999) reported a U-shape relationship between the two whereas other authors unveil a more linear relationship. Effectively, higher capital ratios result either from higher riskiness (Shrieves and Dahl (1992), Blum (1999, 2008), and Duran and Lozano-Vivas (2014) which is translated via a higher total capital requirement imposed by the regulator, or via higher surpluses which are set as a precautionary measures (Jacques and Nigro (1997), Van-Roy (2005) and Berger et al. (2008)). In the first case, we expect that banks with higher capital ratios exhibit a greater fall in CET1 due to the materialization of the risk factors contributing to the higher capital requirement. In the second case, the voluntary aspect behind holding capital higher than the requirement would underpin the fact that the bank is generally conservative in its risk-taking.

¹²These are Austria, Belgium, Cyprus, Germany, Estonia, Spain, Finland, France, Greece, Ireland, Italy, Luxembourg, Latvia, Lithuania, Malta, Netherlands, Portugal, Slovenia and Slovakia.

¹³Note that because CET1 in 2016 is expressed post-AQR adjustments we need to consider CET1 post-AQR in 2013 to avoid any spurious noise to the data.

Under this assumption, the banks with higher surpluses would be expected to experience smaller falls in CET1. Our model will test which of these hypotheses holds.

On the other hand, given that the leverage ratio is so far a non-binding constraint on banks, intuition would suggest that banks with higher leverage ratios are inherently safer banks which will exhibit smaller shortcomings during the stress scenario. Note that we also include the interaction term $\text{AQR CAP RATIO} * \text{AQR LEV RATIO}$ to analyze the behavior of banks holding high levels of both ratios.

Moreover, given our earlier revelation that the AQR had a high impact on CET1 before the stress test was conducted, one question we ask is whether capital adjustments had any bearing on the results after the stress test was conducted¹⁴. In principal, banks with more adjustments would signal more deficiencies in their internal capital assessments. The inadequacy itself would therefore suggest a riskier bank. However, as the ECB is expected to have covered all balance-sheets, we expect there to be no impact on changes to CET1 under the stress test. If not, then depending on whether the level of adjustments was a signal of more adjustments which remained undetected or if it was sufficient in clearing most deficiencies, the sign on the adjustment variable (AQR CAP ADJ) expressed in basis points could be either negative or positive, respectively.

The remaining variables are a set of controls (X) which describe different characteristics of the banks' balance sheets. These include the PNL RATIO , NPE RATIO , COVERAGE RATIO , $\text{LEVEL 3 (Assets) RATIO}$.

3.2. Sample Description

We first inspect the data for any outliers. Figure 6 is a histogram of AQR CAP RATIO which clearly shows the single instance of an outlier. This bank had a CET1 ratio of 281% which if included could significantly bias the estimates in our model. Also, we exclude one bank which did not report its leverage ratio (and adjustments) for consistency purposes and to maintain the same number of observations for all variables. The rest of the data provides clean estimates as can be seen for instance in the case of the AQR LEV RATIO in Figure 7.

This leaves us with 128 banks in our sample. Note that when we conduct our analysis using only the sample of banks which experienced a shortfall under the adverse scenario, our sample will be smaller in comparison to that shown by the ECB as 2 banks were not relevant for our exercise. Those banks were included in the ECB shortfall sample because they experienced shortfalls either prior to the stress tests or during the baseline scenario but not under the adverse scenario.

We now describe the set of variables for the full, non-shortfall and shortfall samples. As expected, we observe in Table I that banks experienced a much more severe decrease in CET1 under the adverse scenario compared to the baseline¹⁵. However, we note that our estimates are mostly statistically insignificant except for the (smaller) shortfall sample. This hinders a proper comparison of the three groups. Hence, it may appear that banks which experienced a shortfall, fell by more those who did not while starting from lower levels of capital ratios. In this case, the lack of significance of the means is magnified by the fact that the standard error for the full and non-shortfall samples is more than twice that of the shortfall sample¹⁶. Coverage ratios, on the

¹⁴ A reminder that ΔCET1 is adjustment free.

¹⁵ This slightly contradicts the results from the ECB which showed an increase of 0.2% under the baseline scenario for the full sample. While the difference is not significant, it could be due to the presence of two additional banks in the sample added to the fact that the computations involve taking the ratio of the change in capital to the change in risk-weighted assets rather than the difference in the overall ratio (see Appendix B).

¹⁶ This does not contradict our main empirical result especially as the shortfall sample is part of the overall sample.

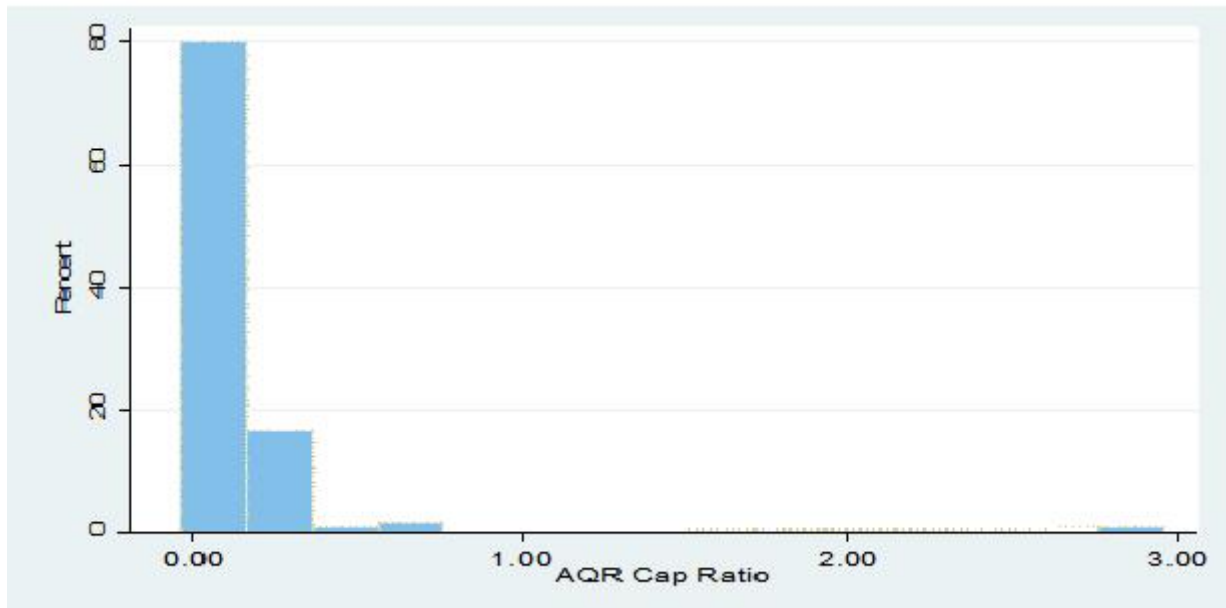


Figure 6: AQR CAP RATIO Histogram

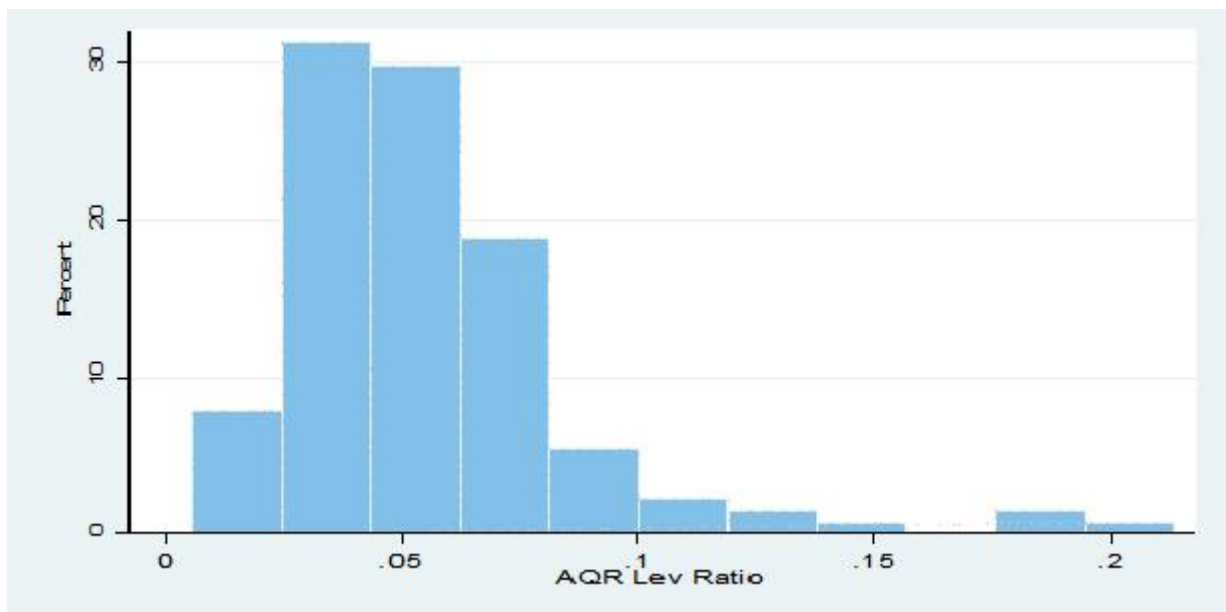


Figure 7: AQR LEV RATIO histogram

other hand, are clearly significant despite being almost equal across samples. We therefore do not expect it to yield any differential effect between banks.

Table I: Descriptive Statistics

Variable	Definition	Full Sample		Shortfall Sample	
		Mean	Std	Mean	Std
$\Delta CET1_{Base}$	Change in CET1 baseline scenario (%)	0.42	1.29	1.26	1.6
$\Delta CET1_{Adverse}$	Change in CET1 adverse scenario (%)	3.78	2.83	6.55	3.32
AQR Cap Ratio	AQR Adjusted capital ratio (%)	12.99	5.69	8.25	4.11
AQR Lev Ratio	AQR Adjusted leverage ratio (%)	5.7	3.21	4.79	1.69
AQR Cap Adj	Capital Adjustments resulting from the AQR (bp)	-66.33	92.55	-171.94	120.31
PNL Ratio	Profit and Loss divided by Total Assets (%)	-0.1	2.5	-342	1025
NPE Ratio	Non-performing Exposures divided by Total Assets (%)	7.75	9.05	19	11.48
Coverage Ratio	Amount of cashflow available to cover NPE (%)	42.75	17.09	39.4	12.33
Level 3 Ratio	Level 3 instruments divided by Total Assets (%)	0.76	1.49	0.73	1.12

Finally, all variables exhibit low to moderate levels of correlations as can be seen in the Table II below. This excludes the case for multicollinearity which could surface for instance between the capital and leverage ratios if included together in a single regression due to the direct relationship between these variables (numerator). However, this is not the case in our setup as the two ratios exhibit a low correlation of 26% which indicates that the two might be carrying independent information with regard to the the outcome of the stress scenario as hinted to by Estrella et al. (2000). This is in line with Demirguc-Kunt et al. (2013) where the authors show that correlation estimates can reach around 63% for a full sample of international banks.

Table II: Correlation Table

	AQR Cap Ratio	AQR Lev Ratio	AQR Cap Adj	PNL Ratio	NPE Ratio	Cov Ratio	Level 3 Assets
AQR Cap Ratio	1.00						
AQR Lev Ratio	0.59	1.00					
AQR Cap Adj	0.15	-0.03	1.00				
PNL Ratio	0.24	0.03	0.21	1.00			
NPE Ratio	-0.38	0.09	-0.51	-0.52	1.00		
Cov Ratio	-0.061	0.21	0.02	-0.11	0.07	1.00	
Level 3 Ratio	0.07	0.15	-0.04	-0.05	0.00	-0.01	1.00

3.3. Model Description

The model can be described using the following regression as shown in equation (1). \mathbf{i} denotes the bank index while $\mathbf{j} \in [\text{Base}, \text{Adverse}]$. We cluster at country level in order to account for idiosyncratic scenario shocks which differ by country. β_4 denotes a vector of coefficients for our pre-defined set of control variables X .

$$\Delta CET1_{i,j} = \alpha + \beta_0 AQR_CAP_RATIO_i + \beta_1 (1 + \beta_2 AQR_CAP_RATIO_i) \times AQR_LEV_RATIO_i + \beta_3 AQR_CAP_ADJ_i + \beta_4 X_i + \epsilon_{it} \quad (1)$$

Due to the cross-sectional nature of our model, some variables initially display a degree of multicollinearity with the intercept which biases the coefficients in the model. We therefore detrend all ratios; the resulting model exhibits no multicollinearity.

4. Results

Our main results are summarized in Table III below. Note that we introduce the capital ratios and their interaction in a step-wise manner in order to gauge their individual significance. In the baseline scenario, we see that all variables are insignificant up to the point where we introduce the full model. Nonetheless, the overall significance is quite low as the F-statistic does not reject the hypothesis that all coefficients are statistically different from 0¹⁷.

In contrast, the capital and leverage ratios appear significant from the onset of the adverse scenario with a significant F-statistic throughout all runs which underlines the predictive power of these variables under stress. Our results show that if the ex-ante capital ratio increases by 1%, this would lead to a fall of more than 0.3% in CET1. The results reject the precautionary savings hypothesis and testify to the fact that banks with higher capital ratios would have held such levels due to higher risk (requirements) in their portfolios which translated into higher losses.

On the other hand, safer banks with high leverage ratios and low capital ratios fared better than the rest while those with high capital ratios still perceived the benefits of holding high leverage ratios as can be seen from the insignificant interaction term. As a reminder that the leverage ratio itself was not a binding constraint on banks at the time of the stress exercise, this adds substance to the addition of the leverage ratio as a backstop measure to fend against high-risk banks.

Moreover, our results emphasize the importance of NPE in predicting slides in capital ratios as opposed to the remaining control variables¹⁸. In line with the importance attributed to impairments (loan losses) by the ECB (EBA), we find that the impact of NPE is detrimental for banks' capital ratios as it erodes their capital base especially during downturns. As 50% of banks held NPE ratios of around 4% or less, Figure 8 suggests that banks above this value were those most likely to experience the largest falls in their CET1 ratios.

In contrast, we see that banks with high PNLs were affected less severely by the stress test. This probably testifies to their general healthier condition at the onset of the exercise which is surprisingly not captured by Level 3 Assets. Similarly, we note that the capital adjustments had no effect on the outcome of the scenarios which, as alluded to earlier, indicates that the AQR did not conceal any deficiencies which could have impacted the stress test.

¹⁷The critical value for the distribution at 10% significance is $F(8,18) \approx 2$ which is greater than the value we obtain of 1.79

¹⁸We expected the ratio of Level 3 assets to hold some significance in this exercise due to the hit these assets would experience in terms of their fair value during adverse scenarios. However, we are reminded that the review was conducted on a "selective basis i.e. not all banks were analyzed" according to the ECB which could indicate that their overall effect is not captured fully in this exercise.

Table III: Main Results

	Base				Adverse			
AQR Cap Ratio	0.358 (1.72)	0.386 (1.65)	0.368** (2.31)	0.694** (2.43)	0.818** (2.57)	0.869*** (3.69)		
AQR Lev Ratio		-0.012 (-0.15)	-0.032 (-0.39)	-0.157 (-1.29)	-0.093 (-0.43)	-0.144 (-0.64)	-0.525** (-2.40)	
CapxLev			-1.758 (-0.34)	-1.515 (-0.41)		1.728 (0.25)	-3.192 (-0.55)	
AQR Cap Adj				-0.000 (-1.02)			-0.000 (-1.19)	
PNL Ratio				-0.140 (-1.62)			-0.477*** (-2.96)	
NPE Ratio				0.017 (1.03)			0.155*** (4.39)	
Coverage Ratio				0.020 (1.22)			-0.004 (-0.15)	
Level 3 Ratio				-0.099 (-0.50)			-0.440 (-1.13)	
CONS	0.002 (0.46)	0.002 (0.45)	0.002 (0.44)	-0.001 (-0.19)	0.029*** (3.02)	0.028** (2.87)	0.028** (2.86)	0.033*** (4.11)
R^2	0.03	0.00	0.03	0.17	0.03	0.01	0.04	0.32
Num Obs	128	128	128	128	128	128	128	128
F-stat	2.95	0.02	1.41	1.89	5.92	0.19	2.52	22.14

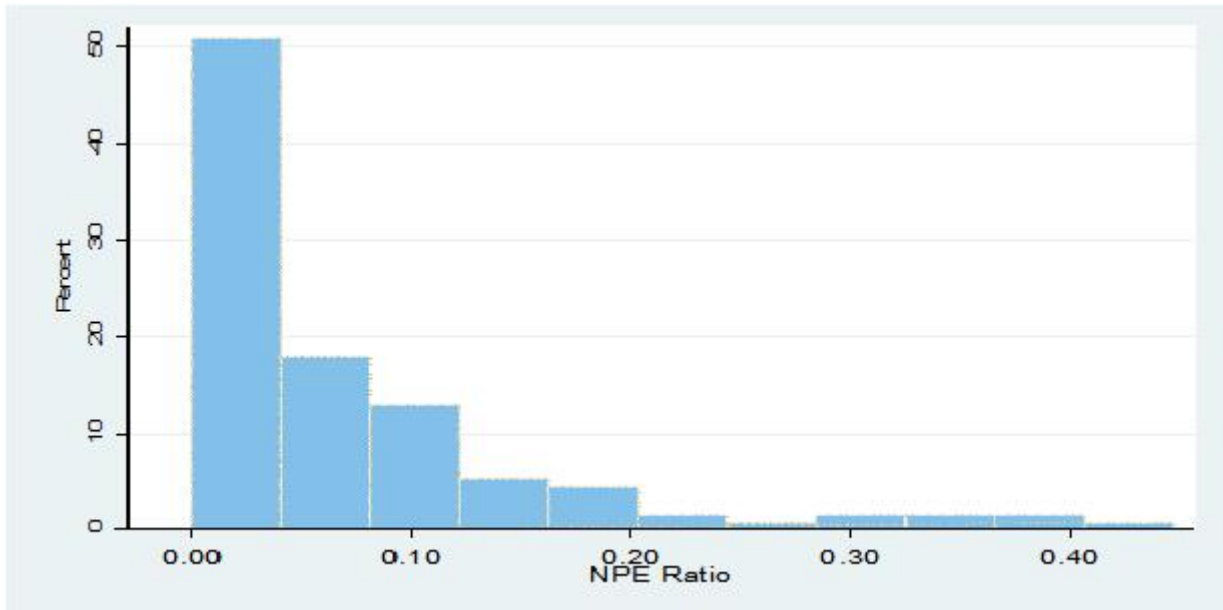


Figure 8: Histogram NPE

5. Robustness

5.1. Means Test

Our analysis has shown that banks with high (low) capital (leverage) ratios experienced higher (lower) falls in CET1. We now show how different these banks were compared to their peers. For this purpose, we conduct a means test of the two groups of banks which held high or low capital or leverage ratios.

We divide our sample into two groups. Using the 50th percentile (median) as our cut-off value, high (low) values of capital or leverage ratios correspond to Group 1 (0). We then run the means test on the percentage change in CET1 for both the full sample and shortfall samples.

Table IV shows that the CET1 ratios of banks with ex-ante higher capital ratios fell by more than 50% on average compared to their peers. The absolute difference between the two groups becomes wider in the case of banks which experienced a shortfall.

While the reverse impact is still observed for the leverage ratio under the full sample, it loses significance and disappears completely for the banks in shortfall. This would appear to come from the fact that whereas the mean difference between the full sample and shortfall samples in terms of 50th percentile is significant (12% as opposed to 7.5%), this is not the case for the leverage ratio which was almost exactly the same (4.8%). This agrees with our mean estimates in Table I.

Table IV: Means Test

Capital Group	Full Sample			Shortfall Sample		
	Obs	Mean	p-value	Obs	Mean	p-value
0	64	0.032	0.004	11	0.049	0.0177
1	64	0.049	-	11	0.082	-

Leverage Group	Full Sample			Shortfall Sample		
	Obs	Mean	p-value	Obs	Mean	p-value
0	64	0.045	0.16	11	0.062	0.66
1	64	0.036	-	11	0.069	-

5.2. Static assumption

In principal, the static balance-sheet assumption would appear to be essential in order not to influence the stress test with endogenous factors. We therefore apply the same model to the sample of banks who conducted the stress tests under the static assumption. The first column in Table V below shows that our previous results are not influenced by the presence of dynamic factors.

5.3. Banks in shortfall

We now run our model on the sample of banks which fell to the lowest levels of CET1 during the adverse scenario by increasing the base hurdle rate of 5.5% by 0.5% increments. Results are shown in Table V.

In principal, at low thresholds such as 5.5%, there are very few observations in our sample (22) to make any strong deductions about our model¹⁹. However, as shown in Table 5, the same results

¹⁹Also, at these levels, the sample of countries is too small with regards to the number of independent variables to be able to cluster by country. We therefore substitute our clustering method with White robust standard errors. This also shows the validity of our model with regard to different empirical specifications.

are obtained for higher thresholds up to and including 8% (52)²⁰. Indeed, while some variables become spuriously significant on an intermittent basis, the capital and NPE ratios effects appear systematically across all thresholds. On the other hand, the leverage ratio only takes effect at the 7% threshold. This re-states our means analysis observation that the leverage ratio did not fully compensate for banks which experienced shortfalls.

Table V: Robustness

	Static	CET5.5	CET6.0	CET6.5	CET7.0	CET7.5	CET8.0
AQR Cap Ratio	1.086*** (2.94)	0.793*** (3.55)	0.892*** (4.74)	1.190*** (4.22)	0.642*** (4.30)	0.750*** (2.83)	0.832*** (3.64)
AQR Lev Ratio	-0.474*** (-2.66)	-0.365 (-0.77)	-0.407 (-0.80)	-0.698 (-1.32)	-1.524*** (-3.14)	-0.658* (-1.99)	-0.633* (-2.01)
CapxLev	-6.642 (-1.18)	1.945 (0.30)	-4.445 (-0.82)	3.777 (0.37)	-13.754* (-1.99)	-3.621 (-0.34)	-3.400 (-0.34)
AQR Cap Adj	-0.000 (-1.09)	0.000** (2.29)	0.000* (1.80)	0.000 (0.04)	-0.000 (-0.57)	-0.000 (-0.02)	-0.000 (-0.04)
PNL Ratio	-0.479*** (-3.13)	-0.072 (-0.39)	-0.081 (-0.40)	0.140 (0.49)	0.020 (0.13)	-0.250 (-1.40)	-0.233 (-1.42)
NPE Ratio	0.155*** (5.08)	0.155** (2.30)	0.179** (2.46)	0.194** (2.67)	0.244** (2.26)	0.136* (1.79)	0.134* (1.76)
Coverage Ratio	-0.006 (-0.20)	0.019 (0.20)	-0.006 (-0.08)	0.008 (0.13)	0.079** (2.24)	0.025 (1.04)	0.017 (0.82)
Level 3 Ratio	-0.517 (-1.26)	-0.796** (-2.86)	-0.753*** (-3.22)	-0.430** (-2.25)	-0.483 (-1.61)	-0.814* (-1.91)	-0.709* (-1.96)
CONS	0.033*** (3.82)	0.104*** (8.87)	0.101*** (8.12)	0.094*** (6.72)	0.060*** (7.84)	0.067*** (11.25)	0.068*** (11.15)
R^2	0.36	0.83	0.83	0.79	0.68	0.63	0.64
Num Obs	105	22	25	30	39	44	52
F-stat	10.64	121.70	176.02	15.05	23.10	6.73	10.79

6. Conclusion

Aside from economic considerations, bank CFOs set the levels of capital in their institution based on three factors. First, and arguably the most important in their regard, is to comply with the regulations which sometimes result in very high penalties for capital-deficient banks. While related to the first, the second factor is the ability to pass any eventual stress scenario, be it as an exercise or in reality. The latter, which can be neglected as the CFO is often long gone before the onset of a crisis, has become a wide subject of regulatory discussion with the creation of “clawback” rules on bonuses, responsibility attribution etc...It is therefore helpful to know which ex-ante factors can help stabilize the banks’ position during stress regardless of which CFO is at the helm.

In this paper, we have aimed to add to the comprehensiveness of the CA by exploring which type of banks experienced greater shortfalls during the stress tests. Using balance-sheet data released by the ECB following the publication of their stress test results in October 2014, this paper takes into account factors in addition to the size and country variables used in its report. Our study shows that ex-ante capital and leverage ratios demonstrate important discrepancies amongst banks in terms of their ex-post CET1 position.

²⁰Note that according to our variance inflation factors, all traces of multicollinearity due to the increased correlation among variables at low levels of observations disappears at the threshold of 7%

The latter, which was the main component under analysis in the stress test, seems to have been more negatively affected by banks with high capital ratios. According to our hypotheses, this would inevitably result from the riskiness of the banks, as evidenced by their higher capital requirements, which crystallizes during periods of stress and results in more significant damage to their capital positions. Thus, our results add support to the main driver behind these shortfalls which was jointly pointed to by the ECB and EBA as being asset impairment and flows directly from riskier balance-sheets.

Fortunately, some banks were aided by their leverage ratios which acted as a control mechanism for the adverse effects of the stress scenario. This ratio, a newcomer to the Basel III regulation, is therefore justified as a backstop measure, despite failing to prevent some of the shortfall cases across the participating banks.

It has sometimes been a misconception that banks which hold high capital ratios are regarded as safer entities Caruana (2014). However, this claim clearly abstracts from the importance of capital requirements which are compulsory in addition to the minimum requirements and which reflect higher risk (known as Pillar 2). While the statement can be true for banks with high precautionary savings, our results should deter risk managers from dissimulating the true nature of their risk behind the height of their capital ratios in their updates to CFOs and board members. It is therefore more important for CFOs to understand the nature of any over-capitalization, rather than suffice with reported capital levels, as this could result in higher losses during downturns which could eventually encumber the firm's business plan.

Moreover, as per the FPC (2014) publication on the leverage ratio, one purpose of the latter is to account for hidden risk. What the ECB report does not say is that the reason the leverage ratio was so effective at alleviating the impact of the stress scenario on participating banks is probably because of the high levels of hidden risk which materialize under stress. This is crucial for any CFO, in order to appreciate the importance of maintaining healthy solvency ratios, and more importantly, doing so outside the scope of a stress test or regulatory requirement.

Note as well that the stress tests took place at a time where the leverage ratio along with the newly introduced counter-cyclical leverage ratio was non-binding on banks. If banks which held high leverage ratios perceived the benefits of having done so on a voluntary basis, we expect the same benefit to occur when these new leverage requirements become binding. This will add to CFOs' incentives to ensure the safety of the banks via higher leverage ratios while at the same time sending a positive (early) signal to the market about the firm's compliance with future regulations. Finally, our result with respect to the leverage ratio is also important for policymakers as it justifies its ability to circumvent some of the shortcomings of the capital ratio such as the discrepancies across banks using internal models.

We also serve notice that the leverage ratio was not able to save some banks from failing the stress tests. This opens up the debate as to what further policy tools could be used to address this issue, paving the way for more regulatory enforcements which CFOs would closely monitor. Unfortunately, any empirical study of failed banks would be limited to the number of observations and harmonization across balance-sheet numbers. A joint stress test across the US and EU would be a step forward toward a truly comprehensive assessment.

Appendix A. Participating banks with a shortfall

Bank Name	CET1 ratio starting point	CET1 ratio post AQR	CET1 ratio baseline scenario	CET1 ratio adverse scenario	Capital shortfall (€ billion)	Net eligible capital raised (€ billion)	Capital shortfall post net capital raised (€ billion)
Eurobank ¹	10.6%	7.8%	2.0%	-6.4%	4.63	2.86	1.76
Monte dei Paschi di Siena	10.2%	7.0%	6.0%	-0.1%	4.25	2.14	2.11
National Bank of Greece ¹	10.7%	7.5%	5.7%	-0.4%	3.43	2.50	0.93
Banca Carige	5.2%	3.9%	2.3%	-2.4%	1.83	1.02	0.81
Cooperative Central Bank	-3.7%	-3.7%	-3.2%	-8.0%	1.17	1.50	0.00
Banco Comercial Português	12.2%	10.3%	8.8%	3.0%	1.14	-0.01	1.15
Bank of Cyprus	10.4%	7.3%	7.7%	1.5%	0.92	1.00	0.00
Oesterreichischer Volksbanken-Verbund	11.5%	10.3%	7.2%	2.1%	0.86	0.00	0.86
permanent tsb	13.1%	12.8%	8.8%	1.0%	0.85	0.00	0.85
Veneto Banca	7.3%	5.7%	5.8%	2.7%	0.71	0.74	0.00
Banco Popolare	10.1%	7.9%	6.7%	4.7%	0.69	1.76	0.00
Banca Popolare di Milano	7.3%	6.9%	6.5%	4.0%	0.68	0.52	0.17
Banca Popolare di Vicenza	9.4%	7.6%	7.5%	3.2%	0.68	0.46	0.22
Piraeus Bank	13.7%	10.0%	9.0%	4.4%	0.66	1.00	0.00
Credito Valtellinese	8.8%	7.5%	6.9%	3.5%	0.38	0.42	0.00
Dexia ²	16.4%	15.8%	10.8%	5.0%	0.34	0.00	0.34
Banca Popolare di Sondrio	8.2%	7.4%	7.2%	4.2%	0.32	0.34	0.00
Hellenic Bank	7.6%	5.2%	6.2%	-0.5%	0.28	0.10	0.18
Münchener Hypothekbank	6.9%	6.9%	5.8%	2.9%	0.23	0.41	0.00
AXA Bank Europe	15.2%	14.7%	12.7%	3.4%	0.20	0.20	0.00
C.R.H. - Caisse de Refinancement de l'Habitat	5.7%	5.7%	5.7%	5.5%	0.13	0.25	0.00
Banca Popolare dell'Emilia Romagna	9.2%	8.4%	8.3%	5.2%	0.13	0.76	0.00
Nova Ljubljanska banka ³	16.1%	14.6%	12.8%	5.0%	0.03	0.00	0.03
Liberbank	8.7%	7.8%	8.5%	5.6%	0.03	0.64	0.00
Nova Kreditna Banka Maribor ³	19.6%	15.7%	12.8%	4.4%	0.03	0.00	0.03
Total	10.0%	8.4%	7.2%	2.1%	24.62	18.59	9.47

Figure A.1: List of banks which experienced a shortfall (Source: ECB (2014))

Appendix B. Validation of the ECB's Bank Size Effect on Shortfall

The ECB argument in section 2.3.3 linking the size of the banks to their performance during the stress scenarios is formulated on the basis of certain data assumptions. In order to understand what goes into these assumptions, we first attempt to reproduce the results in Figure 5 (Figure 23 in the ECB report).

To do so, we first rank the banks according to their risk-weighted assets (RWA). Dotted lines represent the different size categories highlighted in the boxes in Figure B.1. As can be seen, with the exception of 1 bank, at least the first 20 banks on each side of the spectrum experienced 0% shortfall. This is the first argument against relating size to any of the shortfalls.

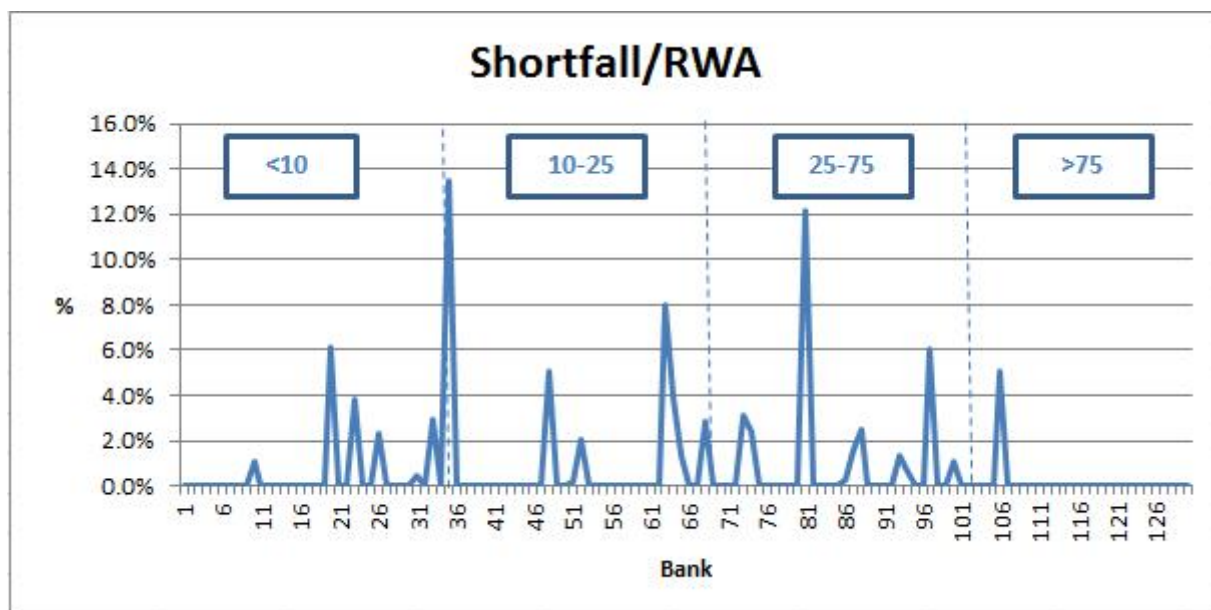


Figure B.1: Full-sample Shortfall/RWA at bank-level (%)

Moreover, by dividing shortfall by the amount of RWA and sorting by RWA, there is a natural inclination for banks with smaller RWA to showcase a larger shortfall. However, a closer inspection of the data reveals that the largest bank with a positive shortfall in the sample with $RWA < \text{€}10$ million has a value of 13.48%. However, the bank corresponding to the same position in the sample $\text{€}10 \text{ million} < RWA < \text{€}25$ million has a value of 1.34%. The latter is hence one order of magnitude less than the one from the smaller RWA sample. While this is only based on a single observation, this highlights the high amount of heterogeneity in the segmentation of the samples.

We now try our hand at reproducing the results of the ECB. We use two methods. The first (SUM/SUM) consists of summing up the shortfalls across the banks in each group and then dividing by total RWA. The second (AVG) computes the shortfalls per bank and averages them up. Depending on which method we choose, we observe a wider discrepancy with the (ECB) results at each end of the spectrum. As shown in Figure B.2, the first method replicates the ECB results perfectly for the small group and almost exactly for the mid-sized group of banks²¹. However, it

²¹Bearing in mind the value for the ECB series are taken as is from the original graph in Figure 5 not accounting for rounding errors.

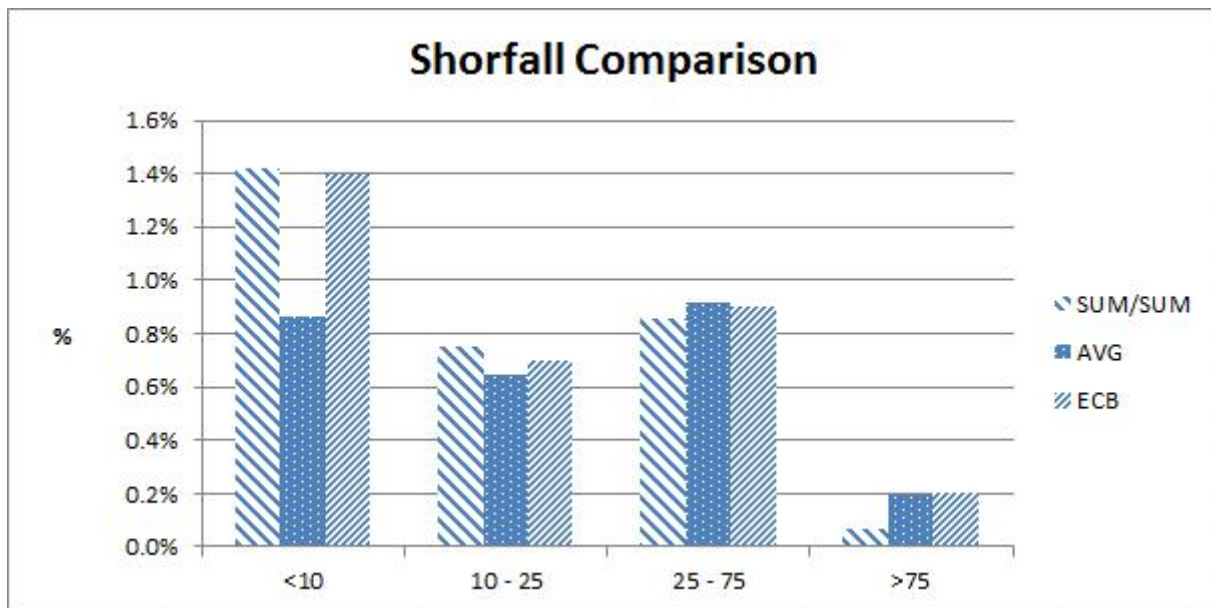


Figure B.2: Full-Sample Shortfall/RWA at bank-level using original sample size (%)

underestimates the value for the sample $>€75$ million. The second method displays exactly the opposite behavior. This seems to suggest that different calculations methodologies were applied for different samples.

The latter assumption would appear reasonable when observing that the highest group in Figure B.1 only contains one bank with a positive shortfall. This means that the categorization only aims at harmonizing the number of banks across the samples rather than the number of shortfalls which would seem more appropriate. To prove this point we try to harmonize the RWA size and create a €50 million category instead of the €75 million. In this case we see that there is clearly no relationship between the shortfall and RWA irrespective of the method used.

We now conduct the same analysis using only the sorted list of banks which experienced a shortfall. As can be seen from Figure B.4, there is clearly no association between size and the level of shortfall. While the sample sizes now become clearly unbalanced, the results in Figure B.5 show a U-shape function related to shortfall versus RWA. This again disappears when using the new category of €50 million (Figure B.6). As a result, we expect size not to have any impact on changes in capital.

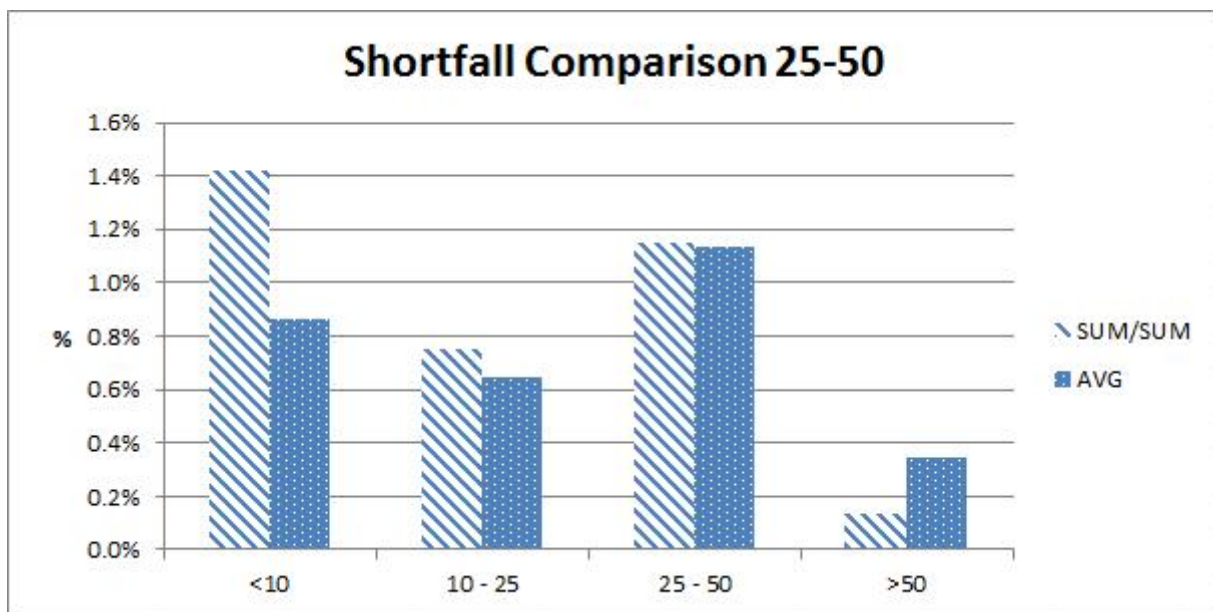


Figure B.3: Full-Sample Shortfall/RWA at bank-level using new sample size (%)

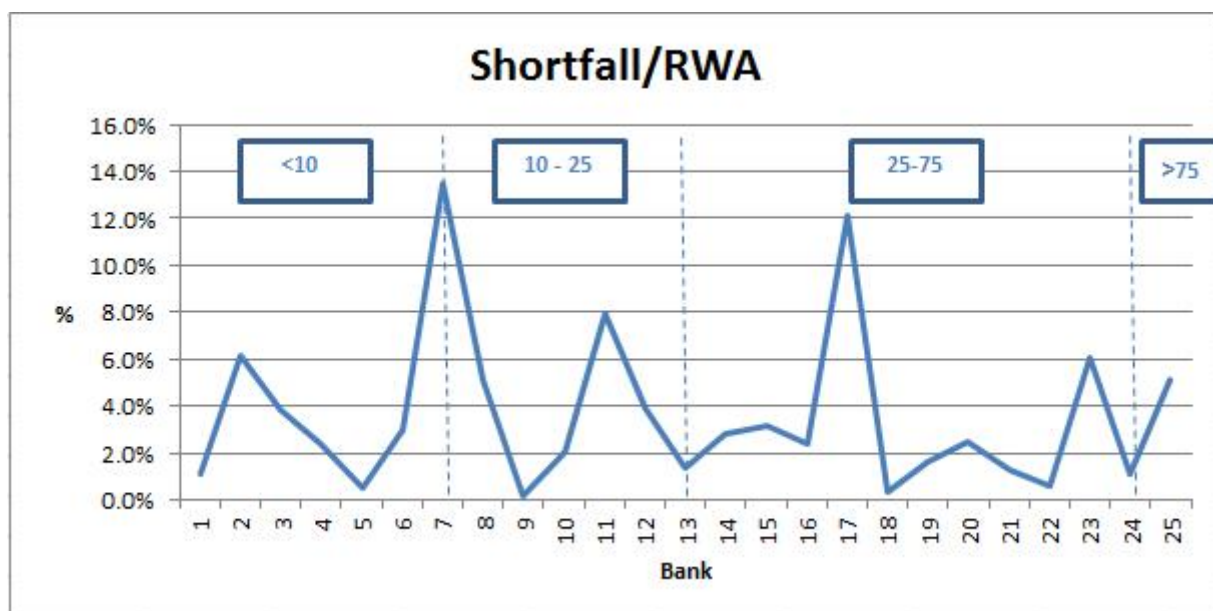


Figure B.4: Shortfall-sample Shortfall/RWA at bank-level (%)

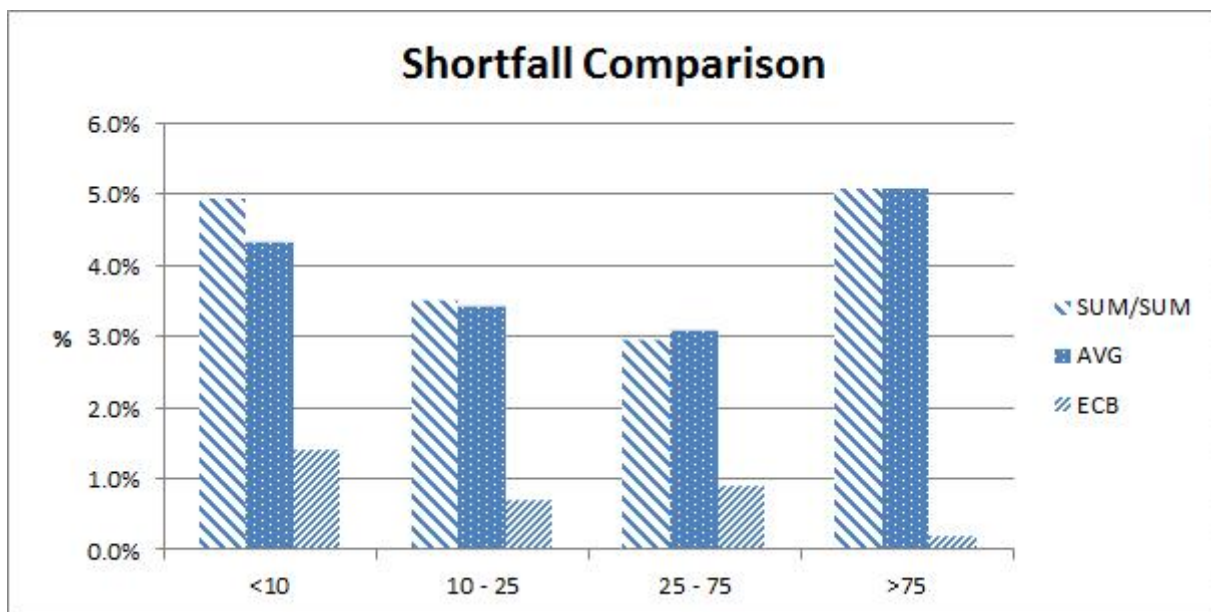


Figure B.5: Shortfall-Sample Shortfall/RWA at bank-level using original sample size (%)

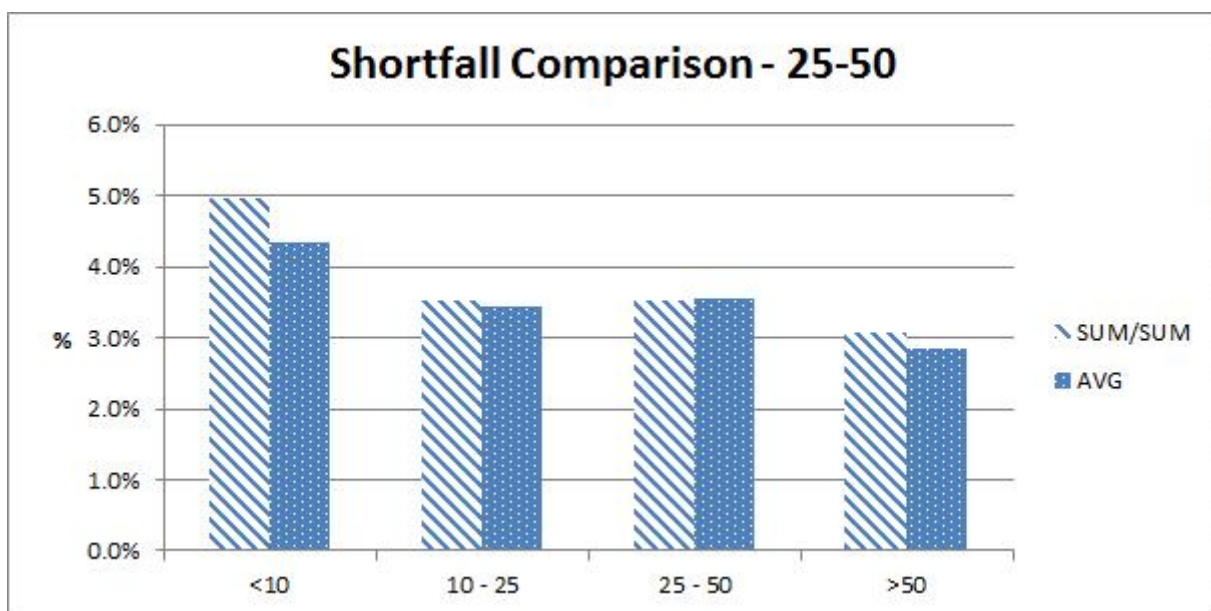


Figure B.6: Shortfall-Sample Shortfall/RWA at bank-level using new sample size (%)

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