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a macroprudentially coherent approach

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INTEGRATING STRESS TESTS WITHIN THE BASEL III CAPITAL FRAMEWORK: A MACROPRUDENTIALY COHERENT APPROACH

by Pierluigi Bologna¹ and Anatoli Segura²

Abstract

In the post-crisis era banks' capital adequacy is established by the Basel III capital standards and, in many jurisdictions, also by supervisory stress tests. In this paper we first describe the ways in which supervisory stress tests can supplement the risk-based capital framework of Basel III and how this could be codified with a stress test buffer. We then argue that in order to ensure coherence with the macroprudential objectives of Basel III, the severity of supervisory stress tests should be procyclical. In addition, to increase the transparency and predictability of the overall capital framework, severity choices should follow a constrained discretion approach based on a simple rule. Finally, we analyze supervisory stress testing practices across some jurisdictions and find that while the United States and the UK frameworks are in line with some of the elements of our proposal, including most notably the need for procyclical severity, this is not the case in the euro area.

JEL Classification: G21, G28.

Keywords: stress test, capital regulation, macroprudential policy.

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1. Introduction¹

The years preceding the 2007-09 crisis exhibited significant expansions in the balance sheets of financial intermediaries. At the peak of the cycle in August 2007 the financial system was highly levered and funded by very short maturity debt. These two elements led to a rapid propagation throughout the whole system of the initial losses associated with subprime assets which were further amplified by systemic deleverage and fire sales (Brunnermeier, 2009, Gorton and Metrick, 2010 and 2012). When the Lehman collapse in September 2008 put the global financial system on the eve of default, public authorities were forced to take an unprecedented set of measures to support financial markets and institutions. The explicit costs to tax payers of the bail-out of a substantial portion of the banking system, as well as the implicit costs stemming from the inability of financially impaired banks to properly perform their vital role for the economy as credit intermediaries, gave policy makers the necessary push to undertake a major regulatory reform.

Motivating some of the elements of this reform is the macroprudential objective of enhancing financial stability and reducing the volatility of the financial cycle. A central tool to achieve this is the Basel III capital framework which, in addition to increasing the quality and quantity of minimum regulatory capital, also requires banks to hold some capital buffers that should be built during expansions and used during downturns. The time-varying nature of these buffers is intended to serve the macroprudential objective in two ways. First, during downturns it will provide a cushion to absorb losses without the need for systemic deleverage, thereby improving the resilience of the financial system as a whole and reducing the probability of a credit crunch. Second, during booms when financial fragilities are built up (Minski, 1982, Guttentag and Herring, 1986, Kindleberger, 2000, Borio and Drehman, 2009) it will help mitigate excessive credit growth.

Another important element of the new policy toolkit is the system-wide stress tests conducted by most supervisory authorities on a regular basis. The stress tests assess the resilience of individual banks to an adverse macroeconomic shock and as such play a role in the supervisory assessment of banks' capital adequacy. Importantly, however, supervisory stress tests are seen as a tool to assess and strengthen not only the resilience of individual institutions but also that of the banking sector as a whole. Supervisors have in fact praised the potential of stress tests as a tool to enhance the macroprudential approach to banking supervision (Constancio, 2015). A vast amount of research capabilities at central banks is being devoted to improve the stress tests' analytical frameworks so

¹ The authors would like to thank Francesco Columba, Dimitri Demekas, Alessio De Vincenzo, Antonio Di Cesare, Rochelle Edge, Antonella Foglia, Giorgio Gobbi, Javier Suarez, Fabrizio Venditti, and Silvia Vori for useful discussions and comments, as well as Diana Rocco for editorial assistance. The views expressed here are those of the authors and should not be attributed to the Bank of Italy. The authors retain all responsibility for any errors or omissions.

that they are able to capture systemic externalities – notably stemming from illiquidity spillovers and contagion through interconnected networks – and the feedback effects both within the banking sector and between it and the rest of the economy in stress situations (Bookstaber et al., 2014, and Demekas, 2015).

However, as recently emphasized by Dudley (2015), the efficient use of the new set of macroprudential instruments requires developing a coherent macroprudential framework that takes into account how the instruments interact with each other, and with the existing microprudential instruments. This call for “macroprudential coherence” also applies to the integration of the capital requirements arising from the supervisory stress tests with those of Pillar 1 of Basel III. Putting the problem in an overly extreme form: if at a particular point of the cycle supervisory stress tests are too lax relative to the resilience level implied by Basel III requirements at that time, they become irrelevant and do not impose additional capital needs; if stress tests are too severe the Basel III capital requirements become redundant, as banks’ capital needs are driven by the objective to ensure resilience to the shock embedded in the stress test.

The objective of this paper is twofold. We first describe the ways in which supervisory stress tests can supplement the risk-based capital framework of Basel III. For implementation purposes, we propose transparently codifying this contribution with the definition of a new capital buffer that adds to those in Basel III Pillar 1, and that depends on each bank’s stress test losses.² Then, we analyze the elements of a supervisory stress test framework that are needed to guarantee that the resulting capital requirements are transparent, predictable and coherent with the macroprudential objectives of Basel III. Our main findings are:

- **Simple and robust measures for the severity of stress tests** should be used. The use of severity measures based on the comparison of adverse scenarios to the outcomes in the most severe past crises should be favoured over more complex probabilistic severity measures.
- **The stress tests should have a procyclical severity**, meaning that severity should increase during expansions and decrease during downturns. The resulting capital requirements faced by banks will exhibit a variation along the cycle consistent with that intended by Basel III, while at the same time ensuring that banks more exposed to systemic risk be subject to higher capital requirements.
- **A constrained discretion approach to the setting of the severity of stress tests** should be adopted and effectively communicated. This approach will increase the predictability of the overall capital requirements and avoid inaction bias from supervisors. Indicators used to

² For some banks the new capital buffer could be associated with a commensurate reduction of Pillar 2 requirements, to the extent that these are motivated by the same risk exposures captured in the stress test.

calibrate the Countercyclical Capital Buffer (CCyB) could contribute to index the severity of the stress test.

Finally, we compare our main recommendations for supervisory stress testing to the current practices in the US, the UK and the euro area. While the stress testing frameworks in both the US and UK share some of our proposals, including notably the procyclicality of stress test severity, supervisory stress tests in the euro area fail to do so. Indeed, there is at present no complete supervisory stress testing framework at the euro-area level, where the capital implications of stress tests seem to be decided on an ad-hoc basis. We think it is necessary that the European Central Bank (ECB) establishes such a supervisory stress testing framework and that it does so in a way that takes into account the importance of macroprudential coherence of the overall capital framework. This requires, among other things, that the severity of the domestic components of the stress test scenario takes into account the different positions in the financial and business cycles of euro-area Member States.

The rest of this paper is structured as follows. Section 2 reviews the principles of bank capital regulation, both from the traditional microprudential perspective and from the more recent macroprudential perspective. Section 3 describes the capital framework of Basel III and briefly reviews the history of stress testing. Section 4 describes how stress tests can be used to supplement the Pillar 1 capital requirements of Basel III with a bank specific buffer that measures the additional capital necessary to ensure banks' resilience against the materialization of the systemic risk sources deemed most relevant by the supervisor. Section 5 argues that in order to ensure that the overall resulting framework is macroprudentially coherent the severity of stress tests should follow a predictable procyclical pattern. Section 6 critically discusses through the lens of our main findings the approaches to stress testing in the US, UK and euro area. Section 7 concludes.

2. The rationale for microprudential and macroprudential bank capital regulation

Banks play two crucial economic roles. First, they provide liquidity and payment services to their customers through the issuance of demand deposits and other money-like short term debt securities. Second, they grant loans to firms and households. The performance of these two activities creates a maturity mismatch in bank balance sheets that exposes them to self-fulfilling panics in which investors withdraw their funds because they fear others will do the same (Diamond and Dybvig, 1984). This fragility has historically led to the introduction of deposit insurance in most jurisdictions. However, deposit insurance distorts banks' privately optimal capital choices, providing the starting point for microprudential bank capital regulation. More generally, the

insolvency of a bank generates costs that go beyond those directly faced by the deposit insurer and that are not properly internalized by bank shareholders,³ and may raise concerns about the strength of other intermediaries, prompting a fast contagion throughout the banking sector.⁴ Bank capital serves as a buffer to reduce the likelihood of, and the expected social costs associated with, a bank's default.

The microprudential approach to bank capital regulation is focused on limiting each bank's risk of insolvency. A draconian way to achieve this would be a 100 per cent capital requirement, thereby eliminating insolvency risk. But this capital requirement would in turn eliminate banks' ability to create liquidity, which is one of their essential economic roles. The socially optimal level of regulatory capital requirements thus balances the social value of permitting banks to "create liquidity" with the expected social costs associated with the possibility that banks default.

In addition to microprudential regulation, the recent financial crisis has brought a consensus among policy makers and academics about the need for a broader macroprudential approach to bank capital regulation that explicitly takes into account how capital requirements may affect the performance of the overall economy along the business cycle (Financial Stability Forum, 2009, Bank of England, 2009, Brunnermeier et al., 2009). In particular, macroprudential regulation is concerned with the procyclicality that may be generated by microprudential regulation that focuses on banks in isolation. To illustrate the procyclicality problem suppose that an economy enters a recession. As banks suffer losses their equity base shrinks and their capital ratios decrease. This brings banks closer to their minimum capital requirements so that in order to grant new loans they may need to issue more capital. However, capital issuances in the midst of a recession might be very costly due to informational asymmetries (Myers and Majluf, 1984) and to the presence of debt overhang problems (Myers, 1977). As a result, banks may instead find it optimal to respond by curtailing new loans. The aggregate reduction in the supply of loans may push the economy into a "credit crunch" that further aggravates the initial recession, and may lead to several rounds of knock-on effects between the banking sector and the rest of the economy. To counter the endogenous amplification of negative shocks and reduce the probability of a credit crunch, macroprudential regulators should reduce capital requirements in recessions thereby allowing banks to fund more loans for a given level of capital. Let us highlight that only a system-wide perspective

³ For example, firms relying on bank loans may see their funding withdrawn, reducing their ability to undertake new investment opportunities or to finance their working capital.

⁴ Indeed, the negative externalities associated with the financial distress of a bank have frequently led governments to bail out banks. Bailouts avoid the social cost of bank defaults but induce other distortions: ex-post they lead to important increases in sovereign debt which might constitute an additional source of distress to the banks and the economy, the recent European sovereign debt crisis being a clear example of this; ex-ante they create moral hazard that encourages banks to engage in excessive risk taking, making the need for government bailouts even more likely.

in which the regulator takes into account the macroeconomic effects of banks' actions would recognize the need to reduce capital requirements in a downturn. Indeed, in a riskier recessionary environment a microprudential supervisor that looks at banks in isolation would be tempted to increase capital requirements.⁵

Of course, if bank capital requirements are to be reduced to avoid a credit crunch in a downturn, regulation has to ensure that banks increase their capital during expansions so that they have a capital buffer to use when the cycle switches. The introduction of countercyclical capital requirements hence gives banks an adjustment margin to withstand losses during recessions and enhances their ability to continue supplying credit in those episodes.

In addition, the build up of countercyclical capital buffers in the upswing of the credit and business cycles reduces banks' incentives to keep on expanding credit, and may serve as well the macroprudential purpose of dampening the excessive volatility of the credit cycle and reducing the social costs associated with it. As emphasized by the recent academic literature on socially optimal countercyclical capital requirements (Repullo, 2013, Malherbe, 2015), the time variation of capital requirements leads to a time variation in the level of resilience required to banks: in expansions, when capital can be increased more easily, banks should be required to operate with a higher level of resilience than in downturns, when capital is depleted as losses materialize.

3. Basel III and stress testing

In the aftermath of the crisis an important regulatory reform of the financial sector was undertaken. In particular, the reform has led to substantial changes in banks' regulatory capital framework. Moreover, a macroprudential approach aimed at promoting a more stable contribution by the financial sector to economic growth has gained ground. In this Section we briefly review the two most important tools used by supervisors to set banks' capital requirements in the post-crisis era: the Basel III capital framework and stress tests.

3.1. The Basel III capital framework

The financial crisis exposed that the capital held by banks, and its loss-absorbing capacity, was largely insufficient to meet the losses generated by that episode. Since then, authorities at the global

⁵ This is for example what happens with the time invariant regulatory capital ratios of Basel II: since the risk-weights associated to banks' assets increase in recessions, banks need more capital in order to satisfy the (fixed) regulatory capital ratio.

level have established more stringent capital requirements for banks (Basel Committee on Banking Supervision, 2011). The new internationally agreed-upon standards, commonly referred to as Basel III,⁶ are currently being implemented, with a phase-in period which will extend to January 2019 for some of the requirements.⁷

The Basel III capital standards include two important differences vis-à-vis the Basel II framework. First, the quantity and quality of hard minimum capital requirements that must be satisfied by all banks at all times have been substantially increased to improve banks' loss absorbing capacity and to enhance creditor confidence that their claims are more likely to be repaid in full even if a resolution occurs.⁸ This in turn should reduce creditors' incentives to run on a bank and increase the probability that a bank may recover without intervention or, should the intervention be unavoidable, provide the resolution authority with more time to organize the proper wind-down of the bank.

Second, it includes three additional capital buffers over and above the minimum requirements. Two of these buffers – the Capital Conservation Buffer (CCoB) and the CCyB – have a system-wide scope and can be used to absorb losses during stress periods. The time variation of these buffers is intended to serve the broad macroprudential objectives of improving systemic stability and smoothing the financial cycle. The third buffer, the G-SII buffer, applies to the banks judged by the Financial Stability Board to be globally systemic and aims at setting a higher resilience standard for banks whose failure would be especially disruptive to the financial system.⁹

3.2. Stress testing: from the crib to the supervisors' toolkit

Stress testing comprises a range of techniques to assess the resilience of an institution or a system under adverse conditions. In the financial sector, the history of stress tests dates back to the 1980s when banks and regulators started to assess the performance of individual portfolios or the resilience of individual institutions to some specific negative shock. These stress tests were initially

⁶ In addition to capital, Basel III introduces two new liquidity requirements, the Liquidity Coverage Ratio and the Net Stable Funding Ratio, whose purpose is to limit banks' maturity and liquidity transformation.

⁷ The Basel III standards were transposed into EU law through the Capital Requirements Directive (CRD IV) on 17 July 2013, and adopted as a regulation by all three federal bank supervisory agencies in the US on July 2013. CRD IV introduced two more capital buffers in addition to those foreseen by Basel III (i.e. the O-SII buffer and the Systemic risk buffer).

⁸ In the Basel III framework the minimum Common Equity Tier 1 ratio (CET 1) is 4.5 per cent of risk weighted assets (up from 2 per cent in Basel II), the minimum Tier 1 ratio is 6 per cent of risk weighted assets (up from 4 per cent in Basel II), and the minimum Tier 1 + Tier 2 ratio is 8 per cent of risk weighted assets (as in Basel II).

⁹ The three buffers have to be met with CET 1 instruments. At full implementation the CCoB will amount to 2.5 per cent of risk weighted assets while the CCyB is set on a quarterly basis from 0 to 2.5 per cent depending on the phase of the credit cycle relative to its trend. The G-SII buffer ranges from 1 to 2.5 per cent of risk weighted assets depending on the risk bucket to which each G-SII is assigned according to the methodology for estimating its systemic relevance.

used as a risk management tool and focused only on some risks in isolation, notably interest rate or credit risk within the trading book. System wide stress tests were introduced in 1999 by the IMF under the aegis of the Financial Sector Assessment Program (FSAP). Unlike earlier stress tests, FSAP stress tests have a financial stability perspective and assess the resilience of the system to a joint set of risks, notably including credit, interest and exchange rate risk (Blaschke et al., 2001).

The financial crisis dramatically altered the history of stress tests, providing a boost to their development. In early 2009, the Federal Reserve conducted the Supervisory Capital Assessment Program (SCAP), a major stress testing exercise intended to reduce information asymmetry and to measure the recapitalization needs of the largest US bank holding companies (BHCs).¹⁰ The US federal supervisors, in collaboration with the BHCs, estimated losses on the banking books and trading books under two hypothetical scenarios, “baseline” and “more adverse”, that included alternative paths designed by the regulators for real GDP growth, unemployment rate, and house prices. The individual results of the stress test were disclosed and ten of the banks experienced a capital shortfall with respect to the test’s hurdle rate and were required to raise additional capital (Federal Reserve Board, 2009).

A similar initiative took place in the EU where in the spring of 2009 the ECOFIN mandated the Committee of European Banking Supervisors (the predecessor of the European Banking Authority, EBA) to coordinate, in cooperation with the European Commission and the ECB, the first EU-wide stress test for 22 major European banking groups (Committee of European Banking Supervisors, 2009). Further tests were then conducted in 2010 and 2011, in the midst of the sovereign debt crisis (Committee of European Banking Supervisors, 2010, and European Banking Authority, 2011).

The SCAP stress tests were perceived as crucial – in conjunction with the Troubled Assets Relief Program – in re-establishing confidence in the US financial sector.¹¹ This success has contributed to the adoption in many jurisdictions of supervisory (system-wide) stress testing as part of the new policy toolkit after the crisis. In the US and UK supervisory stress tests of the largest banking institutions are now mandatory and run with an annual frequency, and their results are used to require banks to strengthen their capital position, if needed. Although in the euro area a policy framework regarding supervisory stress testing has not yet been defined, stress tests are also conducted with regularity. In particular, in preparation for the operational start of the Single Supervisory Mechanism (SSM) in the euro area in November 2014, the EBA conducted – in close cooperation with the national authorities and the ECB – an EU-wide stress test of 123 banks

¹⁰ The SCAP covered the 19 BHCs with consolidated assets above \$100 billion.

¹¹ In contrast, the EU stress tests during the financial and sovereign debt crises were not able to reestablish confidence in the EU banking system. Some authors have argued that this failure was due to the absence of a credible public backstop for banks with a capital shortfall (Kashyap et al., 2011) and to a lax approach to stressing sovereign debt exposures (Schuerman, 2014).

(European Banking Authority, 2014, and European Central Bank, 2014) following which the banks not satisfying the hurdle rate were required to cover their capital shortfall. Another EU-wide stress test (without a pass/fail threshold) has been conducted in 2016 on a smaller sample of 51 EU banks (European Banking Authority, 2016a).

4. Basel framework and supervisory stress tests: why two instruments to set capital requirements?

With both the Basel III capital framework and the system-wide stress test available to assess banks' capital adequacy a natural question arises: are both instruments necessary? In the first part of this Section we address this question and discuss how stress tests may supplement the risk-based capital framework of Basel III. We then argue that a transparent way to implement this contribution is with the introduction of a new capital buffer that adds to those in Basel III Pillar 1, and that is based on each bank's stress test losses.

4.1. Portfolio invariance of the Basel framework and stress tests

The objective of the capital requirements imposed by both Basel II/III frameworks and supervisory stress tests is to ensure that banks have sufficient loss absorbing capacity to withstand unexpected large negative shocks. Yet, the two instruments do so in a very different form conceptually. The general principle in the Basel risk-based capital requirements is that for every risk exposure, banks should hold enough capital to cover the losses associated with such exposure with a sufficiently large probability. The riskiness of each asset, and hence its associated capital requirement, is based on an estimation of the asset's loss distribution. The overall capital requirement faced by the bank is then the sum of the individual assets' risk-based capital requirements. As argued by Wall (2013), the Basel risk-based capital requirements can be construed as the result of conducting an independent sequence of stress tests of the same severity to each of the assets in a bank's balance sheet. A particularly helpful property for operational purposes of the Basel capital charges is portfolio-invariance, meaning that the capital requirement for each asset depends only on the asset's own characteristics, and not on the rest of the bank's portfolio.¹² A portfolio-invariant capital framework reduces operational and reporting requirements for banks, and makes it simpler to manage both for banks and supervisors. It also makes the capital needs

¹² An exception in this regard are the market risk capital requirements that, when computed with internal value-at-risk models, do account for correlation within the portfolio.

associated with banks' daily operations more transparent, which streamlines the capital allocation decisions within the different activities of the bank.

An important shortcoming of the portfolio-invariance design is its inability to identify fragilities arising from common tail events and interconnections, which, as the financial crisis has underscored, may be a material source of risk for single institutions and for the entire system.¹³ Supervisory stress tests are a suitable instrument to address this crucial fault line. In a system-wide stress test exercise, supervisors assess the capital adequacy of the banks by estimating the losses they would suffer under an appropriately designed adverse economic scenario. This approach supplements the weaknesses of risk-based capital requirements in two (related) fundamental dimensions.

First, at the bank level the entire balance sheet is assessed under the set of negative shocks defining the adverse macroeconomic scenario, which captures the effect of correlated exposures within the institution and provides a firm-wide view of the effects of the risks deemed more relevant by the supervisor. The contribution of stress tests along this dimension is essentially microprudential. As previously noted, although both banks and supervisors ran stress tests prior to the crisis, these were typically limited to particular risks or portfolios in isolation and hence could not be integrated into a comprehensive view across credit, market and liquidity risks of the various business lines of the banks. For example, in the run-up to the crisis, a firm-wide view may have been able to uncover the inconsistencies in the risk perceptions about US subprime mortgages between retail lenders, which in some cases were reducing new issuances of these loans, and traders, who were increasing their exposures to securities backed by these same loans.

Second, all banks are evaluated under the same adverse economic scenario, which allows to measure the effect of correlated exposures across banks and to capture the negative feedbacks between the banking sector and the rest of the economy. The contribution of supervisory stress tests along this dimension has a macroprudential perspective: it may allow supervisors to identify situations in which the common exposures of banks are such that an initial negative shock gets amplified, leading to several waves of knock-on effects between the banking sector and the rest of the economy.¹⁴ In order to properly capture the spillovers generated by the banking system during crisis episodes, the stress testing models need to incorporate some key additional elements. These

¹³ The Basel portfolio-invariant capital requirements are able to capture correlations across asset returns only under restrictive assumptions on their distribution, such as those of the single systematic risk factor model in Gordy (2003).

¹⁴ According to Wall (2013), the system-wide coverage of supervisory stress tests may address another shortcoming of the Basel risk-based capital requirements, namely that of downward risk biases due to bank modeling choice. The comprehensiveness of supervisory stress tests renders results comparable across banks which could help identify and correct those biases. This contribution of supervisory stress tests to the Basel framework could be interpreted as microprudential.

include accounting for the effects of banks' fire sales and refinancing problems, which constitute significant levers of distress within the banking sector during crises (Greenlaw et al., 2012, Bernanke, 2013, Tarullo, 2014). In addition, stress tests should include a bank lending channel that accounts for the feedback between the banking sector and the real economy as banks' capital position gets eroded along the stress test horizon. Since the onset of the crisis, stress testing modelling techniques have improved and currently allow to capture some equilibrium effects of the dynamics of crisis episodes.¹⁵ However, further work is still necessary to fully achieve this objective (for an account of the most important dimensions still to be developed, see Demekas, 2015).

The "partial" stress tests conducted by banks and supervisors prior to the crisis were part of the Pillar 2 supervisory review process of the Basel II accords. Pillar 2 is aimed at ensuring that banks have adequate capital to support all their business risks and addresses the fragilities not fully captured by the risk-based capital requirements of Pillar 1 (Basel Committee on Banking Supervision, 2006). The last crisis reinforced how important it is that banks integrate a firm-wide risk-management framework to their capital planning. Moreover, the supplemental guidance to the Pillar 2 framework emphasizes the responsibility given to supervisors in ensuring this (Basel Committee on Banking Supervision, 2009). The accelerated transition from partial stress tests to supervisory stress tests can hence be viewed as a natural response within the two-pillar capital framework to address the weaknesses uncovered in the crisis.

4.2. Integrating stress tests in the Basel macroprudential framework: the Stress Test Buffer

To integrate supervisory stress tests in the Basel III framework we propose introducing a new bank-specific capital requirement, that we call the *Stress Test Buffer (STB)*. This buffer would be additional to the other capital requirements banks face under Pillar 1 of the Basel framework and, consistent with our discussion above, its purpose is to ensure that the overall capital requirements faced by each bank are sufficient to withstand as a going concern a macroeconomic adverse scenario. More precisely, to compute the STB we first partition the set of Basel III capital buffers into two classes, depending on whether the buffers can be used to absorb the losses resulting from

¹⁵ Examples of models that capture the interaction of solvency and liquidity shocks are the RAMSI model and its extensions developed by the Bank of England (Alessandri et al., 2009, Aikman et al., 2009, Kapadia et al., 2012) and the ARNIE model of the Oesterreichische Nationalbank (Feldkircher et al., 2013, Pühr and Schmitz, 2013). The MFRAF model developed by the Bank of Canada also captures network spillovers from counterparty risk in the interbank market (Anand et al., 2014). Finally, the Bank of Japan and the Bank of Korea have developed models capable of capturing some macro feedback effects (Bank of Korea, 2012, Kitamura et al., 2014).

the exercise (*usable buffer*) or not (*non-usable buffer*). This partition is consistent with the intended objectives of each buffer. This means that the CCoB and the CCyB, introduced to augment the loss-absorbing capacity of banks during recessions, should be considered usable buffers during stress periods and “for stress test purposes.” In contrast, the G-SII buffer and the O-SII buffer in Europe, introduced to increase the resilience of institutions whose failure would be disruptive for the financial system, should be considered non-usable buffers. Then, we define the stress test hurdle rate as the sum of the hard minimum capital requirement and the bank-specific non-usable buffers.¹⁶ Finally, for each bank the losses resulting from the supervisory stress test (ST losses) are compared to its usable capital buffers. If the latter exceed the former, the bank has sufficient loss absorbing capacity to withstand the adverse economic scenario, and the STB is set to zero. Otherwise, the STB is equal to the difference between the two, so that by construction the sum of the usable buffers and the STB is sufficient to absorb the ST losses should the adverse scenario materialize. In more formal terms:

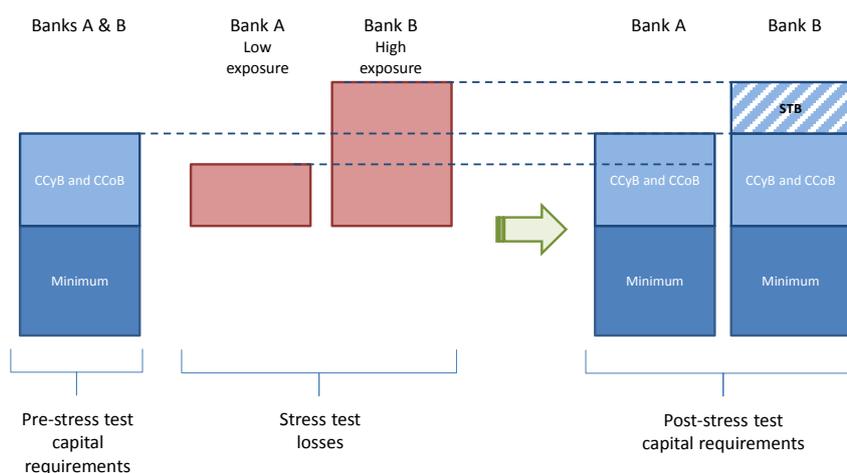
$$STB = \max \left\{ \frac{ST \text{ losses}}{Risk \text{ Weighted Assets}} - (CCoB + CCyB), 0 \right\}$$

In Figure 1 we illustrate, in a stylized example, how the STB would be calculated in practice and how it would add to the Basel III Pillar 1 capital requirements. We show two hypothetical banks, A and B, that are required to hold some hard minimum capital requirement and two usable buffers, a CCoB and a CCyB. For simplicity we assume that neither of the two banks is subject to a non-usable buffer requirement. Hence, for both banks the hurdle rate in the stress test coincides with the minimum capital requirement. As a result of the stress test each bank experiences some losses depending on its exposure to the adverse scenario. Let’s assume that, on one hand, Bank A exhibits a low risk exposure so that the estimated ST losses are low. In this case they can be fully absorbed by the usable buffers and as a consequence the STB is zero. For Bank B, on the other hand, we assume a high risk exposure so that the ST losses are larger than its usable buffers. In this case the STB, defined as the difference between the bank’s stress test losses and its usable buffers, is positive and increases the capital requirements faced by Bank B. The STB for Bank B ensures that the bank has enough capital to be able to withstand the adverse macroeconomic scenario without breaching the Basel III minimum capital requirements.

It is important to note that the STB is defined with respect to the Basel III capital requirements the bank is subject to and not with respect to the actual level of the bank’s capital, which might include a voluntary buffer held on top of the overall capital requirements. Although the existence,

¹⁶ Note that this implies that the hurdle rate might differ among banks based on the level of the bank-specific requirements for the non-usable buffer.

Figure 1. Defining the Stress Test Buffer (STB): a stylized example



The figure illustrates how the Stress Test Buffer is obtained from the difference between the stress test losses experienced by the bank and the overall buffers it holds that can be used to absorb losses in the exercise (the CCyB and CCoB in the example). Bank A and Bank B represent two institutions whose exposure to the stress test adverse scenario is low and high, respectively.

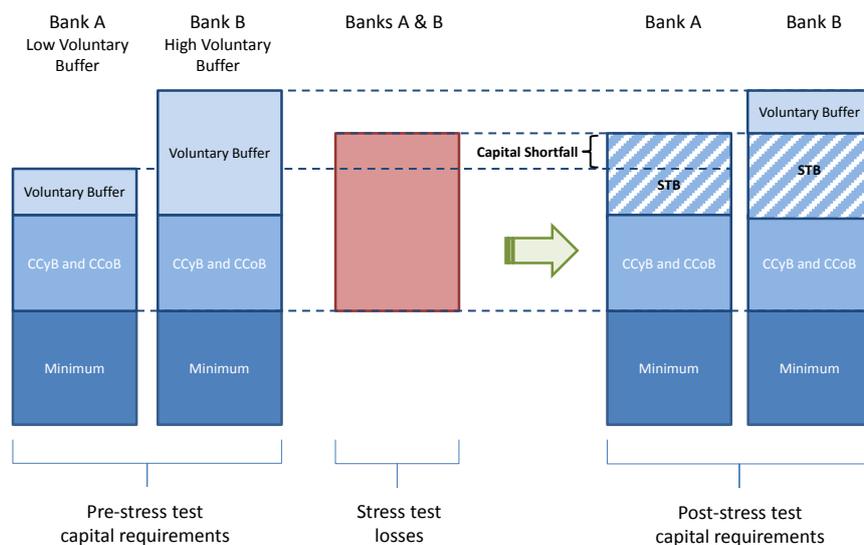
if any, of a voluntary buffer does not affect the computation of the STB, it might affect how a bank would cover the additional capital requirements associated with a positive STB. Indeed, as illustrated in Figure 2, any positive STB could be covered with a commensurate reduction in any voluntary buffer held before the stress test and only if the STB were larger than such voluntary buffer, would the bank suffer an actual capital shortfall requiring it to raise new capital.¹⁷

Our proposal to introduce an STB requirement to implement the outcome of supervisory stress tests into the Basel framework differs from the approach typically taken by supervisors in most jurisdictions in which the stress test results are presented in terms of a bank's capital shortfall, i.e. the amount of new capital a bank has to raise in order to satisfy the hurdle rate of the stress test. While different, a capital shortfall and the STB are closely interlinked: a stress test identifies a capital shortfall for some bank when its required STB is larger than the voluntary buffer held by the bank prior to the exercise, and in this case the capital shortfall amounts to the difference between the two.

In order to integrate supervisory stress testing in the Basel III framework, the STB has several advantages over the capital shortfall measure currently used by supervisors. First, it allows market participants to understand whether a potential capital shortfall is due to a high exposure to the adverse scenario, which results in a large STB, or to a low pre-test voluntary buffer. Second, even if a bank does not experience a capital shortfall as a result of the stress test, a positive STB would

¹⁷ Note that the availability of a voluntary (pre-stress test) buffer provides flexibility in using it to comply with a positive STB requirement, without precluding the bank from raising new capital should it choose to keep the level of the voluntary buffer constant.

Figure 2. Illustration of the relationship between voluntary buffer, Stress Test Buffer (STB) and capital shortfall



The figure illustrates the relationship between a bank's pre-stress test voluntary buffer, and its post-stress test STB, voluntary buffer and capital shortfall. Bank A and Bank B represent two institutions whose voluntary buffer prior to the stress test is low and high, respectively.

indicate to market participants that a fraction of the pre-test voluntary buffer is a mandatory capital requirement after the stress test. Last but not least, the STB codifies the capital implications of supervisory stress tests in the language of capital requirements shared by the Basel framework, thereby enhancing transparency.

5. Ensuring macroprudential coherence: implications for supervisory stress testing

Bank capital is a cushion that protects debt holders against losses. As discussed in Section 2, requiring banks to hold some minimum levels of capital can be interpreted as requiring them to operate under sufficient levels of resilience. When a capital framework uses several instruments to set the appropriate level of capital for each bank it is of the maximum practical importance that each single instrument be calibrated in a way that is consistent with the level of bank resilience intended by the overall framework. This in particular applies to the use of supervisory stress testing to effectively supplement Basel III micro and – most importantly – macroprudential capital requirements. Since Basel III instruments have been “already calibrated” the remaining task is to properly calibrate stress tests. When doing so, stress testing should not be intended to structurally

increase or change the overall “level of bank resilience” foreseen by the Basel framework;¹⁸ rather it should complement the Basel framework by addressing the risks not already captured by the Basel capital requirements. With the calibration of a stress test being virtually the same as the choice of its severity, we get to the most important question this paper addresses: how severe should supervisory stress tests be to supplement Basel III capital standards in a coherent way along the cycle?

5.1. The severity of stress tests

The question of “how severe stress tests should be” calls for the need to answer the more simple question of “how severe a stress test is,” or, in other words, the existence of a measure of stress test severity. Although a first notion of stress test severity simply ties severity to how negative or harsh the adverse macroeconomic scenario constituting the input of the exercise is, developing a rigorous severity measure is a non-trivial task.

So far, supervisors and practitioners have relied on two methodologies to measure the severity of a stress test. The first links the severity of a scenario to the likelihood of its materialization, which captures the idea that the more severe a scenario is the less likely it should be that it occurs. Using this methodology, in an initial stage a forecasting model for the macroeconomic variables is estimated and a baseline forecast is constructed. With the help of the macroeconomic model a “distance” measure between a specific scenario and the baseline forecast can be defined. This distance captures the likelihood of the scenario taking into account correlations among variables and gives rise to a natural notion of scenario severity (see Breuer et al., 2009, 2012, and Breuer and Csiszar, 2013).¹⁹

An alternative approach to measure the severity of an adverse scenario consists in comparing the evolution of the most relevant variables in the scenario to that observed in some benchmark past recession. For example, for the measurement of the severity of scenarios in US stress tests Yuen (2015) proposes focusing on four of the scenario variables, namely on GDP growth, unemployment rate, stock price index, and house price index, and to each of them assign a 100 per cent severity weight if its average quarterly change in the nine quarters of the exercise is above that observed in a nine quarter interval starting in the 2008 recession, a zero per cent severity weight if the average

¹⁸ As confirmed by the G20 meeting in Shanghai (G20, 2016) there is currently a consensus among politicians and policymakers that the overall level of capital requirements in Basel III should not be significantly increased and that the focus should be on ensuring coherence of the framework.

¹⁹ In the above mentioned papers the authors also propose the following methodology to choose adverse scenarios: for a given threshold distance chosen by the supervisor, the adverse scenario in a stress test should be the scenario generating more capital losses within those whose distance to the baseline forecast lies below the threshold.

change is zero, and a linear interpolation for intermediate values. The severity of a scenario is then defined as the weighted average of the severity along the four relevant macroeconomic variables. Similar recession based approaches to the measurement of stress test severity could be developed for other jurisdictions taking into account the specificities of their recent most severe recessions.

From a practical point of view, when deciding between a probabilistic and a recession based severity measure there are two crucial aspects to take into consideration. First, the measure has to be robust, meaning that if it indicates that some scenario is severe then such scenario must indeed be associated with substantial economic losses. While by construction recession based severity measures satisfy this robustness criterion, probabilistic severity measures may be exposed to the risk of not generating sufficiently severe scenarios, especially during the expansionary phases of the cycle. The reason is that probabilistic measures rely on models estimated out of past observations that generally do not include extreme events. They might hence be misspecified for those events, rendering statistical inferences misleading. Indeed, as already highlighted by Haldane (2009) and Borio et al. (2012), under those models the movements in some asset prices and economic variables in the recent crisis constituted twenty-plus standard deviations and hence would be unique in the life span of the universe. A probabilistic severity measure would have considered the shock leading to the past financial crisis so severe as to be implausible, while scenarios with a plausible severity would have generated losses very far from those observed in that episode.²⁰

A second useful property for a severity measure is its simplicity. A simple measure is easier to understand and replicate by third parties, which helps the supervisor in the communication of its severity choices and enhances its accountability. Moreover, simplicity improves transparency and facilitates the comparison of severity choices along time. When evaluating severity measures according to their simplicity, recession based measures are clearly preferable. We recommend supervisory authorities to rely on this type of severity measures.²¹

5.2. Cyclical severity and the Stress Test Buffer

The Basel III capital framework introduces capital buffers (namely the CCyB and the CCoB) to increase the resilience of the banking sector through the business cycle, thereby promoting a more

²⁰ There are some recent working papers that propose a probabilistic approach to the measurement of stress test severity and to the choice of adverse scenarios and that explicitly take into consideration misspecification problems (e.g. Bidder and McKenna, 2015). However, we think that at the current stage these techniques are still preliminary and their reliability has not yet been sufficiently tested to be considered for implementation purposes.

²¹ An advantage of probabilistic measures over recession based measures is that the former may make a more efficient use of the available information. Yet, we think this potential benefit does not compensate for the disadvantages mentioned above.

stable contribution by the banking sector to economic growth. As argued in the previous Section, stress tests can supplement this objective by detecting the additional capital banks may need (the STB) to ensure their resilience to systemic risk stemming from a macroeconomic shock. In this respect, the purpose of stress tests is not to ensure resilience to any possible shock (which would require a capital ratio of 100 per cent for all banks) but a level of resilience compatible with that implied by the Basel capital framework along the cycle. The build-up of capital buffers during expansions that can be used to absorb losses in downturns defines a capital framework in which banks are allowed to operate with a lower level of resilience in downturns than in expansions. Hence, to ensure macroprudential coherence between the Basel III buffers and the STB, the level of resilience required by stress tests should follow the same cyclical pattern, meaning that the severity of stress tests should increase during expansions and decrease during downturns, i.e. severity should be procyclical.²²

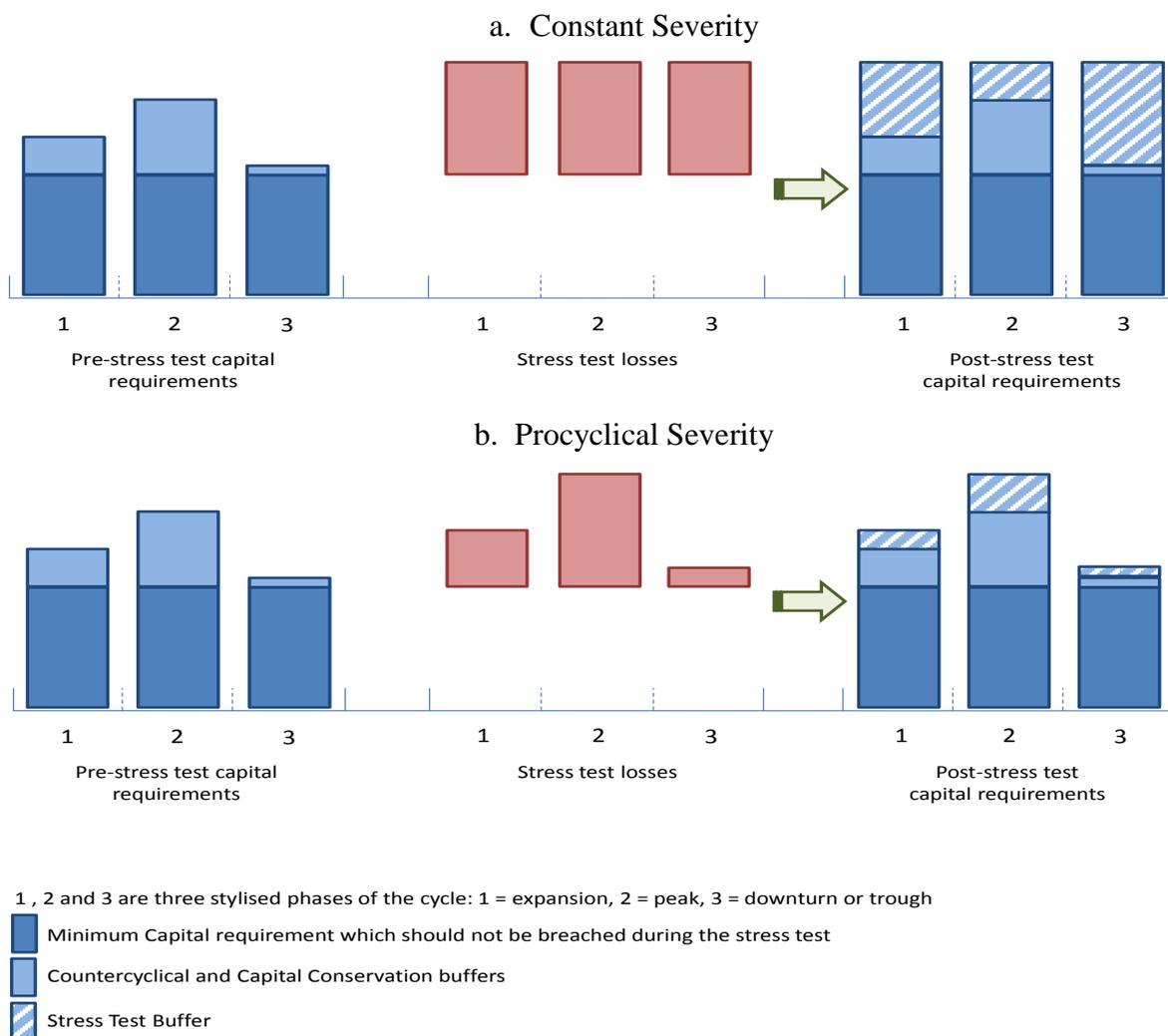
Figure 3 graphically illustrates the macroprudential coherence problem by plotting the overall capital requirements (Basel III Pillar 1 + STB) faced by a typical bank based on two different patterns for the severity of stress tests along the cycle. In both panels we depict three phases of the cycle (expansion, peak and downturn) and assume that the cumulated CCyB and CCoB requirements are at their highest level at the peak, at a very low level or possibly zero during the downturn and somewhere in-between during the expansion phase.

In Panel A we assume that stress tests are run with a constant severity along the cycle. More in detail, during the expansion when the CCyB is at an intermediate level (phase 1 in the figure) the severity of the stress test is too high relative to the macroprudential stance of the Basel III capital requirements, which leads to a large STB and high overall capital requirements. As the economy expands and credit grows relatively faster the CCyB is built up to reach its maximum at the peak of the cycle (phase 2). However, since the severity of the stress test is held constant, the increase in the CCyB is approximately offset by a reduction in the STB so that the overall capital requirement faced by the bank remains (roughly) invariant.²³ Note that the decrease in the STB does not reflect a reduction in the fragility associated with the materialization of a systemic shock but instead the

²² Supervisory stress tests have also been praised as a powerful crisis management tool (see, e.g., Borio et al., 2012). When, in the course of a crisis, a negative shock creates important adverse selection problems that hamper the functioning of financial markets, these exercises may identify those institutions most affected by the shock and in this way reestablish confidence in the rest of the system. We think stress tests with procyclical severity may still perform this crisis management function. During crises, severity will be relatively lower but stress tests that could be interpreted also as transparency/asset quality exercises will still have the ability of reducing the information asymmetries at the root of systemic distress.

²³ Even if stress test severity is constant, banks' exposure to the macroeconomic shocks defining the scenario may vary and will generally lead to some fluctuations in overall capital requirements. However, these potential variations are of a second order of magnitude compared to those arising with procyclical severity (see Panel B in Figure 3).

**Figure 3. Stress Test severity along the cycle:
Implications for bank capital requirements and the ST Buffer**



The figure illustrates how the overall capital requirements faced by a typical bank (Basel III + STB) would evolve along the cycle under two paths for the severity of supervisory stress tests. Panel A presents a situation in which stress test severity is constant along the cycle. Panel B presents a situation in which the stress test severity is procyclical (i.e. more severe in expansions and less severe in downturns).

lower severity of the stress test scenario relative to the resilience level imposed by the CCyB at that point of the cycle. Hence, when the economy approaches its peak and the CCyB is high, the fixed severity of the stress test becomes low relative to the macroprudential stance of Basel III and the STB becomes systematically low (i.e. low for all banks irrespective of their exposure to the materialization of systemic risk). When the cycle switches and Basel III allows banks to use capital buffers to absorb losses (phase 3), the reduction in Pillar 1 requirements is offset to a very large extent by a sudden increase in the STB. This increase is not the result of an increase in the bank's exposure to systemic risk (which has just been realized) but is mechanically due to the relatively high severity of the stress test at that point of the cycle. The resulting framework hence exhibits a

high and constant level of capital requirements over time that might not serve the macroprudential role of stabilizing credit along the cycle.

Panel B instead shows how overall capital requirements would evolve when the supervisor chooses a procyclical stress test severity. In an expansion when the CCyB is at an intermediate level (phase 1) the severity of the stress test is commensurate with the macroprudential stance of Basel III, which brings the overall capital requirements to an intermediate level. As the economy approaches the peak of the cycle (phase 2) the increase in the CCyB (which in the case of a constant severity would reduce the STB) is accompanied by an increase in the severity of the stress tests and, all things equal, by an increase in the STB. The increase in the STB from phase 1 to phase 2 captures the extent to which the increase in the CCyB might not be sufficient to ensure the bank's resilience to the materialization of systemic risk. When the cycle switches (phase 3), Basel III allows banks to use capital buffers to absorb losses and the reduction in Pillar 1 requirements is accompanied by a diminished stress test severity, leading to substantially lower overall capital requirements, thereby stabilizing credit along the cycle. The resulting capital framework is therefore capable of ensuring the coherence of the macroprudential stance along the cycle and effectively supplementing the weaknesses of Pillar 1 risk-based standards by capturing correlated exposures while at the same time preserving the cyclical variation in capital requirements necessary to limit the procyclicality of the banking sector.

5.3. Implementation of cyclical stress tests

An adequate implementation strategy for cyclical stress tests has to be defined and communicated for the ST capital buffer to effectively contribute towards the macroprudential objective of the Basel III capital framework. An implementation strategy consists of a plan that specifies how supervisors would choose the severity of stress tests in different states of nature. It may range from a rule-based approach, in which a predefined rule determines the severity of stress tests as a function of some indicator variables, to a discretionary approach, in which the supervisor relies on its judgement to set the severity of stress tests using all the information at its disposal.²⁴

In defining the preferred implementation strategy it should be kept in mind that in addition to ensuring the coherence of the overall macroprudential stance at any point in time, the strategy should also enhance the predictability of the stress test severity and avoid inaction bias from supervisors. Below, we argue that currently these objectives can be best achieved with a

²⁴ A discretionary strategy is far from random, as it should describe the set of factors that might inform supervisors' judgement when taking a decision.

“constrained discretion” approach, where the balance between rules and discretion weighs in favour of the first so that severity is based on a pre-defined rule supplemented when needed by some degree of supervisory judgement.

The importance of the predictability of the overall macroprudential stance can be illustrated by means of an example. Suppose the cycle switches from an expansion to a downturn. At this point Basel III macroprudential standards would allow banks to use their capital buffers to absorb losses without curtailing credit. However, in order for banks to be willing to deplete their capital buffers and continue providing credit to the economy (as opposed to restraining credit to maintain their capital ratios) they must be confident that a consistent macroprudential stance is kept across all policy instruments including stress testing, whose severity will be mild and will remain so until economic conditions substantially improve. Instead, uncertainty about stress test severity may lead banks to voluntarily maintain their capital buffers, thereby largely neutralizing the intended goals of the macroprudential capital framework. Furthermore, unpredictable severity may come as a surprise to the market, which might consider it to be either excessively harsh or soft relative to their ex ante expectation. The resulting misalignment in market and supervisors’ assessments could impair the credibility of the exercise, opening the floodgates towards an undesirable worsening in financial stability.²⁵

The predictability of the cyclical path for the severity of stress tests can be enhanced in two ways. First, supervisors should use measures for stress test severity that are informative, simple, and transparent. As commented above there are currently two approaches to the measurement of severity: probabilistic and recession based. Probabilistic measures possibly have the advantage of using information more efficiently. However, they may reduce the predictability of the severity path because they are exposed to robustness problems with respect to modelling choices. In addition, they are more intricate, and their use would introduce an extra layer of complexity to the stress testing process which is already complex in itself. At the current stage the more simple recession-based severity measures should be preferred.

Second, predictability is improved if the level of supervisory discretion in the choice of severity is kept as low as possible. This can be done by relying to an important extent on some pre-specified rule that transforms the relevant indicator variables into severity levels (once a suitable severity measure has been chosen). When deciding the severity of stress tests supervisors should use the severity determined by the rule as a benchmark. Should they judge that economic and financial conditions warrant some divergence in the severity with respect to the predetermined rule, they could opt for it but should communicate and explain the rationale for this discrepancy to the public.

²⁵ A real life example of such a situation occurred with the 2010 stress test exercise carried out by the EBA.

Some residual level of supervisory discretion is necessary also because of the novelty of stress testing as a supervisory tool, a feature shared with other macroprudential instruments. Indeed, the resulting “constrained discretion” in selecting severity could be similar to that used for the CCyB. Moreover, since the path at which the CCyB and the severity of stress tests change over the cycle should be similar, the main variable used to index the CCyB (i.e. the credit-to-GDP gap) could also play an important role in setting the severity. Other leading indicators of financial distress, such as an overvaluation of some asset classes (most notably in the real estate sector), might also be used in indexing the severity of stress tests (Borio et al., 2012).

A “constrained discretion” approach is very important not only for the predictability of the severity stress test along the cycle, but also for tackling the non-negligible risk of inaction bias by supervisory authorities. Indeed, during economic expansions, procyclical stress test severity may lead to additional capital requirements which may have a quantifiable short-term impact on banks, whose profits may be reduced, and on borrowers, whose funding costs may increase, while its benefits in terms of enhanced financial stability would only materialize in the medium to long-term and affect society at large. Similarly, during a contractionary phase of the cycle, policymakers may face a short-run trade-off between the resilience of the financial sector and the speed of economic recovery (Alessandri and Panetta, 2015). These asymmetries may make supervisors reluctant to take decisions that lean against the wind, decisions that may find strong opposition from the concerned stakeholders. These time-consistency problems, which are shared with other macroprudential instruments, can be overcome with implementation setups in which rules play an important role in policymakers’ decisions.²⁶

6. Critical assessment of supervisory stress testing approaches in the United States, the United Kingdom and the euro area

In the previous Sections we argued that regularly conducted supervisory stress tests are a useful tool in supplementing the Basel III capital standards so as to ensure an adequate resilience of the banking system along the cycle. Operationally, we have proposed introducing a bank-specific ST buffer that captures the capital that each institution needs to hold in addition to the Basel III buffers in order to withstand as a going concern an adverse macroeconomic scenario. Finally, we showed that to ensure the macroprudential coherence of the overall capital framework, the severity of stress

²⁶ See Quagliariello and Libertucci (2010) for a discussion of the need for rule-based guided discretion for macroprudential policy and Kowalik (2011) for a thorough discussion of inaction bias in the context of the CCyB

tests should be procyclical, and that for their efficient implementation simple measures of scenario severity should be defined and a constrained discretion approach for its choice should be used.

In this Section we review the current use of supervisory stress testing in the United States, the UK and the euro area, and discuss them in relationship to the main messages of the paper. We find that in both the United States and the UK the need for procyclical scenario severity has already been recognized, although we identify several elements of their stress test frameworks that differ from those in our proposals. In contrast, the supervisory stress testing framework in the euro area still exhibits some degree of incompleteness, as there is uncertainty surrounding the supervisory implications of stress test results. Moreover, in practice the exercises conducted so far do not seem to have taken into account the importance of stress test cyclicity emphasized in this paper.

6.1. Stress testing in the United States

Since 2011 the Federal Reserve runs annual supervisory stress tests as part of the Comprehensive Capital Analysis and Review (CCAR) program to assess the capital adequacy of large bank holding companies (BHC).²⁷

Detailed information on the principles and rules followed by the Federal Reserve to select the stress test adverse scenarios have been published in a policy statement in 2014.²⁸ According to the Federal Reserve Board (2014), the adverse scenario must reflect the conditions that characterized US post-war recessions, with a particular focus on the Great Recession.²⁹ In particular, since increases in the unemployment rate are the most common pattern in US recessions, the Federal Reserve gives a primary role to this variable in the design of its adverse scenarios, where the unemployment rate is generally expected to rise at least four percentage points or to a level of 10 per cent, whichever results the higher. This rule introduces procyclical severity to the stress test exercises carried out in the US: in an expansion - when arguably the economy is close to full employment - the adverse shock has to be very severe to attain the 10 per cent minimum unemployment rate; a milder shock is needed however when the unemployment rate is higher. The

²⁷ Section 165(i) of the Dodd-Frank Act and the capital plan rule (12 CFR 225.8) require the Federal Reserve Board to conduct annual supervisory stress tests to BHCs with total consolidated assets of \$50 billion or more and to nonbank financial companies that the Financial Stability Oversight Council has designated for supervision by the Board. The Federal Reserve may require a strengthening of the capital position of the banks failing to satisfy the capital hurdle ratios used in the stress test. It is interesting to note that in addition to hurdle rates based on the minimum risk weighted capital ratios of Basel III the stress tests also include a hurdle Tier 1 leverage ratio.

²⁸ See Federal Reserve System 12 CFR 252, appendix A, January 2014.

²⁹ Note that the supervisory stress tests conducted by the Federal Reserve include an adverse scenario and a severely adverse scenario. For the sake of brevity, when we say adverse scenario we refer to the so called severely adverse scenario in the Federal Reserve terminology.

rest of the macroeconomic variables in the stress test are then modelled to evolve consistently with the pre-defined unemployment rate target and in line with their typical behaviour in past US recessions.

So, consistently with our proposals in this paper, supervisory stress tests in the US exhibit a cyclical pattern. In addition, the selection of adverse scenarios is to an important extent determined by a simple rule for the path of the unemployment rate which prevents the risk of inaction bias by the supervisory authority. However, the Federal Reserve has not yet defined a comprehensive measure for scenario severity that takes into account a broader set of macrofinancial variables beyond the unemployment rate.

There are two additional differences between the Federal Reserve approach to supervisory stress testing and what we advocate in this paper. First, although the US stress tests have binding implications on banks' capital planning decisions, they are not codified by means of a capital buffer. As argued in Section 4, we think such a codification would enhance the transparency of the overall capital framework. Second, the above mentioned Federal Reserve policy statement that describes how the severity of their stress tests procyclically varies has a rather limited visibility. In addition, in the more widely accessible annual documents describing the stress test scenarios and the stress tests results for the period 2011-2016 there is only one reference to the procyclicality of stress test severity, and even there it is located in a non-central position of the document.³⁰ The Federal Reserve has touched upon its cyclical approach to stress testing in a rather ad-hoc manner also in some Board member speech and policy paper by staff economists.³¹ We think nevertheless that a wider, more systematic and effective communication effort would increase stakeholders' awareness and enhance the predictability of the overall capital framework.

6.2. Stress testing in the United Kingdom

The Bank of England is moving in the direction of conducting independent annual supervisory stress tests of the most important banking institutions in the UK. In November 2015 it published a widely visible policy document where it describes its stress testing framework from 2016 to 2018 (Bank of England, 2015). Consistent with the message of this paper, their new approach to stress testing is explicitly countercyclical: the severity of stress tests will increase as risks build-up and

³⁰ The only reference to the cyclicity of stress tests is: "This year's severely adverse scenario features a more severe downturn in the U.S. economy as compared to last year's scenario. This increase in severity reflects the Federal Reserve's scenario design framework for stress testing, which includes countercyclical elements." It appears on page 12 of "2016 Supervisory Scenarios for Annual Stress Tests Required under the Dodd-Frank Act Stress Testing Rules and the Capital Plan Rule," Federal Reserve Board, January 2016.

³¹ See Tarullo (2013), and Edge and Lehnert (2016).

decrease after they crystallise or abate in a way that will lead to a capital framework that is macroprudentially coherent. The new cyclical framework for stress testing has been communicated through several channels.³²

There are nevertheless two main lines of departure between the way the Bank of England intends to implement cyclical stress tests and the proposals in this paper.

First, it will use the stress test results to calibrate the CCyB so that under their approach, the stress test capital losses in excess of the CCoB that are systematic across all banks will serve to set the level of the CCyB. Then, each bank's stress test losses in excess of the sum of the CCoB and the CCyB (calibrated as just described) will give rise to an additional buffer the institution will be required to hold, referred to by the Bank of England as the PRA buffer.³³ The approach differs from our proposal for the introduction of a bank-specific ST buffer only in that we take the CCyB as defined according to the globally harmonized methodology. Although both implementation methods would imply identical overall capital requirements for most banks,³⁴ we think our approach is indeed more transparent in assigning the capital requirements derived from stress tests, and additional to those included in Basel III. Moreover, under Basel III the supervisory authorities have to set the CCyB on a quarterly basis while stress tests are conducted on an annual basis, which may pose difficulties to the Bank of England's methodology that relies on the latter to calibrate the former.

Second, the implementation of cyclical stress tests described in Bank of England (2015) grants the central bank a great deal of discretion in selecting scenario severity. Such discretion is in turn compounded by the absence of a clearly defined measure of scenario severity. This may hamper the predictability of the overall capital framework and lead to supervisory inaction bias. As argued in the previous Section, the two weaknesses may be overcome with the use of a simple recession-based measure of scenario severity and a constrained discretion approach to severity choice.

³² These include, in addition to the Bank of England (2015), the Financial Stability Report, the document on the "Key elements of the 2016 stress test", speeches and online videos.

³³ PRA is an acronym for Prudential Regulation Authority, the body within the Bank of England responsible for prudential bank supervision.

³⁴ To illustrate the potential difference between the two approaches, suppose a situation in which, on aggregate, stress test losses are larger than usable buffers, which leads the Bank of England to increase the CCyB. Consider a bank with a low exposure to the adverse economic scenario and whose stress test losses are lower than its usable buffers. Under our proposal, this bank would not face a positive STB, and its overall capital requirements would be unchanged with respect to those prior to the stress test. In contrast, under the Bank of England's approach, this bank would face higher overall capital requirements as a result of the increase in the CCyB required of all banks.

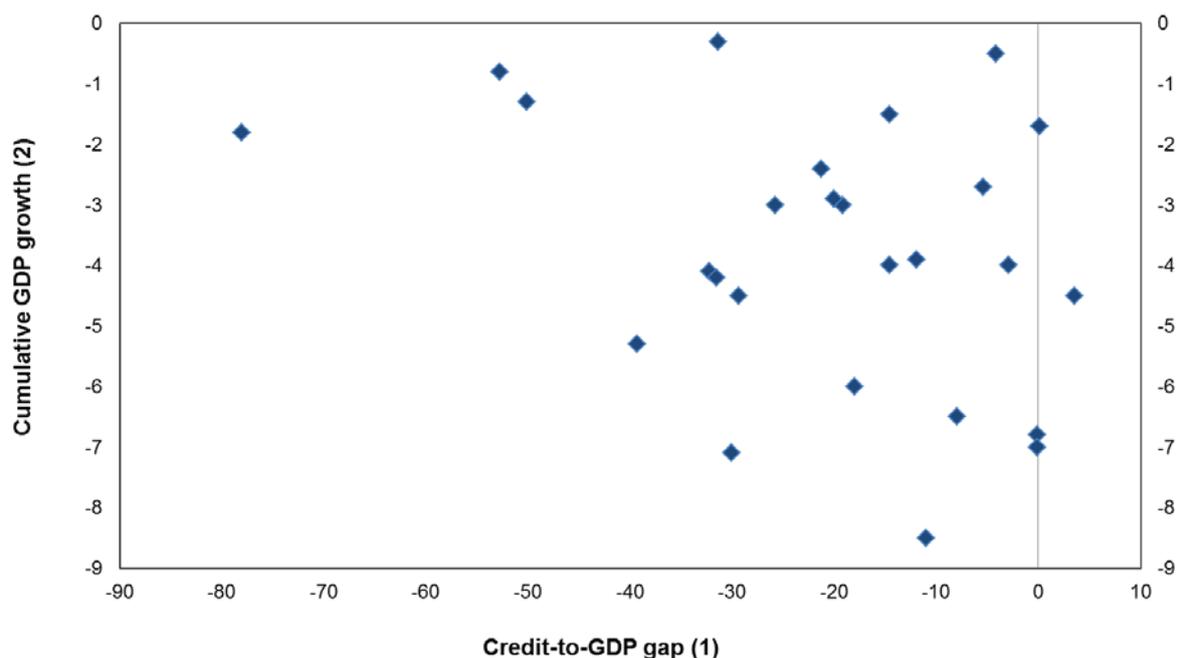
6.3. Stress testing in the euro area

CRD IV (Directive 2013/36/EU) requires the ECB, which has been responsible for the supervision of the banking system in the euro area since November 2014, to carry out supervisory stress tests on an annual basis and to use their results in the annual Supervisory Review and Evaluation Process (SREP). CRD IV does not require the use of a pass/fail threshold: although one was used in the 2014 exercise, it was not part of the 2016 stress test. As clarified by the EBA a few weeks before the publication of the 2016 stress test results, in the context of the SREP supervisory authorities would primarily use the results to develop Pillar 2 capital guidance that is not directly binding (European Banking Authority, 2016b). This means that capital requirements will be tied to stress test losses in a manner that is far from transparent and very much dependent on the ECB's discretion. Furthermore, it is not clear whether the approach taken in this exercise should be considered a "one-off" decision for this year or a choice for a more stable stress test framework. This uncertainty makes it difficult for banks to make capital planning decisions and for investors to interpret both the purpose of these exercises and their results. We think that the ECB should therefore establish a definitive supervisory stress testing framework and communicate it to its stakeholders. To increase transparency, such a framework should define the capital requirement implications of stress tests in terms of a stress test buffer as described in Section 4. In this regard, it might be interesting to explore the possibility of using the Systemic Risk Buffer, which is already included in the European legislation, to implement what we have called in this paper the ST Buffer. In addition, the need to ensure the macroprudential coherence of the capital framework requires explicit introduction of procyclical stress test severity. This cyclicity must take into account that euro-area stress tests cover banks whose main activities are conducted in several countries with different economic and financial cycles. This means that the severity of each of the euro-area countries' components in the adverse scenario should be based on each country's individual cyclical position: countries experiencing an expansion should be exposed to more severe adverse scenarios than countries suffering a recession.

Finally, the EBA – which is required by the CRD IV to provide technical guidelines to EU supervisory authorities – has published a Consultation Paper on stress testing where the issue of procyclical severity is completely absent (European Banking Authority, 2015). Furthermore, the severity of the country-specific components of the adverse scenario in the 2016 EU-wide stress test suggests that the heterogeneity of EU countries' cyclical position did not seem to play a significant role in setting the severity level for the exercise, as shown in Figure 4 by the scattered plot of the EU countries' credit-to-GDP gap in the third quarter of 2015 (a standard indicator of the cyclical

Figure 4. Cross-country comparison of EBA 2016 stress test:

Credit-to-GDP gap vs Cumulative GDP growth



The figure exhibits a scattered plot of the credit-to-GDP gap of EU countries in 2015Q3 (horizontal axis) and their GDP contraction under the 2016 EBA adverse scenario (vertical axis). (1) Credit-to-GDP gap on 2015Q3. (2) Cumulative GDP growth is the difference between the GDP level at the trough under the adverse scenario of the EBA 2016 stress test and the GDP at the end of 2015.

position of a country) against each country's GDP fall under the 2016 EU-wide EBA adverse scenario (a partial measure of country-specific scenario severity).

The figure shows that there is no pattern linking the two, while procyclical stress test severity would lead to a positive relationship between these variables.³⁵ It is worth mentioning that the countries with the most significant reductions in domestic GDP under the adverse scenario (namely, Latvia, Estonia, Greece, Ireland, Portugal and Bulgaria, with a cumulated drop in GDP of more than 10 percentage points) also show large and negative credit-to-GDP gaps (-29.6 per cent on average for the group). At the same time, some of the countries with the lowest credit-to-GDP gap (such as France and Germany) are also the ones to face some of the lowest GDP contractions, which is starkly at odds with a macroprudentially coherent approach to stress testing at the euro-area level. A similar picture emerges when looking at the fall in GDP under the adverse scenario vis-à-vis a measure of output gap, another indicator of a country's cyclical position.

³⁵ The same message can be inferred from the 2014 EU-wide stress test exercise.

7. Conclusions

As the dust settles on the 2007-09 crisis and on the regulatory reforms of the financial sector it spurred, policy makers' attention has to move towards ensuring a coherent use of the new set of instruments at their disposal. Coherence requires a comprehensive perspective that takes into account how the interaction between instruments may affect their functioning and intended objectives.

In the post-crisis era banks' capital adequacy is established by the Basel III capital standards and, in many jurisdictions, also by supervisory stress tests. Each of these instruments in isolation has the potential of enhancing the macroprudential approach to banking supervision. In this paper we make a set of recommendations to ensure that, when used together, the Basel III standards and supervisory stress tests lead to a transparent and predictable capital framework that is macroprudentially coherent.

We argue that the severity of supervisory stress tests has to be procyclical and that severity choices should follow a constrained discretion approach based on a simple rule in choosing scenario severity. We also describe how the codification of the capital implications of supervisory stress tests could be achieved transparently with the introduction of a new stress test buffer additional to the Pillar 1 Basel III capital requirements. From a prudential perspective, such a buffer would have a "hybrid" nature. On the one hand, it would be bank-specific as it aims to ensure the institution's resilience to a negative shock, and as such could be seen as a microprudential instrument. On the other, the new buffer would be determined on the basis of a stress test exercise that assesses all banks against the materialization of the same macroeconomic shock. In this sense, it would have a macroprudential nature, further strengthened by the procyclical severity of the stress test. The proposed stress test buffer would complement the capital buffer framework of Basel III by "bridging the gap" between the existing microprudential capital instruments and the macroprudential ones, which (except for the structural G-SII buffer) do not differentiate across individual institutions.

We recognize, though, that operationalising the cyclical approach to stress testing is easier said than done and that a full operational specification of such a policy strategy, which goes beyond the scope of this paper, requires further work along several dimensions. These include the definition of a simple and robust severity measure and the identification of a proper rule to "guide" severity choices along the cycle. In turn, these instruments require a deeper understanding of the relevant cycle to which stress tests have to be related – i.e. the business or the financial cycle or a combination of both, as the two cycles tend to be correlated, but do not coincide – and an

improvement in the techniques used to identify the cyclical position of the economy and financial sector, as turning points in particular are currently difficult to catch. An additional challenge for the operationalization of a cyclical scenario comes in the cases of globalized financial systems exposed to cycles in different jurisdictions that are not synchronized (as in the US), or when exercises cover several jurisdictions with differing cyclical positions (as in the euro area).

We find important differences in the supervisory stress testing practices across jurisdictions. While in the United States and the UK these practices take into account some of our proposals, including most notably the need for procyclical severity, in the euro area this is not the case. Indeed, a complete and transparent framework for supervisory stress testing in the euro area has not yet been defined: the exercises are conducted in a rather ad-hoc manner, which very likely poses difficulties to the capital planning of banks, ultimately harming lending to the real economy. The time has come for authorities in the euro area to establish a clearer setup under which they intend to conduct these exercises. The most important features emphasized in this paper should be followed so that a macroprudentially coherent capital framework results. Otherwise supervisory stress tests may create more harm than good. And the euro-area economy simply cannot afford this.

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