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Measuring capital adequacy: supervisory stress-tests in a Basel world

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Executive summary

Measuring capital adequacy: supervisory stress-tests in a Basel world
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The U.S. is now committed to using two relatively sophisticated approaches to measuring capital adequacy: Basel III and stress-tests. The purpose of this paper is to consider how the two methodologies could work together to help us achieve our supervisory capital adequacy goals, focusing in particular on how stress-testing could mitigate weaknesses in Basel III. The paper begins by explaining that the two methodologies take fundamentally different approaches to measuring a bank's risk exposure. The Basel III methodology relies on risk-weighting assets using risk estimates obtained from recent historical data. The stress-test methodology focuses on the evolution of bank capital levels in response to a stressful economic scenario. The paper then discusses specific weaknesses of the Basel III methodology with respect to how it measures credit and interest rate risk and bank capital, and the way it creates countercyclical capital buffers. As a part of this discussion, the paper explains how differences in methodologies potentially allow the stress-tests to mitigate these weaknesses in Basel III. In most cases, the key difference is that stress-tests give supervisors an added degree of freedom in the form of being able to specify a stress scenario that addresses a limitation in the Basel III methodology. However, the paper also emphasizes the extent to which stress-tests add value will depend upon the exercise of supervisor discretion in the design of stress scenarios.

Measuring capital adequacy: supervisory stress-tests in a Basel world[1]

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Abstract
The U.S. is now committed to using two relatively sophisticated approaches to measuring capital adequacy: Basel III and stress-tests. This paper shows how stress testing could mitigate weaknesses in the way Basel III measures credit and interest rate risk, the way it measures bank capital and the way it creates countercyclical capital buffers. However, the paper also emphasizes the extent to which stress-tests add value will depend upon the exercise of supervisor discretion in the design of stress scenarios. Whether supervisors will use this discretion more effectively than they have used other tools in the past remains to be seen.

1 I would like to thank Scott Frame, Gillian Garcia and Bev Hirtle for helpful comments on a prior version called "Supervisory stress testing: will the long-run benefits exceed the on-going stress." Any remaining errors are solely the responsibility of the author. The opinions expressed in this paper are those of the authors and do not necessarily reflect the view of the Federal Reserve Bank of Atlanta or the Federal Reserve System.

1. Introduction

The U.S. is now committed to using two relatively sophisticated approaches to measuring capital adequacy. The first approach, stress-testing, was pressed into service in early 2009 to help restore confidence to the banking system and was made into an ongoing annual requirement by the Dodd–Frank Act.[2] The second measure, Basel III, was adopted as a regulation by all three federal bank supervisory agencies in July 2013 for the implementation to start on 1 January 2014.[3] Both of these measures are not only more sophisticated, but also more complex, costly and time consuming to implement than the capital adequacy measures brought in place in the U.S. in 2009.[4]

Capital adequacy ratios have been an important tool of prudential supervision dating back prior to the adoption of the first Basel Accords in 1988.[5] Conversely, stress-testing has a shorter history and generally played less of a role in micro-prudential supervision. Prior to 2009, stress-tests were used to analyze the overall financial stability of the banking system and the risk in selected parts of banks' balance sheets.[6]

The Supervisory Capital Assessment Program (SCAP) in 2009 took these stress-tests to a different level and that change has continued in the U.S. under the follow-up Comprehensive Capital Analysis and Review (CCAR) and the Dodd–Frank Act Stress Tests (DFAST) programs.[7] An important part of the change was philosophical, with the blending of microprudential and macroprudential supervision as emphasized by Hirtle et al. (2009). However, the operational changes were also substantial according to Bookstaber et al. (2013), who call the current version of stress-testing "Stress Testing 2.0." They observe that starting with SCAP, in the U.S., there was a substantial expansion of the scale and granularity of the data collection and modeling used in stress-testing.

Given the existence of one costly risk-based measure, an obvious question is what is the incremental value of implementing a second costly measure?[8] The purpose of this study is to provide an answer to this question from the perspective of how supervisory stress-tests could mitigate problems with Basel III. The primary reasons for asking how the stress-tests can add value is that, as we shall see, the supervisors have considerably more flexibility in the implementation of the stress-tests and they can use that flexibility to minimize the impact of Basel III's weakness. A secondary reason is that Basel III purports to measure the full range of bank risks whereas the stress-tests only measure the losses associated with a handful of specific scenarios.[9]

The paper is organized as follows. Section 2 provides an overview of the workings of Basel III capital ratios (Pillar I) and the stress-tests as conducted in the U.S. Sections 3, 4 and 5 discuss the potential contributions of stress-testing to overcome weaknesses in Basel III's approach to measuring credit risk, interest rate risk and bank capital. The sixth section considers how stress-testing could provide an alternative method of implementing countercyclical capital buffers that may be less subject to political pressure than the mechanism in Basel III. The paper concludes with a summary of the possible contributions of stress-testing to the measurement of individual bank capital.

2 Geithner (2009) announced the stress-tests and the Board of Governors of the Federal Reserve System [hereafter BOGFRS (2009)] announced the results. Wall (2013b) provides an overview of the history of stress-tests used to measure capital adequacy in the U.S. and E.U.

3 The announcement at the time of the BOGFRS's adoption of Basel III is available at http://www.federalreserve.gov/bcreg20130702a.pdf [accessed 22 September 2013]. More generally, the Basel Committee on Banking Supervision home page for Basel III is http://www.bis.org/bcbs/basel3.htm and the BOGFRS's home page for the Basel Regulatory Capital Framework is http://www.federalreserve.gov/bankinforeg/basel/USImplementation.htm [both accessed 22 September 2013].

4 The U.S. had not adopted Basel II at the start of 2009. Instead, the U.S. was operating under a combination Basel I (including its amendments) and a leverage ratio that had gross total assets in the denominator.

5 A comprehensive review of this literature on capital adequacy ratios would go far beyond the scope of this paper. Wall (2013b) provides a condensed history of the capital regulation focusing on the development of the Basel capital accords.

6 Schuermann (2012) provides a short review of the literature on stress-testing. See Borio et al. (forthcoming) for a critical review of the use of stress-tests for macroprudential purposes.

7 Wall (2013b) provides a brief overview of stress-testing for capital adequacy purposes, including SCAP, CCAR and DFAST. See also Bernanke (2013) for a discussion of Federal Reserve stress-testing, starting with the SCAP. See also http://www.federalreserve.gov/bankinforeg/stress-tests/dodd-frank-act-stress-testing.htm (accessed 21 October 2013) for a discussion of the similarities and differences between CCAR and DFAST.

8 Another motivation for stress-testing conducted using the expanded scale and granularity of the U.S. tests would be to provide more sensitive tests of financial stability. Bookstaber et al. (2013) provide both a set of relatively minor variations on current stress-testing that they call "Stress Testing 2.1" and bigger set of changes that they call "Stress Testing 3.0", which would make the exercises more useful for financial stability purposes.

9 In principle, it would be possible to use stress-tests to estimate the full distribution of losses associated with a bank's portfolio. However, this would require supervisors to adopt one or more macroeconomic models, simulate these models thousands of times and use each of these simulations as the scenario for the stress-tests applied to each bank. Such an application of stress-tests appears unlikely for the foreseeable future, given that thus far the individual bank tests have been run on at most a handful of scenarios.

2. A comparison of Basel III and stress-testing

Basel III and stress-testing, as implemented in the U.S., both rely on projections of losses in an extreme scenario to evaluate the adequacy of individual bank's capital. Both measures require the estimation of statistical models. In many cases, banks and the supervisors have data covering at most the past two decades, a period that includes only one severe business cycle.

However, the two measures also differ in some fundamental ways according to Wall (2013b). Basel III provides an unconditional static measure, with the risk adjustment occurring in the risk weighting of assets (the denominator of the capital adequacy ratio). In contrast, the stress-tests, as currently applied to measuring individual bank capital adequacy, are conditional, dynamic measures, with the risk adjustment occurring via reductions in capital (the numerator of the capital adequacy ratio). Basel III is an unconditional, static measure in that it measures capital adequacy at a single point in time using a process that does not depend upon projections of the future state of the economy. That is, the calculation of the Basel III ratios uses data on past performance to estimate the loss distributions associated with various portfolio positions. The estimated loss distributions are then used to calculate the expected losses in the extreme tail of the distribution. The current portfolio positions (assets and derivatives) are then summed using weights derived from the expected losses to calculate the denominator of the Basel III ratios. In effect, Basel III derives a generic, severely adverse scenario for each portfolio category from that category's own (recent) past experience.

Basel III provides three different methods of risk weighting assets. In the standardized approach, the supervisors provide the risk weights to the banks based on their estimates of the riskiness of different assets. In the internal ratings based (IRB) approach, banks supply their own estimates of the probability of default, which is then entered into supervisory models to obtain risk weights. Finally, in the "advanced IRB" approach, banks also come up with their own estimates of loss given default and exposure at default, along with their estimate of the probability of default.

In contrast to the relatively sophisticated approach to calculating risk-weighted assets for the denominator of the Basel III ratio, the calculation of the measure of capital is mechanical. Basel III uses three different measures of capital: common equity tier-1, which includes items, such as common equity and retained earnings that are available to absorb losses on a going-concern basis; tier-1 capital, which includes other perpetual instruments that are subordinated to the deposits and subordinated debt of the bank and that meet additional criteria; and tier-2 capital, which includes items available to absorb losses only on a gone-concern (in resolution) basis, such as subordinated debt.[10] Basel III also provides for certain mandatory deductions from capital, such as subtracting the value of certain intangible assets from tier-1 capital. However, the values of each of the items in capital and the deductions from capital are taken from the financial statements of each bank holding company (BHC).

The stress-tests begin with several different regulatory measures of capital adequacy. Among these measures are the Basel III risk-based ratios. However, the stress-tests are dynamic in that they simulate how these regulatory ratios would evolve over time and are conditional in that the results are calculated for a specific scenario for the economy. The primary focus of the stress-tests has been on estimating changes in accounting capital following the standards set by the Financial Accounting Standards Board (FASB) in the U.S. or the International Financial Reporting Standards (IFSR) in the E.U. The estimates of the change in accounting capital are based in part on estimates of each bank's losses in each portfolio in each period. However, given that the stress-tests are dynamic, they also include estimates of each bank's pre-provision net revenue (PPNR).

The first step in conducting a stress-test is to estimate the historical impact of economic variables, such as GDP growth on bank's losses and PPNR, given certain important characteristics of each bank's portfolio. The next step is to develop one or more internally consistent scenarios for the future evolution of the economy.[11] Estimates of losses and PPNR for each period in each scenario are then obtained by plugging in the characteristics of the bank's portfolio and the stress scenario into the bank's and the supervisor's models estimated using historical data. The projected losses and projected capital distribution are subtracted

10 See Basel Committee on Banking Supervision (2011, pp. 12–28) for a discussion of the requirements for inclusion under one of more of these definitions of capital.

11 The scenarios supplied by the U.S. supervisors have involved increasingly severe economic downturns. But in the future, some scenarios could involve higher levels of growth and inflation that stress bank's interest rate risk management.

from PPNR to estimate each period's change in capital. The capital at the end of each period is then its value at the start of the next period.

One way of illustrating the differences between Basel III and stress-tests is to imagine them as different approaches to looking for risk. Basel III casts a dim light over a wide range of possible scenarios. Basel III's use of historical loss distribution data allows it to predict losses in tail of the distribution across a wide variety of scenarios. However, Basel III cannot say very much about what may happen in any particular scenario. In contrast, each individual stress-test casts a very bright light but only on one particular scenario. To the extent the models are correct, the stress-test is intended to provide a good estimate of what happens in a particular scenario. The results of the test of any one scenario are likely to be representative of the losses that would arise in similar scenarios, but such a result is not guaranteed. Moreover, there is no reason to expect that any given scenario will be predictive of the results of a very different stress scenario.[12]

3. Credit risk mis-measurement

Arguably, the biggest risk to banks is that of credit risk. This section considers potential weaknesses in Basel III's measurement of credit risk and how stress-tests may mitigate some of these problems.

In order to understand the vulnerability of Basel III or any other measure of capital adequacy, it is helpful to first understand how banks will respond when confronted with a possible deficiency in capital. In general, a bank approaching deficiency can implement some combination of two possibilities: increase the denominator (retain more earnings or issue new capital or both) or reduce the numerator (report taking less risk).[13] Although bank supervisors would often prefer that banks retain more earnings and/or issue new capital, banks generally view equity capital as their most costly source of funding. In many cases, banks find that reducing their reported risk would be less costly.

A bank that seeks to reduce its reported risk may employ some combination of the following three options: (a) shrink its overall portfolio while retaining the same allocations within the portfolio, (b) reallocate part of its portfolio away from positions with higher capital charges and toward positions with lower capital charges and (c) change the way risk is measured so that, holding the portfolio constant, the estimated risk exposure is lower than in the original model.

A bank that shrinks its overall portfolio while retaining the same allocations will reduce its risk level. Supervisors' concern here is that if all banks shrink their portfolios at the same time, the resulting reduction in the supply of credit may reduce economic growth (or deepen a recession), which in turn would produce an offsetting increase in the risk of banks. The Basel III requirements provide no mechanism for preventing banks from meeting their requirements solely by shrinking their portfolios. On the other hand, stress-tests may be designed to force banks to issue capital as the U.S. did with the 2009 SCAP. A policy of forcing banks to issue new capital will not necessarily result in more new loans, but it removes inadequate capital as a reason for banks to refuse to make new loans or extend existing loans.[14]

The next subsection considers how banks reallocate their portfolios when subject to binding capital regulation. The following two subsections examine the potential for systematic errors due to limited data and biased measurement approaches.

3.1 Portfolio reallocation

Portfolio reallocation could be an effective way of increasing capital adequacy if the risk weights in Basel III are the "correct" weights. Portfolio reallocations would be in the direction of reducing exposures to positions where the bank had previously underestimated the asset's risk and possibly increasing positions where the bank had overestimated the risk.

However, there are a variety of reasons to expect that the Basel III contains many random errors. The standardized approach is intended to provide a rough approximation of the average

12 For example, the results of a severe economic downturn scenario are unlikely to be very informative about the consequences of a scenario with sharp increases in inflation and interest rates.

13 See also Wall and Peterson (1996) for a discussion of banks' response to binding capital requirements.

14 While the stress-tests can be designed to force banks to issue new capital, even the stress-test approach would have difficulty forcing banks to make new loans to support economic growth. Supervisors are (quite correctly) concerned about forcing banks to make new credit risky loans that the banks judge to have too low of an expected return for their risk.

risk of various risk buckets across banks, implying that it will measure the risk of individual banks with error unless these risk buckets have exactly the same risk within all banks. The IRB approaches are more sensitive to each bank's position. However, Haldane (2011) estimates that Basel III has more than 200,000 risk buckets. The weights for each of these buckets must be estimated using complex statistical procedures, procedures which themselves recognize the likelihood of estimation errors.

The combination of unavoidable estimation errors and banks' portfolio reallocations to reduce their capital requirements implies that actual banks' capital adequacy will be less than the stated standards of Basel III. In order to illustrate this problem, start by assuming that Basel III is correct on average. That is, if Basel III was applied to existing portfolio, those cases where the risk weights were too low would be almost exactly offset by cases where the weights are too high.[15] However, banks will respond to binding regulations by seeking to reduce their Basel III capital requirements in the way that has the least adverse impact on shareholder wealth. Given the existence of the safety net (deposit insurance, lender of last resort, "too-big-to-fail" implicit subsidies), this implies that the bank portfolios should show the largest reductions in those areas where the Basel III risk weightings are too high relative to actual risk and the smallest reductions in those areas where the risk weightings are too low. The result of this portfolio reallocation is that even if the Basel III standards were correct on average prior to banks reallocating their portfolios, total risk-weighted assets (RWA) will be too low after banks finish reallocating their portfolios.

The measurement errors associated with stress-tests are not necessarily smaller than those with Basel III but they are likely different. Basel III uses historical data to estimate unconditional loss distributions, whereas stress-tests use historical data to estimate the relationship between losses and specified economic variables (such as GDP growth). The difference in estimation methods implies that the errors from Basel III are unlikely to be perfectly correlated with those from the stress tests. For some of the asset classes where Basel III underestimated the losses, the stress-test loss estimates will overestimate the losses or at least underestimate by a smaller margin. Thus, it is likely that stress-tests will reduce banks' incentives to shift their portfolios toward assets whose RWA would be too low under Basel III.

The stress-tests also provide supervisors with the option of designing stress scenarios that discourage investment in assets that the supervisors think have too low of a risk weight under Basel III. For example, suppose that the supervisors conclude that the Basel III weights underestimate the risk of commercial real estate lending and as a result they see banks increasing their portfolios allocations to these loans. The supervisors could require banks to run a stress-test that has an especially adverse scenario for commercial real estate lending.

3.2 Biased credit risk measures

The problem of banks shifting their portfolios toward assets underweighted by Basel III is compounded if the source of the underweighting is due to something other than a random error. Basel III has at least two weak links in its estimation of credit that could lead to systematic underestimation of the riskiness of many assets: some important risky scenarios are not observed in the relatively recent historical data and banks may use their discretion to pick models that underestimate risk.

3.2.1 Bias due to data

The loss distribution models in Basel III have to be estimated from historical loss distributions. If the historical data is drawn from a benign economic period with relatively low losses, the estimated loss distributions may understate the true potential losses during a more volatile period. For example, estimates of potential losses on residential real estate obtained during the early 2000s, when few loans defaulted for a loss because of the general trend toward higher house prices, would not necessarily reflect the potential for losses if national average housing prices drop.

A possible solution, if the recent losses have been low, would be to go further back in time. The problem is that the further one goes back in time, the more likely they are to incorporate structural change(s). For example, the last time house prices fell nationally was during the 1930s. As Rowe (2013) points out, such structural changes undermine the assumption implicit in most statistical analysis that the underlying stochastic process is stable. For example, the economy and housing finance systems of the early 2000s were very different from those of

15 The following subsection will discuss a variety of reasons why the Basel III weights might on average be too low.

the 1930s, implying that estimates derived from 1930s data may not be very predictive of the losses that did happen in 2000s after house prices started to fall.

The loss models used in stress-tests are also estimated using historical data. However, stress-tests provide supervisors with an additional degree of freedom to pick stress scenarios that are not observed in the recent data. How stressful the scenario should be would depend upon the supervisors' beliefs about the stress-test loss models. If the supervisors' believe the loss models would deliver reasonably accurate estimates of the likely losses, they only need to specify a scenario that incorporates their concerns. For example, even if the data used to estimate the models lacks a 10% national housing decline (as would have been the case prior to 2006), the supervisors could require banks to calculate their expected capital positions given a 10% decline.[16]

A bigger problem arises if the supervisors believe their models would underestimate losses in a stress scenario. This problem could arise, for example, if the historical data suggests a linear relationship between losses and their scenario but the supervisors believe the true relationship is convex (an increase in the severity of conditions leads to a more than proportional increase in losses). For example, suppose the model predicts that a 20% housing decline would lead to 4% losses, whereas the supervisors judge the losses would be substantially more than 4%. Even with this modeling problem, the supervisors could still design stress-tests that would reveal appropriately large losses by requiring banks to use an even more severe scenario. However, in order for this to work, the supervisors might need to require banks to hold capital to withstand an extraordinarily severe scenario that almost all knowledgeable observers would argue is not plausible. Although it is easy to argue that in principle supervisors should impose implausible scenarios when they think their models significantly underestimate likely losses, doing so in the face of bankers' and borrowers' objections is likely to prove challenging in practice.

16 The last time national house prices declined was the Great Depression, according the United States Council of Economic Advisors (2012, p. 101).

3.2.2 Bias due to bank modeling

Banks estimate the models to determine the Basel III risk weights under both the IRB and A-IRB approaches. As a result, wherever there is any discretion to be exercised, it is the banks that select the data and statistical procedures. This raises an obvious concern that banks will pick the data and procedures that produce the lowest risk weights [Blum (2008)]. This concern is somewhat reduced by banks' need to obtain prior supervisory approval for their modeling. However, it is not practical for the supervisors to review all of the decisions made in the estimation of more than 200,000 risk weights in Basel III model. In order to better understand the extent of cross-sectional dispersion in risk modeling, the Basel Committee on Banking Supervision (2013, p. 7) asked a group of large banks in Europe, North America and Asia to evaluate a common set of "largely low-default" credits. Given a 10% capital benchmark, the study found that the risk-weights calculated by the banks could vary by as much as 1.5 to 2 percentage points in either direction, albeit most were within 1 percentage point.[17]

Stress-tests are also based in part on models estimated by the banks. However, unlike Basel III calculations, the U.S. stress-tests are based, in part, on supervisory models. That is, the Federal Reserve estimates its own models and then applies those models to detailed information supplied by banks about their individual portfolios. As a result, the supervisors can compare their estimates of losses and PPNR in each scenario with the estimates produced by each of the banks subject to stress-testing. Additionally, the supervisory stress-tests are conducted at the same time using the same set of scenarios, which facilitate the comparison of estimated losses and PPNR across banks. This puts supervisors in a better position to identify bank models that produce significantly lower loss estimates. Further, because the U.S. supervisory stress-tests are conducted as a part of an overall review of banks' capital planning, material weaknesses in a bank's stress-test modeling

17 Cross-sectional comparisons of Basel III weights have been used by the Danish supervisory agency Finanstilsynet, according to Newton (2013). However, reliance on purely cross-sectional comparisons may recreate a problem similar to that observed with the U.S. supervision of capital adequacy prior to the U.S. adoption of numeric standards in 1981. The problem according to Marcus (1983) was that absent firm supervisory standards, although the supervisors could stop individual banks from decreasing their capital ratios to levels notably below those of their peers, they could not prevent the banking industry from gradually reducing its capital adequacy ratios.

procedures is itself a consideration as to whether the Federal Reserve will object to a bank's capital distribution plans.[18]

The advantage of stress-tests in discouraging banks from producing low loss estimates is offset by the disadvantage that it encourages banks to use models that produce results similar to those of the Federal Reserve's model, according to Schuermann (2013). As a result he argues, "if everybody uses the same scenario (which they do) and works hard to get the same numbers (and they are trying), then we have a very narrowly specialized risk machine that is inflexible and unresponsive to unexpected shocks." He further argues that deviating from standard industry practice is becoming discouraged, resulting in less innovation even in cases where risk managers see opportunities for more accurate modeling.

4. Interest rate risk mis-measurement

Stress-tests could, in principle, provide better interest rate risk measurement because Basel III only incorporates the effect of interest rates on market values for those assets held for trading (the trading book). Currently, there is no interest rate risk measure for assets likely to be held to maturity (the banking book). [19]

The first common capital adequacy framework set out by the Basel Committee on Banking Supervision (1988) agreement focused exclusively on credit risk. The measurement and associated capital requirements (if any) for interest rate risk were the responsibility of national authorities. The market risk amendment to Basel I [BCBS (1996)] incorporated a measure of interest rate risk into the agreed-upon method of calculating capital adequacy but only for the trading book. That is only for instruments that a bank held to profit from short-term price movements and which a bank marked-to-market on a daily basis. The provision of capital for the interest rate risk in the rest of a bank's portfolio, its "banking book," remained the responsibility of national authorities. While the Basel accords have seen considerable change since 1996, Basel III still does not have a measure of interest rate risk for the banking book. This is not to suggest that the U.S. supervisors ignore interest rate risk. In fact, they issued guidance in 2010 and frequently asked questions (FAQ) about the guidance in 2012.[20] However, while the supervisors provide guidance on the governance and measurement of interest rate risks (including periodic stress testing), that guidance has no direct link to banks' capital requirements.

In principle, the supervisory stress-tests used in the CCAR exercises could provide a mechanism for incorporating interest rate changes into the analysis of banks' capital adequacy. The models used in these stress-tests reflect the effect of the change in rates on estimated PPNR and, where relevant, on estimated credit losses over the next two or three years.

However, the supervisory stress-tests have a variety of weaknesses as tools for measuring interest rate risk for capital adequacy purposes. First and foremost, the stress-tests, as currently conducted, do not use the wealth of detailed information about assets in the banking book used in the loss analysis. Rather, the Board of Governors of the Federal Reserve (2013, p. 46) reports that its stress-test model for PPNR uses a series of "autoregressive models that relate the components of a BHC's revenues and non-credit-related expenses to BHC characteristics, and to macroeconomic variables." It further reports that models are estimated for 17 different components, including 5 components of interest income and 3 of interest expense. The reliance on highly aggregated data and regressions based on historical data would seem to afford considerable opportunity for banks to increase their actual exposure to interest rate changes without showing appreciably higher exposure in stress-tests.

Moreover, even if the stress-tests did model individual items in the banking book, they could at best partially capture the risk of those positions because the stress-tests focus on book values

18 Bloom (2008) shows that the addition of a leverage ratio may also increase the effectiveness of the advanced approach of Basel II in two ways: (a) the leverage ratio reduced the extent to which a bank may reduce its capital requirements by understating risk and (b) a higher leverage ratio makes supervisory threats to fine banks that are found to understate risk more credible. Not only can properly designed stress-tests help accomplish the first goal in a more risk sensitive way than the leverage ratio but the enforcement mechanism used in the stress-tests (changes to banks capital distribution plans in good times and requirements to issue new capital in bad times) is credible in a wider variety of circumstances.

19 Becker (2013) reports that efforts are under way at the Basel Committee on Banking Supervision but that these efforts are at a relatively early stage.

20 The guidance and the FAQ were issued as "Interagency guidance" jointly by the Board of Governors of the Federal Reserve System (FRB), the Federal Deposit Insurance Corporation (FDIC), the National Credit Union Administration (NCUA), the Office of the Comptroller of the Currency (OCC) and the State Liaison Committee as Interagency. The 2010 guidance is available at http://www.federalreserve.gov/newsevents/press/bcreg/bcreg20100107.pdf and the FAQ is available at http://www.ffiec.gov/PDF/01-12RR_FAQs.pdf [accessed 21 September 2013].

rather than market values. For example, a shift up in the term structure of interest rates will decrease the value of a 30-year, fixed-rate mortgage loan both because of higher discount rate applied to all of the loan repayments and slower prepayments at a time of high reinvestment rates. However, the current supervisory stress-tests only capture lost income over the next three years, essentially the losses that may arise because higher rates increase the cost of funding but do not increase the rate paid on a fixed-rate mortgage.

Another weakness of stress-tests is that they only measure interest rate risk for the tested scenarios. Banks may have considerable interest rate risk, but that risk may be concentrated in scenarios that are not examined. For example, banks may seek to compensate to boost their spread income in a low interest rate environment by investing in longer maturity assets while holding the maturity of their funding constant. However, if supervisors' primary concern is credit risk, the stress-tests may focus on scenarios in low or negative economic growth scenarios, which may capture the banks' exposure to credit risk but which assume continuing low rates and hence miss the banks' interest rate risk.

Moreover, even if the supervisors try to stress banks' exposure to interest rate risk, the tests may fail to capture the risk. One way this could happen would be if the supervisors try to stress banks' exposure to rates by including a scenario with sharply rising rates but some banks make a contrarian bet. That is, some banks position their portfolios to gain from rate increases at the cost of being exposed to rate declines.[21] Another alternative, facilitated by the existence of interest rate options (including embedded options), is that a bank is hedged against large interest rate moves but exposed to losses from smaller moves. For example, if supervisors develop a reputation for stressing banks using a 200 basis point change, a bank might be able to acquire out of the money options that provide an effective PPNR hedge against 200 basis point moves but provide no PPNR protection against 190 basis point moves.[22]

5. Capital mis-measurement

The measures of capital used in Basel capital accords (Basel I, II and III) are taken directly from banks' financial statements, with only mechanistic adjustments reflecting the impact of various items on a bank's ability to absorb losses.[23] Unfortunately, financial accounting principles balance a variety of objectives and give bank management responsibility for a large number of judgmental decisions. As result, the supervisory capital ratios (all of which are based on financial accounting measures of capital), lacked credibility during the financial crisis of 2008 [Wall (2013b)].

In contrast, stress-tests are designed to measure changes in capital given a particular scenario. A sufficiently adverse scenario maintained over a long enough period is likely to force a bank to (at least partially) recognize credit losses embedded in their portfolio. The SCAP scenario was adverse and had a two-year horizon, partly to force recognition of the embedded credit losses. As a result, one of the accomplishments of SCAP was to help restore confidence in banks by providing better estimates of the unrecognized losses embedded in their portfolios.

A weakness of stress-tests in measuring capital is that their effectiveness depends in large part upon the stress scenario being tested. A sufficiently favorable scenario may not require a bank to recognize most of the embedded losses in its portfolio. Wall (2013b) emphasizes that U.S. supervisors could choose a stressful scenario being confident that the results would not adversely impact market participants' confidence in banks' existing values (the post-Lehman runs suggested that participants already had little confidence in reported equity) and the U.S. supervisors had a mechanism for addressing any capital inadequacies that could not be made good by private issues of new capital (Capital Purchase Program of the Troubled Assets Relief Program, TARP).

Another set of changes that may partially reduce the relative value of stress-tests in measuring capital would be the proposed changes in accounting standards. Wall (2013a) discusses a proposal by the Financial Accounting Standards Board (FASB) that would require banks to recognize expected losses rather

21 Admittedly, this is a scenario more easily imagined if short-term rates were several percentage points higher than their current level.

22 See Jarrow (2013) for a discussion of the incentive created by stress-testing to concentrate risk in the extreme tail of the loss distribution.

23 For example, certain intangible assets are deducted from capital reflecting likely declines in the values of these assets in a distress situation.

than incurred losses, which result in earlier loss recognition and eliminate an important source of managerial discretion to delay loss recognition.

6. Countercyclical capital buffers

Capital adequacy rules that require a constant minimum throughout the business cycle are unavoidably procyclical.[24] Estimates of riskiness for RWA purposes are likely to be at cyclical lows during boom times and additional capital is likely to be readily available, especially additional retained earnings.[25] As a result, banks are best able to expand their lending and support economic growth when times are already good. Conversely, risk estimates are likely to be higher and losses may be depleting capital during stress periods, reducing bank's ability to lend and possibly leading them to refuse to roll over or make new loans to good customers.

The problem of procyclical capital regulation during the crisis sparked efforts to vary capital requirements in a countercyclical manner to dampen loan growth in boom times and facilitate bank lending during bad economic times. One result was that Basel III was modified to include a countercyclical capital buffer. The size of this buffer is to be determined by national supervisory authorities within a range of 0% to 2.5%.

The questions that national authorities must answer are when to invoke this buffer and how large a buffer should be required of banks. The problem with non-discretionary triggers is that the state of the art for measuring the buildup of risks to financial stability is not very advanced.[26] The alternative is to give the supervisors discretion in setting the buffer. Supervisory determined buffers are unlikely to be consistently set at optimal levels, but without any external pressure the buffers would likely be varied in ways that are superior to the current fixed buffers. However, a discretionary decision to change the buffer will surely be a high-profile decision that will attract public attention. Supervisors considering a change in the buffer will face considerable external pressure to not increase the buffer in a timely manner (or to prematurely decrease the buffer) from banks, and sectors of the economy benefiting from economic booms.

Stress-tests provide another, not mutually exclusive, mechanism for enforcing countercyclical capital buffers. As Acharya (2012) notes, a way of accomplishing this would be to use an adverse scenario that does not moderate during good times. For example, the assumption of a 10% unemployment rate may imply only a small increase in unemployment during a recession but a rather larger increase in unemployment during a boom. As a result, banks would automatically need to hold a larger capital buffer during good times than bad. Moreover, the use of such a constant scenario over the business cycle would likely put the supervisors in a better position to defend countercyclical capital requirements than a purely discretionary decision under Basel III.

7. Conclusion

Basel III and stress-testing represent significant increases in the sophistication and cost of measuring banks' capital adequacy. This paper discusses a variety of ways in which stress-testing could be used to mitigate problems with Basel III. These problems, including cases where Basel III underestimated credit risk, but not explicitly include interest rate risk, relies on potentially inflated estimates of bank capital and on the use of politically vulnerable discretion for the implementation of its countercyclical capital buffer.

The weaknesses in Basel III can be mitigated by stress-testing because of differences in the way the two measures are structured and implemented. Stress-testing can mitigate the incentives created by Basel III credit risk underestimation for three reasons: (a) stress-test errors are unlikely to be perfectly correlated with Basel III errors, (b) stress-tests are less reliant on models run by banks and (c) stress-test scenarios can be designed to address weaknesses in both the Basel III risk weightings and supervisors' perception of estimation error in the stress-test models. Stress-testing could mitigate the failure of Basel III to include an explicit interest rate risk component by including an interest rate stress scenario in the analysis and using more granular data on individual bank's current exposure. Stress-testing can mitigate Basel III's use of possibly overvalued book capital by forcing banks to estimate losses over a multiyear period

24 The actual effect in practice, however, is likely to be somewhat less procyclical as regulatory capital adequacy requirements give banks an incentive to build up capital buffers in good times, which can then be run down during periods of stress.

25 See Repullo and Suarez (2012) and Andersen (2011).

26 See Edge and Meisenzahl (2011) for a discussion of the unreliability of one proposed measure of buildups, the credit-to-GDP ratio. See also Pritsker (2012) who provides a recent theoretical analysis of the choice of stress-test scenarios.

in scenarios in which economic conditions do not improve enough to make good embedded credit losses. Finally, stress-testing can mitigate Basel III's reliance on the exercise of discretion for countercyclical capital buffers by the use of scenarios that do not become significantly more adverse during downturns.

Given that stress-tests can add value, the question becomes will they add value. The answer depends, to a very considerable degree, upon the stress-test scenarios implemented by banks and supervisors. Identifying the buildup of risky credit exposures before they turn into large losses requires that the supervisors are willing to test seemingly very adverse scenarios at a time when banks are still doing relatively well. Similar to identifying economic losses in a stressful situation, supervisors will require the use of a scenario that could potentially reveal losses that would leave some banks reporting capital well below regulatory minimums over parts of the stress horizon. Although such risk identification ex-ante and loss recognition ex-post are possible using stress-tests, supervisors have not always been particularly aggressive in using their other powers to identify risks or require loss recognition. Whether this supervisory reluctance will change merely because the supervisors are now employing stress-tests is not obvious.[27]

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27 Indeed, the 2010 and 2011 European stress-tests already provide an example where stress-tests were designed and implemented in a way that gave a misleadingly favorable impression of many bank's condition, see Ahmed et al. (2011) and Wall (2013b).

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