

Understanding the Effects of the U.S. Stress Tests

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Stress Testing: A Discussion and Review
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Understanding the Effects of the U.S. Stress Tests

I. Introduction

Concurrent stress tests—testing all major banks with the same macroeconomic and market scenarios at the same time—were a key innovation growing out of the financial crisis of 2007-09. Their original intent in 2009 was to identify the capital needed by banks to continue functioning in a deep recession and require them to raise the capital, from private sources or the government, to support the economy. The stress tests were an important part of the government’s response to the financial crisis, and are viewed as critical to bolstering public confidence in the banking system and ending some of the worst moments of the crisis.

The stress tests have evolved considerably since 2009, but the underlying rationale remains to assure that major banks can continue to supply credit to households and businesses in circumstances of deep economic and financial distress. The tests allow policymakers to assess the adequacy of capital buffers and to require remediation when necessary through modifications to institutions’ capital plans.

Assurance that banking services can continue to be delivered under severely adverse conditions requires that banks not only have enough capital to withstand the severe stress scenario that the Federal Reserve Board stipulates, but also that banks have robust enough risk management and capital planning processes to identify and react to their own individual risks in a forward-looking manner. To that end, the tests encompass an assessment of the capital planning processes at participating banks.

Stress tests are a strong microprudential tool, with important macroprudential elements. They stress each individual bank sheet against a common scenario and test that bank’s capital adequacy. They also strengthen microprudential regulation by giving supervisors quantitative insight into the characteristics of each bank’s portfolio and into the modelling and risk management, and capital distribution practices of each bank.

The macroprudential elements of the stress tests arise from: the scenario design, which is set to vary over time with the economic and financial cycles; the requirement to hold portfolios constant in the stress, which is intended to assure that in such circumstances banks don’t need to reduce credit supply in order to maintain adequate capital ratios; and the requirement to hold enough capital to fund future capital distributions even in a severe stress, as distributions rise in good times and fall in bad.

Our objective in this paper is to assess some of the effects of this new prudential tool as implemented in the United States, to contribute to the Federal Reserve Board’s review of its supervisory stress tests.¹ Vice Chairman for Supervision, Randal Quarles, has reached out to the public to participate in the review which has a goal “to preserve the strength of the test, while

¹ This paper is one of three papers written for the conference. One of the others is on stress testing as a policy tool for setting capital requirements or for other policy purposes, and another is on dynamism and transparency of stress tests.

improving its efficiency, transparency, and integration into the post-crisis regulatory framework.”²

A challenge for assessing the effects is to separate the effects of stress tests from the effects of the many other changes in bank regulation that followed the Global Financial Crisis, and from the effects of the natural and desirable shift in bank risk appetite after the excesses of the 2000s that led to the crisis. For example, the level of bank capital relative to total or risk-weighted assets has risen substantially since the years before the crisis. Undoubtedly this rise reflects the phase in of Basel III point-in-time capital standards, including the capital conservation buffer and the surcharge for global systemically important banks (GSIBs), as well as the capital requirements implied by the stress tests.

Thus, we frame our questions to focus on features of the stress tests that distinguish them from higher regulatory capital requirements. In particular, capital requirements implied by the stress tests will be forward-looking and based on tail risks, will change more with economic and financial conditions, and may affect banks’ risk management practices in ways different from point-in-time regulatory requirements.

For this paper, we analyze the data that are publicly disclosed about the stress tests for their implications for bank capital requirements and risk management, and we marshal the evidence from existing studies on the effects of stress tests on credit rather than undertaking new efforts. In addition, we interviewed a number of people knowledgeable about the stress tests to get their views on their effects. These included current and former supervisors and Federal Reserve economists (some of whom are now at consultancies advising banks on stress tests or at interest groups), current and former bankers involved in the stress tests at the banks, and other interested observers.³ This helped us fill in some of the gaps.

That said, there are a number of important caveats. A major purported benefit of the stress tests is the increased resilience of the financial system in a major economic downturn, as banks with forward-looking, less procyclical capital buffers will not pull back as much when the downturn occurs. But we have not yet experienced a downturn, so we do not really know how banks, investors, and supervisors will react. In addition, the empirical studies of the effects of stress tests on the cost of credit cover a period in which banks were also transitioning to higher point-in-time capital requirements. Studies of longer-run effects of higher capital suggest that longer-run effects could well be smaller after banks adjust and if monetary policy can offset higher costs. Moreover, studies do not evaluate welfare effects if credit supply shifts from larger banks that are subject to the stress tests to smaller banks or nonbanks.

² Randal Quarles, Inviting Participation: The Public's Role in Stress Testing's Next Chapter, February 06, 2019. <https://www.federalreserve.gov/newsevents/speech/quarles20190206a.htm>

³ We conducted 14 interviews involving 17 people. Respondents were assured of confidentiality and anonymity.

We focus on looking at the evidence on the following three questions about stress test effects.⁴

1. Have the stress tests helped to counter potential procyclicality of bank capital?

Yes, and that should help lending in the next recession, though perhaps more because of the requirement to pre-fund their proposed dividends and share repurchases than the countercyclical macroeconomic scenarios.

An important difference between the stress tests and Basel III point-in-time capital requirements (as implemented in the U.S. with the countercyclical capital buffer set at zero) is that the stress tests aim to reduce procyclicality from the construction of the scenarios. In the scenarios, certain critical variables--importantly the unemployment rate--are stressed to at least a minimum level of 10 percent each year, which implies that the lower (higher) the current unemployment rate, the greater (lesser) the increase and hence degree of stress. So, other things equal, stress test-related capital requirements should increase in good times (and decrease in bad after losses have already been realized).

In the past several years with an expanding economy, capital ratios relative to risk-weighted assets for the largest bank holding companies (BHCs) have been flat rather than declining, as they might have as loan quality improved with the economy. Of course, the ratios might reflect the continued phase in of Basel III and the natural rebuilding of capital post crisis. But CCAR, which many observers cite as the marginal constraint on capital, probably also contributed to the maintenance of capital ratios. For domestic BHCs that are not GSIBs, the capital requirement from the stress tests excluding shareholder payouts has risen since 2014. In contrast, for the GSIBs, while the stress-test capital requirements excluding shareholder payouts are somewhat higher on balance in 2018 than in 2014, there has not been an underlying upward trend.

The requirement in the stress tests for prefunding future shareholder payouts (dividends assuming they continue at last year's level for DFAST, and planned distributions--both dividends and share buybacks--in CCAR) may have been an even more powerful countercyclical force. Because dividends and buybacks have been rising, as generally the case in good times, the capital required related to the prefunding also has been rising. This rise has been more pronounced for the GSIBs than the non-GSIBs.

Consequently, a good part of the benefit of a countercyclical impulse for capital from the stress test would be lost if the supervisory program were to scale back substantially its requirement to pre-fund shareholder payouts. The pre-funding of share repurchases and the willingness of banks to scale back share repurchases by more than dividends would provide a significant

⁴ In this paper, we use the term stress tests to refer to either or both Dodd Frank Stress Tests (DFAST) and the Comprehensive Capital Analysis and Review (CCAR). DFAST is a quantitative assessment of whether banking firms have enough capital to withstand a severe recession and assumes that dividends will be at a pace equal to that in the past year and share repurchases will be zero. CCAR is a supervisory program to assess both capital adequacy in a severe recession and the quality of internal processes that firms use to assess their own capital needs. For the quantitative part of CCAR, banks' proposed plans for dividends and share repurchases are incorporated rather than assuming dividends at the past year's pace as in DFAST. DFAST and CCAR use the same macroeconomic and financial scenarios and hence, when the minimum quarter is the same, give the same estimates of losses from credit and market exposures and counterparty default.

absorber of losses if the economy were to enter a recession. A simple example below illustrates the significance of this requirement for the ability of banks to weather the start of a recession and a subsequent CCAR without having to cut back dividends or raise new equity; concerns about that possibility might lead banks to reduce lending precisely at a time when they are most needed to continue to lend and support the economy.

2. Have the stress tests improved risk management and capital planning at tested institutions?

Yes, absolutely, driven importantly by the public qualitative assessment.

As noted, the CCAR tests have focused not only on the quantity of capital after a severe stress, but also on the quality of the capital planning processes. The Federal Reserve has objected to a bank's plans to distribute capital through dividends and share repurchases not only on the quantitative grounds of insufficient capital post stress, but also on the "qualitative" grounds that aspects of capital planning are deficient; it also has issued "conditional nonobjections" in which distributions could go ahead as planned but processes needed improvement. The public character of these qualitative assessments was designed to motivate improvements in capital planning processes.

In our discussions with participants and informed observers, all judged that stress tests and the public qualitative assessments had greatly improved risk management and capital planning. Banks were focusing much more on tail risks in loan books and had greatly improved their ability to model the capital effects of these risks. Risks were being assessed holistically across the entire institution, whereas before they had been mostly viewed on a division by division basis. In addition, the upper management and boards of directors now were more closely involved in risk management and capital planning on a forward-looking basis.

In addition, the stress test capital planning requirements appear to have mitigated the effects of earnings distributions on the procyclicality of capital. Requiring banks to meet minimum capital levels in a stressful period even while executing (under CCAR) planned capital distributions through dividends and share repurchases has linked the decisions on distributions to the risks that firms might face in the future. Moreover, dividend payments, which have been harder to reduce under adverse circumstances than share buybacks, have become a smaller proportion of distributions, at least partly under the influence of an informal 30 percent limit on dividends in the stress test assessments.

3. Have the stress tests affected the cost and availability of credit from the largest banks?

Yes, but this may be a feature rather than a bug.

We review a number of empirical studies for the effects of stress tests and assess that, on balance, stress-tested banks do appear to have increased loan spreads relative to non-stress-tested banks and to have reduced the availability of loans, most particularly riskier ones. Most studies, however, cannot distinguish between the effects of stress tests and those of regulatory capital

requirements and other regulatory changes that were put in place for the largest banking firms following the financial crisis. Still, because stress tests appear to be the marginal constraint for many stress-tested banks, the capital charges related to them should affect the funding costs of the banks, which could be passed through, at least in part, into the cost and availability of credit from the banks to borrowers.

Many of the studies making this finding focus on business loans. Firms large enough to tap the bond markets or have access to syndicated loans have had readily available and relatively inexpensive alternatives to borrowing from banks. Smaller businesses have fewer alternative sources of credit, but studies that look at county- or local-market level credit suggest that smaller banks have stepped in to supply credit to smaller businesses, though presumably at a higher price than those businesses would have been paying for credit from the larger stress-tested banks.

Just a few studies have looked at residential mortgage lending. While these loans at commercial banks have fallen, the empirical evidence for the effects of the stress tests is inconclusive. One study shows that stress-tested banks pulled back from jumbo mortgages in 2011, but not in other years; another shows no effect; a third shows negative effects but cannot distinguish a separate effect of stress tests on mortgage credit availability from the many other changes applicable to the regulatory treatment of mortgage loans.

It's important to emphasize that any effects of stress tests (or other new regulations) on credit cost and availability from the largest banks may be a feature rather than a bug. Manifestly, credit was too readily supplied before the reckoning of the crisis relative to capital available to absorb losses, and not only in residential real estate. And the excesses of the largest banks that put them at risk had the greatest externalities. None of the studies makes a judgment about whether the reduction in the supply of credit has pulled it back beyond the socially optimal level that incorporates externalities.

II. Stress tests and bank capital

Do stress tests mitigate procyclicality of bank capital?

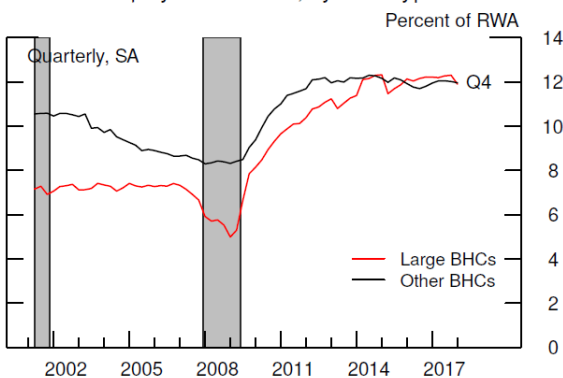
Stress tests in the U.S. have been operationalized so that banks would build buffers that they can draw down while continuing to lend when the economy enters a deep recession, and in this way try to mitigate procyclicality. This feature is consistent with a major objective of Basel III to reduce the procyclicality of bank capital standards, in addition to raising the quantity and quality of capital. In March 2009, the Group of 20 issued a statement to establish new standards *to mitigate procyclicality, including a requirement for banks to build buffers of resources in good times that they can draw down when conditions deteriorate.*

Bank capital ratios increased substantially after the crisis through about 2014 and have remained at higher levels since then (figure 1). The higher levels are due to a combination of higher Basel III requirements and banks' own choices to rebuild capital, as well as the stress tests. CCAR stress test capital buffers (STCBs), which have increased from about 5 percent in 2014 to 6.25

percent in 2018 (figure 2), suggest they are supporting the higher capital ratios in recent years. The CCAR STCBs are measured by the difference in the starting CET1/RWA ratio to the minimum CET1/RWA implied by the combined path of net losses to capital (losses minus pre-provision net revenues and adjustments) and total proposed shareholder distributions through the quarter of the minimum capital ratio.

Figure 1.

Common Equity Tier 1 Ratio, by BHC type

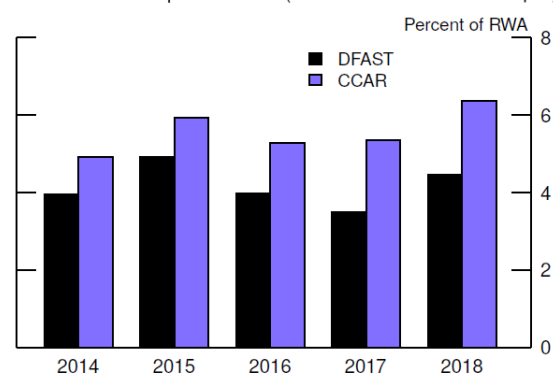


Note: Prior to 2014:Q1, the numerator of the CET1 ratio is Tier 1 common capital for adv. approaches BHCs (prior to 2015:Q1, for non-adv. approaches BHCs). Afterwards, the numerator is CET1 capital. Large BHCs are domestic firms with \$50 billion or more in total consolidated assets. Series shown are weighted means.

Source: FR Y-9C.

Figure 2.

Stress Test Capital Buffer (Decline in Common Equity Ratio)



Note: Capital buffer is starting capital minus minimum capital for domestic BHCs. Prior to 2015, the numerator of the CET1 ratio is Tier 1 common capital for adv. approaches BHCs (prior to 2016, for non-adv. approaches BHCs). Afterwards, the numerator is CET1 capital. Minimum quarter may not be the same under DFAST and CCAR.

Source: Public DFAST and CCAR stress test disclosures.

DFAST STCBs are less than those for CCAR each year, and are only modestly higher in 2018 than they were in 2014. DFAST STCBs are lower than for CCAR because DFAST assumes only dividends at a rate based on dividends in the past year, and therefore excludes any proposed increase in dividends and any share repurchases. Neither the CCAR nor DFAST capital buffers, however, have declined on net from 2014-18, which might have been expected as the quality of loans on bank balance sheets tends to improve with the economic expansion.

One way the stress tests mitigate procyclicality is through the construction of the macroeconomic scenarios. In the severely adverse scenario, the unemployment rate is stressed to at least a minimum level each year, 10 percent, which means that the lower the unemployment rate, the greater the increase, implying higher stress (figure 3). Other macroeconomic variables in the scenarios are specified through a large macroeconomic model, FRB/US, to be consistent with the stress to the unemployment rate. House prices have been specified to fall by more when prices were high, and less when prices are low, and guidance has been issued recently to achieve a minimum house price-to-income level rather than a price level. The scenario may also incorporate salient risks to evaluate whether banks are resilient to building financial vulnerabilities, such as the sharp rise in leveraged loans and high levels of corporate debt, and the scenarios in 2018 reflected sharper than typical increases in BBB-rated corporate yields (figure 4). Other things equal, STCBs should rise in good times and fall in bad times.

Figure 3.

Unemployment Rate in Supervisory Scenarios

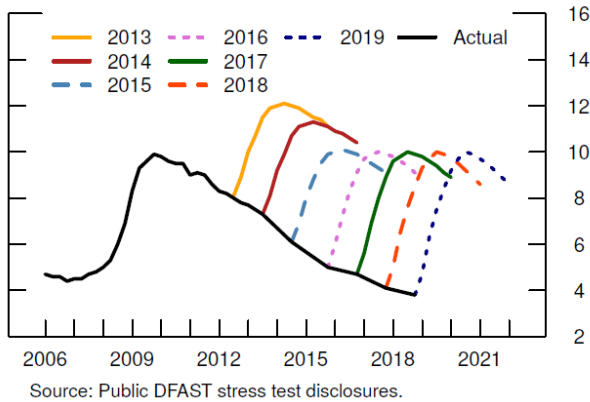
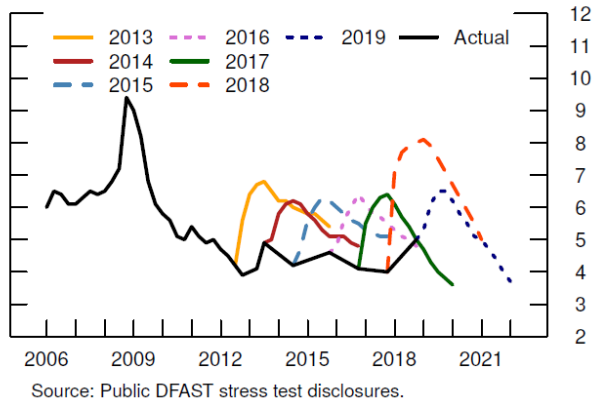


Figure 4.

US BBB Corp Yield in Supervisory Scenarios



Another way that stress tests mitigate procyclicality of capital requirements is by requiring that proposed shareholder payouts, both dividends and share repurchases, be included in the CCAR STCB. Share repurchases are a flexible form of payout and generally increase when “free cash flow” rises and decrease when free cash flow falls, and thus can act as a shock absorber for bank losses (Brav et al, 2004). Common dividends also tend to increase with excess cash flow, but they tend to be sticky on the downside--indeed firms were slow to cut dividends at the onset of the crisis in 2008 whereas share repurchases were cut quickly (figures 5 and 6). In CCAR, banks that want to increase payouts are expected to show they would have sufficient capital to carry through their plans even in a severe recession, given their reluctance to cut them in the past. Since firms tend to increase payouts in good times, CCAR STCBs should rise in good times and fall in bad times, and will fall by more if dividends are a smaller share of payouts. In this regard, as discussed below, the supervisory soft limit for dividends to be 30 percent of distributions will likely contribute to mitigating procyclicality of required bank capital ratios.

Figure 5.

Common Dividends, 2003-2018

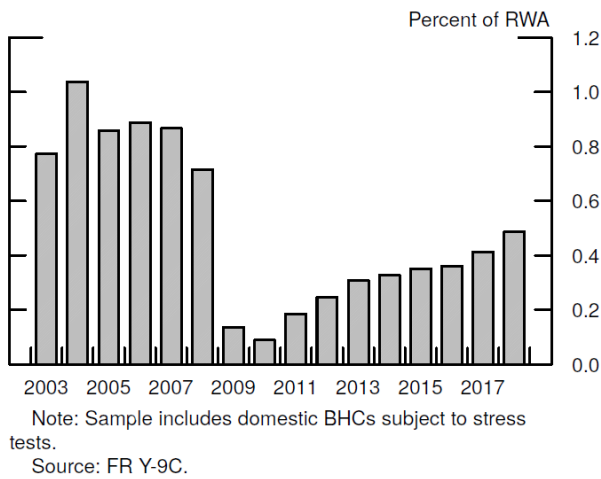
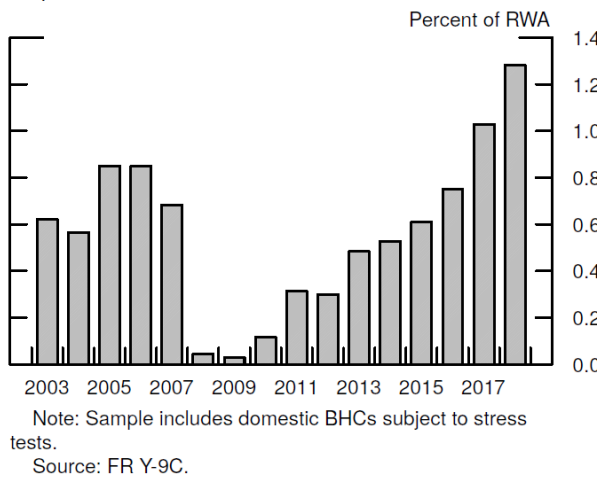


Figure 6.

Repurchases, 2003-2018



To see the relative contributions of the macroeconomic scenario and shareholder payouts to rising STCBs, we decompose the STCB into net losses (losses minus pre-provision net revenues and adjustments) and assumed shareholder payouts.⁵ We also separate the firms into the eight GSIBs, which are subject to a market trading shock and a counterparty default shock, and the other domestic BHCs, called non-GSIBs. We define:

$$STCB = \text{Starting CET1/RWA} - \text{Minimum CET1/RWA}$$

$$\begin{aligned} STCB_CCAR &= \text{Net losses} + \text{Proposed shareholder payouts (at minimum CET1/RWA)} \\ &= (LOSSES - PPNR - Adj) + (DIV^* + REP^*) \end{aligned}$$

$$\begin{aligned} STCB_DFAST &= \text{Net losses} + \text{Assumed dividends (at minimum CET1/RWA)} \\ &= (LOSSES - PPNR - Adj) + DIV_{t-1} \end{aligned}$$

where *LOSSES* are estimated losses from loans and securities in the banking book, losses from the market shock, and losses from the single largest counterparty default, *PPNR* is pre-provision net revenue, *Adj* is adjustments, such as changes in the tax code, *DIV** is proposed dividends, *REP** is proposed share repurchases, and *DIV_{t-1}* is assumed dividends based on the most recent four-quarter rate.

For this decomposition, we use the DFAST estimates since we can approximate dividends with the previous four quarters of dividends (and multiply the average by the estimated number of quarters until the minimum ratio is reached), whereas information on proposed shareholder payouts for individual firms for CCAR is confidential and not available. That is, *STCB excluding dividends = Net losses = STCB_DFAST - Div_{t-1}*.⁶

As shown in figures 7 and 8, the STCB excluding dividends in 2018 was about 4.3 percent for GSIBs and 2 percent for non-GSIBs. There is not much trend in the STCB excluding dividends for the eight GSIBs, even after abstracting from the large value in 2015, but there has been an upward trend for the non-GSIBs. We interpret these patterns to suggest that the countercyclical scenario design is leading to higher net losses on the bank books (loans and securities) even as current economic conditions and loan performance improve, predominantly reflecting credit

⁵ Adjustments include, among other items, changes incident to business combinations that result in regulatory capital, tax loss carryforwards, and changes in the tax code. Specific data for these adjustments, such as due to differences in tax liabilities, are not provided by firm in the public disclosure documents. Berrospide et al (2019) disclose them in the aggregate for each year 2014 to 2018 (0.34, 0.14, 0.58, 0.49, 0.54, respectively). They vary across years but do not exhibit a trend.

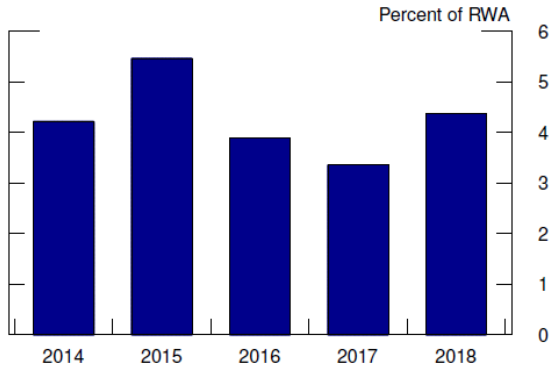
⁶ *Net losses* are the same under DFAST and CCAR, and our measure based on DFAST will match CCAR if the quarter in which the capital ratio reaches its minimum is the same in both DFAST and CCAR.

losses in the severely adverse stress scenario, but losses for the trading account and the largest counterparty default have not been rising. Indeed, trading losses (which include counterparty losses) are fairly constant over the sample period, about 1.6 percent of RWA in each year from 2014 to 2018, except for a dip to 1.2 percent in 2017 (see Berrospide, et al, 2019).

A different pattern emerges for dividends, shown by dividends estimated through the quarter the minimum capital ratio occurs for DFAST. There is a clear upward trend in dividends for the GSIBs, and the amounts have increased from about 0.4 percent of RWA to 0.7 percent of RWA, assuming the minimum quarter for most of the GSIBs is reached in the fifth quarter of the scenario horizon (figure 9). In contrast, dividends have been relatively steady at less than 1.0 percent of RWA for the non-GSIBs, assuming the minimum quarter for the non-GSIBs is reached in the eighth quarter of the scenario horizon (figure 10).

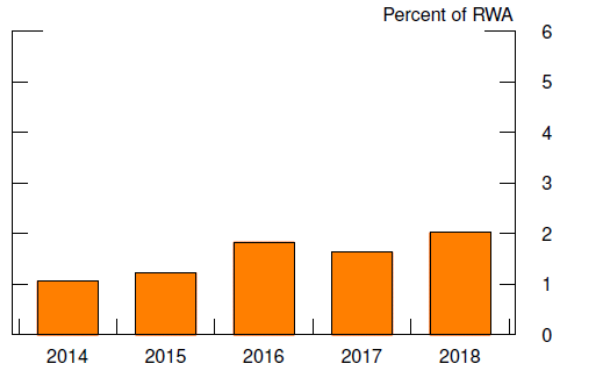
Figures 7 - 10

Stress Test Capital Buffer Excluding Dividends, GSIBs



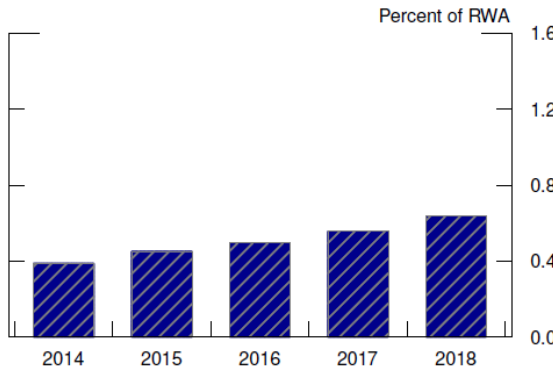
Note: DFAST capital buffer is starting capital minus minimum capital, less estimated dividends for 8 BHCs subject to the market shock and counterparty default.
Source: Public DFAST stress test disclosures.

Stress Test Capital Buffer Excluding Dividends, Non-GSIBs



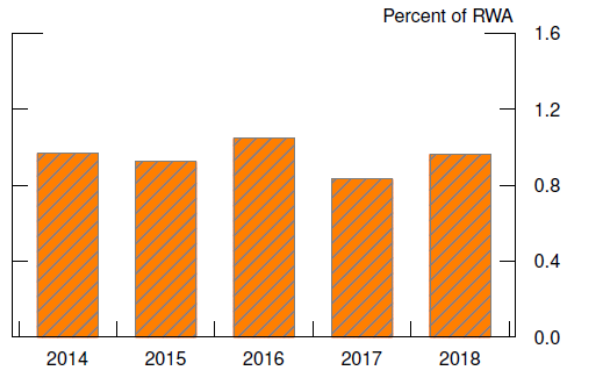
Note: DFAST capital buffer is starting capital minus minimum capital, less estimated dividends for other domestic BHCs.
Source: Public DFAST stress test disclosures.

Estimated Dividends to Minimum, GSIBs



Note: Estimated dividends are calculated under the DFAST framework for 8 BHCs subject to the market shock and counterparty default assuming minimum capital ratio is reached at 5 quarters.
Source: FR Y-9C and public DFAST stress test disclosures.

Estimated Dividends to Minimum, Non-GSIBs

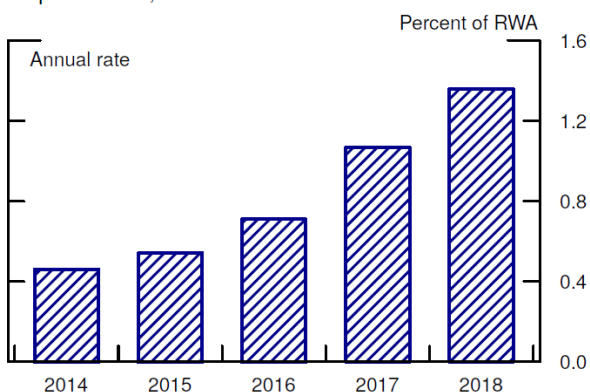


Note: Estimated dividends are calculated under the DFAST framework for other domestic BHCs assuming minimum capital ratio is reached at 8 quarters.
Source: FR Y-9C and public DFAST stress test disclosures.

While, as noted previously, proposed share repurchases are not available, actual data on repurchases show a steep upward trend in recent years for both GSIBs and non-GSIBs (figures 11 and 12). Actual share repurchases for GSIBs have risen sharply from about 0.5 percent of RWA to 1.4 percent in 2018, and have risen almost as notably for the non-GSIBs. These data indicate that the net rise in capital requirements from CCAR for the GSIBs comes primarily from the requirement that banks need to demonstrate they have sufficient capital to carry out their proposed shareholder distributions even in a severe stress, and less from *Net losses*.

Figure 11.

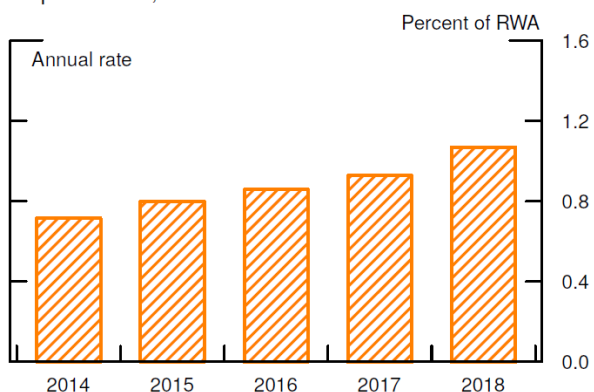
Repurchases, GSIBs



Note: Sample is 8 BHCs subject to the market shock and counterparty default.
Source: FR Y-9C.

Figure 12.

Repurchases, Non-GSIBs



Note: Sample is other domestic BHCs subject to stress tests.
Source: FR Y-9C.

In sum, shareholder payouts have increased substantially in recent years, and the CCAR STCB for GSIBs is divided roughly into *Net losses* which have not risen much in recent years and proposed shareholder payouts which have. While macro scenarios get most of the attention for their role to attenuate procyclicality, the estimated *Net losses* have not increased notably on net (though they also do not fall) for the largest banks with the economic expansion. The assumptions about shareholder payouts seem to be more important for mitigating capital procyclicality of the largest banks. For stress-tested non-GSIB banks, both *Net losses* and share repurchases seem to have driven the increase in capital requirements from CCAR.

Does uncertainty about stress tests lead to higher capital?

Another effect of CCAR could be on the level of capital. First, the CCAR STCB might be larger than the Basel III-required capital buffers of SIFI surcharges and capital conservation. Banks and expert observers often cite the capital implications of the stress tests themselves as the marginal regulatory constraint on capital, keyed to the leverage ratio requirement for the GSIBs and the risk-weighted requirement for the others. A severely adverse scenario in CCAR that led to higher capital could reflect the risk appetite of the regulators in constructing the scenarios and have little societal cost if that risk appetite were to mirror that of society's. Second, a bank also may choose to hold an additional buffer to protect its ability to distribute earnings in the face of

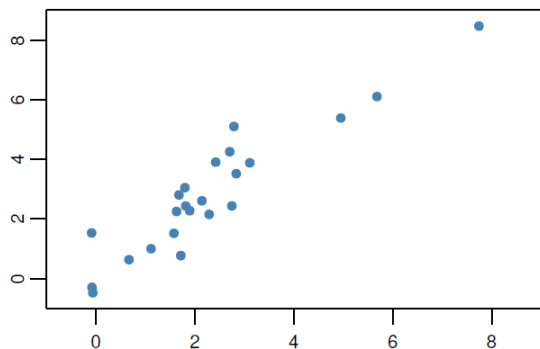
uncertainty. In this case, there could be net gains to reduce uncertainty about the test that was above levels consistent with uncertainty about possible future economic and financial conditions.

Capital requirements under stress tests are more uncertain than under regulatory point-in-time requirements, due in part to variation in macroeconomic scenarios each year and the unknown specifications of the Federal Reserve’s models used to run the tests. Some of the variation in the macroeconomic scenarios arises from changes in the starting unemployment rate but also different degrees of stress in some credit markets because of possible salient risks. Greenwood et al (2017) argue that the primary benefit of stress tests relative to hard-coded regulatory requirements is from supervisors having some flexibility to design scenarios to test the resiliency of banks to negative shocks based in part on which balance sheet exposures have been rising rapidly. That is, neither supervisors nor banks can know with certainty what the exact source of potential losses might be for the banks each year, so introducing some variation in risks provides a better chance of protecting the system than a static scenario.

We look at year-to-year variation in estimated STCBs excluding dividends (*Net losses*). Correlations vary by year and were as high as 0.93 between 2017 and 2018 values and as low as 0.75 between 2015 and 2016 (figures 13 and 14). Regression analysis for STCB excluding dividends using a pooled time-series for 2014-18 shows a positive and significant coefficient of 0.80 on its lag. Of course, different components of *Net losses* may vary more than when combined. While what would be the right amount of predictability each year is hard to specify, it seems almost certainly that it would be below 0.99, nearly perfect predictability, as Glasserman and Tangirala (2015) show for loan losses between 2012-13 and 2013-14, but also higher than random noise.⁷

Figure 13.

Stress Capital Buffer Excluding Dividends, 2017-2018
Percent of RWA



Source: Public stress test disclosures, FR Y-9C.

Figure 14.

Correlation of Stress Test Capital Buffer Excluding Dividends

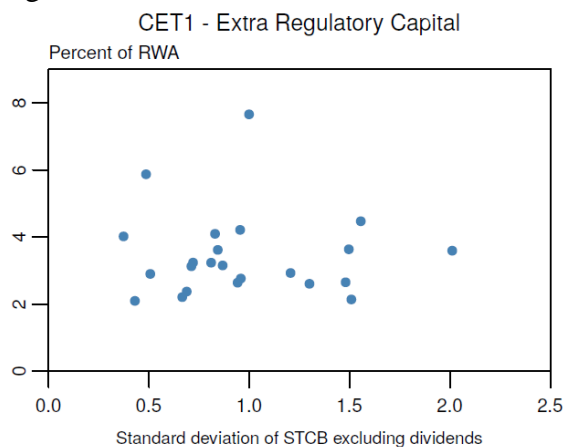
2014-2015	0.86
2015-2016	0.75
2016-2017	0.78
2017-2018	0.93

Source: Public stress test disclosures, FR Y-9C.

⁷ Gutierrez, Schuermann, and Duane (2015) observe that based on analysis for 2012 to 2015, CCAR capital requirements were starting to stabilize and banks were starting to manage their capital more tightly, as it appeared they were not penalized by investors for initial aggressive shareholder payout requests.

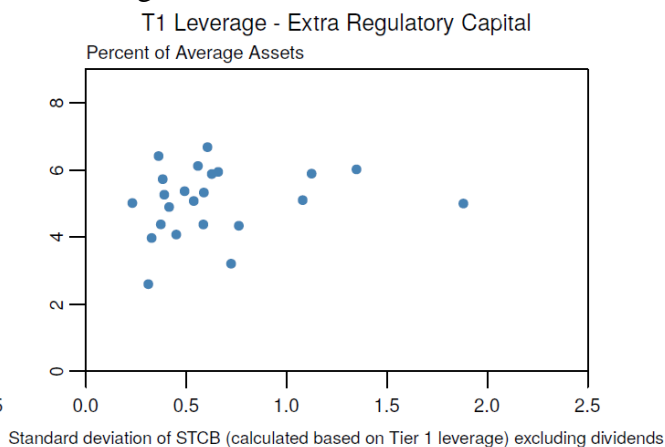
We also look at a firm's standard deviation of its *Net losses* from 2014 to 2018. We find no relationship between the standard deviation and the amount of capital above regulatory minimums at year-end 2018 (2018 CET1/RWA minus required (Minimum + CCoB + GSIB surcharge)) capital and of capital above the leverage ratio (figures 15 and 16). Also, we find no relationship between the coefficient of variation (standard deviation / average of *Net losses*) and extra capital as percent of required (not shown).

Figure 15.



Note: Extra Regulatory Capital is CET1/RWA above regulatory requirements in 2018.
Source: Public stress test disclosures, FR Y-9C.

Figure 16.



Extra Regulatory Capital is Tier 1 leverage ratio above regulatory requirements in 2018.
Source: Public stress test disclosures, FR Y-9C.

In sum, while *Net losses* (STCBs excluding dividends) vary over time, there is a high correlation year-to-year. We do not find strong evidence that uncertainty about *Net losses* is leading systematically to higher capital ratios above minimum requirements, although this is clearly an area where more research would be helpful.

Will bank capital constraints bind in the next recession?

An important question for whether the CCAR program is mitigating procyclicality of bank capital is to consider how banks might fare if the economy were to actually enter a moderate recession and bank capital were to fall significantly before the start of the next annual CCAR. Specifically, is the system designed so that initial buffers are sufficient for bank capital to decline in a modest recession and still be able to demonstrate that it could meet minimum requirements in a new CCAR, reflecting the possibility that the recession could continue or intensify in the following year? If initial buffers are not sufficient, it could imply that the new stress test, even with a less severe scenario as specified in the guidance when the starting unemployment rate is higher, could require that banks raise additional capital in an already weakened economy.

We illustrate the issues with two simple examples, an average GSIB and non-GSIB, to highlight where policy choices can make a difference. We assume there is a moderate recession which

would result in bank capital falling by 1/2 of its *Net losses* in the first four quarters. We assume banks will continue to pay out dividends for four quarters, but will cut back share repurchases to zero after two quarters. We use 2018 data as the starting point.

For a non-GSIB, the starting capital ratio is 11.9 percent of RWA, estimated net losses are 1.0 percent (1/2 of 2.0 percent), dividends are 0.50 percent (4/9 of 1.1 percent), and share repurchases are 0.6. In a normal recession, with the assumptions above, the bank would end the year with capital of 9.8 percent (see Table 1). In this situation, supervisors would then specify a new scenario for the subsequent stress test: for example, the unemployment rate in the severely adverse scenario would be assumed to increase by 3 to 5 percentage points per guidance. This scenario would be viewed as less severe than the previous one in which the unemployment rate was assumed to rise by more than 6 percentage points, to its pre-specified minimum level of 10 percent, but clearly would be severe. Assuming that dividends are not increased and share repurchases would have been shut off in a CCAR submission, the projected *Net losses* would need to be higher than 4.3 percent of RWA before supervisors would disclose that a non-GSIB bank would fall below a required minimum of 4.5 percent. The historical range of average *Net losses* (STCBs excluding dividends in figure 8) from 2014 to 2018 of between 1 and 2 percentage points suggest that this outcome would be unlikely.

For a GSIB, however, the historical range of *Net losses* from 2014 to 2018 are significantly higher than for a non-GSIB, while the starting capital ratio is not much higher. In this case, again using 2018 data as the starting point for this simple example, the starting capital ratio is 12.3 percent, estimated net losses are 2.2 percent (1/2 of 4.4 percent), dividends are 0.6 percent (4/9 of 1.3 percent), and share repurchases are 0.7 percent of RWA (1/2 of 1.4 percent annual share repurchases for these firms in 2018). With these assumptions for a normal recession, the bank would end the year with an 8.8 percent capital ratio (which would be just at the Basel III requirement of 8.83 percent for an average bank with a GSIB surcharge of 1.83 percent in 2018). As above, supervisors would then specify a scenario with a smaller increase in the unemployment rate. If dividends are assumed to not increase and share repurchases are shut off in the new CCAR, a typical GSIB would need to have a projected STCB of less than 3.6 in order to avoid having supervisors disclose a post-stress capital ratio of less than 4.5 percent. A projected STCB excluding dividends of 3.6 percent of RWA is at the lowend of the range of average estimates of 3.25 to 5.5 percent observed from 2014 to 2018. (Given the post-stress tier 1 leverage ratio is the more binding constraint for these firms, that minimum would be hit earlier.) Thus, an average GSIB may view it somewhat likely that the CCAR capital constraint will be binding in the year following the start of a normal recession, and take actions, such as cutting dividends or raising equity, or shrinking assets.

Table 1. Hypothetical capital ratios after a normal recession starts and followed by a new CCAR

(percent of RWA)	Average Non-GSIB	Average GSIB
Starting CET1 ratio	11.9	12.3
Losses in first year of a moderate recession (1/2 of 2018 STCB excluding dividends)	1.0	2.2
Shareholder payouts: Dividends (4/9 of past dividends)	0.5	0.6
Shareholder payouts: Share repurchases (1/2 of actual repurchases in 2018)	0.6	0.7
Ending CET1 ratio	9.8	8.8
Next CCAR		
Proposed shareholder payouts (assume dividends with no increase and repurchases are zero, and minimum ratio is achieved at 8 quarters for Non-GSIBs and 5 quarters for GSIBs)	1.0	0.7
Max <i>Net losses</i> (STCB excluding dividends) under new scenario to be above the minimum CET1 requirement of 4.5 percent	4.3 <i>Net losses</i> ranged from 1 to 2 percent in 2014 to 2018 Max of 4.3 is well above the range	3.6 <i>Net losses</i> ranged from 3.3 to 5.5 percent in 2014 to 2018 Max of 3.6 is near the low-end of the range

These examples highlight that it is useful to extend the analysis beyond one period when evaluating whether the stress test program can prevent destabilizing actions in an actual recession. They illustrate that while banks appear well-positioned to absorb losses if the economy were to enter a recession, an average GSIB may not have sufficient capital to remain above minimum requirements in the subsequent stress test and may have to reduce dividends or raise equity in a downturn. A risk is that to avoid this situation, banks would pull forward their actions and reduce lending during the first year of the recession, exactly the situation that the stress test program is designed to avoid.

Two aspects contribute to this potential for procyclicality: the severity of the scenario and the starting level for capital. To deal with possible procyclicality, the supervisors could reduce the

severity of the scenario that would be applied in the CCAR once a recession was underway. The revisions to the guidance emphasize that supervisors could use the flexibility to increase the unemployment rate by less in this situation. Although this might help keep banks from anticipating being required to reduce payouts or raise capital in year two, supervisors would also need to keep in mind that investors and those funding banks would be looking for strong assurance that banks can weather a prolonged recession or an intensification of stresses. Some banks might still argue that an increase at the lower end of the range of 3 to 5 percentage points after a recession was already underway would exceed what happened during the global financial crisis, and thus is unnecessarily draconian. However, banks were supported by substantial amounts of government capital in the financial crisis, which almost certainly prevented the unemployment rate from rising further than it did.

Another policy option relates to raising the starting capital positions for GSIBs. While GSIBs have substantially larger *Net losses* than non-GSIBs, their starting capital ratios are not materially higher, 12.3 versus 11.9 on average, indicating they are less likely to avoid falling below a minimum in the CCAR following the start of a normal recession. Adding the GSIB capital surcharge to the minimum requirements for CCAR (as had been proposed in the SCB proposal, April 2018), would likely lead firms to raise capital levels in order to avoid breaching the higher minimums under the stress test scenarios. This option could be coupled with reducing the severity of scenarios once a recession was underway. Another option would be to raise the countercyclical capital buffer when supervisors believed that systemic risks were elevated and banks would experience unusually high losses when the economy or credit cycle turned down. Unlike the option of adding the GSIB to the minimum, the countercyclical capital buffer could be released and could be more supportive of lending in the downturn because using that capital would not trigger constraints on distributions.

To conclude this section on implications of stress tests for capital and whether they mitigate procyclicality: CCAR appears to have supported capital requirements at a higher level in recent years during the ongoing economic expansion than might have been the case with regulatory requirements on their own. Scenario design has contributed to mitigating procyclicality, but the assumptions for shareholder distributions have been very important for the GSIBs. When the analysis is extended beyond one period, there is some prospect that the stress test program as currently implemented could incentivize some GSIBs to cut lending to avoid having to cut dividends or raise equity in order to avoid falling below the 4.5 percent CET1 requirement of the subsequent stress test. Uncertainty about stress tests, whether due to scenarios, Fed models, or other adjustments, does not at first glance appear to have increased capital ratios, though more research is needed.

III. Effects of stress tests on risk management and capital planning

Stress test framework for risk management and capital planning

The crisis revealed critical shortcomings in the ability of many institutions to identify and manage the risks they were exposed to, which in turn affected their ability to judge their capital needs. Supervisors also lacked a systematic way of judging the resilience of the institutions they were overseeing to unanticipated stresses. Partly as a consequence of these shortcomings, financial institutions continued to pay dividends in 2007-08 as the financial system slid into crisis, failing to build loss-absorbing capacity just when it was most needed and thereby contributing to an erosion of confidence and the resulting runs, fire sales, and freezing up of credit.

In response, having banks develop rigorous risk management and forward-looking capital planning processes has been a key goal of the stress test regime. For example, in its announcement of the 2013 stress tests the Board said: “The aim of the annual reviews is to ensure that large, complex banking institutions have robust, forward-looking capital planning processes that account for their unique risks, and to help ensure that institutions have sufficient capital to continue operations throughout times of economic and financial stress.”⁸

The stress tests apply a limited number of scenarios to a point-in-time balance sheet. The capital planning aspect of the stress tests recognizes that assurance that banks will be able to intermediate credit and deliver other services in a severe stress requires them to have risk management systems that consider a variety of risks that individual banks may be exposed to and could arise at any time, and to incorporate those risks into capital planning. In assessing capital planning the Federal Reserve focuses on six key areas: governance, risk management, internal controls, capital policies, scenario design, and projection methodologies.⁹

The evaluation of capital planning has been accomplished importantly by the qualitative aspect of the stress test review. The Federal Reserve can object to a bank’s plans to distribute capital to shareholders on quantitative grounds—such a distribution would lead to capital levels at their low point that would fall below a particular hurdle rate—or on a qualitative assessment of each firm’s capital planning processes. The Federal Reserve also issues “conditional nonobjections” to capital distribution plans where processes need improvement, but distributions can go forward because problems are not so severe as to potentially undermine viability in a stress. The public character of these qualitative objections and conditional nonobjections has given banks a strong incentive to bring capital planning up to the Federal Reserve’s standards.

⁸ <https://www.federalreserve.gov/newsevents/pressreleases/bcreg20121109b.htm>

⁹ Board of Governors CCAR 2018. <https://www.federalreserve.gov/publications/2018-june-ccar-assessment-framework-results-qualitative-assessment.htm>

In addition, the Federal Reserve embedded in CCAR two constraints on capital distributions designed to enhance the resiliency of the system in a stress. First, planned distributions over the nine quarters of the stress event had to be “pre-funded” in the bank’s capital; that is, the bank had to have enough capital to make those planned distributions and still remain above the minimum capital ratios at their low point in the severe stress. And second, it placed an informal limit on dividends—as opposed to share repurchases—of 30 percent of capital distributions. Weighting distributions toward repurchases should make it easier to cut back on distributions to retain more earnings in a stress event. Historically, dividend payouts have changed gradually, and banks have been reluctant to cut them in a stress out of concern about the signal it would send about their strength; share repurchases are normally more variable and easier to reduce without adverse effects.

The effects of stress tests on risk management and capital planning

The bankers, regulators, and others familiar with CCAR we talked to were unanimous in their view that the Federal Reserve’s CCAR process had greatly improved risk management at stress-tested banks. To be sure, after the experience of the crisis, many banks were going to work at better gauging their vulnerability to unexpected developments. But we were told that the demands of the regulators to build the infrastructure to meet CCAR requirements has fundamentally changed risk management at many institutions along a number of dimensions that had proven inadequate in the years leading up to the crisis.¹⁰

We don’t have good empirical measures of the overall improvement to capital planning and risk management at banks. The qualitative results of the CCAR exercise show that the Federal Reserve perceives that capital planning built on risk management has greatly improved. In 2013 it issued four objections or conditional nonobjections to the capital plans of U.S. banks based on qualitative deficiencies. That number fell to one each year from 2014 to 2017 and to zero last year. More revealing perhaps is the language the Federal Reserve has used to summarize the qualitative results of CCAR. In 2016 it wrote: “Most LISCC and other large and complex BHCs have made progress since CCAR 2015, though **many** continue to fall short of meeting the higher supervisory expectations that the Federal Reserve has for the largest firms.” In 2017 it observed that “most of the largest firms have made progress since CCAR 2016, though **some** firms continue to fall short of meeting supervisory expectations.” By 2018 it could write, “The qualitative assessment conducted as part of CCAR 2018 found that **most firms either meet or are close to meeting** the Federal Reserve’s supervisory expectations for capital planning.” (emphasis added in each sentence).

The experts we talked to emphasized improvement in several aspects:

¹⁰ Box 4 in Board of Governors CCAR 2018 details the expectations of the Board for capital planning and gives examples of deficiencies that had been identified during CCAR reviews. Our narrative in the text is drawn from our discussions with market participants but is consistent with the Board publication.

Data: The regulators have required sufficient, accurate, accessible data to model risks across the entire organization.

Risk identification and management: The CCAR process has forced banks to bring tail risk and scenario analysis to loan books and to estimates of pre-provision net revenue, whereas previously the identification of tail risks and their effects had been mostly confined to market and trading book risk. It has embedded a culture of forward-looking risk management in business decisions and forced a holistic view of risks across the enterprise; before risk management had often been done on a business line basis. It has driven much greater use of a variety of scenarios to assess risks by banks for internal purposes. It has led to major improvements in modeling that have been carried through to risk management throughout the firms.

A few of our respondents were concerned that the resources banks were devoting to replicating Federal Reserve models were crowding out risk identification and modeling that would prove more useful for the circumstances of the individual institution. But others noted that the business decisions of the banks reflected the results of their own individual modeling and risk management, not necessarily the models for the stress tests. In fact, the qualitative assessment is based importantly on how well the firm can assess its own particular risks.¹¹ In addition, bank model results have diverged from Fed results, suggesting that banks are not just trying to replicate Fed models but are developing and using their models independently. Moody's has emphasized in various reports that there are differences in BHC's own stress test results and Fed supervisors' results. For example, in 2016, 10 BHCs (34 percent) had higher stress test capital buffers than supervisors' estimates (Moody's 2016); in 2018 11 of 27 BHCs (40 percent) that had reported their own results to the public immediately after the supervisors were more conservative (4 were GSIBs and 7 were regional banks (Moody's, 2018)). Bassett and Berrospide (2018) calculate the differences between the post stress minimum capital ratios in the BHC's own stress tests and the Fed's supervisory stress tests for 2015-17. They find that this capital gap is positive on average, but more than one-quarter are negative—that is, the banks had estimated lower post-stress ratios.

Governance: CCAR has provided a framework for banks' staff to communicate views about risks to upper management and directors—and has forced them to pay attention and get involved. This framework is being utilized by banks for consideration of risks more broadly, not just for the results of the CCAR test.

¹¹ For example the 2014 CCAR results document states that “Particular attention was given to the processes surrounding the development and implementation of the BHC stress scenario to ensure that these processes are robust and *capture firm-specific vulnerabilities and risks* (emphasis added), and that the translation of the scenario into loss, revenue, and capital projections was sound in both concept and implementation.”

Many of the market participants we talked to noted that an important benefit of the CCAR process has been to involve both the Chief Risk Officer and the Chief Financial Officer in discussions about risk and distributions. Previously, the CFO had generally proposed dividends and share repurchases based on last year’s earnings and forecasts of the most likely near-term earnings outcome; now the downside risks and the implications for capital of a severe stress also must be considered.

Capital distributions: In the stress test, a firm must have enough capital to meet minimum requirements for remaining viable in a severe stress even as it carries through on its plans for capital distributions. Thus, CCAR has required that decisions on dividends and share repurchases be linked to the risks that firms face which could affect future capital and earnings.

Figure 17 shows the mean of dividends plus share repurchases as a proportion of risk-weighted assets. Compared to before the crisis, distributions were restrained through 2016 as capital was built up to meet new standards. They have, however, jumped in the past two years to above pre-crisis proportions. The composition of distributions has shifted noticeably, however. Figure 18 shows that the share of total payouts that are dividends relative to share repurchases has been falling, as share repurchases are rising faster than dividends, related in part to the informal 30 percent limit on dividends in CCAR. This lower share should help resilience and stability by making it easier for banks to cut back distributions should adverse conditions materialize.

Figure 17.

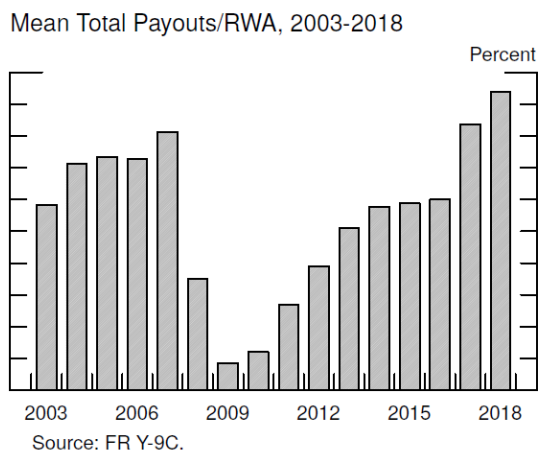
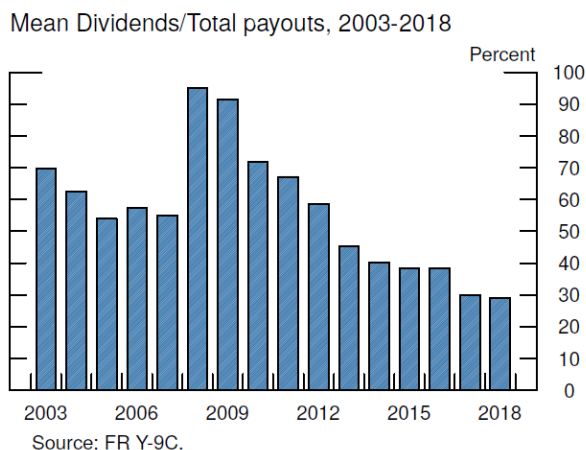


Figure 18.



Finally, many we talked to emphasized that the public disclosure portion of the CCAR, in which the Federal Reserve issued public non-objections or objections to proposed capital plans, was critical to achieving these improvements in risk management, but its benefits had diminished as more banks came up to standards. Even those who expressed views of diminishing benefits, however, felt that removing the public portion would reduce the attention paid by directors and senior managers of the firms and that banks could well backslide on some of the improvements.

IV. Stress tests and credit supply

This section considers the effects of the stress tests on credit supply. We review a number of papers that have looked closely at effects on quantities, prices, and quality of loans, and have brought a wide variety of data sets and methodologies to the issues (see Table 2 for specific studies we include in this review, and details on empirical approaches and data). Some of these studies try to identify the effects of stress tests on credit supply by looking at capital buffers required by CCAR, while trying to control for demand factors, but others use a simple indicator of whether the banks were subject to the stress tests or just bank size. These simple indicators make it difficult to attribute all of any measured effects to the stress tests since these banks also were subject to many types of increased regulations at the same time, including Basel III capital requirements, changes in mortgage underwriting standards, and anti-money laundering and know your customer regulations. A few studies take an important further step and test if borrowers who face any supply reductions are still able to access credit and continue to invest and spend.

While these studies provide interesting insights into changes on credit supply, they do not assess welfare implications. Certainly, some reduction in credit by the largest banks relative to the lead up to the crisis is desirable in exchange for reducing the probability of failure of the largest banking firms and of a broader financial crisis—in effect internalizing the externalities of large bank distress—but how much credit reduction is appropriate or how to value gains if smaller banking firms pick up some slack are issues that are not addressed in these papers. Moreover, these studies are focused on a period in which the banking system was transitioning to a higher capital regime. Other studies that have looked at longer-term steady state costs of higher capital requirements suggest costs are likely to be small when banks can adjust gradually. For example, Basel III standards were premised on a study that a 1 percentage point increase in capital requirements would increase loan rates by 13 basis points and a reduction in the level of GDP in the long run of 9 basis points, but would reduce the probability and severity of a financial crisis (BCBS 2010).¹²

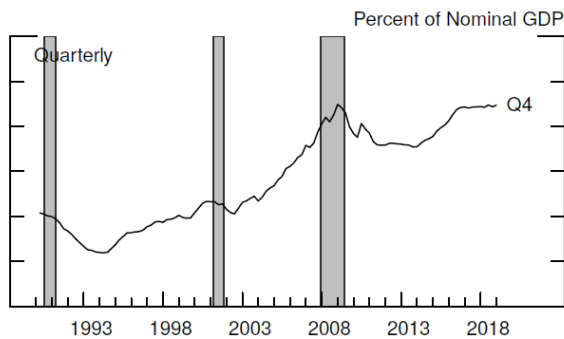
Another important caveat to assessing the effects of stress tests on credit supply is that we have had only the experience of an upswing in the business cycle. A major proposed benefit of stress tests is that they will increase the resilience of banks and thereby limit any reduction in credit supply in a downturn. Requiring firms to hold sufficient capital in order to continue to lend in a downturn is a key stability benefit, but one we cannot assess until after the business cycle turns down.

¹² Such estimates require assumptions about the required return on equity, size of any Modigliani-Miller offset, and ability of monetary policy to offset any rise in capital requirements on bank funding costs. Studies since then (for example, Firestone et al (2017), Brooke, et al (2015), and summarized in Liang (2017)) have varied some of these assumptions, and provide a range for the increase in loan rates for a 1 percentage point increase in capital of between 3 and 10 basis points.

To set the stage, we look at commercial bank loans and leases outstanding relative to GDP. This ratio grew rapidly in the mid-2000s, fell from peaks reached during the financial crisis, but fully recovered to those levels by 2016 (figure 19). C&I loans have more than rebounded and commercial real estate loans also have increased notably, while residential real estate have fallen. Consumer loans and other loans have risen modestly (not shown). Overall, while the mix of loans has changed, total bank loans as a share of GDP have not fallen.

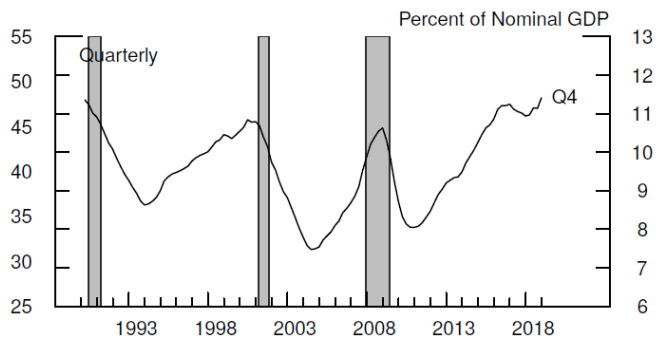
Figures 19 – 22

Loans and Leases in Bank Credit



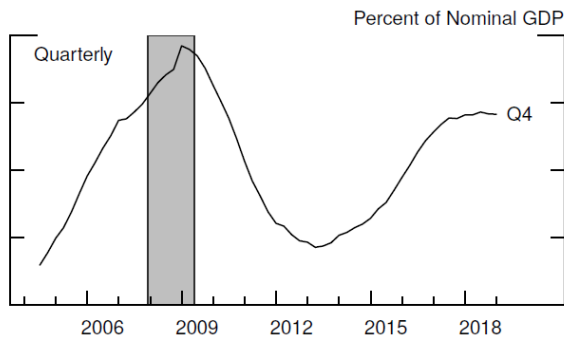
Note: Loans and leases in bank credit are divided by GDP, which is represented as an eight quarter moving average.
 Source: Board of Governors of the Federal Reserve System (Loans and Leases in Bank Credit, All Commercial Banks); U.S. Bureau of Economic Analysis via FRED, Federal Reserve Bank of St. Louis (Gross Domestic Product).

Commercial and Industrial Loans



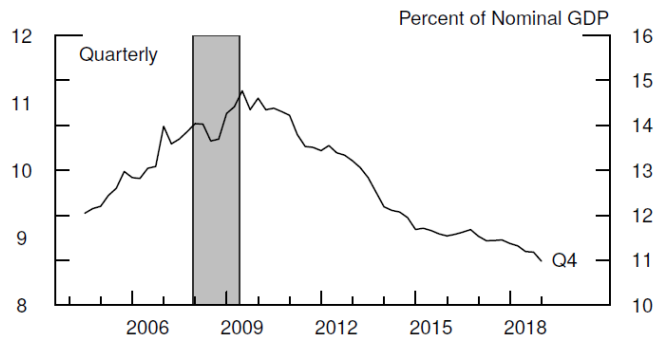
Note: Commercial and industrial loans are divided by GDP, which is represented as an eight quarter moving average.
 Source: Board of Governors of the Federal Reserve System (Commercial and Industrial Loans, All Commercial Banks); U.S. Bureau of Economic Analysis via FRED, Federal Reserve Bank of St. Louis (Gross Domestic Product).

Commercial Real Estate Loans



Note: Commercial real estate loans are divided by GDP, which is represented as an eight quarter moving average.
 Source: Board of Governors of the Federal Reserve System (Commercial Real Estate Loans, All Commercial Banks); U.S. Bureau of Economic Analysis via FRED, Federal Reserve Bank of St. Louis (Gross Domestic Product).

Residential Real Estate Loans



Note: Residential real estate loans are divided by GDP, which is represented as an eight quarter moving average.
 Source: Board of Governors of the Federal Reserve System (Residential Real Estate Loans, All Commercial Banks); U.S. Bureau of Economic Analysis via FRED, Federal Reserve Bank of St. Louis (Gross Domestic Product).

The papers we have surveyed have generally concluded that the banks subject to stress tests (or more stringent regulations broadly) have reduced loan supply, with lower quantities and higher prices, and reduced the riskiness of new loans made. However, the studies that have looked at state and local markets find that credit originations from all providers of small business loans or mortgages do not decline as other lenders, including smaller banks and nonbanks, increase their

share of originations. In addition, credit supply for larger corporate borrowers appears to have been quite abundant in bond and leveraged loan markets, so these borrowers do not appear to have been constrained in their ability to spend and invest.

Acharya et al (2018) provide an overview and find that over the period 2004 to 2014, banks subject to stress tests after 2010 had a lower ratio of total loans and unused commitments to total assets, as measured by the Call Reports, relative to before 2010 and to other banks not subject to the stress tests. They find the ratios of commercial real estate loans to assets and credit card loans to assets are both lower, but the ratios of C&I loans to assets and residential real estate loans to assets are not lower. Dummy variables are significant each year for total loans, and do not appear to increase over time. Covas (2017) looks at small business loans (those with amounts of less than \$1 million) from 2001 to 2016, and using a similar dummy variable as Acharya (banks subject to CCAR in 2011 and later) finds evidence that small business loan growth at these banks is lower than at other banks after 2011. Coefficients are negative and significant for small non-farm nonresidential real estate loans, but are not consistent for small C&I loans.

While these studies include many bank characteristics and business cycle factors, other studies that use other data sources can control better for demand effects. A number of studies look at new originations rather than changes in outstandings, and at the cost of new credit. Others look at loan originations at a county or MSA level, which may better capture local market conditions that all lenders in the same market will face.

Berrosptide and Edge (2019) study loans to large business borrowers by banking firms that were subject to CCAR from 2012 to 2016 using C&I loan data from the submitted confidential Y-14 data on loan originations by banks subject to stress tests. They look at the effect of a bank's stress test capital buffer, measured by the estimated change in capital to the minimum under the stress test (rather than just a stress test dummy as in Acharya et al (2018) and Covas (2017)) and can control for demand factors by looking at firms that borrow from multiple banks. They find that the C&I loan growth, utilized and committed, is lower at banks with higher stress-test capital buffers after the stress tests from 2012 to 2016, and contracted by more for borrowers with higher leverage and lower bank-internal credit ratings. They develop the analysis further using unique information on the borrowers available from the Y-14 and from Compustat, and they find firms that borrow from stress-tested banks do not have lower overall debt growth or lower investment or employment. Overall, while banks more constrained by stress tests have lower C&I loan growth, large business borrowers from these banks appear able to find other sources of credit when banks more constrained by the stress tests pull back their supply of C&I loans. Acharya et al (2018) also study individual loans from the DealScan dataset, mainly syndicated loans to business borrowers, and find that banks subject to stress tests after 2010 reduced the size of loans, increased loan spreads, and shortened loan maturities, suggesting an inward shift of

loan supply to large business borrowers. Moreover, stress-tested banks raised loan spreads by more for riskier borrowers, such as those with higher leverage and lower profits, which the authors argue is consistent with better risk management.

There are several studies of the effects of stress tests and the post-crisis regulatory regime on small business lending. A reduction in small business lending due to stress tests might be especially costly because small businesses have fewer alternatives than large businesses for other sources of credit. Cortes et al (2018) look at originations of small business loans at the county level using CRA data from 2012-2015. They find banks more constrained by stress tests as measured by their stress test exposure (the same measure used by Berrospide and Edge) reduce their supply of small business loans in more risky counties, which they define as those that have a higher sensitivity of local employment to national employment. Moreover, the reduction is in non-local markets, defined by counties where they do not have branches. They also show banks more constrained by stress tests raise interest rates by more for riskier loans (using internal risk ratings from STBL) and rebalance their portfolios to less risky loans. They argue that banks price the implied increase in capital requirements from stress tests in markets where they have a comparative advantage (where they have a branch) and on riskier loans in those markets, and exit markets where they do not. In addition, the reduction in loan supply by banks more constrained by the stress tests does not lead to overall declines in small business loan originations because smaller banks not subject to the stress tests increase their loan originations.

The channel proposed by Cortes et al (2018) for less lending by stress test banks is consistent with Chen, Hanson, and Stein (2017) that evaluates small business lending practices at the largest four banks (using CRA and Paynet data). They show the largest four banks had rapidly increased small business lending from 2000 to 2007, relying on automated credit scoring systems. But they pulled back sharply in 2008 when charge-offs began rising steeply and did not re-enter during the recovery. They say they cannot distinguish among plausible explanations for the reduction at the four largest banks, which include stress tests, higher regulatory capital requirements, and know your customer regulations (they believe KYC is a significant factor). Also they show that small business loans at the county level had recovered by 2014, with the share of originations by small banks increasing significantly, and the share by nonbanks also increasing. Still the counties with a sharp pullback in lending by the big banks have lower wage growth that persisted even after loan originations and economic growth recovered.

Two studies have focused on the effects of stress tests on residential mortgages, but identifying the effects of stress tests for this category of lending is especially difficult given many significant regulatory changes for these lenders and for mortgage underwriting practices. Calem, Correa, and Lee (2016) find that banks subject to stress tests in 2011 originated a lower share of conventional jumbo mortgage loans by state relative to other banks, and approved a lower share of mortgage applications, but they did not find evidence of a lower share for later stress tests

during 2012 to 2014. Morris-Levenson, Sarama, and Ungerer (2017) look at mortgage originations (mortgages less than \$5 million in HMDA) from 2000 to 2014, by banks in different size categories and nonbanks. They do not isolate the effects of stress tests, and emphasize that the largest banks, those above \$50 billion, became subject to a number of new regulations after 2010. They find that the largest banks cut originations by more than mid-tier banks (those between \$10 billion and \$50 billion). But they also find that mortgage originations in counties most dependent on banks that became more regulated did not decline by more than in counties less dependent on these banks—there is an increase in originations by smaller banks and nonbanks in these markets--and there is no significant differential in house prices.

Table 2. Summary of empirical studies of stress tests on credit

	Approach and measures of stress test effects	Measures of credit supply	Summary of main results
Acharya, Berger, Roman (2018)	<p>Compare stress test banks to non-stress test banks, before and after SCAP in 2009 on loan spreads, originations, other non-price terms, loan outstandings</p> <p>Stress test bank dummy variable 2010-2014</p>	<p>Spreads, amounts, and other loan terms from loans in DealScan (mostly syndicated), 2004-2014.</p> <p>Borrower characteristics from Compustat;</p> <p>Bank loans outstanding from Call Reports;</p> <p>Small business loans, bank-county level from CRA.</p>	<p>Find higher loan spreads for stress-test banks, and smaller loan amounts and shorter maturities.</p> <p>Find lower loan-to-asset ratios for CRE and credit cards loans, but not C&I and RRE loans at stress-test banks.</p> <p>Find lower small business loans per population by stress-test banks.</p> <p>They conclude that banks reduce credit supply particularly to relatively risky borrowers to decrease their credit risk.</p> <p>Regressions control for bank characteristics and macro economy, but do not control for changes in other financial regulations</p>
Berrospide, Edge (2019)	<p>Compare C&I loan growth of banks more constrained by stress tests, as measured by a bank's stress test capital buffer, defined by the capital decline from start to minimum.</p> <p>Can identify effects from borrower demand by including multiple banks.</p> <p>Looks at overall borrower debt growth, and substitution of credit providers</p>	<p>C&I loans at CCAR banks to firms 2012-2016, based on confidential Y-14 data. Also has information on borrower characteristics, such as overall debt, investment, and can match some firms with Compustat for more borrower characteristics.</p>	<p>Banks with larger stress-test buffers reduce C&I lending (utilized and committed) of banks, and by more to riskier borrowers;</p> <p>Borrower's loans from stress-test banks declines, but total debt is not reduced, suggesting borrowers find other sources of credit.</p> <p>Borrower employment and investment generally is not reduced.</p>

<p>Cortes, Demyanyk, Li, Loutschina, Strahan (2018)</p>	<p>Compare small business loans made by banks based on their stress test capital buffer, defined by capital decline from start to minimum. Also looks at loans at a local market level (county) and whether bank has a local market branch.</p> <p>Looks at county-level loan growth and substitution of credit providers</p>	<p>Small business loans, bank-county-year data, 2012-2015, from CRA; Price and risk of small business loans, 2013-2016, from STBL survey of banks</p>	<p>Lower growth in small business loans by banks with higher stress-test exposures in riskier markets and if do not have a branch in the market. Higher rates on riskier loans (based on bank internal ratings) and make fewer riskier loans.</p> <p>County-level small business loans do not fall with more stress test exposure, and small banks not subject to stress tests increase their market share.</p>
<p>Bassett, Berrospide (2018)</p>	<p>Capital gap is difference of capital hit from stress implied by supervisors and banks own models. Also implied capital ratio based on banks own stress test estimates. Estimates of start to minimum capital, 2013-17</p> <p>Compares CCAR and non-CCAR banks (> \$10 B)</p>	<p>Loans, Call Reports; Lending standards, SLOOS</p>	<p>Loan growth does not differ based on capital gap; Loan growth is higher at non-CCAR banks, but not related to the capital gap. In subsample of more similar BHCs, negative and marginally significant effect of capital gap on loan growth; Positive marginal significant effect of capital gap on lending standards (easier)</p>
<p>Calem, Correa, Lee (2016)</p>	<p>Compare stress test banks to non-stress test banks before and after SCAP for mortgage loan originations</p> <p>Stress test bank dummy 2011-2014</p>	<p>Jumbo mortgage loan originations, HMDA for bank and nonbank lenders, 2009-2014; bank-state level data</p>	<p>BHCs subject to CCAR 2011 originated fewer jumbo mortgages in subsequent three quarters, and approval rates were lower than for non-CCAR banks, but there was no difference for stress tests in 2012-2014. Declines in originations and approval rates are greater for CCAR banks that had below-median capital ratios.</p>
<p>Covas (2017)</p>	<p>Compare stress test banks to non-stress test banks, and before and after stress tests for small business loans</p> <p>Stress test bank dummy variable 2011-2016</p>	<p>Small business loans by bank, Call Reports 2001-2016</p>	<p>Negative and significant effect on stress test dummy for growth in small business loans secured by nonfarm non-residential properties. Finds less robust results for growth in small business C&I loans.</p>
<p>Chen, Hanson, Stein (2017)</p>	<p>Compare county-level outcomes for small business loans from 2006-08, 2008-10, and 2010-14 based on the presence of four largest BHCs</p> <p>Not specific to stress tests</p>	<p>Small business loans bank-county level 2006-2014, from CRA Credit registry for nonbank lenders, PayNet</p>	<p>Share of originations of small business loans by the four largest BHCs falls, but the share for small banks (<\$50 B) and nonbanks increases.</p> <p>Large banks had expanded into small business loans from 2000-</p>

			<p>2007 and relied on automated systems. With high charge-offs in 2008, they began to pull back, especially smaller loans (\$100,000 to \$250,000), and have not re-entered.</p> <p>Authors suggest multiple regulations play a role, including higher capital requirements, stress tests, and know your customer regulations.</p> <p>Originations of small business loans mostly recovers by 2014, but counties with high market share of largest banks in 2006 had lower wage growth that persisted until 2014, though economic and employment growth differences mostly disappeared by 2014.</p>
<p>Morrison-Levenson, Sarama, Ungerer (2017)</p>	<p>Compare more-regulated mortgage lenders with less regulated, including smaller commercial banks and nonbanks</p> <p>Controls for demand effects with mortgage originations at the county level</p> <p>Looks at overall mortgage originations and house price growth at the county level for substitution of credit</p> <p>Not specific to stress tests; they highlight a range of new regulations for banks and mortgages</p>	<p>Mortgage originations from HMDA, 2000-2014, by lender type. House price data by county from CoreLogic.</p>	<p>Mortgage originations by more regulated lenders (BHCs with >\$50 billion in assets) grew slower than those of mid-tier BHCs (between \$10 and \$50 billion). Reduction in lending of regulated larger BHCs is offset by increases in mid-tier banks and nonbanks (mortgage companies and credit unions).</p> <p>No difference in county-level mortgage originations or house price growth in counties more dependent on more regulated banks than less regulated banks.</p>

V. Conclusion

We focused on three questions for evaluating the effects of stress tests, based on features of the stress test program that distinguish stress tests from regulatory capital requirements. We collected existing evidence and supplemented with data on recent stress tests. First, we find that the stress tests appear to offset some procyclicality in capital ratios, driven not only by the

macroeconomic scenarios but the requirement to pre-fund shareholder payouts, which rise as the economy expands. However, since there has not been an economic downturn, it is not certain that a major objective of the stress tests to assure that banks won't amplify a downturn by pulling back on lending when it is most needed will be achieved. We use an example to highlight two aspects—initial levels of capital and the severity of the scenario once a recession is underway—which are important to avoid putting the countercyclical benefits of the stress test program at risk. Second, our interviews indicated that market participants universally believed that stress tests have led to significant improvements in risk management at banks. Many noted the importance of linking proposed shareholder payouts to potential risks and that CCAR prompted senior management and directors to pay more attention to this nexus. Third, we reviewed empirical studies that focus on the effects of stress tests on the cost of loans. While many are not able to isolate the effects of stress tests from other regulatory changes, higher capital requirements for the largest banks have prompted a reduction in the supply of credit, especially to riskier borrowers. But it appears that smaller banks not subject to stress tests or nonbanks have increased their provision of credit, even for small businesses.

This review suggests that there many other questions that could be pursued, and we conclude by highlighting some important areas where more research would be helpful to assure stress tests remain an effective risk management tool:

- Could good measures of risk management quality be created? We did not find any, and thus could not measure improvements in risk management. It would be useful for supervisors to develop objective quantitative metrics of risk management practices that banks, supervisors, and investors could track.
- Have banks' business models become more similar as a result of stress tests? Are the banks constrained by the leverage ratio adjusting their portfolios to become more like banks facing the RWA constraint, and vice versa? Is there evidence of increased sensitivity to the same macroeconomic risks, or evidence that banks are ignoring risks that are not captured in the stress tests?
- Are there costs that exceed benefits from the variation in capital requirements from stress tests, above the variation that reflects actual uncertainty about economic and financial conditions?
- What are the long-run effects of higher capital requirements on credit supply?
- Will stress-tested banks be able to support the economy through lending in the next severe downturn? What would be the effects of actual and proposed changes in the stress test program?
- To what extent have the stress tests, with their sharp decline in house prices, affected mortgage credit? How have the stress test implications for mortgage loans interacted with the other changes in the mortgage market?

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