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Evaluating the Information in the Federal Reserve Stress Tests

Mark Flannery
Beverly Hirtle
Anna Kovner

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Abstract

We present evidence that the Federal Reserve stress tests produce information about both the stress-tested bank holding companies and the overall state of the banking industry. Our evidence goes beyond a standard event study, which cannot differentiate between small abnormal returns and large, but opposite-signed, abnormal stock returns. We find that stress test disclosures are associated with significantly higher *absolute* abnormal returns, as well as higher abnormal trading volume. More levered and riskier holding companies seem to be more affected by the stress test information. We find no evidence that stress test disclosures have reduced the production of private information. After disclosure begins, stress tested firms attract equity analysts without changing analysts' forecast dispersions or their mean forecast error.

Key words: stress test, bank capital, event study

Flannery: Securities and Exchange Commission and the University of Florida. Hirtle, Kovner: Federal Reserve Bank of New York (e-mail: beverly.hirtle@ny.frb.org, anna.kovner@ny.frb.org).
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1. Introduction

When the first supervisory stress tests were administered to large U.S. bank holding companies (BHCs) in the first half of 2009, the Federal Reserve took the unprecedented step of announcing publicly its assessment of the BHCs' capital positions under stress. The Supervisory Capital Assessment Program (SCAP) of 2009 evolved into a series of annual supervisory stress tests beginning in 2011. The process now includes two related reviews of BHC capital: the Dodd-Frank Act stress tests (DFAST) and the Comprehensive Capital Analysis and Review (CCAR). As these processes have evolved, the Federal Reserve has provided increasingly detailed public disclosures about the tests' results and implications. This paper evaluates two questions about the publication of this official sector analysis. First, how do the announced DFAST and CCAR results affect private investors' assessments of the tested BHCs' values? And second, does this disclosure affect the production of private information about stress tested firms?

Other authors have studied market reactions to U.S. or European stress test announcements (Morgan et al. 2014, Petrella and Resti 2013, Candelon and Sy 2015, Bird et al. 2015, Fernandes, Igan and Pinheiro 2015) and found mixed evidence of whether banking firms experience significant abnormal average stock returns when supervisory stress test results are disclosed.[1] These studies report statistically significant average abnormal returns on some disclosure event dates but not on others. Some studies report both positive and negative average abnormal returns across different event dates.

To at least some extent, we believe that these variable findings reflect assumptions embedded in standard event study methodology. For example, this approach assumes that all treated firms react in the same direction, so a zero mean abnormal return implies no effect on treated firms. But a mean return for a set of stress-tested banks could be zero for two quite different reasons. Either the abnormal return is very small for all firms, or the returns are large in absolute value, but positive for some BHCs and negative for others. Disparate revaluations are particularly likely when an event's timing is known to investors. Standard event study methodology assumes that the events are unanticipated, making market expectations zero by definition. By contrast, because stress test announcement dates are known well in advance, their information content must be evaluated in relation to the market's prior beliefs about each firm's condition. Large negative or positive announcement effects are both consistent with the stress test results conveying new information to the market. In sum, a standard event study does not necessarily tell us what we need to know about new information produced in the stress tests.

[1] Other studies have described alternative methods for calculating bank capital adequacy needs under stress. For example, Acharya and Steffen (2014) assess capital shortfalls at European banks using range of book-value and market-based models and Hirtle et al. (2016) presents results from a simplified "top down" stress test model for large U.S. banks.

To address this conceptual shortcoming, we examine several additional measures that should better capture whether the market responds to stress testing disclosure. First, we examine the average absolute cumulative abnormal return (|CAR|) associated with stress test result announcements. This measure should be large if investors react to the announcement, regardless of the distribution of positive and negative effects. Second, the existing literature concludes that trading volume also spikes upwards if new disclosure affects investors' prior beliefs (Bamber et al. 2011, Karpoff 1986). We estimate a measure of abnormal trading volume ("CAV") that captures deviations in BHC trading volume from what would be expected given market-wide trading volume. We interpret these price and volume changes as empirical measures of information production. Third, we explore the absolute change in credit default swap spreads, which price a firm's probability of default and loss given default. Again, the absolute value of this measure should be larger on event dates, regardless of whether the news is good or bad. Finally, we look at changes in option implied volatility across the disclosure dates, motivated by the evidence that a firm's earnings announcements resolve some uncertainty about its condition and hence lowers its stock's price volatility (Ederington and Lee 1996). [2]

The history of U.S. stress testing provides nine dates through 2015 on which the Federal Reserve disclosed its stress-related assessments of large BHCs. For each date, we also examine a comparison group of large BHCs not subject to supervisory stress testing to determine whether stress test results contain significant information about the banking industry in general, and not just about the stress tested firms. Stress testing might provide information about non-stress tested BHCs if these firms have businesses, activities or exposures in common with stress tested BHCs.

Our results suggest that disclosure of supervisory stress test results generates significant, new information about stress tested BHCs. As in other studies, we find statistically significant average cumulative abnormal returns (CARs) around many, though not all, of the stress test disclosure dates. These CARs are sometimes positive and sometimes negative, suggesting that simply averaging positive and negative abnormal returns could obscure the impact of stress test disclosures. In fact, average absolute value CARs (|CAR|) are significantly larger than pre-disclosure event values around most disclosure dates for stress tested BHCs. Our results contrast with research suggesting that the information value of the U.S. stress disclosures has declined over time (Glasserman and Tangirala 2015).

We also find evidence that stress test results convey information about non-stress-tested BHCs, although the tested sample's |CAR| almost always exceeds that of the non-stress tested sample. Non-stress tested firms that are more similar to stress tested firms, as measured by stock price covariance

[2] A uniform price increase across treated firms might occur if the announcements reduce the amount of (systematic) uncertainty associated with the firms' valuations.

with an index of stress tested firms, experience larger abnormal stock price movements on stress testing announcement dates.

We find similar results using other measures of new market information. Average abnormal trading volumes are significantly higher (by more than 1 percent) on the typical stress test disclosure date. Again, the mean abnormal trading volumes (CAV) are larger and more significant for stress tested BHCs than for other banking companies. Option implied volatility falls significantly around some event dates, though it rises significantly on others.[3] Finally, CDS prices of stress tested firms move relative to the index by more than 4 percent on stress testing dates, although the differences are statistically significant only in 2009. It appears that stress testing announcements are producing information that is meaningful across all types of markets. Stress test disclosures also provide significant information about non-stress tested banks.

We next investigate whether the market reaction to supervisory stress test results affects some types of BHCs – e.g. riskier institutions – more prominently. For each event date, we regress |CAR| or abnormal trading volume on variables measuring the BHCs' leverage and risk to see if these characteristics are associated with greater information on stress test disclosure dates. Our results suggest that the stress tests produce more information about riskier or more highly leveraged BHCs. This result holds even in the sample of firms not subject to stress testing, suggesting information is being produced about industry performance, not just specific firms.

Disclosing supervisory stress test results might affect market values for at least two (non-exclusive) reasons. The disclosures might contain new information about the tested firms' financial conditions, or they might imply something about the Federal Reserve's likely treatment of the tested firms. We attempt to separate these two effects by examining non-stress tested BHC. The disclosures related to financial conditions should affect non-tested BHCs more if their stock returns are more highly correlated with an index of the stress-tested BHCs' returns. The implications of stress test disclosures for future regulatory treatment of non-tested firms should vary with their size, since asset size heretofore has been the sole determinant of which BHC are subject to DFAST and CCAR testing. We find that stock return correlation is positively related to the magnitude of non-stress tested BHCs' |CAR|, but a dummy variable for the larger non-tested banks is insignificant. It thus seems that the information contained in stress test disclosures is at least partly related to the banking industry's condition.

The final part of the paper investigates Goldstein and Sapra's (2014) suggestion that the public disclosure of stress testing results may drive out private information producers (such as stock analysts),

[3] Ellahie (2013) examines option implied volatilities, as well as bond and equity bid-asked spreads, around the release of the 2011 European stress test results and finds the disclosures reduced information asymmetries among investors and allowed sorting of strong and weak banks, but increased uncertainty more broadly.

or may have other negative welfare effects. We begin by examining if the release of stress testing information by the Federal Reserve discourages private information gathering. We find no evidence of reduced equity analyst coverage or deterioration in the accuracy of analysts' earnings forecasts. Next, we look for evidence that supervisory stress test disclosures have affected bank managers' choices about asset or loan growth or about the composition of the loan portfolio. Such shifts could negatively affect social welfare if they distort credit allocation decisions by, for instance, causing banks to disproportionately increase their loans to sectors with relatively low Federal Reserve-estimated loss rates. In fact, we find no evidence that stress tested firms significantly change their loan portfolio composition in response to stress testing results. We also examine the hypothesis that supervisory stress test disclosure negatively impacts private risk sharing. We find no indication that stress-tested firms reduce their interbank borrowing and lending, which is consistent with no change in ex ante risk-sharing through interbank markets. In sum, we see little evidence of negative social welfare consequences of supervisory stress test disclosure.

We acknowledge two key limitations of our analysis. First, these disclosures mostly occurred in the context of a relatively benign environment for banking firms. With the exception of 2009, only a relatively small number of firms have "failed" the CCAR stress tests. Therefore, we cannot rule out the possibility of different results in a different climate for the banking industry. Second, we cannot analyze any changes to firm behavior that may have occurred within portfolios, because we have only aggregate portfolio data.

This paper is organized as follows. Section 2 provides a brief history and description of the U.S. stress testing process and the associated public information releases. Section 3 describes our main hypotheses. Results about market reaction to stress test announcements and the relationship between BHC characteristics and market information are presented in Section 4. Section 5 discusses our analysis of possible welfare-reducing effects of supervisory stress test disclosures. The paper concludes with a summary and discussion of the results.

2. Overview of U.S. Supervisory Stress Testing

We present here a review of supervisory stress testing programs in the United States. A more detailed review of the history and goals of US stress testing can be found in Hirtle and Lehnert (2014), which also describes the coordinated supervisory stress tests conducted in Europe in the years since the financial crisis.

A. Supervisory Capital Assessment Program

The first coordinated supervisory stress testing exercise in the United States was the 2009 Supervisory Capital Assessment Program (SCAP). Nineteen U.S.-owned bank holding companies (BHCs) with assets of at least $100 billion, representing two-thirds of the assets of the U.S. banking system, participated in the SCAP (Board of Governors of the Federal Reserve System 2009a). Conducted in the months following the collapse of Lehman Brothers and the resulting financial market turmoil, the goal of the SCAP was to ensure that the largest U.S. BHCs had sufficient capital to withstand a worse-than-anticipated macroeconomic outcome and continue to be viable financial intermediaries.

Bank holding companies whose stressed capital ratios fell below minimum target levels were required to raise new capital in amounts sufficient to eliminate the shortfall between the post-stress ratio and the target level.[4] The ten firms with identified shortfalls, along with several others without capital shortfalls, raised $100 billion in common equity following the SCAP (Hirtle and Lehnert, 2014). Results of the SCAP for each BHC were publicly disclosed on May 7, 2009. Information about the stress test framework and methodology had been publicly released a few weeks before the publication of the results, on April 24 (Board of Governors of the Federal Reserve System 2009a, 2009b). These disclosures, which provided unprecedented confidential supervisory information, were intended to help restore confidence in the capitalization of the BHCs participating in the SCAP and in the banking system more broadly (Board of Governors of the Federal Reserve System 2009b).

B. Dodd-Frank Act Stress Tests

Following the SCAP, stress testing was formally integrated into the Federal Reserve's on-going supervisory assessment of BHC capital adequacy. This integration occurred through two separate, though related, channels: the Dodd-Frank Act stress tests (DFAST) and the Comprehensive Capital Analysis and Review (CCAR).

Enacted in 2010, the Dodd-Frank Wall Street Reform and Consumer Protection Act ("Dodd-Frank Act") requires the Federal Reserve to conduct annual stress tests of all BHCs with assets exceeding $50 billion, as well as certain other large, complex financial companies subject to Federal Reserve supervision. The Dodd-Frank Act also requires BHCs with assets greater than $10 billion to do annual stress tests based on scenarios provided by the Federal Reserve, and BHCs with assets greater than $50 billion to do additional stress tests based on their own scenarios. The Federal Reserve and BHCs with

[4] It was announced that the U.S. Treasury would provide capital for qualifying BHCs unable to raise required equity in the market. This capital backstop was accessed by one SCAP firm (Ally Financial).

assets greater than $50 billion are required to publish stress test results based on the Federal Reserve's scenarios.

The first DFAST results were released in March 2013, when the Federal Reserve and the BHCs reported their firm-level simulation results under the severely adverse scenario. Since DFAST 2014, the Federal Reserve has disclosed results under both the adverse and severely adverse scenarios. BHCs must disclose their own estimates under the severely adverse scenario, and are free to disclose results under the other scenarios. Most have limited their disclosures to the severely adverse scenario.

C. Comprehensive Capital Analysis and Review

In 2011, the Federal Reserve implemented a new supervisory program for assessing capital planning and capital adequacy at large, complex bank holding companies, the Comprehensive Capital Analysis and Review (CCAR). The CCAR involves both a qualitative assessment of the internal capital planning processes and a quantitative assessment of the capital positions of each BHC subject to the program. Each year, BHCs submit a capital plan to the Federal Reserve describing their internal capital planning processes and governance, a capital policy governing their decisions about dividends and other capital distributions, stress test results based on scenarios provided by the Federal Reserve as well as internal scenarios intended to be uniquely stressful to each BHC based on its business focus and strategies, and information about the dividends and other capital actions the BHC would like to take over the coming two years. The Federal Reserve assesses each capital plan based on the material submitted in the plan, as well as on supervisory stress test results generated by the Federal Reserve. The BHC and supervisory stress test results are used to assess whether the BHC's regulatory capital ratios would fall below minimum required levels under the stress scenarios (Board of Governors of the Federal Reserve System 2015a).

If the Federal Reserve does not object to a BHC's capital plan, the BHC is free to make the capital distributions included in the plan. If the Federal Reserve objects to the plan – either because the stressed capital ratios fall below required minimum levels or because aspects of the BHC's internal capital planning processes fail to meet supervisory expectations – then the firm may make only those capital distributions approved by the Federal Reserve. Because of the implications for dividends, share repurchases, and other capital actions, the CCAR results typically attract considerable attention and are covered extensively by the financial press.

A description of the first CCAR was publicly released by the Federal Reserve in March 2011, but did not include individual BHC stress test results or information about which BHCs' plans the Federal Reserve objected to. Some BHCs subsequently disclosed that the Federal Reserve had objected to their

plans. Beginning with the 2012 CCAR, the Federal Reserve disclosed individual BHC stress test results and, starting with the 2013 CCAR, also disclosed which firms' capital plans were objected to along with a brief description of the reasons for the objection (Board of Governors of the Federal Reserve System 2015a). Through 2015, CCAR results were disclosed in March of each year.

The CCAR and DFAST stress tests share the same macroeconomic scenarios and are based on a common set of net income projections, but differ in their assumptions about the BHCs' actions affecting capital. In the CCAR stress test results, the dividend, share repurchase and other capital actions used to calculate equity and regulatory capital are the actions included in each BHC's capital plan.[5] This is consistent with one of the goals of the CCAR exercise, which is to evaluate each BHC's ability to maintain adequate capital after taking its planned capital actions. In contrast, the capital actions used in calculating equity and regulatory capital in the DFAST results are stylized assumptions specified in the regulation implementing the Dodd-Frank Act requirements. These assumptions set dividends at recent historical levels for each BHC (in dollars) and set share repurchases and share issuance at zero, except for issuance associated with employee compensation (Board of Governors of the Federal Reserve System 2015a, 2015b).

D. Timing and Content of Public Disclosure

Results of the DFAST stress tests are typically released about a week before the corresponding CCAR results. The DFAST disclosures include details of the net income projections and their primary components – pre-provision net revenue, loan losses and loan loss rates, losses on trading and counterparty positions, losses on securities, as well as balance sheet and risk-weighted asset projections – in the aggregate and for each of the participating BHCs. The DFAST disclosures also include the starting, ending and minimum values of each BHC's regulatory capital ratios. The CCAR stress test results, disclosed approximately a week later, combine the DFAST net income projections with the capital actions in each BHC's capital plan to yield a different set of starting, ending and minimum regulatory capital ratios. Since 2014, BHCs have had the opportunity to make a one-time downward adjustment to their planned capital actions under CCAR (giving them the ability to adjust in case their initially projected regulatory capital ratios fall below minimum required levels). The CCAR disclosures include minimum stressed ratios under both the original and adjusted capital actions (Board of

[5] Specifically, the capital actions included in the stressed regulatory capital ratios are those from each BHC's baseline scenarios, even for stress test results calculated under the adverse and severely adverse scenarios. The policy objective of using baseline distributions in stress scenarios is to see whether the BHC could make those distributions and remain above minimum regulatory capital levels even under stressed conditions (Board of Governors of the Federal Reserve System 2015a).

Governors of the Federal Reserve System 2015a). Table 1, Panel A contains a timeline of the disclosure events from the SCAP, CCAR and DFAST programs between 2009 and 2015.

E. Stress Tested Entities

The set of BHCs participating in the CCAR and DFAST programs has expanded over time. The original SCAP BHCs participated in the 2011 to 2013 CCAR exercises as well as the initial DFAST in 2013.[6] In 2014, the CCAR and DFAST exercises expanded to include an additional 12 BHCs with assets greater than $50 billion. As of 2015, 31 BHCs participated in the DFAST and CCAR programs. Additional large, complex financial institutions supervised by the Federal Reserve, including savings and loan holding companies and nonbank firms designated as systemically important by the Financial Stability Oversight Council (FSOC), will participate in the programs over time as they become subject to the Federal Reserve's regulatory capital rules. Table 1, Panel B includes a list of stress tested entities and the date at which public disclosure of their supervisory stress test results began.

3. Measuring Market Response to Stress Testing Announcements

We examine five distinct aspects of market reactions to the announcement of supervisory stress test results: the cumulative abnormal return (CAR), the absolute CAR (|CAR|), cumulative abnormal trading volume (CAV), the absolute change in CDS spread (|CACDS|), and the change in equity's option implied volatility (ΔVOL). In each case, we estimate our measure over an event window around the disclosure date and compare that measure to values during a 120-day, pre-event estimation period that ends ten days before the disclosure date.[7]

For each event date, we collect a sample of all public banking firms with total assets exceeding $10 billion at the quarter-end and complete stock price data during the 120 day estimation period.[8] We exclude some stress-tested firms from our analysis: Metlife, Inc. (which ceased to be a BHC in 2013, after which we have no balance sheet data), Ally Financial (which did not have publicly traded equity until shortly after the 2014 CCAR), and seven BHCs that are subsidiaries of foreign banks (excluded since

[6] In 2013, Metlife, Inc. dropped out of the program after it sold its commercial bank and ceased to be a bank holding company. Starting in 2012, approximately one dozen additional BHCs with assets greater than $50 billion but not in the original SCAP group also submitted capital plans to the Federal Reserve. The capital plans for these firms were reviewed in a separate, parallel exercise to the CCAR. While the capital plans for these firms contained BHC-generated stress test results, the Federal Reserve did not calculate supervisory stress test results for these firms until the 2014 CCAR. (Board of Governors of the Federal Reserve System 2013, 2014a).

[7] There are two announcement dates in 2013-2015. Our estimation period ends five days before the announced DFAST results, which corresponds to about ten days before the CCAR announcements.

[8] Public banking firms are defined as BHCs and commercial banks that have both CRSP PERMCOS and Federal Reserve RSSDIDs (identified using the Federal Reserve PERMCO-RSSDID link). Not all firms have available data in every specification. If accounting information was missing, we filled it from SEC filings if available.

they have no publicly traded stock for their US operations). The stress tested sample begins with 17 firms but expands to 23 firms by the end of the sample period. We also examine our measures for non-stress tested BHCs, to determine whether stress test announcements convey significant information about the state of the banking industry. We limit this sub-sample to the large BHCs that are most similar to firms in the stress-tested sample. The non-stress tested sample varies from 39 to 53 firms depending on the event date. BHCs' accounting information is taken from the Federal Reserve's quarterly Consolidated Financial Statements for Holding Companies (FR Y-9C). Stock price information comes from CRSP, implied volatility data comes from Option Metrics, and CDS data from Markit.

A. Directional Measure: Cumulative Abnormal Returns

Abnormal returns are required for two of our five test statistics: CAR and absolute CAR (|CAR|). Since the stress tested BHCs are the largest bank holding companies in the United States, we choose a three factor model as in Fama and French (1993) to model normal returns.[9] By contrast, Morgan et al. 2014 use a banking stock index and Candelon and Sy 2015 and Glasserman and Tangirala 2015 use a single-factor market model. After estimating the three-factor model over the pre-event period [t-130, t-10], we cumulate abnormal returns for the 3-day window [t-1, t+1]. This relatively short event window ensures that we capture the impact of stress testing public disclosures, although at the risk of understating the impact of stress testing if information arrives in the market outside this window.

B. Direction-Neutral Measures of Information Arrival

Because conventional event studies average computed CARs across sample BHCs, the test fails to distinguish between positive and negative information effects. Yet stress test announcements could lead investors to revise their estimate of a BHC's value either up or down from their prior opinions.[10] To address this conceptual shortcoming of the standard event study methodology, we examine four additional measures that should better capture disparate, significant changes in share price.

[9] Abnormal returns are calculated using the daily Fama-French Factors described at this link: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/f-f_factors.html and accessed in May 2015. Relative to a single factor market model, a model that includes a size factor is important since it will account for systematic differences in the returns of larger firms.

[10] For instance, Morgan et al. (2014) found a significant association between abnormal returns and the difference between the expected and actual size of each BHC's capital "gap" in the SCAP results.

Absolute CAR

First, we examine the average, 3-day cumulation of absolute abnormal returns ("|CAR|"):[11]

$$|CAR| = \frac{\sum_{i=1}^{J} |CAR_i|}{J}. \quad (1)$$

where J is the number of BHCs in the stress tested or non-stress tested group. This measure should be large if investors react to the announced information, regardless of how positive and negative effects are distributed across the sample. All else equal, absolute abnormal returns will be larger the more new information is revealed by the stress test disclosures.

Because |CAR| is an absolute value, it is inappropriate to assess statistical significance by comparing this statistic to zero. Instead, we assess the significance of |CAR| during the event window by comparing it to its average value over the pre-event estimation period. We compute the statistical significance of |CAR| comparing the difference in means between event-period and pre-event period values using a Wilcoxon rank sum test. This non-parametric test, unlike the t-test, does not require the underlying populations to be normally distributed. Significance is similar when calculated using a t-test or Corrado's (1989) alternative non-parametric test statistic. (Not reported.)

Abnormal Trading Volume

The second direction-neutral way in which we measure the information content of stress tests is by looking at abnormal trading volume. This measure, which is similar to one used in the accounting literature (Bamber et al. 2011 provide a summary) is based on the hypothesis that trading volume increases if new information affects investors' prior beliefs (Karpoff 1986).[12] We would thus expect to see abnormally high trading volume during periods of high information dispersal.

Analogously to abnormal stock returns, we measure abnormal trading volume as deviations in BHC trading volume relative to what would be expected given market-wide trading volume. To calculate abnormal trading volume, we regress each BHC's daily trading volume on daily market trading volume:

$$Vol_{i,t} = \beta_0 + \beta_1 Vol_{Market,t} + \varepsilon_{i,t}. \quad (2)$$

Daily trading volume for BHC *i*, $Vol_{i,t}$, is defined as number of shares traded on day t divided by number of shares outstanding. Market trading volume, $Vol_{Market,\,t}$, is the total number of shares traded in the CRSP Total Index divided by the number of shares outstanding in the firms comprising the index . The regression is estimated using daily data over the 120 day pre-event

[11] Bird et al. (2015) examine the absolute value of daily abnormal returns around CCAR disclosure dates and find that the absolute value of abnormal returns increases on average for CCAR disclosure dates in 2012 to 2014. Fernandes, Igan and Pinheiro (2015) look at |CAR| using a longer event window and do not find significant results.

[12] See Lo and Wang (2000) for a discussion of this method in the context of mutual fund separation.

window. Abnormal trading volume is the difference between the actual and predicted trading volumes on each day around the disclosure date. Cumulative abnormal trading volume (CAV) equals that sum of abnormal trading volume over the 3-day [t-1, t+1] window around the disclosure date.

Absolute Change in CDS Spreads

Since stress testing is oriented towards performance in bad macroeconomic and financial market outcomes, supervisory stress test disclosures may be more informative for instruments that are more sensitive to downside risk. To explore this possibility, we examine changes in credit default swap (CDS) spreads. Similar to stock returns and volumes, we estimate an abnormal change in CDS spreads as the fitted residual from a regression of daily changes in CDS spreads on changes in a "market" CDS spread measure, estimated over the 120 day estimation window

$$\left(\frac{CDS_{i,t}}{CDS_{i,t-1}} - 1\right) = \gamma_0 + \gamma_1 \left(\frac{CDX_t}{CDX_{i,t-1}} - 1\right) + \varepsilon_{i,t} \quad (3)$$

where $CDS_{i,t}$ is the CDS spread on the i^{th} BHC's 5-year CDS contract on day t, and CDX is the spread of the CDX North America Investment Grade CDS index.

Since a stress test might reveal unanticipated strength or weakness at sample BHCs, we again take the absolute value cumulative abnormal spread change, |CACDS|. We found reliable data on CDS contracts for more than half of the stress-tested BHCs, but only for 6 of the non-stress tested BHCs.[13] Accordingly, we present results only for the stress-tested subsample (in Panel A of Table 2).

Change in Option Implied Volatility

The literature on the market reaction to earnings announcements suggests that stress test results might affect a BHC's option implied volatility. If information is disclosed on stress testing announcement dates, implied volatility should fall once that information has been released to the market (see Ederington and Lee 1996, Patell and Wolfson 1981 and Donders and Vorst 1996). To test this idea, we calculate each BHC's implied equity volatility from one month, at the money (|delta| = 50) call and put options using data from Option Metrics.[14] Change in implied volatility (ΔVOL) is the cumulative percent change of the average implied volatility in the event window [t-1,t+1]. Options traded infrequently for some of the non-stress tested BHCs. Therefore, we limited the panel to firms with more than $25 billion in assets and with option

[13] CDS information is available for 10 to 16 stress tested firms depending on the event date.

[14] Results are slightly stronger if calculated using out of the money options and using only put options, although with more extreme changes for individual firms.

volumes that were greater than the first quartile of option volume for this subset of non stress-tested firms.

4. Stress Test Disclosure Effects

This paper examines three key questions about U.S. supervisory stress test disclosures. First, do these disclosures produce market-relevant information about the stress tested BHCs and/or about the broader banking industry? The prior literature on stress testing has found mixed market price reactions using standard CARs, which do not fully distinguish between positive and negative announcement returns. Direction-neutral measures of market impact seem appropriate for stress test disclosures, since it can be difficult to measure accurately market expectations concerning the disclosures. Our |CAR| results are more consistent over time. Next, we ask whether BHC characteristics (specifically, leverage, asset risk and liquidity) are correlated with the amount of information produced by stress test disclosures.[15] For example, market participants might find supervisory stress test information more valuable for riskier BHCs, which may be more vulnerable to negative economic and financial market conditions. Finally, we assess whether public disclosure of private supervisory information has negative welfare consequences, as in Goldstein and Sapra (2014). We examine whether these disclosures are associated with reduced information production by private sector participants, and find that they are not. The information environment for public equity appears, if anything, better for stress tested firms. We also test whether stress test results affect banks' portfolio composition or their willingness to share risks through the interbank market, but find no support for either possibility.

A. Announcement Effects

Table 2 presents test statistics for various dimensions of the market reactions to stress testing announcements. Panel A applies to stress tested firms, Panel B applies to the non-stress tested BHCs, and Panel C tabulates differences between the two groups. The columns in each Panel of Table 2 report results for each measure of abnormal performance. The first ten rows correspond to the nine announcement dates identified in Table 1 (there are two rows for SCAP), while the last three rows test joint hypotheses about combinations of the event dates. Rows 1 and 2, concerned with SCAP results, bear special mention. Despite the general view that the

[15] Previous research (Morgan 2002, Hirtle 2006) has found that more highly levered BHCs are more opaque, suggesting a higher value for additional information about these institutions. Similarly, new information about riskier firms or those with lower liquidity (and hence more danger from potential runs) may be particularly valuable.

SCAP provided substantial information about the banking sector's overall condition, its effect in the first row of Table 2 Panel A is often statistically insignificant. Upon closer inspection, the lack of statistical significance arises from the fact that the absolute abnormal returns in the SCAP estimation period are quite high. The estimation period spans November 2008 to April 2009, including much of the market turmoil following the collapse of Lehman Brothers. As an alternative for the SCAP announcements, we also computed our test statistics using a 120 day model estimation period after the SCAP disclosure [t+10, t+130] and report these results in the second row of each Panel in Table 2.

Column (1) reports the conventional event study results. The stress-tested BHCs' average abnormal returns (in Panel A) differ across announcement dates in sign and significance. Averaging across all dates in the first column, we estimate a mean CAR of 87 bps for stress tested BHCs and 76 bps for the non-stress tested firms. (See row 12 in Panels A and B.) Although both of these CAR values differ significantly from zero, the difference between the two groups is not statistically significant. Thus, disclosure of stress test results appears to affect the value of all large BHCs. The last row of Panel A indicates that even when the SCAP results are omitted, the average CAR remains significantly positive. Some of our results are similar to those reported by earlier researchers (e.g., Morgan et al. 2014 for SCAP, Candelon and Sy 2015 for SCAP through DFAST/CCAR 2013), despite differences in our return generating functions.

Column (2) reports results for the absolute value of cumulative abnormal returns, |CAR|. (Recall that significance for this statistic is computed for the difference between its event period value in Column (2) and its value during the model estimation period (in column (6)). Across all disclosure dates, the stress tested BHCs have average |CAR| of 2.75 percent (see rows (11) and (12) of Panel A), an amount that is statistically significantly higher than the pre-event window value. The stress-tested BHCs have excess average |CAR| of at least one percent on each supervisory stress test disclosure date. Unlike the CAR results in column (1), the |CAR| test yields uniform results: |CAR| exceeds its estimation period value for all nine events and seven of those differences are statistically significant at the 5% level. Beginning in 2013, the DFAST disclosures appear to generate larger market reactions than CCAR disclosures, perhaps because DFAST disclosures slightly precede CCAR disclosures.

Panel B of Table 2 indicates that supervisory stress test disclosures also affect non-stress tested BHCs' stock returns. The average for these firms' excess |CAR| is 2.38 percent (see row (12)) across all the disclosure dates, and differs significantly from its pre-event average at the 1 percent level. However, only four of the nine individual disclosure dates have statistically significant test statistics. Panel C indicates that the information effect is stronger for the stress

tested firms, whose |CAR| significantly exceeds that of the non-stress tested firms on four individual event dates, and across the set of all event dates (row (12)). Combining all event dates, and using the post-SCAP estimation window, the |CAR| is 37 basis points higher (p = 1%) for stress tested firms than for non-stress tested firms, a difference of 14 percent. Further tests indicate that this difference reflects more than just firm size.[16]

Column (3) of Table 2 reports results for cumulative abnormal trading volume, CAV. Stress-tested BHCs' shares trade more during all the stress test event periods, and statistically significantly more during seven of the nine event periods. (See Panel A.) This is consistent with the findings of Bird et al. (2015), who show that actual trading volume on CCAR disclosure dates in 2012, 2013 and 2014 exceeds the average volume on the days immediately preceding the disclosures.[17] A similar result in Panel B indicates that non-stress tested BHCs' equity likewise trades more when stress test results are announced. Panel C indicates that the trading volume changes for stress-tested BHCs significantly exceed those for the non-stress tested firms. Across all event dates, the average stress-tested BHC's trading volume increases 1.49 percentage points (p = 1%) more than that for the non-stress tested sample. (See row 12 in Panel C.)

Column (4) in Panel A reports changes in the stress-tested banks' CDS spreads around supervisory stress test disclosure dates.[18] The average |CACDS| across all event dates (4.18 percent) differs insignificantly from the average |CACDS| during the pre-event estimation window (3.72 percent, in column (7)). These averages are influenced by the very high abnormal spread changes at the SCAP disclosure, the individual disclosure event date for which |CACDS| differs most significantly from its pre-event value. Omitting the SCAP results (row 13 of Panel A), the average |CACDS| falls to 3.12 percent, which is economically equivalent to the pre-event window's average value reported in column (7). In words, except for the SCAP in 2009, stress test results seem to have had little effect on the market's beliefs about firm default, perhaps because the probability of the adverse macroeconomic scenarios occurring appeared to be very low.

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[16] In unreported results, we calculated |CAR| and CAV values for the largest publicly traded non-bank companies and for non-bank financial firms (NAICS codes starting in 52), many of which are comparable in size to the stress tested BHCs in market capitalization. The stress tested BHCs have higher |CAR| and CAV on almost all announcement dates, a difference that is statistically significant when event dates are pooled, excluding or including 2009, suggesting that the abnormal returns are not driven exclusively by firm size.

[17] Fernandes, Igan and Pinheiro (2015) find statistically significantly higher abnormal trading volumes around a longer event window at the SCAP and 2012 CCAR disclosure dates, but not for other event dates.

[18] Recall that the scarcity of CDS data for non-stress tested BHCs lead us to undertake these tests only for the stress-tested sample, reported in Panel A.

The change in implied volatility across announcement dates, ΔVOL, is reported in Column (5). Implied volatility for stress-tested firms changes significantly on five of the nine disclosure dates (Panel A), but with different directions: three negative and two positive. Across all event dates, average implied volatility falls by 1.7 percentage points, statistically significant at the 5 percent level. The most dramatic average decline (20 percentage points) occurs around the CCAR 2011 event date.

The disparate changes in implied volatilities seem puzzling in light of the observation that corporate earnings announcements generally result in a uniform reduction in investor uncertainty. However, the event dates with increased volatility suggest that a firm's stress-testing performance may increase uncertainty. Unlike earnings announcements, where the information is specifically focused on firm's financial condition, stress test disclosures may also contain information about the Federal Reserve's likely treatment of the firm. For example, in the cases of firms that do not have a positive outcome on the CCAR for qualitative reasons, the disclosures may actually increase uncertainty about the firm and its ability to distribute capital. Thus, the theoretical impact of the disclosures on implied volatility is ambiguous; we can only measure the net effect. Consistent with this explanation, we find a small negative correlation between CAR and the change in option implied volatility.

As we have seen for the other information measures, results for non-stress tested BHCs (in Panel B) are qualitatively similar to results for the stress tested firms, although magnitudes and statistical significance are lower. Panel C indicates that the volatility changes for stress-tested BHCs exceed those for non-stress tested BHCs, although only the CCAR 2014 difference is statistically significant.

Figure 1 presents our |CAR|, CAV and |CACDS| results graphically for the stress tested BHCs across the nine event dates. These values are highest for the original SCAP disclosures in 2009. While these three measures have decreased since 2012, the hypothesis that the values are the same (and non-zero) for the 2013 to 2015 disclosures cannot be rejected for |CAR|, CAV or |CACDS|.[19] Our results are inconsistent with the hypothesis that the market's response to supervisory stress test disclosures has become insignificant (Glasserman and Tangirala (2015)).

In summary, Table 2 and Figure 1 present evidence that stress testing disclosure dates are associated with statistically significant absolute abnormal stock returns and abnormal trading volumes. Although the recent announcements have had smaller effects than the

[19] The implied volatility measure, ΔVOL, has a different pattern, as it varies in sign and magnitude across disclosure dates. However, ΔVOL registers its second-largest decline for CCAR 2015, suggesting that the impact of disclosure on this measure, while variable, is not declining over time.

influential 2009 SCAP, these abnormal securities movements have been relatively constant since 2011. In total, the findings suggest that supervisory stress test disclosures continue to provide relevant information to investors and other market participants. Further, while supervisory stress test disclosures are most relevant for the stress tested BHCs, the information also affects investor beliefs about the banking industry in general.

B. Cross-sectional Effects

Does stress testing produce more information about riskier BHCs? Or about BHCs with specific business models? We examine the cross section of market reactions to see if observable BHC characteristics are associated with abnormal securities movements. We focus on |CAR| and CAV, since we lack CDS and implied volatility measures for many of the non-stress-tested BHCs. In particular, we run a panel regression over the nine event dates, with separate regressions for stress tested and non-stress tested firms:

$$|CAR|_{i,t} \text{ or } CAV_{,i,t} = a + \beta\,(\textit{BHC characteristics})_{i,t} + \Sigma_y + \varepsilon_{i,t} \qquad (4)$$

where $(\textit{BHC characteristics})_{i,t}$ is a set of observable characteristics, defined in Appendix A. Accounting characteristics are taken from the BHC's last quarterly Y-9C filing before the event date, while market characteristics are calculated through the end of the last full quarter preceding the event date. These *BHC characteristics*, defined in Appendix A, are intended to capture variation in leverage, risk and liquidity across BHCs. Rejecting the hypothesis that $\beta = 0$ would suggest that the BHC characteristic in question is associated with significant variation in information. Σ_y is a set of year fixed effects, included to control for variation in business conditions over time. Note that these are similar to event date fixed effects in 2009 to 2012. Starting in 2013, however, we have two events per year.

Table 3 presents summary statistics for the panel of BHCs, with one observation per firm per event date. Not surprisingly, stress tested BHCs are much larger, in both total assets and market capitalization. Stress tested BHCs have lower equity capital ratios measured in book and market terms. (The difference in the market leverage ratio is not statistically significant.) Stress tested BHCs appear similar to non-stress tested BHCs in terms of stock price volatility and losses in the financial crisis, although they have a lower ratio of risk weighted assets to total assets. They have more liquid assets, but also more runnable liabilities relative to those liquid assets (lower liquidity coverage).

The relationship between firm characteristics and two information variables are presented in Table 4 for |CAR| and in Table 5 for CAV. In both tables, Panel A shows the results for stress tested firms and Panel B for non-stress tested firms, and the standard errors are clustered by BHC. We start by demonstrating that the dependent variables include substantial time variation: the first columns in Tables 4 and 5 indicate that year fixed effects alone explain 18.5 percent of the variation in absolute value abnormal returns and 13 percent of the variation in abnormal volumes for the stress tested firms. Columns (2) through (9) report individual measures of leverage, risk and liquidity. In column 10, we combine subsets of our measures of leverage, risk and liquidity, including only the explanatory variable in each category with the highest p-value since we expect our different measures of BHC characteristics may be correlated.

More highly levered firms are likely to be more vulnerable to a severely adverse macroeconomic scenario, and therefore stress testing information may be more salient for these firms. In fact, the results suggest that banking firms with higher leverage have larger absolute abnormal returns and abnormal trading volumes on disclosure event dates. The estimated coefficient on the equity ratio is negative whether we examine book leverage (Tier 1 capital / risk-weighted assets) or market leverage (equity market capitalization / total assets), although only the market leverage measure is statistically significant.[20] The lack of statistical significance for the Tier 1 ratio is consistent with the idea that book value regulatory capital ratios have less power to discriminate between healthy and stressed banks than market-value capital measures (Haldane 2011). For a stress tested firm with one standard deviation lower equity market capitalization, both its absolute value abnormal return and its abnormal trading volume exceed the predictions of a market model by about 50 basis points on stress testing announcement dates (Panel A of Tables 4 and 5, Column 3). The relationship between market leverage and |CAR| or CAV is of the same sign, but statistically insignificant for non-stress tested BHCs.

Columns (4) through (7) of Tables 4 and 5 indicate that stress testing is more informative about riskier firms in general. Abnormal CAV is significantly positively related to several risk measures: stock price volatility, earnings volatility, the ratio of risk-weighted assets to total assets, and mean losses during the crisis period. For |CAR|, all four variables have positive coefficients, although only the mean loss coefficient is significant. The effect of financial crisis

[20] Results are similar if we look at equity market value divided by market value of assets and at tier 1 capital divided by total assets.

losses on abnormal returns and volumes is not small: for stress tested BHCs, a one standard deviation higher Mean Loss is associated with about 60 basis point higher absolute abnormal returns and about 75 basis point higher abnormal trading volumes. While differences in the coefficients estimated in the stress tested panel are sometimes materially different in scale from those estimated for the non-stress tested panel, the differences are rarely statistically significant.

Results for our liquidity proxies are mixed, in terms of signs and statistical significance. Column (8) includes three liquidity measures: asset liquidity, liability runnability, and the ratio of undrawn loan commitments to total assets plus undrawn loan commitments.[21] In column (9), we construct a single measure of liquidity mismatch, using weights similar to those in the Basel liquidity coverage ratio.[22] These individual liquidity measures' coefficients are largely insignificant throughout Tables 4 and 5

When we combine measures of leverage, risk and liquidity into a single regression (column (10)), the coefficient signs are generally consistent with the signs from the univariate regressions. We do not find that any single measure dominates across specifications in terms of statistical significance. This may reflect the fact that leverage, risk and liquidity are not independent.

In summary, consistent with the stated goal of Federal Reserve stress testing to focus on capital in a tail risk scenario, we find evidence that absolute abnormal returns and abnormal trading volumes are higher for BHC holding riskier assets. More highly leveraged and riskier stress tested BHCs have larger absolute abnormal returns and abnormal trading volumes.

Panels 4B and 5B further indicate that non-stress tested BHCs with more volatile business models also experience higher |CAR| and CAV on stress testing disclosure dates. The coefficients on market volatility are positive and statistically significant for both |CAR| and CAV and the coefficient on the accounting-based measure of volatility (ROA) is positive and significant for |CAR|. This suggests that the stress tests may produce information about the banking industry more broadly.

To test this hypothesis more directly, we calculate a measure of the "Similarity" between stress tested and non-stress tested firms: the correlation between the stock price of the non-stress tested firm and a market weighted index of the stress tested firms, estimated in

[21] Antoniades (forthcoming) and Cornett et al (2011) mention undrawn credit lines as potential liquidity risks.
[22] We cannot calculate LCR directly due to definitional differences between the US regulatory data and the LCR. Therefore we use weights as described in Choi (2014), to construct a liquidity coverage ratio that is 1-LCR (higher values indicate more liquidity). http://libertystreeteconomics.newyorkfed.org/2014/04/the-liquidity-stress-ratio-measuring-liquidity-mismatch-on-banks-balance-sheets.html#.VtYGSHIUWUk

the pre-event window. The average correlation between non-stress tested firms and the index of stress tested firms is 0.8 (see the bottom row of Table 3), although there is significant heterogeneity. As shown in Tables 4 and 5 (Panels B, column 11), non-stress tested firms that are more similar to stress tested firms by this measure have higher event date |CAR|. These specifications also include a dummy variable for firms larger than $30 billion (*Assets > $30B*). We include this control, because we want to be sure that we are capturing the similarity of firms' businesses rather than the probability of a firm becoming stress tested. The regression thus captures the relationship between market movements and the correlation with stress tested firms after controlling for the relationship between market movements and firms that are more likely to be stress tested in the future (larger firms).[23] Specifically, the estimated coefficient on *Similarity* in column (11) of Table 4B implies that a one standard deviation increase in correlation is associated with a 2 percentage point increase in |CAR|. This increase in |CAR| is economically large – nearly one-third of the estimation window |CAR|.

5. Are there Negative Consequences of Disclosure?

Goldstein and Sapra (2014) synthesize a range of prior theoretical work suggesting that supervisory stress test disclosures could be detrimental to social welfare.[24] First, disclosure of supervisory stress test results could lower the value of private information production. Seemingly authoritative information from the official sector could reduce the value of private information, even if that private information were superior to or more precise than the information contained in the supervisory stress tests. With less private information production, traders would have less incentive to trade, making market prices less informative and thus limiting the usefulness of market information as a complement to supervisory information.

Second, disclosure of supervisory stress tests could harm risk-sharing infrastructure such as the interbank lending market. Because stress test results could help market participants identify weaker institutions, banks could be unwilling to provide liquidity insurance to weak banks via interbank lending, which could prevent the interbank market from functioning. As initially modelled by Hirshleifer (1971), disclosure can be ex ante inefficient, since it limits welfare-enhancing risk-sharing that would otherwise occur. Goldstein and Sapra (2014) argue that this effect is likely to be stronger in normal times, when

[23] Re-calculating the direction neutral measures of market response to stress testing on the panel of non-stress tested firms with assets less than $30 billion, our measures continue to be statistically significant and different from zero (not shown).

[24] For conciseness, we do not cite individual papers referenced in Goldstein and Sapra (2014), which contains detailed descriptions of the papers and an extensive reference section.

few banking companies would be in weak condition, and less important during stress periods, when interbank lending would likely be limited in any case, since many banks would be stressed.

Third, disclosure of supervisory stress test results could affect incentives of bank managers in choosing assets and business focus. Bank managers might adjust their lending and other activities to produce better stress test results, even if those choices are not (privately) value-maximizing. This incentive could strengthen over time, as banks become more familiar with the stress tests and are better able to predict the results.

In this section, we seek empirical evidence consistent with the predictions of these theories. In general, our results do not suggest that stress test disclosures have had a significant negative impact on private information production or distorted real world choices made by bank managers about risk-sharing or portfolio choice.

A. Crowding out private information production

The production of information by supervisors need not improve welfare if it displaces private information production. We assess the impact of stress testing on private sector information production by examining changes in the number of analysts following BHCs over time and the quality of the information they produce. If stress testing is displacing private information production, we would expect to see less analyst coverage and noisier earnings estimates for stress tested BHCs. We do not see this. If anything, there are more equity analysts and their earnings estimates appear to have improved in forecast accuracy.

The results of our analysis of equity analyst information are reported in Table 6 for the regression specification

$$IBES_{i,t} = a + \beta_1(\text{SCAP Firm})_i*(\text{Post SCAP})_t + \beta_2(\text{SCAP Firm})_i*(\text{Post CCAR 2014})_t + \beta_3(\text{CCAR 2014 Addition})_i*(\text{Post CCAR 2014})_t + \beta_4(\text{Post SCAP})_t + \beta_5(\text{Post CCAR 2014})_t + \beta_6(\text{SCAP Firm})_i + \beta_7(\text{CCAR 2014 Addition})_i + \beta_8(\textit{BHC characteristic})_{i,t} + \varepsilon_{i,t} \quad (5)$$

where $IBES_{i,t}$ is one of several measures of analyst information production using quarterly earnings forecasts from I/B/E/S:[25] *Number of Analysts*$_{it}$, the number of analysts who filed any forecast with I/B/E/S for the *i*th bank in quarter *t, Mean Forecast Error*$_{it}$, the mean earnings forecast error for the *i*th bank in quarter *t*, as a proportion of bank i's share price at the end of the prior calendar quarter, and *Estimate SD/Share Price*$_{it}$, the standard deviation of analysts'

[25] I/B/E/S data is widely used in the literature. Michaely and Womack (2005) summarize some of the stylized facts and limitations of analyst recommendations.

forecasts for the *i*th bank in quarter *t*, divided by bank *i*'s share price at the end of the prior calendar quarter.

Each specification includes a non-overlapping set of time fixed effects: *Post SCAP*$_t$, which is equal to one for the quarters 2009:Q3 to 2014:Q1, else zero, and *Post CCAR 2014*$_t$ which is equal to 1 for quarters with the expanded set of stress-tested banks (2014:Q2 to 2015:Q1). We also use dummy variables to distinguish the early stress-test participants from the later ones. Specifically, *SCAP Firm*$_i$ is always equal to 1 for the largest BHCs that were included in stress tests from 2009 through 2013, while *CCAR 2014 Addition*$_i$ is equal to 1 for U.S. BHCs that were added to the stress-tested universe in 2014. These variables are constant for firms over time, and thus drop out of the even numbered specifications which include firm fixed effects. We estimate the regressions for all banking firms with assets greater than $10 billion and available share prices over the sample period (2006:Q3 to 2015:Q1).

Finally, we add controls for firm characteristics at time *t* (*BHC characteristic* $_{i,t}$)that are associated with analyst coverage such as firm size (equity market capitalization normalized by the S&P Composite Index market value), whether the firm is about to release a negative earnings report and the recent abnormal returns for the firm (following Gomes et al. 2006).[26] In addition, we estimate each specification with firm fixed effects, which allows us to control for constant unobservable characteristics of the firm that may be associated with analyst coverage.

The coefficients on the time dummy variables indicate average changes over time in our measures of analyst coverage. The interactions with the stress testing cohorts allow us to see if those changes depend on a BHC's participation in stress testing. Thus, the interaction measures whether the initial group of BHCs subject to stress testing *(SCAP Firm)* have different information production by analysts, relative to the pre-stress testing period and relative to the average change in information production for other large U.S. banking firms.

The first two columns in Table 6 examine the simplest possible interpretation of information production, the number of analysts following each firm. Even after controlling for market capitalization, stress tested firms have more analyst coverage than do other large BHCs (the coefficients on *SCAP Firm* and *CCAR 2014 Addition* are positive and statistically significant). The introduction of stress testing does not seem to stop analysts from covering these firms. Relative to the period before stress testing began, and relative to the average change for all banking firms, SCAP firms average more than 4 additional analysts (see the coefficients on *SCAP*

[26] Size based on Bhushan (1989); Brennan and Hughes (1991); Lang and Lundholm (1993, 1996); and Chung and Jo (1996). The other explanatory variables are dimensions of firm performance, as in Bhushan and O'Brien (1990). Results are similar if none of these controls are included.

Firm Post SCAP* and *SCAP Firm*Post CCAR 2014*). This increase in analysts following stress-tested banks is beyond the broader increase of approximately 3 analysts per bank in 2009-2013 and 2 analysts in 2014-2015. Thus, the average stress tested BHC has attracted 6 to 7 additional analysts since stress testing began. Firms that were first exposed more recently to stress testing also appear to add analyst coverage: the estimated coefficient on (CCAR 2014 Addition)*((Post CCAR 2014) is 1.09, significant at the 10% level. In words, BHCs first stress-tested in 2014 attract one additional analyst (beyond the 2 analyst increase in coverage experienced by all firms at this time), all else equal. These results are driven by changes in analyst coverage within firms – estimated coefficients are very similar if we include firm fixed effects (see column (2)).

What about the quality of the information produced by these analysts? Regardless of whether we include firm fixed effects, the coefficients on the time dummies, the stress-testing dummies, and their interactions are generally insignificant. These results provide no evidence of a significant deterioration in forecast quality for stress-tested BHCs since supervisory stress test results have been disclosed relative to other firms in the industry.

The variability of analysts' estimates is sometimes used as a measure of firm opacity. We therefore examine the standard deviation of analysts' forecasts, scaled by share price, in columns (5) and (6) of Table 6. Once again, we find little evidence for a changed information environment. The specification including firm fixed effects (in column (6)) indicates (marginally) lower estimation variance after stress-testing has started, but these effects are not significantly associated with stress-tested parts of the BHC population.

B. *Distorting Managerial Decisions*

Disclosing supervisory stress test results may give stress tested BHCs an incentive to change their business focus or asset composition in order to perform better on the stress tests. If the stress tests provide new information about the underlying risks of certain activities or assets, then changes the BHCs make in response to that information could be welfare enhancing. However, tested BHCs may choose investments that perform well on supervisory stress tests but are not value-maximizing in the long run. (Goldstein and Sapra (2014) argue that BHCs' ability to alter portfolios in this way becomes stronger over time as supervisory stress tests are repeated.) If DFAST models over-estimate balance sheet risks, banks may be forced to cut back on positive-NPV loans because they cannot sell sufficient equity to make those loans at the required capital ratios. Schuermann (2013) makes another point, about "model monoculture." He observes that BHCs have strong incentives to develop internal models that mimic the Federal Reserve's stress test results, rather than reflecting a variety of different potential

risks. Consequently, the entire banking system (and its regulator) could be more likely to overlook new emerging risks. Finally, BHCs could alter their portfolios to perform well on supervisory stress tests, but retain risk in forms not well-captured in the stress tests.

Although out data do note permit tests for all of these possibilities, we can examine whether BHCs appear to alter the growth of assets or loans in response to supervisory stress test results. Starting in 2013, the tested BHCs released their own estimates of loan losses in multiple categories. To the extent that the bank's estimates are lower than the Fed's for a particular loan type, the bank might be lead to shift dollars out of that loan category. And vice versa. Finding that BHCs respond to the gap between the Fed's and their own stress test projections would imply that supervisory stress test results affect BHCs' portfolio choice. Simply finding a relationship does not necessarily indicate that this influence reduces welfare, but finding no relationship suggests that these potential distortions may be less prominent.

We estimate cross sectional regressions of loan or asset growth in the three quarters following the release of the DFAST results on the gap between the Federal Reserve's and the BHC's stress test projections:

$$Y_{i,t} = \beta_0 + \beta_1 GAP_{i,t} + \gamma_t + \varepsilon_{i,t}, \quad (6)$$

where $Y_{i,t}$ is growth in assets or loans at BHC i in the three quarters following the stress test disclosures in year *t*, $GAP_{i,t}$ is the Federal Reserve's estimated loan losses for BHC *i* under the severely adverse scenario in year *t,* less the BHC's own estimate, and Υ_t is a fixed effect for year *t*. The equations are estimated using data for the 2013, 2014 and 2015 DFAST disclosures. A negative value for β_1 would suggest that assets or loans grew more slowly at BHCs for which the Federal Reserve's stress test projections were more severe than the BHC's own projections.

Panel A of Table 7 reports estimates of regression (6) for various components of the loan portfolio. These regressions relate growth of different categories of loans to the GAP for that loan type. Results are reported for all observations and for observations involving just material portfolios (defined as portfolios representing at least 3 percent of total loans), since BHCs might have greater incentives to adjust larger (more consequential) loan portfolios.

The table provides little consistent evidence that BHC loan portfolios grow more slowly when the Federal Reserve projects higher loss rates for those loans. There is a statistically significant relationship for two of the seven individual loan categories, but one of these suggests that loan growth in higher when the Federal Reserve projects a higher loss rate than the BHC (so that "GAP" is positive).

When the results focus just on material portfolios, the results are significant for only one loan category (commercial real estate loans), and again, the sign of the coefficient on the Fed-BHC GAP is the opposite of what we would expect if BHCs were adjusting their portfolios to perform better on the supervisory stress tests.

Panel B of Table 7 presents the results of regressing total asset and total loan growth on the Federal Reserve – BHC GAP in two more comprehensive stress test projections: pre-tax net income (scaled by assets) and the minimum value of the tier 1 common capital ratio. Each of these measures captures differences in the overall severity of the BHCs' and the Federal Reserve's stress test results. The coefficients on the "GAP" variables for pre-tax net income and the tier 1 common ratio are not statistically significant for either the asset or loan growth equations. In other words, we find no meaningful relationship between the relative severity of the Federal Reserve's stress test results and asset or loan growth.

In sum, the Table 7 results provide little evidence that asset choices (either between loans and securities or among loan types) are influenced by differences between the Fed's and the bank's loss estimates.

C. Ex Ante Reduction in Risk Sharing

A traditional motivation for limiting disclosure of supervisory information is reducing the possibility of runs. Hirshleifer (1971) suggests that there may be endogenous costs of disclosure. For example, disclosure can reduce welfare by reducing mutual risk sharing, such as interbank lending. In a related vein, Heider et al. (2009) and Acharya et al. (2009) model contagion risk from information asymmetry in the unsecured overnight interbank lending market. In these models, eliminating the risk of firm default can prevent the market from unraveling.

To explore these potential effects of stress test disclosures, we compare the interbank borrowing done by stress tested and non-stress tested BHCs, focusing on the shortest maturity borrowing. The dependent variable in this specification is each BHC's federal funds and repo borrowing scaled by total assets, as reported in quarterly FR Y-9C. The time period is 2007:Q1 to 2015:Q1. Each specification includes the same time fixed effects as in Table 6 (and explained in equation (5)), for the time period after SCAP (2009:Q3 to 2014:Q1) and after CCAR 2014 (2014:Q1-2015:Q1). The omitted time period is thus 2007:Q1 through 2009:Q2. As before, we interact the time fixed effects with dummies for stress tested firms.

The results are shown in Panel A of Table 8. We observe a decrease in interbank lending since 2009 for all firms – the coefficients on the two time period dummy variables are both

negative and statistically significant. However, structural changes in the interbank lending markets that were initiated at the same time as stress testing make it unlikely that this change reflects the impact of stress testing on these markets in the time series.[27] Looking within the cross-section, we estimate a positive, statistically significant coefficient on the interactions for the BHCs that have been stress tested for the longest. Not only do we find no differential decrease in interbank borrowing by stress tested BHCs, but we find their borrowing increased relative to other firms.

Perhaps interbank risk-sharing should be expected to fall only for relatively weak BHCs. We investigate this possibility in Panel B of Table 8, which reports the results of regressing the change in fed funds and repo borrowing of the stress tested and non-stress tested BHCs between December 31 (of the previous year) and March 31 (i.e. the quarter end before and after the stress testing announcement dates) in the years in which supervisory stress test results were disclosed. The first two columns examine the change in borrowing amount, and the second two columns examine the change in average pricing (defined as the interest expense on fed funds and repo normalized by the quarter end fed funds and repo balance).

While on average, stress tested BHCs appear to be reducing interbank borrowing (negative coefficient on stress tested dummy variable), the estimated coefficient is not statistically significant. Notably, we find no significant decline in interbank borrowing for BHCs whose stressed capital ratios fall below minimum levels ("quantitative failure") or for those BHCs experiencing a broader range of negative DFAST/CCAR outcomes, including capital plan objections, reducing their original capital distribution requests, and stressed capital ratios below minimum levels ("negative outcomes"). Further, columns (3) and (4) of the table show no evidence that borrowing costs increase for these firms relative to the rest of the sample.

These risk-sharing results must be interpreted with care, because most of our event dates take place in a relatively benign climate for large banking firms. Further, while we are executing a difference-in-differences analysis, comparing the changes for stress tested firms to the changes for non-stress tested firms, the high excess reserves of the post-2008 environment for interbank risk sharing may not provide the best environment for identifying changes in risk sharing, since overall fed funds volumes have fallen sharply.

6. Conclusion

[27] The unsecured overnight market in the US experienced dramatic declines after October 2008, when the Federal Reserve began paying interest on reserves. Similarly, changes to the repo market reflect increased supervisory attention to those markets after the 2008 financial crisis.

Methodologically, we question the appropriateness of simple event studies to assess the impact of supervisory stress test disclosures, because they require estimates of the market's expectations at the time stress test information was disclosed. Instead, we rely on two other measures of information: the absolute value of affected BHCs' share price returns, and abnormal share trading volume. Using these measures, we find that the disclosure of supervisory stress testing information about large BHCs consistently provides material information to investors in these firms. Stress testing disclosures are accompanied by abnormal price and volume movements. Information appears to be most meaningful for more highly leveraged and riskier, more volatile BHCs. While the initial stress test in 2009 had the largest announcement effects on stress tested BHCs, subsequent stress testing disclosures continue to inform the market, with statistically significant abnormal volumes and returns and implied volatility changes for even the most recent (2015) DFAST and CCAR results. Stress disclosures appear to provide information not only about stress tested BHCs, but also about other large banking firms that were not directly involved in the stress tests. These last findings support the idea that the information contained in stress test disclosures at least partly concerns the fundamentals of the banking industry, rather than being solely related to the supervisory treatment of stress-tested firms.

Despite the theoretical possibility of negative welfare impacts from stress testing disclosure, our analysis finds no such evidence. Stress tested BHCs (and the banking industry) have more analysts whose earnings estimates are no less accurate than before stress testing was initiated. Risk sharing does not appear to be reduced, and banks do not seem to adjust their asset allocations or growth in response to Fed loss estimates in the stress test.

The fact that we find little evidence of negative repercussions of stress testing disclosures does not mean they would not emerge for a different set of firms or under different market conditions. We are evaluating the consequences of stress testing disclosure in a relatively benign environment in which BHC leverage is at recent historical lows. A full analysis of the consequences of stress testing disclosure may require the realization of a major bank failure or another period of widespread stress for the banking industry.

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Figure 1

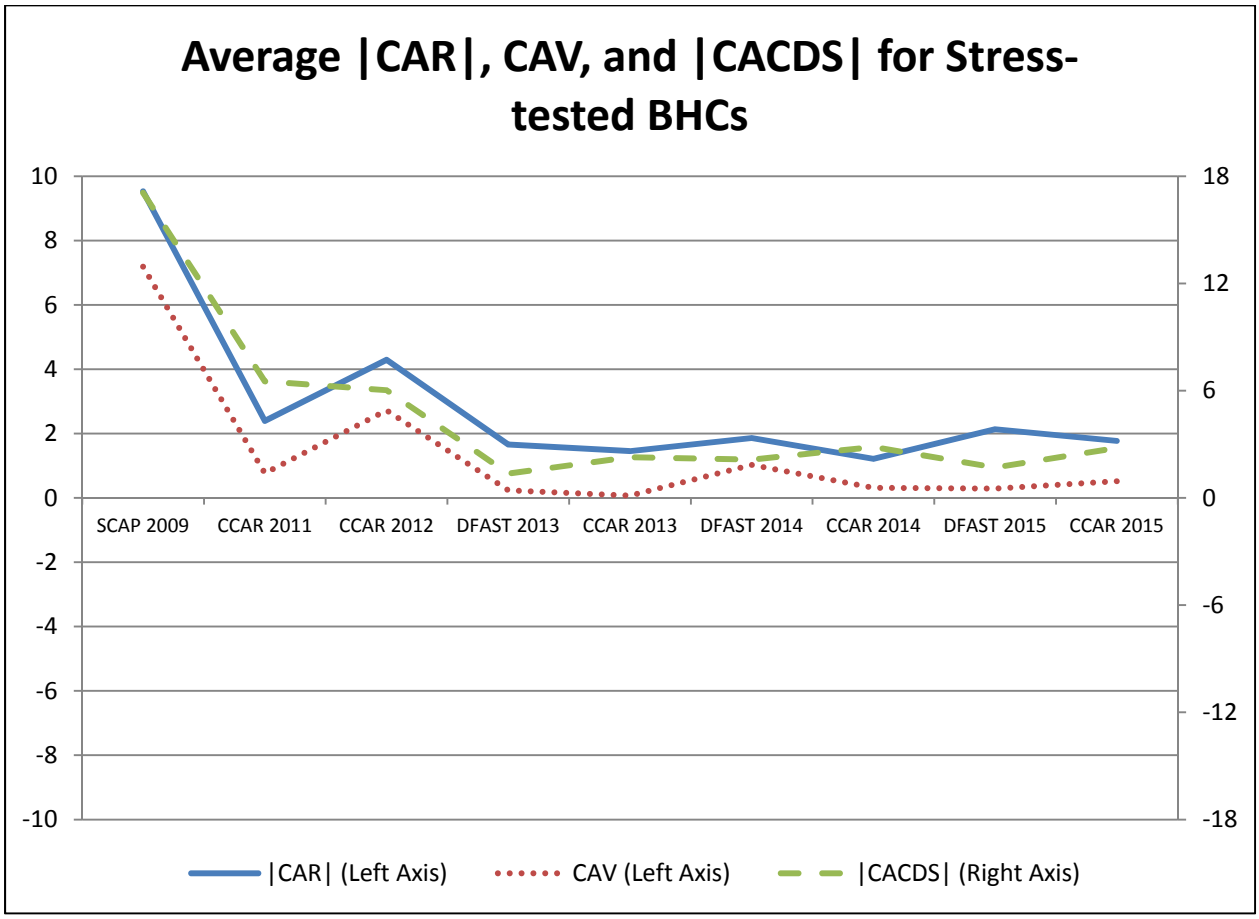
Average |CAR|, CAV, and |CACDS| for Stress-tested BHCs
10
8
6
4
2
0
-2
-4
-6
-8
-10
18
12
6
0
-6
-12
-18
SCAP 2009
CCAR 2011
CCAR 2012
DFAST 2013
CCAR 2013
DFAST 2014
CCAR 2014
DFAST 2015
CCAR 2015
|CAR| (Left Axis)
CAV (Left Axis)
|CACDS| (Right Axis)

Table 1, Panel A: Timeline of Supervisory Stress Test Disclosures (2009 to 2015)

Stress Testing Event Date	Information Disclosed
May 7, 2009	SCAP stress test results released
March 18, 2011	2011 CCAR results released
March 13, 2012	2012 CCAR results released
March 7, 2013	2013 DFAST results released
March 14, 2013	2013 CCAR results released
March 20, 2014	2014 DFAST results released
March 26, 2014	2014 CCAR results released
March 5, 2015	2015 DFAST results released
March 11, 2015	2015 CCAR results released

Note: Stress testing announcements are typically made after the market closes. The event date (t=0) is the first trading day after the announcement.
Source: federalreserve.gov

Table 1, Panel B: List of Stress Tested Entities

Firm	Original SCAP BHC	Initial Disclosure Date	U.S.-Owned BHC?
Ally Financial Inc.	Yes	2009	Yes
American Express Company	Yes	2009	Yes
Bank of America Corporation	Yes	2009	Yes
BB&T Corporation	Yes	2009	Yes
BBVA Compass Bancshares, Inc.	No	2014	No
BMO Financial Corp.	No	2014	No
The Bank of New York Mellon Corporation	Yes	2009	Yes
Capital One Financial Corporation	Yes	2009	Yes
Citigroup Inc.	Yes	2009	Yes
Citizens Financial Group, Inc.	No	2014	Yes
Comerica Incorporated	No	2014	Yes
Deutsche Bank Trust Corporation	No	2015	No
Discover Financial Services	No	2014	Yes
Fifth Third Bancorp	Yes	2009	Yes
The Goldman Sachs Group, Inc.	Yes	2009	Yes
HSBC North America Holdings Inc.	No	2014	No
Huntington Bancshares Incorporated	No	2014	Yes
JPMorgan Chase & Co.	Yes	2009	Yes
KeyCorp	Yes	2009	Yes
M&T Bank Corporation	No	2014	Yes
Morgan Stanley	Yes	2009	Yes
MUFG Americas Holdings Corporation	No	2014	No
Northern Trust Corporation	No	2014	Yes
The PNC Financial Services Group, Inc.	Yes	2009	Yes
Regions Financial Corporation	Yes	2009	Yes
Santander Holdings USA, Inc.	No	2014	No
State Street Corporation	Yes	2009	Yes
SunTrust Banks, Inc.	Yes	2009	Yes
U.S. Bancorp	Yes	2009	Yes
Wells Fargo & Company	Yes	2009	Yes
Zions Bancorporation	No	2014	Yes

Table 2, Panel A: Market Impact on Stress Tested Firms of Stress Testing Disclosure

		Event Date									Est. Window	
		(1) CAR		(2) |CAR|		(3) CAV		(4) |CACDS|		(5) ΔVOL		(6) |CAR|	(7) |CACDS|
(1)	SCAP 2009 Before	2.41		9.53		7.19	***	17.07	***	0.52		6.48	8.36
(2)	SCAP 2009 After	3.33	***	9.38	***	10.73	***	13.47	***	0.52		2.72	6.93
(3)	CCAR 2011	-2.23	***	2.39	***	0.77	**	6.52		-20.69	***	1.62	3.58
(4)	CCAR 2012	4.29	***	4.29	***	2.72	***	6.03	*	5.87		1.81	4.58
(5)	DFAST 2013	0.82	*	1.66	**	0.24		1.37		-4.13	***	1.22	2.51
(6)	CCAR 2013	-0.32		1.45		0.07		2.27		0.54		1.22	2.51
(7)	DFAST 2014	-0.37		1.86	**	1.02	***	2.14		1.59		1.03	2.93
(8)	CCAR 2014	-0.91	***	1.21		0.31	**	2.85		1.07	*	1.03	2.93
(9)	DFAST 2015	2.04	***	2.13	***	0.29	*	1.70		3.63	***	1.08	2.07
(10)	CCAR 2015	1.55	***	1.77	***	0.52	***	2.79		-6.15	***	1.08	2.07
(11)	All Events (with SCAP before)	0.78	**	2.76	***	1.33	***	4.18		-1.70	**	2.08	3.72
(12)	All Events (with SCAP after)	0.87	***	2.75	***	1.62	***	4.12		-1.70	**	1.52	3.66
(13)	All Events Except 2009	0.60	***	2.04	***	0.71	***	3.12		-1.93	**	1.31	3.10

Table 2, Panel B: Market Impact on Non- Stress Tested Firms of Stress Testing Disclosure

		Event Date								Est. Window
		(1) CAR		(2) |CAR|		(3) CAV		(4) ΔVOL		(6) |CAR|
(1)	SCAP 2009 Before	8.18	***	12.07		2.32	***	0.61		5.98
(2)	SCAP 2009 After	5.48	***	9.23	***	0.26		0.61		3.73
(3)	CCAR 2011	-0.98	**	1.55		-0.91	**	-18.31	***	1.91
(4)	CCAR 2012	3.01	***	3.16	***	0.62	***	-0.40		1.81
(5)	DFAST 2013	0.50	*	1.38		0.23	*	-2.35	**	1.34
(6)	CCAR 2013	-0.87	***	1.45		0.59	***	2.52		1.34
(7)	DFAST 2014	-0.52	**	1.20		0.39	***	8.35		1.24
(8)	CCAR 2014	-1.08	***	1.62	***	-0.26	**	5.37	**	1.24
(9)	DFAST 2015	2.41	***	2.52	***	0.07		-1.18		1.22
(10)	CCAR 2015	0.01		0.80		0.10		-2.78		1.22
(11)	All Events (with SCAP before)	1.06	***	2.71	*	0.34	***	-1.22		2.17
(12)	All Events (with SCAP after)	0.76	***	2.38	***	0.13		-1.22		1.80
(13)	All Events Except 2009	0.28	**	1.68	***	0.12		-1.40		1.48

Table 2, Panel C: Market Impact on Stress Tested - Non Stress Tested Firms

		(1) CAR		(2) |CAR|		(3) CAV		(4) ΔVOL	
(1)	SCAP 2009 Before	-5.77		-2.54		4.86	*	-0.09	
(2)	SCAP 2009 After	-2.15		0.15		10.47	***	-0.09	
(3)	CCAR 2011	-1.25	***	0.85	**	1.68	**	-2.38	
(4)	CCAR 2012	1.29		1.13	**	2.10	***	6.27	
(5)	DFAST 2013	0.32		0.28	**	0.01		-1.78	
(6)	CCAR 2013	0.54		0.00		-0.52		-1.97	
(7)	DFAST 2014	0.15		0.66		0.63		-6.75	
(8)	CCAR 2014	0.18		-0.40		0.58	***	-4.30	**
(9)	DFAST 2015	-0.37		-0.38		0.22		4.82	
(10)	CCAR 2015	1.54	***	0.97	***	0.42	***	-3.37	
(11)	All Events (with SCAP before)	-0.29		0.06	***	1.00	***	-0.47	
(12)	All Events (with SCAP after)	0.10		0.37	***	1.49	***	-0.47	
(13)	All Events Except 2009	0.32		0.37	***	0.59	***	-0.53	

Table 2 reports equity, CDS and options market reactions to the nine Federal Reserve stress testing (SCAP, CCAR, and DFAST) disclosures between 2009 and 2015. The sample consists of banking firms with publicly traded equity and assets greater than $10B on the event date which exist in the entire estimation window for the event, and excluding subsidiaries of foreign firms. Results are separated by stress-tested and non-stress tested firms, where firms are included in the stress tested group only for the event dates for which they are subject to stress testing (17 firms in the stress tested sample for events before 2014 and 23 firms thereafter, see Table 1, Panel B). In order of event dates there are 42, 39, 41, 40, 53, 53, 47, 47, 50 and 50 firms in the non-stress tested group. In order of event dates there are 10, 13, 14, 14, 16, 16, 16, 16, 15, and 15 firms with CDS data in the stress-tested group. All public stress-tested firms have options, but not all non-stress tested firms have them (panel includes between 11 and 19 firms, depending on the event date).

We use standard event study techniques to calculate unexpected changes in stock prices, volumes, option implied volatility and CDS. The estimation window consists of a 120 day window preceding the event date by 10 trading days [t-130,t-10] for SCAP 2009 and CCAR 2011-2012. The estimation window for DFAST/CCAR event dates are the same for 2013-2015 and consist of a 120 day window preceding the DFAST event date by 5 trading days [t-125, t-5]. Abnormal returns are cumulated over the three day window surrounding the event date [t-1,t+1]. We also calculate abnormal returns using a 120 day estimation window following the event date for the SCAP event date "SCAP 2009 After" [t+10,t+130]. Abnormal returns are calculated using a Fama-French three-factor market model for stock price returns (CAR and |CAR|), and one factor models for volumes (CAV) and CDS (CACDS), with market measures of the volume of the CRSP Total Index and the CDX North America Investment Grade CDS index, respectively. VOL is the cumulative percent change of the average option implied volatility of one month, at the money call and put options (|delta| = 50 and TTM = 30).

Significance of CAR, CAV, and VOL are based on the p-values of hypothesis tests based on a standard t-test against the null hypothesis that the measures are equal to zero. Significance of |CAR| and |CACDS| are based on the p-values of the hypothesis tests based on a Wilcoxon rank sum test against the null hypothesis that the statistics equal their values in the estimation window. *, **, and *** indicate that the event date values are significant at the 10%, 5%, and 1% level, respectively.

Table 3: Summary Statistics

	Stress Tested			Non-Stress Tested			Stress Tested - Non-Stress Tested		All Firms		
	N	Mean	Standard Deviation	N	Mean	Standard Deviation	Difference	Sig. Diff	N	Mean	Standard Deviation
Assets ($B)	177	613.94	734.47	423	26.90	23.17	587.04	***	600	200.08	480.28
Equity Market Cap. ($B)	177	60.58	64.19	423	4.18	5.57	56.40	***	600	20.81	43.54
Log(Share Price)	177	3.56	0.80	423	3.17	0.87	0.39	***	600	3.28	0.87
Dummy: 1 if Firm in Stress Test	177	1.00	0.00	423	0.00	0.00	1.00	***	600	0.30	0.46
Tier 1 Capital/RWA (%)	177	13.03	2.23	379	14.00	6.17	-0.97	**	556	13.69	5.27
Market Value/Total Assets	177	0.13	0.10	423	0.17	0.25	-0.03		600	0.16	0.22
SD/Mean Share Price (%)	177	8.50	7.47	423	8.88	8.44	-0.38		600	8.77	8.16
Rolling 8Q SD ROA	177	0.11	0.16	373	0.15	0.27	-0.04	*	550	0.14	0.24
RWA/Total Assets (%)	177	69.47	18.38	380	72.50	14.01	-3.04	**	557	71.54	15.58
Mean Loss (07:Q3-08:Q4) / Assets (Ann. %)	177	-1.05	0.75	345	-1.08	2.36	0.03		522	-1.07	1.97
(Sec. + Trad. + Cash)/Total Assets (%)	177	34.09	17.67	423	28.23	15.23	5.87	***	600	29.96	16.20
Short-Term Liabilities/Total Liabilities (%)	177	39.91	22.10	422	35.76	14.87	4.15	***	599	36.99	17.40
Undrawn Loan Commitments/(Total Assets + Undrawn Loan Commitments) (%)	177	27.57	14.12	422	16.20	8.86	11.37	***	599	19.56	11.87
Liquidity Coverage (1 - LSR) (%)	177	53.77	10.39	422	62.29	11.31	-8.52	***	599	59.77	11.70
Number of Analysts	177	24.84	4.49	423	12.14	6.13	12.70	***	600	15.89	8.12
SD of Analyst Estimates	177	0.11	0.25	407	0.20	2.76	-0.09		584	0.18	2.31
Similarity (Weighted by Market Cap)	177	0.97	0.19	423	0.82	0.22	0.15	***	600	0.87	0.22

Summary statistics of bank characteristics for the event study sample with one observation per bank-event date (as available). The events are the nine Federal Reserve stress testing (SCAP, CCAR, and DFAST) disclosures between 2009 and 2015. Summary statistics are reported separately for stress tested firms and for non-stress tested firms. Income statement and balance sheet data are from regulatory data filings from the quarter prior to the event date. Similarity is the correlation between the stock price of the non-stress tested firm and a market weighted index of the stress tested firms, estimated in the pre-event window. Detailed definitions of variables are available in Appendix A. *, **, and *** indicate difference between stress tested and non-stress tested firms is significant at the 10%, 5%, and 1% level, respectively.

Table 4 Panel A: |CAR| and Leverage, Risk, and Liquidity of Stress Tested Firms

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Leverage										
Tier 1 Capital/RWA (%)		-0.1302								
		[0.088]								
Market Value/Assets			-4.9881**							0.5236
			[2.272]							[2.916]
Risk										
SD/Share Price (%)				0.4507						
				[0.345]						
8Q SD ROA					8.6274					
					[7.671]					
RWA/Total Assets (%)						0.0243				
						[0.015]				
Mean Loss (07:Q3-08:Q4) / Assets							0.7825**			0.7554*
							[0.307]			[0.407]
Liquidity										
(Sec. + Trad. + Cash)/Total Assets (%)								-0.0438		
								[0.029]		
Short-Term Liabilities/Total Liabilities (%)								0.0033		
								[0.014]		
Undrawn Loan Commitments/(Total Assets + Undrawn Loan Commitments) (%)								-0.0293		
								[0.026]		
Liquidity Coverage (%)									0.0360	0.0249
									[0.022]	[0.024]
Observations	177	177	177	177	177	177	177	177	177	177
Adjusted R-squared	0.185	0.183	0.189	0.301	0.233	0.188	0.194	0.184	0.185	0.186
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Stress Tested	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Table 4 Panel B: |CAR| and Leverage, Risk, and Liquidity of Non-Stress Tested Firms

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Leverage											
Tier 1 Capital/RWA (%)		-0.0235									
		[0.034]									
Market Value/Assets			-1.0150							-0.2465	
			[0.812]							[0.273]	
Risk											
SD/Share Price (%)				0.5004**						0.5003**	
				[0.194]						[0.194]	
8Q SD ROA					8.8588**						
					[4.025]						
RWA/Total Assets (%)						0.0172					
						[0.023]					
Mean Loss (07:Q3-08:Q4) / Assets							0.1398				
							[0.111]				
Liquidity											
(Sec. + Trad. + Cash)/Total Assets (%)								-0.0218*			
								[0.012]			
Short-Term Liabilities/ Total Liabilities (%)								-0.0380*		-0.0301*	
								[0.020]		[0.017]	
Undrawn Commit./(Assets + Undrawn Commit.) (%)								-0.0436			
								[0.036]			
Liquidity Coverage (%)									0.0607		
									[0.044]		
Similarity											
Similarity											8.8318***
											[2.874]
Assets > $30B											0.5700
											[0.666]
Observations	423	379	423	423	373	380	345	422	422	422	423
Adjusted R-squared	0.173	0.175	0.172	0.318	0.259	0.176	0.169	0.180	0.181	0.322	0.221
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Stress Tested	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Sample is the event study sample with one observation per bank-event date (as available). The events are the nine Federal Reserve stress testing (SCAP, CCAR, and DFAST) disclosures between 2009 and 2015. The dependent variable is $|CAR|$, the absolute value of the abnormal return cumulated over the three day window surrounding the event date calculated by estimating a Fama-French three-factor market model Income statement and balance sheet data are from regulatory data filings from the quarter prior to the event date. *Similarity* is the correlation between the stock price of the non-stress tested firm and a market weighted index of the stress tested firms, estimated in the pre-event window. *Assets > $30B* is a dummy variable equal to one if the BHC assets are larger than $30 billion. Detailed definitions of variables are available in Appendix A. Regressions include fixed effects for each year. Standard errors are clustered by firm. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table 5 Panel A: CAV and Leverage, Risk, and Liquidity of Stress Tested Firms

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Leverage										
Tier 1 Capital/RWA (%)		-0.1507								
		[0.090]								
Market Value/Assets			-5.4097**							3.2303
			[2.543]							[3.128]
Risk										
SD/Share Price (%)				0.5199*						
				[0.299]						
8Q SD ROA					11.7643*					
					[6.271]					
RWA/Total Assets (%)						0.0339*				
						[0.016]				
Mean Loss (07:Q3-08:Q4) / Assets							0.9816***			1.1381***
							[0.306]			[0.394]
Liquidity										
(Sec. + Trad. + Cash)/Total Assets (%)								-0.0133		
								[0.036]		
Short-Term Liabilities/Total Liabilities (%)								-0.0211		
								[0.023]		
Undrawn Loan Commit./(Total Assets + Undrawn Loan Commit.) (%)								-0.0078		
								[0.038]		
Liquidity Coverage (%)									0.0517*	0.0450
									[0.030]	[0.031]
Observations	177	177	177	177	177	177	177	177	177	177
Adjusted R-squared	0.128	0.127	0.133	0.280	0.219	0.137	0.144	0.128	0.133	0.139
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Stress Tested	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Table 5 Panel B: CAV and Leverage, Risk, and Liquidity of Non-Stress Tested Firms

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Leverage											
Tier 1 Capital/RWA (%)		0.0230									
		[0.033]									
Market Value/Assets			-0.1229							-0.2921	
			[0.146]							[0.220]	
Risk											
SD/Share Price (%)				0.1114**						0.1083**	
				[0.055]						[0.054]	
8Q SD ROA					2.5007						
					[1.965]						
RWA/Total Assets (%)						-0.0026					
						[0.013]					
Mean Loss (07:Q3-08:Q4) / Assets							0.0190				
							[0.025]				
Liquidity											
(Sec. + Trad. + Cash)/ Total Assets (%)								0.0028			
								[0.008]			
Short-Term Liabilities/Total Liabilities (%)								-0.0129			
								[0.009]			
Undrawn Commit./(Assets + Undrawn Commit.) (%)								-0.0138			
								[0.016]			
Liquidity Coverage (%)									0.0271**	0.0266*	
									[0.013]	[0.013]	
Similarity											
Similarity											2.2707
											[1.419]
Dummy: 1 if Assets > $30B											0.3401
											[0.417]
Observations	423	379	423	423	373	380	345	422	422	422	423
Adjusted R-squared	0.056	0.064	0.054	0.100	0.120	0.062	0.058	0.056	0.064	0.104	0.076
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Stress Tested	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Sample is the event study sample with one observation per bank-event date (as available). The events are the nine Federal Reserve stress testing (SCAP, CCAR, and DFAST) disclosures between 2009 and 2015. The dependent variable is *CAV*, the abnormal volume cumulated over the three day window surrounding the event date calculated by estimating a single factor model where the market is the CRSP Total Index Income and all volume measures are normalized by shares outstanding. Income and balance sheet data are from regulatory data filings from the quarter prior to the event date. *Similarity* is the correlation between the stock price of the non-stress tested firm and a market weighted index of the stress tested firms, estimated in the pre-event window. *Assets > $30B* is a dummy variable equal to one if the BHC assets are larger than $30 billion. Detailed definitions of variables are available in Appendix A. Regressions include fixed effects for each year. Standard errors are clustered by firm. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table 6: Equity Analysts

	(1)	(2)	(3)	(4)	(5)	(6)
	Number of Analysts	Number of Analysts	Mean Forecast Error (%)	Mean Forecast Error (%)	Estimate SD/Share Price (%)	Estimate SD/Share Price (%)
Time Periods X BHC Group						
(SCAP Firm)*(Post SCAP)	4.43***	4.14***	-24.94	-51.95	-1.58	-1.23
	[0.504]	[0.298]	[44.626]	[44.768]	[3.315]	[3.109]
(SCAP Firm)*(Post CCAR 2014)	4.94***	4.34***	0.23	-41.76	2.37	0.94
	[0.781]	[0.463]	[68.921]	[69.320]	[5.123]	[4.824]
(CCAR 2014 Addition)*	1.46	1.09*	26.22	5.60	5.17	4.37
(Post CCAR 2014)	[1.098]	[0.636]	[96.299]	[94.483]	[7.160]	[6.577]
Time Period Fixed Effects						
Post SCAP (2009q3 to 2014Q1)	3.38***	3.46***	28.62	28.77	1.90	-3.41*
	[0.277]	[0.180]	[25.221]	[27.733]	[1.883]	[1.931]
Post CCAR 2014 (q > 2014Q1)	1.83***	2.14***	10.48	22.70	-0.72	-4.79*
	[0.417]	[0.268]	[37.610]	[40.938]	[2.803]	[2.855]
BHC Group						
SCAP Firm	4.40***		96.95*		17.84***	
	[0.557]		[49.685]		[3.688]	
CCAR 2014 Addition	8.13***		20.83		4.54*	
	[0.417]		[36.725]		[2.726]	
Other Control Variables						
Log(Market Cap/S&P Index)	1.86***	1.35***	-35.98***	-125.55***	-7.16***	-24.97***
	[0.131]	[0.180]	[12.057]	[29.254]	[0.894]	[1.999]
Actual Earnings < 0	2.53***	0.64***	88.39***	77.14**	14.89***	9.83***
	[0.362]	[0.230]	[32.147]	[34.767]	[2.400]	[2.417]
Absolute Value of	0.84	1.25***	78.82	-17.65	11.96***	-0.79
Abnormal Return	[0.556]	[0.336]	[49.819]	[51.027]	[3.726]	[3.554]
Abnormal Return < 0	-0.08	-0.08	23.37	32.72*	-0.39	2.26*
	[0.206]	[0.122]	[18.381]	[18.406]	[1.371]	[1.283]
Constant	25.01***	22.93***	-353.88***	-1,038.82***	-64.98***	-199.66***
	[1.196]	[1.447]	[109.399]	[233.260]	[8.111]	[15.906]
Observations	2,162	2,162	2,076	2,076	2,061	2,061
Adjusted R-squared	0.648	0.884	0.012	0.068	0.086	0.244
Firm FE	NO	YES	NO	YES	NO	YES
Number of firm_id		86		86		84

The sample includes all banking firms with assets greater than $10B on the event date with publicly traded equity with quarterly observations from 2006:Q3 to 2015:Q1 (as available), excluding subsidiaries of foreign firms. *SCAP Firm* is a binary variable equal to 1 in 2009 and thereafter for all firms that were included in the 2009 SCAP. *CCAR 2014 Addition* is a binary variable equal to 1 in every quarter for the 6 BHCs that were included in the CCAR events subsequent to 2013. *Post SCAP* is a

binary variable equal to 1 for all quarters between 2009:Q3 and 2013:Q4, inclusive. *Post CCAR 2014* is a binary variable equal to 1 for all quarters including and after CCAR 2014. The dependent variable in the first two specifications is *Number of Analysts*, the number of equity analysts producing at least one earnings estimate for the firm in the quarter. This variable is 0 for firms with no equity analyst coverage in I/B/E/S. The dependent variable in the next two specifications is *Mean Forecast Error*, the mean forecast error for earnings in that quarter as a percentage of the share price for the previous quarter. The dependent variable in the final two specifications is *Estimate SD/Share Price*, the standard deviation of analysts' estimates normalized by the share price at the beginning of the quarter. *Log(Market Cap/S&P Index)* is the natural log of the ratio of the firm's market capitalization to the market capitalization of the S&P 500. *Absolute Value of Abnormal Return* is the sum of the daily abnormal returns for each firm in the quarter calculated using a one factor market model. *Abnormal Return <0* is an indicator variable equal to 1 if the sum of the daily abnormal return in the quarter is negative. Standard errors are clustered by firm. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table 7: Supervisory Stress Tests and BHC Portfolio Choice

Panel A: Fed-BHC Loss Rate Gap and Loan Growth by Loan Type

"GAP": Fed - BHC	Total Loans	First Liens	Junior Lien/ HELOCs	Commercial Real Estate	Commercial and Industrial	Credit Cards	Other Consumer Loans	Other Loans
				All Observations				
Fed – BHC Loss Rate	0.132	0.423	1.438	2.093***	0.197	-0.259***	0.078	1.502
	(0.485)	(1.291)	(1.004)	(0.579)	(1.239)	(0.057)	(0.439)	(1.144)
"GAP" Median (%)	0.60	1.80	1.90	3.45	1.30	0.10	1.00	0.60
Growth Rate Median (%)	3.83	0.88	-5.10	5.03	6.01	8.57	5.74	8.58
Observations	79	71	70	72	74	57	75	75
R-squared	0.027	0.005	0.077	0.100	0.037	0.047	0.034	0.113
				Material Portfolios				
Fed – BHC Loss Rate		0.423	-0.073	1.055*	0.197	-0.426	0.114	-0.127
		(1.291)	(0.297)	(0.562)	(1.239)	(0.683)	(0.313)	(0.608)
"GAP" Median (%)		1.80	1.40	3.50	1.30	0.35	0.70	0.50
Growth Rate Median (%)		0.88	-5.18	4.93	6.01	8.40	5.37	8.37
Observations		71	55	63	74	22	58	71
R-squared		0.005	0.045	0.031	0.037	0.139	0.020	0.033

Panel B: BHC-Fed Minimum Capital Ratios and Pre-tax Net Income and Asset and Loan Growth

"GAP": BHC - Fed	Asset Growth		Loan Growth	
Pre-tax Net Income/Assets	-0.607		0.617	
	(0.489)		(0.676)	
Tier 1 Common Ratio Minimum		-0.676		0.249
		(0.414)		(0.566)
"GAP" Median (%)	0.03	0.60	0.03	0.60
Growth Rate Median (%)	3.25	3.25	3.83	3.83
Observations	79	79	79	79
R-squared	0.067	0.084	0.041	0.030

Notes: Panel A reports results of regressions relating the difference between the Federal Reserve's and each BHC's projected loan loss rate on loan growth in the 3 quarters following release of the stress test results., while Panel B reports results of regressions relating the difference between the Federal Reserve's and each BHC's projected pre-tax net income/assets and minimum Tier 1 common ratio on asset and loan growth in the subsequent 3 quarters. The Commercial and Industrial loan portfolio regressions in Panel A omit one outlier observation with a very large value for the FED-BHC "GAP" (40 percentage points). The dependent variables in all regressions are winsorized at 2%/98% tails. "Material loan portfolios" are defined as those portfolios representing at least 3% of the total loan portfolio. Loan categories are based on Y-9C definitions, which might not perfectly match definitions used in the stress tests. All regressions include year fixed effects. Residuals are clustered at the BHC level. Standard errors are in parentheses. The symbols *, **, and *** represent statistical significance at the 10%, 5% and 1% levels, respectively.

Table 8, Panel A: Interbank Borrowing

	FF+Repo. Liab./Total Assets (%)
Time Periods x BHC Groups	
(SCAP Firm)*(Post SCAP)	3.2335**
	(1.435)
(SCAP Firm)*(Post CCAR 2014)	3.2227**
	(1.327)
(CCAR 2014 Addition)*(Post CCAR 2014)	0.8453
	(0.605)
Time Period Fixed Effects	
Post SCAP (2009q3 to 2014q1)	-3.7892***
	(0.680)
Post CCAR 2014 (q > 2014q1)	-5.1524***
	(0.835)
BHC Groups	
SCAP Firm	-2.4144
	(1.462)
CCAR 2014 Addition	-3.4656***
	(0.796)
Constant	8.6438***
	(0.881)
Observations	2,021
Adjusted R-squared	0.127
Years	2007-2014
SE Clustering	Firm

The sample includes all banking firms with assets greater than $10B on the event date with publicly traded equity with quarterly observations from 2007:Q1 to 2015:Q1 (as available), excluding subsidiaries of foreign firms. *SCAP Firm* is a binary variable equal to 1 in 2009 and thereafter for all firms that were included in the 2009 SCAP. *CCAR 2014 Addition* is a binary variable equal to 1 in every quarter for the 6 BHCs that were included in the CCAR events subsequent to 2013. *Post SCAP* is a binary variable equal to 1 for all quarters between 2009:Q3 and 2013:Q4, inclusive. *Post CCAR 2014* is a binary variable equal to 1 for all quarters including and after CCAR 2014. The dependent variable in Panel A is the sum of fed funds purchased and securities sold under agreements to repo normalized by total assets. Standard errors are clustered by firm. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table 8, Panel B: Change in Interbank Borrowing After Stress Test Disclosure

	(1) %Chng FF+Repo Bal.	(2) %Chng FF+Repo Bal.	(3) Change FF+Repo Rate	(4) Change FF+Repo Rate
Dummy: 1 if Firm in Stress Test	-5.0761	-4.6194	-5.6153	-5.5233
	(6.151)	(6.155)	(18.677)	(19.047)
Quantitative Failure	-2.6162		-0.6618	
	(5.534)		(40.967)	
Negative Outcomes		-5.7374		-1.2209
		(3.472)		(23.532)
Constant	5.0884	5.0884	16.2532	16.2532
	(6.242)	(6.242)	(15.076)	(15.076)
Observations	527	527	522	522
Adjusted R-squared	-0.003	-0.003	-0.004	-0.004
Years	2007-2014	2007-2014	2007-2014	2007-2014
SE Clustering	FIRM	FIRM	FIRM	FIRM

Sample is the event study sample with one observation per bank-event date (as available). The dependent variable in the first two specifications is *%Chng FF+Repo Bal,* the percent change in fed funds purchased and securities sold under agreements to repo between the quarter end preceding and following the stress test announcement dates (Q4 and Q1). The dependent variable in the second two specifications is the change in basis points in the interest rate (calculated as interest expense on fed funds and repo normalized by quarter end balances of fed funds and repo), Panel A is the total fed funds and repo liabilities normalized by total assets. *Stress test firm* is a binary variable equal to one if the firm is included in the stress test in that year. *Quantitative failure* is a binary variable equal to 1 if the BHC had at least one stressed capital ratio fall below a minimum target level in that year. *Negative Outcomes* is a binary variable equal to 1 if the BHC had at least one stressed ratio below minimum target levels, changed its initial capital distribution request, or had its capital plan objected to in the CCAR. Standard errors are clustered by firm. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Appendix A: Variable Definitions

Tier 1 Risk Based Capital/RWA (%)	Tier 1 Risk-Based Capital - Basel III - BHCA8274 (if available) or Basel I bhck8274
Market Value/Total Assets	Market value of equity (price*shares outstanding) / Total Assets (bhck2170)
SD/Mean Share Price in Prev. Year (%)	Standard deviation of closing split-adjusted share price in previous calendar year/ mean of closing split-adjusted share price in previous calendar year
Rolling 8Q SD ROA	Standard Deviation of Net Income (bhck4340) /Total Assets (bhck2170) over previous 8 quarters
RWA/Total Assets (%)	Total Weighted Assets - Combined Basel I&III bhcaa223 if available else
Mean Loss (Net Inc. * -1) (07:Q3-08:Q4) / Assets (07:Q2) (Ann. %)	Net income (bhck4340) / Total Assets (bhck2170)
(Sec. + Trad. + Cash)/Total Assets (%)	Securities (UST (bhck0211 + bhck1289 + bhck1294 + bhck1287 + bhck1293 + bhck1298) + MBS (bhckg300 + bhckg304 + bhckg308 + bhckg312 + bhckg316 + bhckg320 + bhckk142 + bhckk146 + bhckk150 + bhckk154 + bhckg303 + bhckg307 + bhckg311 + bhckg315 + bhckg319 + bhckg323 + bhckk145 + bhckk149 + bhckk153 + bhckk157) + All Other Securities (bhck1737 + bhck1742 + bhckc026 + bhckg336 + bhckg340 + bhckg344 + bhck1741 + bhck1746 + bhcka511 + bhckc027 + bhckg339 + bhckg343 + bhckg347 + bhck8496 + bhck8499)) + Trading Assets (bhck3545) + Cash (bhck0081 + bhck0395 + bhck0397)/Total Assets (bhck2170)
Short-Term Liabilities/Total Liabilities (%)	FF Purchased & Securities Sold under Agreements to Repo (bhdmb993 + bhckb995) + Trading Liabilities (bhck3548) + Commercial Paper (bhck2309) + Other Borrowed Money – less than 1 year (bhck2332) + Foreign Deposits and Domestic Noninterest-Bearing Balances, IBDD, and Time Deposits of 100k or More (bhcb2210 + bhcb3187 + bhcb2604 + bhod3189 + bhod3187 + bhod2604 + bhfn6631 + bhfn6636)/Total Liabilities (bhck2948)
Undrawn Loan Commitments/ (Undrawn Loan Commitments + Total Assets) (%)	Unused Commitments (bhck3814 + bhckj455 + bhckj456 + bhck3816 + bhck6550 + bhck3817 + bhckj457 + bhckj458 + bhckj459)/Unused Commitments (bhck3814 + bhckj455 + bhckj456 + bhck3816 + bhck6550 + bhck3817 + bhckj457 + bhckj458 + bhckj459) + Total Assets (bhck2170)

Appendix A: Variable Definitions (cont'd.)

Liquidity Coverage (%)	1-(Weighted Liabilities + Weighted Off Balance Sheet Items)/Weighted Assets, where weights proxy those in the Basel Liquidity Coverage Ratio (LCR). Liabilities and off balance sheet items include unused commitments, total deposits, fed funds purchased and securities sold, securities lent, other borrowed money (less than one year), and commercial paper. Assets include cash, treasury securities, fed funds sold and securities purchased, agency MBS, and non-agency MBS.
Number of Analysts in Previous Quarter	Number of unique analyst IDs that have 1Q ahead estimates for EPS in the previous quarter in IBES
SD of Analyst Estimates in Previous Quarter	SD of last 1Q ahead EPS estimates 30-90 days before the forecast period end date of each analyst ID in IBES
Similarity	Correlation between the correlation between the stock price of the non-stress tested firm and a market weighted index of the stress tested firms, estimated in the pre-event window [t-120,t-10]
Mean Forecast Error (%)	Mean forecast error of last 1Q ahead earnings estimates 30-90 days before the forecast period end date of each analyst ID in IBES, normalized by share price for the previous quarter
Estimate SD/Share Price (%)	SD of Analyst Estimates, normalized by share price for the previous quarter
FF_Repo. Liab./Total Assets (%)	FF Purchased & Securities Sold under Agreements to Repo (liability) (bhdmb993 + bhckb995)/Total Assets (bhck2170)
Quarterly Change in FF+Repo Balance (%)	Quarter over quarter change in Fed Funds and Repo Balance (bhdmb993, bhckb995)
Quarterly Change in FF+Repo Exp. Ratio (%)	Quarter over quarter change in (Fed Funds and Repo Expenses (bhck4180) / Fed Funds and Repo Balance (bhdmb993, bhckb995)