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Banking stress test effects on returns and risks☆

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ABSTRACT

We investigate the effects of the announcement and the disclosure of the clarification, methodology, and outcomes of the U.S. banking stress tests on banks' equity prices, credit risk, systematic risk, and systemic risk. We find evidence that stress tests have moved stock and credit markets following the disclosure of stress test results. We also find that banks' systematic risk, as measured by betas, declined in nearly all years after the publication of stress test results. Our evidence suggests that stress tests affect systemic risk.

1. Introduction

Stress testing has become an important tool for bank supervisors. In stress tests, the implications for individual banks' financial positions under several macroeconomic scenarios are examined taking the banks' exposures and business models into account. Stress tests may affect bank behavior. Acharya et al. (2018) conclude that stress tests result in safer banks in terms of capital ratios and risk-weighted asset ratios. However, Flannery et al. (2017) find no evidence that stress tested banks significantly change their loan portfolio composition in response to stress testing results nor that they reduce their interbank borrowing and lending. Recently, Cornett et al., 2018 examined differences between U.S. banks involved in stress tests and those not involved in stress tests. They find that stress tested banks lower dividends significantly more than non-stress tested banks. Finally, banks involved in stress test spend significantly more on lobbying. Kohn and Liang (2019) review the experience with stress testing in the US. They conclude that stress tests have helped to counter procyclicality of bank capital and that stress tests improved risk management and capital planning at tested institutions. Furthermore, tested banks increased loan spreads relative to non-tested banks and reduced the availability of loans, most particularly riskier ones.

Stress tests have several characteristics (Goldstein and Sapra, 2014). First, they are forward looking. Second, they generally put much weight on highly adverse scenarios, thereby providing supervisors with information about tail risks. Third, common scenarios are applied to banks so that consistent supervisory standards across banks are applied. Finally, unlike traditional supervisory examinations that generally are kept confidential, the results of bank stress tests are frequently publicly disclosed in order to restore confidence and reduce market uncertainty (Federal Reserve, 2009b). It is widely believed that U.S. stress tests have provided valuable information to the market. Referring to post-crisis stress tests then Federal Reserve chairman Bernanke stated:

"Even outside of a period of crisis, the disclosure of stress test results and assessments provides valuable information to market participants and the public, enhances transparency, and promotes market discipline" (Bernanke, 2013) .

However, Goldstein and Sapra, 2014 argue that while stress tests uncover unique information to outsiders, there are also potential endogenous costs associated with such disclosure. For instance, disclosure might interfere with the operation of the interbank market and the risk sharing provided in this market. It may also induce sub-optimal behavior by banks which will develop an incentive to pass the tests rather than engage in prudent risk-taking behavior. Other potential adverse implications of disclosure on market operations include panics among bank creditors and other bank counterparties and reduction in information aggregation and processing in the market. This implies that there is no optimal disclosure strategy.

This paper examines the impact of banking stress tests in the U.S. on banks' stock prices, CDS spreads, systematic risk (proxied by banks' betas), and "systemic risk" over the 2009–15 period. We consider the effects of the disclosure of stress test outcomes, but also analyze the financial market impact of the disclosure of other information about stress tests, such as their announcement and the disclosure of the stress test methodology. The first test considered is the Supervisory Capital Assessment Program (SCAP) of the 19 largest Bank Holding Companies (BHCs).[1] The outcomes of this test were disclosed on May 7, 2009. Since then the Federal Reserve implemented two supervisory programs. The first program, the Comprehensive Capital Analysis and Review (CCAR), assesses the capital planning processes and capital adequacy of banks and has been conducted annually since 2011. The CCAR combines quantitative stress test results with qualitative assessments of capital planning processes of banks. The second program stems from the Dodd-Frank Act and requires assessing how bank capital levels would fare in stressful scenarios (Federal Reserve, 2013b). The first Dodd-Frank Act Stress Test (DFAST) results were publicly released on March 7, 2013. Our research distinguishes analytically between the DFAST and CCAR exercises as the underlying assumptions between the tests differ and, consequently, the weight attached to their results by market participants might differ. For example, while DFAST was conducted conditional on no change in banks' capital distributions, CCAR incorporated the capital plans proposed by the banks and, therefore, may have better reflected banks' creditworthiness (Federal Reserve, 2013a).

Theoretically, the market reaction to the disclosure of stress test information is not clear a priori. First, the response may depend on the type of information being disclosed (Petrella and Resti, 2013). For instance, markets may respond differently to the announcement of a stress test than to the publication of the outcomes of a stress test. Second, the circumstances under which the stress test has been performed may affect how markets respond, notably to the disclosure of the stress test results. For instance, during financial crises there is much more uncertainty about the quality and hence valuation of assets held by banks than under normal circumstances (Schuermann, 2014). This implies that under crisis circumstances, the release of information about individual banks may provide news to which markets respond. Under normal circumstances, the release of stress test outcomes may not surprise markets. Indeed, Ahnert et al. (2018) find that the outcomes of stress tests are to a large extent predictable. These authors report that a bank's asset quality and its return of equity are significant pre-

dictors of the pass or fail stress test outcome of a bank. They also find that banks with a higher capital buffer, higher asset quality, lower leverage, and a less risky business model earn higher abnormal equity returns at the stress test release. Finally, stock and CDS markets may react differently because stock holders and creditors may have different incentives with respect to the disclosure of stress test information (Georgescu et al., 2017). These authors report a disconnect between the stock market and the CDS market after the publication of the outcomes of the European Central Bank's (ECB) Comprehensive Assessment in 2014.

Our research adds to the literature in three ways. Our first contribution is that we use an event study approach to examine the effects of post-crisis stress tests in the U.S. over the period 2009–2015. We distinguish between the effects on banks that had a capital shortfall and those that passed the test (gap and no-gap banks); see also Ahnert et al. (2018). We also examine the impact of the disclosure of stress test information on individual banks' stock prices and CDS spreads. Several previous studies have also analyzed financial market effects of the disclosure of stress test outcomes (see Section 2 for an extensive discussion of previous research). The papers that come closest to our research are Flannery et al. (2017) and Fernandes et al., 2017, who also consider a wide range of U.S. stress tests over the period 2009–15. In fact, we use the sample period 2009–2015 to make our results comparable to these studies. In contrast to these studies, we also examine the impact of the disclosure of stress test information on systematic and "systemic risk" (see below). Furthermore, these studies neither examine differences between gap and no-gap banks nor the impact of the disclosure of stress tests information on individual banks' stock prices and CDS spreads (Ahnert et al. (2018) also consider CDS spreads).[2]

Our second contribution is that we not only examine market reactions to the disclosure of stress test outcomes, but also analyze the financial market impact of the disclosure of other information about stress tests, like their announcement (see also Ahnert et al., 2018) and the disclosure of the stress test methodology. This is important as these events may also provide information to markets (Gick and Pausch, 2012; Petrella and Resti, 2013).

Our third contribution is that in contrast to previous research, our analysis is not confined to the effects of the disclosure of stress test information on equity returns and CDS spreads but also considers the impact of stress tests on bank betas. Betas capture systematic risk based on the co-movement of returns with the overall market and are therefore particularly relevant for understanding the effects of stress tests. In addition, we study whether the change in betas is due to changes in individual bank risk, or due to changes in "systemic risk" following the approach suggested by Nijskens and Wagner (2011). (We write "systemic risk" to distinguish this approach from proposed measures of systemic risk as discussed in Section 4.)

As will be pointed out in more detail in Section 2, our paper is related to three strands of literature. The first strand examines whether information provided by the disclosure of the outcomes of stress tests reduces the opacity of banks (Beltratti, 2011; Ellahie, 2012; Fernandes et al., 2017; Flannery et al., 2017; Morgan et al., 2014; Petrella and Resti, 2013). Most (but not all) studies conclude that stress tests produce (some) valuable information for market participants and can play a role in mitigating bank opacity. The second strand of related literature examines to what extent supervisory information should be disclosed (e.g. Goldstein and Sapra, 2014; Schuermann, 2014). Several of these studies conclude that it may not always be optimal to fully disclose stress test results.

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[1] We refer to BHCs as large banks. The size of the banks varies between the SCAP and subsequent stress tests. In 2009 all banks having total consolidated assets of $100 bln or more were subject to stress testing. In subsequent years the size was $50 bln or more.

[2] We like to stress that as our analysis is based on an event study approach, like most previous studies in this line of research, it suffers from the shortcomings of this approach as discussed by MacKinlay (1997).

The final related strand of literature examines how stress tests can be used to set capital ratios, limit capital distributions, and set-up resolution regimes in case of financial distress (BCBS, 2012).

Our findings suggest that the release of stress test information has occasionally affected stock and credit markets. Stock markets reacted overall positively to the release of information concerning the results of a stress test while credit markets consistently show declines in CDS spreads. Moreover, in comparison with the SCAP, post-crisis stress tests show smaller effects and are statistically weaker. We find mixed results for the release of other stress test information. Our analysis of systematic risk indicates that bank betas were affected by the publication of the outcomes of all stress tests. Moreover, we find some evidence that the decline in betas is in part driven by the correlation of the banks' stocks with the market. We interpret these findings as a decrease in "systemic risk".

The paper is structured as follows. Section 2 provides a summary of related literature and outlines how our research is related to this literature. Section 3 gives an overview of the stress tests conducted in the U.S. Section 4 outlines our methodology and Section 5 presents our findings. Finally, Section 6 concludes.

2. Related studies and contribution

Our study is related to three strands of literature. First, several studies examine whether bank opacity differs from that of non-financial firms in 'normal' times (cf. Morgan, 2002; Flannery et al., 2004; Iannotta, 2006; Jones et al., 2012; Haggard and Howe, 2012). A good example is the paper by Flannery et al. (2013) who study bank equity's trading characteristics and find only limited evidence that banks are unusually opaque during normal times. From this perspective, several studies examine the information value of U.S. stress tests. Morgan et al. (2014) conclude that market participants correctly identified which institutions had sufficient capital under the 2009 SCAP stress test, but were surprised by how much capital was required for under-capitalized banks. These authors also find that under-capitalized banks experienced more negative abnormal returns. Flannery et al. (2017) examine the average absolute cumulative abnormal returns (CARs) associated with U.S. stress test result announcements. In addition, these authors examine whether trading volume deviates from what would be expected given market-wide trading volume. They find that disclosure of supervisory stress test results generates significant, new information about stress tested BHCs. The reported CARs are sometimes positive and sometimes negative, while average absolute value CARs are significantly larger than pre-disclosure event values around most disclosure dates for stress tested BHCs. These authors also find that average abnormal trading volumes are significantly higher on the typical stress test disclosure date. Finally, their results suggest that stress tests produce more information about riskier or more highly leveraged BHCs. Also Fernandes et al., 2017 conclude that there appears to be new information in U.S. stress tests, especially when markets are under distress. Ahnert et al. (2018) find that banks that passed the test experience positive abnormal equity returns and tighter CDS spreads, while banks that failed show strong drops in equity prices and widening CDS spreads. The authors also document strong market reactions at the announcement date of the stress tests.

Stress tests have also been conducted by European supervisors and several papers examine whether the disclosure of the outcomes affected financial markets. Petrella and Resti (2013) find significant but modest market responses to the European Banking Authority (EBA) stress test in 2011 and conclude that the stress test produced valuable information for the market as investors were not able to anticipate its results. Ellahie (2012) studies equity and credit market data of Eurozone banks that took part in the EBA stress tests in 2010 and 2011. His findings indicate that equity and

bid-ask spreads were not significantly affected by stress test announcements but declined after the disclosure of stress test results. Beltratti (2011) argues that the 2011 EBA stress test produced new information, as investors could not a priori distinguish between capitalized and under-capitalized banks. Carboni et al., 2017 examine the market reaction to every single step of the ECB's Comprehensive Assessment (CA) run in preparation of the Single Supervisory Mechanism (SSM), i.e. the European Banking Union. They find that the CA exercise was able to produce new valuable information. These authors also report a negative treatment effect for banks subject to direct ECB supervision, which were penalized both at the disclosure of CA results and at the official launch of the SSM. Earlier research by Sahin and de Haan, 2016, which is also based on an event study methodology, found that banks' stock market prices and CDS spreads generally showed no reaction in response to the publication of the CA outcomes, although for some banks the assessment led to increased transparency, as markets responded to the provision of new information. Lazzari et al. (2017), who measure the novel informational content of the CA by quantifying the portion of the cross-section variation of its findings explained by available public information, report that even though the CA did not add much to the publicly available information set, abnormal returns were negative across almost all banks in response to the disclosure of the CA findings. According to these authors, this reflects that investors rather than learning how sound each bank was, became aware that the new supervisory regime would be harsher and priced bank stocks accordingly. Georgescu et al. (2017) also use an event study approach to analyze how market participants reacted to the 2014 Comprehensive Assessment and the 2016 EBA EU-wide stress test. These authors conclude that stress test disclosures revealed new information that was priced by the markets. They also provide evidence that the impact on bank CDS spreads and equity prices tended to be stronger for the weaker performing banks in the stress test.[3]

Table A.11 in the Appendix provides a summary of recent empirical papers on the market response to stress tests. In line with some previous papers on European stress tests, in our analysis of U.S. stress tests we distinguish between several test related events, such as the announcement of the stress test and the disclosure of the methodology and the stress test outcomes. We also distinguish between banks with and banks without capital shortfalls.

The literature on supervisory transparency and disclosure is also closely related to our work. The central question addressed in this line of research is to what extent supervisory information should be disclosed. According to Goldstein and Sapra, 2014, in certain environments more disclosure is not necessarily better if one considers economic efficiency.[4] Accordingly, the costs associated with disclosure of stress test results can be minimized in particular by disclosing aggregate, rather than bank-specific results. Also Schuermann (2014) argues that the degree of optimal disclosure may depend on the environment. During times of crisis, the need for bank-specific disclosure is greater while during normal times the cost-benefit analysis of the disclosure of stress test information may lean towards more aggregated information. Like-

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[3] Philippon et al. (2017) provide an evaluation of the quality of banking stress tests in the European Union. They conclude that stress test model-based losses are good predictors of realized losses and of banks' equity returns around announcements of macroeconomic news. Furthermore, they do not detect biases in the construction of the scenarios, or in the estimated losses across banks of different sizes and ownership structures.

[4] Goldstein and Sapra, 2014 argue that the public disclosure of stress test results may drive out private information producers (such as stock analysts). However, Fernandes et al., 2017 conclude that the public disclosure of the stress test results (and methodology) does not seem to have reduced private incentives to generate information, while Flannery et al. (2017) find no evidence of reduced equity analysts' coverage or deterioration in the accuracy of analysts' earnings forecasts.

wise, Goldstein and Leitner (2018) find that during normal times, no disclosure is optimal while during bad times some disclosure is necessary, as it may be able to produce a stabilizing effect. Goncharenko et al., 2018 conclude that the information disclosure may result in a reduction of risk-adjusted expected profits for a non-negligible fraction of banks in the system. In their model, systemically important banks gain the least from the disclosure and bear the highest cost in terms of its volatility. Moreover, their likelihood of experiencing a negative disclosure effect (as a result of new information) is higher. Gick and Pausch, 2012 argue that a supervisory authority can create value by disclosing the stress test methodology together with the stress test results.

Our work is related to this line of literature, as we do not only examine the effects of the publication of the stress test results, but also the effects of the announcement of the stress test (Carboni et al., 2017; Petrella and Resti, 2013) and the disclosure of the methodology (Carboni et al., 2017; Gick and Pausch, 2012).

Finally, our paper is related to the literature on the impact of regulation of Systemically Important Financial Institutions (SIFIs). Stress tests are used to set capital ratios, limit capital distributions, and set-up resolution regimes in case of financial distress (BCBS, 2012). Bongini and Nieri, 2013 investigate the response of financial markets to the Financial Stability Board's publication of the list of institutions that are too-big-to-fail. They quantify the value of an implicit too-big-to-fail subsidy and find that financial markets did not strongly react to the proposed new regulation regarding SIFIs. Schaefer et al., 2013 investigate the reaction of the stock returns and CDS spreads of U.S. and European banks to several regulatory reforms including the too-big-to-fail regulation in Switzerland. These authors report significant market reactions in response to this regulation, which strongly increased CDS spreads of systemic banks, but affected equity prices only mildly.

Our study is related to this literature as we examine whether the reaction of SIFIs' stock prices and CDS spreads to the publication of stress test information is different from that of non-SIFIs. Furthermore, we analyze the systematic risk of banks. We expect the beta of a bank to decline following the publication of the results of a stress test. The information provided by the stress tests could reduce the uncertainty on bank stability and therefore would lower the overall level of risk in the industry. This would lead to a decline in bank betas. To study the underlying shifts in systematic risk we decompose the changes in betas into changes in the correlation of stocks with the market ("systemic risk") and changes in the relative variance (idiosyncratic risk) following a similar approach as Nijskens and Wagner (2011). These authors study credit risk transfers of banks through issuance of CDS and CLO contracts. They disentangle the changes in betas and find that the increase in betas was primarily due to an increase in the correlation of stocks with the market. Although banks became individually less risky using credit risk transfers, "systemic risk" increased. As we examine the changes in betas in a similar way we can analyze how stress tests have affected "systemic risk".

3. Stress tests in the U.S.

The Federal Reserve's CCAR exercises conducted in 2011–15 can be classified as micro-prudential supervisory stress tests. They are 'top down' in the sense that the Fed independently produced loss estimates using its own supervisory models. Although the Fed publishes the results of stress tests, the specification of the models used to arrive at them remains a 'black box' (Bernanke, 2013). An important reason for this is to prevent the homogenization of stress test models, as banks would over time have fewer incentives to maintain independent risk management systems and adopt the specifications used by the Fed. These tests were conducted in the aftermath of the crisis and unlike the SCAP in 2009 were not cri-

sis management stress tests. The latter differ in their emphasis on solvency, current risks, and their specific 'constrained bottom-up' approach (Oura and Schumacher, 2012). For the SCAP exercise the Fed relied more on the banks' own estimates.

Although stress tests have been criticized because of insufficient coverage or their implementation strategy, they have become an important instrument in supervisory authorities' toolkit. This is true for micro-prudential (BCBS, 2012) as well as macroprudential stress tests (Borio et al., 2013).[5] Table 1 provides a descriptive overview of the stress tests conducted in the U.S. over 2009–2015 on which we focus. Stress test design evolved.[6] In subsequent stress tests, the Fed refined the hypothetical scenarios taking into account the pro-cyclicality of the financial system and severe adverse developments on housing, equity, and asset markets (Federal Reserve, 2012; 2013a; 2013b). A capital plan rule, introduced in CCAR 2012, required banks to submit a description of internal processes for assessing capital adequacy. This rule includes both a minimum capital requirement and a buffer, which serves as an early warning to regulators, and allows regulators to limit banks' capital distribution plans if a bank approaches its minimum requirements. Although the Fed eliminated the qualitative objection as part of CCAR 2017 for large and non-complex firms the capital planning evaluation remains part of the normal supervisory process for these banks.

As pointed out by Ng et al. (2016), media coverage is key in understanding market reactions. Therefore, we checked whether media reported about stress tests outcomes for individual banks. As shown in Table A.12 in the Appendix, there was substantial media coverage. Ng et al. (2016) also show that positive versus negative media coverage plays an important role in explaining market reactions. That is why we distinguish between banks that passed the stress test and those that did not. Our news analysis suggests that the SCAP received considerable more attention than the subsequent CCAR and DFAST assessments. The news analysis also reveals that stress tests were a substantial part of market sentiment in 2009–2015. About 10 percent of all news about the U.S. banking industry in this period is related to stress tests. Not surprisingly, the highest frequency of news reports on this topic appeared when the stress test outcomes were disclosed. Other peaks occurred when the details of the stress tests were announced and when the results for participating banks were released. As Table A.12 shows, media like Reuters and Bloomberg extensively reported the results for the individual bank stress test outcomes but these reports did not contain other bank-specific announcements so that we can be confident that we identify market reactions to stress test events and not their reaction to other news.

We also check whether banks in our sample have received government aid or capital injections during our event windows. To ensure that announcements of such aid are not confounding stress tests announcements, we checked whether the banks in our sample received government support under three government programs (Bassett et al., 2016). First, the Capital Purchase Program

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[5] Macro-prudential stress testing has evolved over time. This type of stress tests is discussed by Galati and Moessner (2013). Criticism raised has led to the development of new stress testing models; see, for instance, Foglia (2009), Chan-Lau (2013), Breuer et al. (2009), and Huang et al. (2012).

[6] See Baudino et al., 2018 for a comparative analysis of system-wide stress tests in the euro area, the U.S. Japan, and Switzerland and Quarles (2018) for proposals concerning the future design of stress tests. As Baudino et al., 2018 point out, the design and optimal degree of disclosure (and, therefore, potentially also the impact of) stress tests depends on several considerations, notably whether the stress test is done under crisis or normal circumstances. During times of crisis, when there is uncertainty about the health of the banking system as well as individual banks, the publication of detailed bank-specific stress test outcomes may be useful in view of the markets' inability to distinguish between a good bank and a bad (Schuermann, 2014).

Table 1

Description of U.S. stress tests. Notes: This table provides an overview of all stress tests conducted in the U.S. (Federal Reserve, 2009a; 2009b; 2012; 2013a; 2013b; 2014a; 2014b; 2015a; 2015b).

	Purpose/Requirements	Results
SCAP 2009	Restoring confidence, identifying future conditions for banks with insufficient capital. Banks are well-capitalized with Tier 1 capital above 6% of RWA and solvent with 4% Tier 1 common equity ratio. A total of 19 banks is assessed.	Ten banks with a capital gap. Tier 1 common capital increased to $759 bln and Tier 1 common equity ratio increased to 10.4%.
CCAR 2011	Quantitative assessment of capital levels and qualitative assessment of internal capital planning processes of banks. Banks submit capital plans to the Fed, largest 6 banks submit trading P&L statements.	Banks mostly had to lower their capital distributions, payout decreased to 15% in 2011 from 38% in 2006.
CCAR 2012	Banks that did not participate earlier are now subject to a Capital Plan Rule. Banks submit a description of internal processes for assessing capital adequacy; policies governing capital actions; planned capital actions; and results of company-run stress tests. Banks are solvent with a 5% Tier 1 common ratio.	Four banks had a capital gap. Doubling of weighted Tier 1 common equity ratio.
DFAST 2013	Quantitatively assess how bank capital levels would fare in adverse economic conditions. Financial companies with total consolidated assets between $10 bln and $50 bln are required to conduct their own stress tests.	One bank failed to adhere to the minimum of 5% Tier 1 common equity ratio.
CCAR 2013	Quantitative and qualitative evaluation of whether a bank's capital accretion and distribution decisions are prudent. Banks have to disclose their own estimates of stressed losses and revenues. The Fed also discloses whether or not it objected to each bank's capital plan.	Two banks conditionally approved, two banks not approved.
DFAST 2014	Assessment of additional banks with $50 bln or more total consolidated assets. The Fed independently projects balance sheets and RWAs of each bank. The Basel III revised regulatory capital framework is incorporated into the assessment. A total of 30 banks is assessed.	Over the nine quarters of the planning horizon, losses at the 30 banks under the severely adverse scenario are projected to be $501 bln. One bank did not pass the assessment.
CCAR 2014	Banks with significant trading activities are required to apply a hypothetical Global Market Shock to trading and counter-party exposures. Banks are subject to a new counter-party default scenario requirement and must include losses from the default of their largest stressed counter-party. A bank's projected capital ratios are interpreted relative to the minimum capital requirements in effect for each quarter of the planning horizon.	Five banks did not pass the test.
DFAST 2015	A total of 31 banks is assessed.	All banks passed the test.
CCAR 2015	Banks were required to reflect the transition arrangements and minimum capital requirements of the revised regulatory capital framework in their estimates of pro forma capital levels and capital ratios.	Two banks did not pass.

(CPP) was part of the Troubled Asset Relief Program (TARP). Under the CPP, the U.S. Treasury provided capital ($204.9 billion) to certain financial institutions in exchange for preferred stock or debt securities, beginning on 28 October, 2008. The final disbursement from the CPP facility originated on 29 December, 2009. Another TARP program, the Targeted Investment Program (TIP), was established in December 2008 to stabilize two firms considered systemically important: Citigroup and Bank of America. Each firm received $20 billion in exchange for preferred stock. Finally, the Community Development Capital Initiative (CDCI) started in February 2010 and was also a component of TARP. This program was much smaller in size ($570 million disbursed) than the CPP or TIP and it provided capital specifically to Community Development Financial Institutions (CDFIs), such as small banks, thrifts, and credit unions. We consulted the U.S. Treasury website whether stress-tested banks received support under CPP or TIP and if so, whether the disbursements coincided with the event windows used in our analysis.[7] It turns out that none of our event windows coincide with dates on which disbursements under these programs were announced and

therefore announcements of government aid are not confounding our stress test results.[8]

4. Data and methodology

4.1. Data

We use equity returns of banks that have participated in the U.S. stress tests over the 2009–2015 period. We employ the S&P 500 returns index as proxy for the market portfolio. Data were obtained from Bloomberg. Table 2 lists the participating banks considered in our research and shows the results of the stress tests.[9] We also use daily data on 5-year senior CDS spreads for a subset of the banks.[10] We employ the CDX Investment Grade Index provided by Bloomberg as proxy for a market portfolio in the CDS market.

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[7] See https://www.treasury.gov/initiatives/financial-stability/program-agreements/Pages/default.aspx.

[8] We would like to thank an anonymous referee for raising this issue.

[9] We include GMAC (Ally Financial) in our CDS analysis but exclude it from our stock analysis as it was not publicly traded. We also exclude MUFG Americas Holdings Corporation and Citizens Financial Group. The banks included in the stress tests cover at least 66% of total US banking sector assets.

[10] The sample for our CDS analysis is smaller as credit default swaps of some banks were not available or not traded. The following banks are included in our CDS analysis: American Express, Bank of America, Capital One Financial, Citigroup, GMAC (Ally Financial), Goldman Sachs, JPMorgan Chase, Metlife, Morgan Stanley, and Wells Fargo.

Table 2

List of the banks which passed/failed the stress tests. Notes: This table presents the list of the banks which passed/failed the 2009–2015 stress tests. '+' means that a bank passed the stress test without any frictions ('No-Gap' banks), and '-' indicates that a bank did not meet the minimum post-stress capital ratio requirements or had deficiencies in its capital planning process that undermine its overall reliability of capital planning process ('Gap' banks). An empty cell denotes that the bank did not participate in the corresponding testing procedure. The banks are divided into global SIFIs, domestic SIFIs, and non-SIFIs according to the classification of the Financial Stability Board (FSB, 2014).

Banks	2009	2012	2013		2014		2015	
Global SIFIs	SCAP	CCAR	DFAST	CCAR	DFAST	CCAR	DFAST	CCAR
Bank of America	-	+	+	+	+	+	+	+
BNY Mellon	+	+	+	+	+	+	+	+
Citigroup	-	-	+	+	+	-	+	+
Deutsche Bank							+	-
Goldman Sachs	+	+	+	-	+	+	+	+
HSBC					+	-	+	+
JPMorgan Chase	+	+	+	-	+	+	+	+
Morgan Stanley	-	+	+	+	+	+	+	+
Santander					+	-	+	-
State Street	+	+	+	+	+	+	+	+
Wells Fargo	-	+	+	+	+	+	+	+
Domestic SIFIs								
Ally Financial	-	-	-	-	+	+	+	+
American Express	+	+	+	-	+	+	+	+
BB&T	+	+	+	-	+	+	+	+
Capital One	+	+	+	+	+	+	+	+
Fifth Third Bank	-	+	+	+	+	+	+	+
PNC	-	+	+	+	+	+	+	+
Regions Financial	-	+	+	+	+	+	+	+
SunTrust Banks	-	-	+	+	+	+	+	+
U.S. Bancorp	+	+	+	+	+	+	+	+
Non-SIFIs								
BBVA Compass					+	+	+	+
BMO					+	+	+	+
Comerica					+	+	+	+
Discover					+	+	+	+
Huntington					+	+	+	+
KeyCorp	-	+	+	+	+	+	+	+
MetLife	+	-						
M&T					+	+	+	+
Northern Trust					+	+	+	+
Zions Bancorp.					-	-	+	+

This index represents the rolling equally-weighted average of 125 of the most liquid North American CDS series with relevant rating of at least "BBB-" or "Baa3" and with 5 years maturity. In all analyses we exclude official holidays and days with limited trading.

Our measures for systematic and "systemic risk" are derived using market data. Alternative systemic risk measures used in the literature consider bank balance sheet data or a combination of balance sheet and market data. Some widely used examples are the Conditional Value-at-Risk (CoVaR) (Adrian and Brunnermeier, 2016), SRISK (Acharya et al., 2017; Brownlees and Engle, 2017), and the Distress Insurance Premium (DIP) (Huang et al., 2012). These measures allow to identify systemic risk at the individual bank level taking into account the size of a bank and its stock of accumulated debt (among other things). In contrast, our approach focuses on the volatility of stocks in relation to the overall market. Beta measures the exposure a particular stock, or a sector, has in relation to the market. This makes our decomposition exercise, explained in the next section, a particularly useful approach in assessing how stress tests have affected "systemic risk" of the banking sector.

4.2. Methodology

To examine whether stress tests have affected equity or CDS markets we follow most of the literature and use an event study methodology described e.g. in Brown and Warner (1985), Thompson (1995), or MacKinlay (1997). Fig. 1 provides an overview of all the relevant stress test events. We present findings for a 3-days event window (-1,+1). As pointed out by Flannery et al. (2017), such a 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.[11] Our estimation window for equity returns and CDS spreads consists of 255 trading days, i.e. the (-265,-10) time interval, where $t = 0$ is the event date of the corresponding stress test. We use shorter windows (up to 155 trading days) when necessary to avoid overlaps with events related to stress tests in other years. All our event windows are sufficiently long to conduct an event study using daily data (MacKinlay, 1997).[12] When event windows are overlapping, or a single event affects multiple banks, we can no longer assume that the abnormal returns of securities are cross-sectionally uncorrelated. Fig. 1 shows that the date of the methodology release and the date of the disclosure of the results of the CCAR in 2012 are particularly close. In this case, the covariance may deviate from zero and we can no longer use the distributional results for the aggregated abnormal returns (MacKinlay, 1997). Consequently, we

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[11] We have considered different event windows: (−2,0), (0,+2), (−2,+2), (−3,0), (0,+3), (−3,+3), (−10,0), (0,+10), (−10,+3) and (−3,+10). These findings (not presented) are in line with our main results.

[12] We have checked our results using longer estimation windows as well (accepting an overlap with events related to stress tests in other years). These findings (not presented) are in line with our main results.
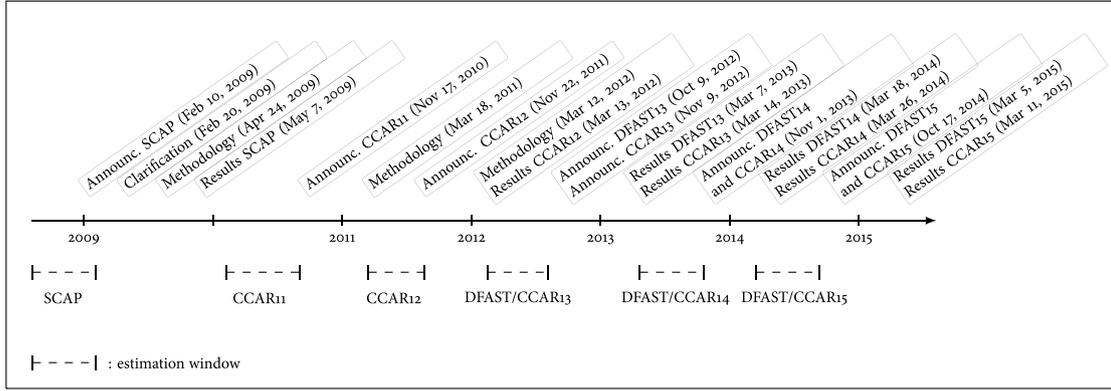
Fig. 1. Chronology of stress test events.

treat the disclosure of the methodology and the results of CCAR 2012 as a "large" event.[13]

To measure the impact of an event we set the abnormal return of a security as the difference between the actual (ex post) return and the normal return over the relevant event window. Normal returns are estimated using the following market model,

$$R_{i,t} = \alpha_i + \beta_i R_{m,t} + \varepsilon_{i,t} \tag{1}$$

where $R_{i,t}$ is the daily return of equity of bank i at time t, and $R_{m,t}$ is the return of a market portfolio (the S&P 500 returns index). Similarly the CDS spread of bank i at time t is regressed on the spread of the overall index, the CDX Investment Grade Index (cf. Norden and Weber, 2004; Morgan et al., 2014). The residuals or abnormal returns (AR) implied by the market model are given by,

$$AR_{i,t} = R_{i,t} - \left(\hat{\alpha}_i + \hat{\beta}_i R_{m,t} \right) \tag{2}$$

where the circumflex indicates that the parameter concerned is estimated. The abnormal returns are summed over the relevant window around the event date to compute the cumulative abnormal return (CAR).[14] In our base line model, we cumulate abnormal returns for the 3-day window (-1,+1). The t-statistics are adjusted for event clustering and event induced volatility following Kolari and Pynnonen, 2010a.[15] The adjusted t-statistics are employed to test whether the CAR is significantly different from zero. In addition, we use the non-parametric generalized rank test described in Kolari and Pynnonen, 2010b which is insensitive to distortions in the returns distribution and to the existence of significant correlation between time series.

In order to assess the possible changes in systematic risk caused by stress test events we decompose the beta into a market correlation component and a volatility component following Nijskens and Wagner (2011). We estimate the relation between returns and a bank's beta using the following model,

$$R_{i,t} = \alpha_i + \beta_i R_{m,t} + \sum \delta_j D^j + \sum \beta_j D^j * R_{m,t} + \varepsilon_{i,t} \tag{3}$$

where α_i is the bank fixed effect, D^j is a dummy variable with value of 1 after the event and up to ten trading days of the following stress test event j with $j \in \{A, M, R\}$ denote the announcement, methodology, and the publication of the stress test results, respectively. The dummy D^j is used to measure the permanent mean effect of stress tests. The interaction terms of interest are $D^A * R_{m,t}$, $D^M * R_{m,t}$, and $D^R * R_{m,t}$. The coefficients β_j capture respectively the change in bank betas after the announcement, methodology, and result events and measure the change in a bank's beta in the total period after an event. Our periods (i.e. trading days) for evaluating beta therefore vary over time.[16]

Next, we decompose the changes in betas into changes in the correlation of stocks with the market and changes in the relative variance. That is, the beta can be represented by,

$$\beta_i = \rho_{i,m} \frac{\sigma_i}{\sigma_m} \tag{4}$$

where $\rho_{i,m}$ is the correlation between equity i and the market and σ_m denotes the variance of the market.[17] The beta in (4) is the product of the correlation of a bank's equity price with the market and its standard deviation relative to that of the market. We then normalize our model in (3) by dividing the equity and market returns by their respective standard deviations.[18] As a consequence, the coefficient of the normalized returns equals the correlation of the previous series, and (4) changes to $\beta_i = \rho_i$. The regression equation is then changed to,

$$\tilde{R}_{i,t} = \tilde{\alpha}_i + \rho_i \tilde{R}_{m,i,t} + \sum \delta_j D^j + \sum \rho_j D^j * \tilde{R}_{m,i,t} + \varepsilon_{i,t} \tag{5}$$

where

$$\tilde{R}_{i,t} = \begin{array}{ll} R_{i,t}/\sigma_{i,t<t_i} & \text{if } t < t_i \\ R_{i,t}/\sigma_{i,t \geq t_i} & \text{if } t \geq t_i \end{array} \quad \text{and}$$

$$\tilde{R}_{m,i,t} = \begin{array}{ll} R_{m,i,t}/\sigma_{m,t<t_i} & \text{if } t < t_i \\ R_{m,i,t}/\sigma_{m,t \geq t_i} & \text{if } t \geq t_i \end{array}$$

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[13] In this respect our approach is similar to that of Morgan et al. (2014) who consider the clarification event of the SCAP in 2009, which actually consist of two events: Bernanke's testimony on 24 March 2009 and the release of further details about the stress test on 23 and 25 March 2009. They disentangle the effects of the events by considering how equity and bond-holders are affected. They reason that the former event mattered for both market participants but the release of the Capital Assistance Plan details mattered only for equity holders.

[14] With a slight abuse of notation, we denote the cumulative abnormal spreads obtained from the CDS counterpart of (1) also as CARs.

[15] In the presence of event clustering, cross-correlation among securities may lead to over rejection of the null hypothesis of zero average abnormal returns. Not all event studies on stress tests adjust for clustering (e.g. Candelon and Sy, 2015), but in our view it is the proper procedure. See also Amici et al. (2013); Fratianni and Marchionne (2013); Elyasiani et al. (2014).

[16] Note that we exclude the clarification and methodology events of 2009 in our beta analysis as they are very close to the announcement and result release of SCAP, respectively. Similarly, we only consider the announcement of DFAST and the results release of CCAR as these are the first and last events of interest in 2013, respectively.

[17] To arrive at (4), note that individual stock beta $\beta_i = \frac{cov_{i,m}}{\sigma_m^2}$ can be represented as $\beta_i = \rho_{i,m} \frac{\sigma_i}{\sigma_m}$ using the correlation notation $\rho_{i,m} = \frac{cov_{i,m}}{\sigma_i \sigma_m}$.

[18] To identify shifts in the relative variance, σ_i/σ_m, we do the following decomposition: $\beta^1 = \beta^0 + \Delta\beta$ where the superscripts denote the beta before and after the event. Using $\beta^1 = \rho_{i,m}^1 \frac{\sigma_i^1}{\sigma_m^1} = (\rho_{i,m}^0 + \Delta\rho_{i,m}) \frac{\sigma_i^1}{\sigma_m^1}$ the relative variance can be rearranged as $\frac{\sigma_i^1}{\sigma_m^1} = \frac{\beta^0 + \Delta\beta}{\rho_{i,m}^0 + \Delta\rho_{i,m}}$ and, therefore, a change in relative variance is $\Delta\frac{\sigma_i^1}{\sigma_m} = \frac{\sigma_i^1}{\sigma_m^1} - \frac{\sigma_i^0}{\sigma_m^0} = \frac{\beta^0 + \Delta\beta}{\rho_{i,m}^1 + \Delta\rho_{i,m}} - \frac{\beta^0}{\rho_{i,m}^0}$.

Table 3

Stock market reaction to stress tests (in %). Notes: This table presents CARs for the main stress test events over the 2009–2015 period calculated using Eq. (2) with a (-1,+1) event window. Reported significance is based on corrected t-statistics. Column 'All' shows the effects of events on the average CARs of all banks. Columns 'No-Gap' and 'Gap' shows the effects for banks with and without capital shortfalls and/or disapproval of capital distribution plans, respectively. Column '% > 0' indicates the fraction of the CARs of all banks that is positive. Statistical significance is denoted as follows: *** - 1%, ** - 5%, * - 10%.

	All	% > 0	No-Gap	% > 0	Gap	% > 0
2009						
Announcement	−.4203	44.4	−.2026	44.4	−.6378	44.4
Clarification	21.13**	100	10.66*	100	31.60**	100
Methodology	.3583	50	4.002	66.7	−3.285	33.3
Results SCAP	14.31	77.8	11.28	77.8	17.33	77.8
2011						
Announcement	−2.348	27.8				
Methodology	−1.766*	16.7				
2012						
Announcement	−.2958	44.4	−.0333	53.3	−1.609***	0
Results CCAR	2.308	88.9	2.935*	93.3	−.8292	66.7
2013						
Announcement	2.320**	94.1				
Results DFAST	1.223	88.2				
Announcement	1.586	82.4	1.626	76.9	1.404***	100
Results CCAR	.6509	70.6	.9765	76.9	−.4072	50
2014						
Announcement	−.8483	25.9	−.9805	21.7	−.0883	50
Results DFAST	.6321	70.4	.7339	73.9	.6310	100
Results CCAR	−1.212	18.5	−1.389*	13	−.1971	50
2015						
Announcement	−1.363	25	−1.355	26.9	−1.464***	0
Results DFAST	1.584	85.7				
Results CCAR	1.448*	85.7	1.606*	88.5	−.6054	50

and t_i stands for the event date. The coefficients ρ_j with $j \in \{A, M, R\}$ in Eq. (5) capture respectively the share of the change in bank betas after the announcement, methodology, and result events that are due to the market correlation component. As these changes signal system-wide changes, we can interpret the latter as "systemic risk" (Nijskens and Wagner, 2011).

5. Results

5.1. How do stress tests affect stock and CDS spreads?

Tables 3 and 4 present our findings over the (-1,+1) event window. Table 3 shows reactions in the stock market and Table 4 shows reactions in CDS spreads. We discuss each in turn, considering the announcement, clarification, methodology, and result events.

5.1.1. Stock market

As shown in Table 3, the *announcements* of stress tests generally had a mixed effect on equity returns. The stock market reacted positively to the announcement of DFAST and CCAR in 2013, but negatively in 2012. The mixed effect on stock prices may reflect that generally stress test announcements provide limited (quantitative) information on the way the stress tests will be conducted or how their results will be used.

The market's reaction to then chairman Bernanke's *clarification* in 2009 that banks would not be nationalized caused an upward movement in equity returns. The clarification event notably increased the CARs of gap banks by 31.6 percent as these banks were at the time considered to be at risk to be nationalized. Similar to Morgan et al. (2014), we find no evidence that the methodology disclosure of the SCAP has led to changes in stock prices. There is some evidence that the publication of the methodology of CCAR

in 2011 has affected stock prices negatively. In the other years the methodology and results were released jointly.[19]

The estimates reported in Table 3 suggest that the release of stress test results after 2009 only occasionally moved stock markets. This holds for both gap and no-gap banks' stock prices.[20] Therefore, our estimation results for 2009 suggest that only the clarification event mattered for the stock market. To assure whether our assessment window is not too narrow, Table A.13 in the Appendix provides findings over extended event windows for the SCAP stress test. The results over longer event windows corroborate our results.

As shown in Table 3, in some years stock markets reacted (weakly) to the release of stress test outcomes. In 2012, for example, we find for the sample of no-gap banks that the equity market reacted positively to the disclosure of the stress test results. Note, however, that the magnitude of the reaction of stock markets to the disclosure of stress test information after 2009 is lower than that in 2009 following chairman Bernanke's clarification. Arguably, during a crisis the need for credible information is greater than in calmer periods so the market may have valued the information disclosed in the clarification in 2009 more (Schuermann, 2014). Finally, our results suggest that the market reaction in response to the disclosure of post-crisis stress test information may change sign. This is particularly so for the announcement effects (negative

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[19] In 2012 the methodology and results were released on two consecutive days. As discussed in our methodology section, we treat these events as a single 'large' event.

[20] Our finding is different from that of Morgan et al. (2014) because in assessing the *average* effect on CARs our methodology accounts for event clustering (Kolari and Pynnonen, 2010a). Another difference is the estimation period. Morgan et al. (2014) estimate their analysis over a relatively less volatile period (July 1, 2006 to June 30, 2007). Our findings are robust to a change in the estimation period.

Table 4

CDS spreads reaction to stress tests (in bp). Notes: This table presents CARs for the main stress test events over the 2009–2015 period calculated using Eq. (2) with a (-1,+1) event window. Reported significance is based on corrected t-statistics. Column 'All' shows the effects of events on the average CARs of all banks. Columns 'No-Gap' and 'Gap' show the effects for banks with and without capital shortfalls and/or disapproval of capital distribution plans, respectively. Column '% > 0' indicates the fraction of the CARs of all banks that is positive. Statistical significance is denoted as follows: *** - 1%, ** - 5%, * - 10%.

	All	% > 0	No-Gap	% > 0	Gap	% > 0
2009						
Announcement	−13.04	0	−10.81	0	−15.83	0
Clarification	18.65	55.6	32.15	60	1.762	50
Methodology	−11.28	33.3	−19.72	20	−.7275	50
Results SCAP	−81.70	0	−55.43**	0	−114.7	0
2011						
Announcement	3.496	60				
Methodology	−11.04**	0				
2012						
Announcement	11.64	70	9.152	57.1	17.42***	100
Results CCAR	−10.63	0	−10.54*	0	−10.84	0
2013						
Announcement	−1.459	33.3				
Results DFAST	.8788	66.7				
Announcement	−8.848	11.1	−9.394	20	−8.167	0
Results CCAR	−4.877*	0	−4.429	0	−5.438*	0
2014						
Announcement	2.369	100	2.258	100	3.251	100
Results DFAST	−.8816	33.3				
Results CCAR	.9118	66.7	.4411	62.5	4.677	100
2015						
Announcement	1.556	89.9				
Results DFAST	−.1971	44.4				
Results CCAR	.8564	89.9				

in 2012 and positive in 2013) but also for the effects of the publication of the stress test results (negative in 2014 and positive in 2015).

5.1.2. CDS Spreads

As Table 4 shows, the *announcement* events had a mixed effect on CDS spreads. Spreads were negatively affected in 2009 for no-gap banks and positively in 2012 for gap banks. Moreover, in contrast to the stock market, Bernanke's clarification of the stress test in 2009 did not affect the CDS market. This response is expected due to the structure of the CDS agreements where any change in ownership due to nationalization would not bring additional losses to contract parties.[21]

For the *methodology* events we find mixed results. The announcement had no impact on CDS spreads in 2009. However, in 2011 CDS spreads declined significantly following the release of the stress test methodology. This suggests that the release of the methodology in 2009 was less informative for the market than the announcement in 2011. In 2011, there was no disclosure of stress test results, which could have led the market valuing the information provided by the methodology disclosure relatively strongly.

Table 4 shows a decline in the average CDS spreads in 2009 for no-gap banks following the publication of the stress test *results*. Average spreads dropped 55.43 basis points for no-gap banks. The disclosure of the results of CCAR in 2012 and 2013 also seem to have led to lower CDS spreads although the evidence is statistically weak. In contrast, the results of DFAST seem to have been unin-

formative to the CDS market. There are two possible reasons why CCAR in 2013 affected CDS spreads stronger than DFAST. Firstly, as Table 2 shows, in DFAST all the banks in our sample received approval while in CCAR three of these banks were not approved. The market may therefore have attached more importance to the results of CCAR. Alternatively, the different respons could be due to the underlying assumptions of the stress tests. While DFAST was conducted conditional on no change in the capital distributions, CCAR incorporated the capital plans proposed by the banks and, therefore, may have better reflected creditworthiness (Federal Reserve, 2013a). Table A.13 in the Appendix offers our results for extended event windows for the SCAP stress test. The results for longer event windows are in line with our main findings for the credit market: spreads decline following the publication of stress test results.

5.2. How do stress tests affect individual banks?

Next, we turn to market reactions at the bank level. As we do not account for individual bank (balance sheet) characteristics in Tables 3 and 4, banks' stocks and CDS spreads may have been affected while this is not picked up in our previous analyses. Table 5 presents stock market reactions following the disclosure of stress test results. After the release of the SCAP results the stock price of some banks, regardless of the assessment outcome, increased. In contrast, stock prices did not respond to the CCAR in 2011 (when the results at the individual bank level were not released). The publication of the stress test outcomes of subsequent tests occasionally impacted the equity returns of banks, and, when this happened, it seems that only one event (either DFAST or CCAR) provided new information.[22] The magnitude of reactions to the CCAR

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[21] Morgan et al. (2014) find a decline in CDS spreads following the clarification event (but only for gap banks). However, they consider CDS contracts with an MR document clause. This entails that these contracts do not suppose full coverage in case of a credit event. As we do not consider these types of contracts a possible nationalization would not affect the spreads.

[22] The exception is the CCAR 2015 results for PNC which seems to have provided information in both the DFAST and CCAR events.

Table 5

Stock market reactions to the disclosure of stress test results at bank level (in %). Notes: This table presents CARs for each bank following the publication of stress test results over the 2009–2015 period calculated using Eq. (2) with a (-1,+1) event window. The banks are divided into global SIFIs, domestic SIFIs, and non-SIFIs according to the classification of the Financial Stability Board (FSB, 2014).

Banks	2009	2011	2012	2013		2014		2015	
Global SIFIs	SCAP	CCAR	CCAR	DFAST	CCAR	DFAST	CCAR	DFAST	CCAR
Bank of Amer.	.2208**	−.0138	.0669	.0315	.0375	.0225	−.0158	.0338*	.0039
BNY Mellon	.1020	−.0007	.0173	.0142	.0017	.0171	−.0092	.0037	.0193
Citigroup	.1525	−.0355	.0016	.0565**	−.0007	.0272	−.0457*	.0086	.0290*
Deutsche Bank								.0181	.0076
Goldman Sachs	−.0026	.0108	.0103	−.0076	.0148	.0040	−.0132	−.0035	.0174
HSBC						−.0234	.0162	−.033**	−.0173
JPMorgan Ch.	.0611	.0039	.0505*	.0071	−.0094	.0128	−.0139	.0023	.0055
Morgan Stanley	−.0409	−.0110	−.0091	.0033	.0349	.0027	−.043**	.0166	.0478***
Santander						−.0093	.0297	−.0128	−.0184
State Street	.1724	−.0211	.0446	.0219	.0105	.0071	−.0192	−.0151	.0080
Wells Fargo	.1466*	−.0240	.0354	.0076	.0344**	−.0033	.0063	.0004	.0219**
Domestic SIFIs									
American Expr.	.0328	−.0020	.0308	.0015	.0071	−.0071	−.0072	.0074	.0246**
BB&T	.0204	−.0279	.0179	.0225	−.0196	.0080	−.0072	.0261**	.0184
Capital One	.4326***	−.0212	.0293	−.0047	.0044	−.0033	.0114	.0167	.0263**
Fifth Third	.5745***	−.0146	.0254	.0076	.0127	.0096	−.032**	.0205	−.0014
PNC	.1885*	−.0157	.0189	.0117	.0141	.0150	−.0169	.0328***	.0288**
Regions Fin.	.1249	−.0454	.0332	.0139	.0181	.0277	−.0212	.0380***	.0236
SunTrust Banks	.1673	−.0050	.0302	.0312	−.0259	.0106	−.0272	.0333**	.0234
U.S. Bancorp	−.0063	−.0228	.0478*	.0032	−.0104	.0108	−.022**	.0146	−.0028
Non-SIFIs									
BBVA Compass						−.0152	−.0194	.0091	.0028
BMO						−.0143	.0139	−.0045	−.0018
Comerica						.0260	−.0331*	.0476***	.0046
Discover						−.0069	−.0073	.0025	.0217*
Huntington						.0097	−.0150	.0287*	.0179
KeyCorp	−.0088	−.0497	.0359	.0244	.0172	.0138	−.0162	.0443*	.0283*
MetLife	.1994*	.0041	−.0552*						
M&T						−.0017	−.0085	.0273**	.0143
Northern Trust						.0205	−.0140	.0174	.0104
Zions Bancorp						.0065	−.0112	.0343*	.0307*

outcomes are also weaker than those in response to the SCAP outcomes. Moreover, the direction of reactions is not uniform. For example, the stock price of Citigroup, which was one of the banks that did not pass the assessment, shows a negative reaction after the release of the CCAR outcomes in 2014. This is likely due to problems with its capital plan such as measurement of risks and losses as divulged by regulators. Table A.12 in the Appendix provides an overview of the likely causes in stock markets movements of gap-banks *as evinced* by news outlets and financial market participants.[23] Surprisingly, stock prices of some banks that passed the stress test also show a negative reaction.

Similarly, Table 6 presents the response in the CDS market at the individual bank level. The findings are in line with our earlier results. That is, the release of SCAP stress test results had some impact on banks' CDS spreads whereas the publication of SCAP stress tests results had little impact on banks' CDS spreads.

To check whether our results are robust to using alternative market indices, we reestimate Tables 5 and 6 using diversified stock and CDS indices geared specifically for banks. The series we use are the S&P500 Banks Index and the Banking 5Y CDS Index. Tables A.14 and A.15 in the Appendix present the findings. As both tables show, while statistical significance is weaker, the findings are similar to our earlier results.[24]

Overall, our findings indicate that over the years stress tests only occasionally moved both stock and CDS markets. The market

responses to the SCAP was generally stronger than those following later stress tests. Moreover, despite the fact that some global SIFIs in our sample had difficulty obtaining regulators' approval for their capital distribution plans the market responses do not seem to indicate a difference in pattern across SIFIs and non-SIFIs.

5.3. How do stress tests affect systematic and "systemic risk"?

This section offers the results of our analysis of systematic and "systemic risk" for which we adopt a longer time horizon. As before, we contrast the findings for gap and no-gap banks. We conclude each subsection by reestimating our findings using an alternative proxy for our diversified returns index.

5.3.1. Systematic risk and "systemic risk"

Table 7 presents the estimation results for our baseline model (3). We focus our discussion on the interaction terms. The findings show that the impact of the *announcement* of stress tests is mixed. In 2009, the announcement of SCAP led to an increase in systematic risk. Given our earlier findings, a likely explanation might be investors' fear for nationalization of banks that would failed the SCAP. For the remaining years there is no consistent evidence of movement in betas. Considering *results* events, in 2009 the betas dropped following the publication of the results of the SCAP. Specifically, we find a strong decline in systematic risk (−.2305) after the publication of its results. Similarly, the beta of banks declined after the release of stress test results in 2013 (−.2174) and 2015 (−.2577). These findings suggest that market participants expected stress test results to be worse than they turned out to be so that the betas declined in 2009, 2013, and 2015.

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[23] For example, other factors that may have caused concerns are the audit and anti-money-laundering procedures of banks, and a failure to correct problems raised earlier by the Fed.

[24] We would like to thank an anonymous referee for making this suggestion.

Table 6

CDS spreads reactions to the disclosure of stress test results at bank level (in bp). Notes: This table presents CARs per bank following the publication of stress test results over the 2009–2015 period calculated using Eq. (2) with a (-1,+1) event window. The banks are divided into global SIFIs, domestic SIFIs, and non-SIFIs according to the classification of the Financial Stability Board (FSB, 2014).

Banks	2009	2011	2012	2013		2014		2015	
Global SIFIs	SCAP	CCAR	CCAR	DFAST	CCAR	DFAST	CCAR	DFAST	CCAR
Bank of Amer.	−102***	−14.18	−21.52	3.82	−2.42	−2.62	3.98	.315	.867
Citigroup	−203***	−12.28	−1.46	−2.85	−5.51	−3.00	4.22	−1.80	1.29
Goldman Sachs	−44.28	−13.91	−17.59	4.03	−3.55	−.954	−.088	−.841	1.99
JPMorgan Ch.	−39.12**	−9.32	−7.45	1.79	−2.34	−2.78	−.697	−.080	1.14
Morgan Stanley	−64.20	−15.25	−21.29	4.66	−4.85	−2.44	−.222	−.261	1.40
Wells Fargo	−81.6***	−7.27	−4.23	−.524	−2.05	.467	−2.40	−.775	−.032
Domestic SIFIs									
Ally Financial	−135.3	−19.96	−32.68	−2.78	−12.17	−6.60	−.056	4.61	2.77
American Expr.	−76.5**	−5.25	−1.32	−.537	−3.78	.367	.383	−.384	−.061
Capital One	−54.9**	−4.39	−2.99	−1.23	−4.24	−1.37	−.214	−1.04	−.062
Non-SIFIs									
MetLife	−50.24	−14.15	−2.77						

Table 7

Systematic risk. Notes: This table presents the estimation results for Eq. (3) over the period 2009–2015. Robust standard errors in parentheses. Statistical significance is denoted as follows: *** - 1%, ** - 5%, * - 10%.

	2009	2011	2012	2013	2014	2015
Market β	1.792***	1.426***	1.566***	1.442***	1.196***	1.126***
	(.0625)	(.0564)	(.0441)	(.0591)	(.0485)	(.0577)
D^A*R_m	.9535***	.0493	.1309	−.1211	.0304	.0563
	(.1491)	(.1420)	(.1222)	(.0978)	(.0817)	(.0861)
D^M*R_m		.1269*				
		(.0723)				
D^R*R_m	−.2305*		−.1105	−.2174**	−.0562	−.2577***
	(.1267)		(.1108)	(.0873)	(.0867)	(.0944)
Number of id	18	18	18	17	28	29
Trading days	597	406	334	445	367	363
R^2	.4720	.6260	.6438	.4881	.4456	.4155

Table 8

Systemic risk. Notes: This table presents the estimation results for Eq. (5) over the period 2009–2015. Robust standard errors in parentheses. Statistical significance is denoted as follows: *** − 1%, ** − 5%, * − 10%.

	2009	2011	2012	2013	2014	2015
Market ρ	.7409***	.7616***	.8589***	.7413***	.6885***	.6385***
	(.0331)	(.0291)	(.0287)	(.0339)	(.0303)	(.0315)
$D^A*\tilde{R}_m$	.0595	−.0756	−.0897*	−.0583	.0076	.0732
	(.0670)	(.0518)	(.0537)	(.0526)	(.0487)	(.0522)
$D^M*\tilde{R}_m$		.0860**				
		(.0415)				
$D^R*\tilde{R}_m$	−.0706*		−.1367***	−.0313	−.0547	−.0141
	(.0398)		(.0421)	(.0455)	(.0462)	(.0664)
Number of id	18	18	18	17	28	29
Trading days	597	406	334	445	367	363
R^2	.4902	.6156	.6467	.5093	.4526	.4116

Table 8 presents the estimation results for our standardized model (5). We again focus on the coefficients of the interaction terms, denoted by ρ. Following Nijskens and Wagner (2011), we interpret a decline in the correlation component as a decline in "systemic risk". Except for a weak effect in 2012, there is no evidence that *announcement* events affected "systemic risk" of banks. However, the *methodology* release in 2011 increased ρ and contributed to the increase in beta reported in Table 7. For *results* events there is a decrease in the correlation of the stock series with the market in 2009 and 2012, suggesting that "systemic risk" declined.[25]

We reestimate Tables 7 and 8 using the alternative market index aimed towards banks in respectively Tables A.16 and A.17 in the Appendix. Using the alternative index there is stronger evidence that more recent stress tests affected systematic risk (albeit in a smaller magnitude) negatively. The significance of the impact of earlier stress tests, notably those in 2009 and 2013, drop although Table A.17 suggests a decline in "systemic risk" in 2012.

5.3.2. Gap versus no-gap banks

To examine whether systematic and systemic risk of gap and no-gap banks were affected differently, we reestimate Eqs. (3) and (5) for no-gap banks and gap banks. The resulting regressions are shown in, respectively, Tables 9 and 10. In what follows we fo-

[25] We attribute the earlier insignificance of the beta for CCAR 2012 in Table 7 to the relative variance component, which may have added sufficient noise to make the overall change in beta insignificant.

Table 9

Systematic risk gap and no-gap banks. Notes: This table presents the estimation results for Eq. (3) over the period 2009–2015. Columns '+' and '-' show the results for banks without and with capital shortfalls and/or disapproval of capital distribution plans, respectively. Robust standard errors in parentheses. Statistical significance is denoted as follows: *** - 1%, ** - 5%, * - 10%.

	2009		2012		2013		2014		2015	
	(+)	(−)	(+)	(−)	(+)	(−)	(+)	(−)	(+)	(−)
Market β	1.774***	1.744***	1.572***	1.543***	1.415***	1.372***	1.184***	1.184***	1.098***	1.045***
	(.0574)	(.0552)	(.0430)	(.0406)	(.0502)	(.0442)	(.0459)	(.0407)	(.0558)	(.0469)
$D^A * R_m$	.9726***	1.002***	.1247	.1544	−.0674	−.0244	.0406	.0406	.0844	.1374*
	(.1470)	(.1464)	(.1218)	(.1212)	(.0918)	(.0890)	(.0802)	(.0774)	(.0849)	(.0798)
$D^R_{No-gap} * R_m$	−.3160***		−.1792*		−.1700**		−.0278		−.1968**	
	(.0923)		(.1065)		(.0775)		(.0845)		(.0953)	
$D^R_{Gap} * R_m$		−.0767		.2259*		−.1682***		−.1560*		−.6198***
		(.1480)		(.1288)		(.0646)		(.0889)		(.1364)
R^2	.4721	.4710	.6443	.6438	.4915	.4907	.4455	.4454	.4139	.4140
Number of id	18		18		17		28		29	
Trading days	597		334		394		367		363	

Table 10

Systemic risk gap and no-gap banks. Notes: This table presents the estimation results for Eq. (5) over the period 2009–2015. Columns '+' and '-' show the results for banks without and with capital shortfalls and/or disapproval of capital distribution plans, respectively. Robust standard errors in parentheses. Statistical significance is denoted as follows: *** - 1%, ** − 5%, * − 10%.

	2009		2012		2013		2014		2015	
	(+)	(-)	(+)	(-)	(+)	(-)	(+)	(-)	(+)	(-)
Market β	1.774***	1.744***	1.572***	1.543***	1.415***	1.372***	1.184***	1.184***	1.098***	1.045***
	(.0574)	(.0552)	(.0430)	(.0406)	(.0502)	(.0442)	(.0459)	(.0407)	(.0558)	(.0469)
$D^A * R_m$	.9726***	1.002***	.1247	.1544	−.0674	−.0244	.0406	.0406	.0844	.1374*
	(.1470)	(.1464)	(.1218)	(.1212)	(.0918)	(.0890)	(.0802)	(.0774)	(.0849)	(.0798)
$D^R_{No-gap} * R_m$	−.3160***		−.1792*		−.1700**		−.0278		−.1968**	
	(.0923)		(.1065)		(.0775)		(.0845)		(.0953)	
$D^R_{Gap} * R_m$		−.0767		.2259*		−.1682***		−.1560*		−.6198***
		(.1480)		(.1288)		(.0646)		(.0889)		(.1364)
R^2	.4721	.4710	.6443	.6438	.4915	.4907	.4455	.4454	.4139	.4140
Number of id	18		18		17		28		29	
Trading days	597		334		394		367		363	

cus our discussion on the beta effects associated with the results events.

The first two columns in Table 9 suggest that the decrease in the beta in 2009 (as reported in Table 7) was due to the effects on no-gap banks. The results of SCAP seem to have caused a significant decrease in betas of no-gap banks while the betas of gap banks were not affected. This finding complements the findings of Morgan et al. (2014) who show that market participants' ex ante expectations of capital shortfalls were too high. Table 9 shows that the results of CCAR 2012 may have affected the beta of no-gap banks negatively (-.1792) and the beta of gap banks positively (.2259) although the evidence in both cases is statistically weak. In 2013, there is a consistent change in the overall beta following the results of CCAR for both gap and no-gap banks. In 2014, only gap banks show a negative change while in 2015 both no gap and gap banks display declines in betas, (-.1968) and (-.6198) respectively. The variation in the magnitude of the coefficients is likely a reflection of the information value of stress tests (which are tied to banks' capital shortfalls and/or disapproval of capital distribution plans) but also of the composition of gap banks which changes over the years. For example, the rather high coefficient for gap banks in 2015 (-.6198) stems from two banks (Santander and Deutsche Bank) where the additional transparency provided by the stress test result may have relieved market participants. Overall, there is strong and consistent evidence for a decline in systematic risk following stress test results in most years.

Table 10 suggests that the publication of the stress test results affected "systemic risk" in 2009, 2012, and 2015. The release of stress test results decreased the "systemic risk" component of the beta of gap banks, in 2009 (−.0846) and 2015 (−.2543), and of no gap banks in 2012 (−.1308).

Finally, Tables A.18 and A.19 in the Appendix present the findings using the alternative market index. The results are similar to our earlier findings.

6. Conclusion

Bank supervisors expect banks to hold sufficient capital to cover losses under adverse economic conditions. As stress testing has become an important tool for bank supervisors to achieve that goal, it is important to consider their effects on stock and CDS markets. We have quantified the market reactions of U.S. stress tests performed after the start of the financial crisis by considering their effects on stock returns, CDS spreads, systematic risk, and "systemic risk".

Our findings suggest that over the years stress tests have moved both stock and CDS markets. The market responses to the 2009 SCAP stress test were generally stronger than those to the subsequent stress tests performed by the Fed. Our findings support the idea that the value attached to the information provided by stress tests depends on financial circumstances at the time. During a crisis, the need for credible information is likely to be greater than during calmer periods and, therefore, the markets may have valued the information provided by the SCAP more. For some of the post-crisis stress tests, the sample of no-gap banks indicate that the equity market reacted positively to the disclosure of the results of stress tests. However, the findings are statistically not very strong. Moreover, the reactions in post-crisis stress tests are not

always uniform, occasionally displaying negative reactions. Overall, stock markets react positively and CDS spreads react negatively following stress test results. Our findings do not indicate that market reactions were systematically different for SIFIs and non-SIFIs.

Our analysis of banks' betas suggests that the publication of stress test results has affected banks' systematic and/or "systemic risk" in nearly all years. We find evidence for a decline of systematic risk in 2009, 2013, 2014, and 2015, while we find mixed evidence for 2012. In 2011, when the stress test results were not published, systematic (and "systemic risk") seem to have increased. "Systemic risk" declined in 2009, 2012, and 2015 following the release of the stress tests results. Overall, our findings consistently show that stress tests conducted during 2009–15 have been a useful tool in mitigating systematic and/or systemic risks. Stress tests therefore have produced valuable information for market participants and can play a role in mitigating bank opacity.

These findings are also relevant for discussions about the future design of stress tests. According to Quarles (2018), several aspects of stress tests warrant further evolution. While some of these proposals aim to improve the efficiency of stress tests, others are geared towards increasing their transparency. More transparency on the inputs and outputs of stress tests may improve their credibility. Our findings support this recommendation only to some

extent. One reason why the SCAP had more impact on stock and CDS markets than subsequent stress tests may be that in SCAP the Fed more heavily relied on banks' own estimates thereby increasing the credibility of the stress test. An important argument against fully opening the 'black box' of stress testing is that it runs the risk that the banks will be gaming the assessment (Bernanke, 2013).

Like most previous studies in this line of research, our main analysis is based on an event study approach. This implies that our study suffers from the drawbacks of this approach. Most importantly, only unanticipated effects will lead to a change in market prices. So, the fact we do often not find significant market responses to the disclosure of stress test information does not imply that these stress tests are not useful (see Kohn and Liang, 2019, for an evaluation of U.S. stress tests). Furthermore, event studies can only identify effects in the short run (i.e. over the event window). An interesting avenue for future research could be to analyze the longer-term effects of stress testing, notably on the risk-taking behavior of financial institutions. Another suggestion for future research is to analyze the impact of stress tests on systemic risk, using the many indicators of systemic risk that have been suggested in the literature.

Appendix A

Table A1
Related studies.

Study	Stress test	Findings
Morgan et al. (2014)	SCAP 2009	Stress tests produce significant market reaction of stock prices. Under-capitalized banks have experienced more negative abnormal returns. CDS spreads, particularly for under-capitalized banks, decline following the release of stress test results.
Flannery et al. (2017)	U.S. stress tests	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.
Fernandes et al., 2017	U.S. stress tests	Markets tend to react positively to stress test announcements and, while the reaction gets weaker as stress tests become more established and the announcement dates known, there appears to be still some information contained in the scenarios released from one year to the next.
Ahnert et al. (2018)	U.S. and E.A. stress tests	Banks that passed the test experience positive abnormal equity returns and tighter CDS spreads, while banks that failed show strong drops in equity prices and widening CDS spreads. The authors also document strong market reactions at the announcement date of the stress tests.
Ellahie (2012)	EBA 2010, 2011	The 2011 stress test reduced information asymmetry (i.e. equity-credit bid-ask spreads) and increased information uncertainty (measured by equity option implied volatilities and ratio of CDS spreads) of banks.
Alves et al., 2013	EBA 2010, 2011	Both European stress tests have affected the stock prices of banks. The 2010 stress test reduced the volatility in stock prices while the volatility increased following the release of the 2011 stress test results.
Petrella and Resti (2013)	EBA 2011	Stress tests significantly affect the market and are a credible evaluation tool that reduce bank opaqueness.
Sahin and de Haan, 2016	ECB's CA	Publication of the Comprehensive Assessment (CA) outcomes had generally no effects on bank stock prices and CDS spreads.
Carboni et al., 2017	ECB's CA	Publication of information in each step of CA exercise produced new valuable information.
Lazzari et al. (2017)	ECB's CA	Publication of CA results had negative effect on abnormal returns reflecting that investors became aware of new supervisor's policies.
Georgescu et al. (2017)	ECB's CA, EBA 2016	Stress test disclosures revealed new information that was priced by the markets. The impact on bank CDS spreads and equity prices tended to be stronger for the weaker performing banks in the stress test.
Philippon et al. (2017)	E.A. stress tests	Stress test model-based losses are good predictors of realized losses and of banks' equity returns around announcements of macroeconomic news. Furthermore, no biases are detected in the construction of the scenarios, or in the estimated losses across banks of different sizes and ownership structures.

Table A2

The causes in the movements of market reactions. This table summarizes the causes of market reactions *as evinced* by news outlets and financial market participants for stress tested banks. The news may have affected the market participants' expectations and may shed light on the causes in the movements of market reactions for gap-banks. The news articles are extracted from a variety of news sources from the Dow Jones Factiva database over the 2009–2015 period for (-1,+7) days around the disclosure of the results. For stress tests conducted between 2013–2015, the window starts -1 day before the disclosure of the DFAST results and ends at +7 days after the disclosure of CCAR results. We searched for all news containing the words "stress test" related to the banking stress tests procedure. Our final list of articles contains news on individual banks, the banking industry, and the U.S. economy. The news was filtered with all the relevant bank names and with the names of related government agencies, such as the Federal Reserve, FDIC and the U.S. Department of the Treasury. We verified all news manually for relevance. News sources include the Financial Times, The Wall Street Journal, The New York Times, Reuters, and Bloomberg.

	2009	2012	2013	2014	2015
Ally Financial	$11.5 bln capital shortfall; Losses from mortgages and auto loans; Lending to distressed General Motors and Chrysler.	4.4% Tier 1 capital in the stress case; Does not fare well in the stress case; Exposure to mortgages.	1.5% Tier 1 capital in the stress case; Exposure to mortgages.		
American Express			Required to make only small adjustments in the capital plan.		
Bank of America	$33.9 bln capital shortfall; The anticipated losses and increased exposure in the subprime market from the Merrill and Countrywide Financial deals; "Steep losses".				
BB&T			Problems with the data for the bank's assets.		
Citigroup	$5 bln capital shortfall; Company's financial conditions.	4.9% Tier 1 capital in the stress case; Still holding the toxic assets, not lending yet; Capital distribution plans too generous.		Problems with the capital plan such as measurement of risks and losses; Concerns about the audit and anti-money-laundering procedures; Failed to correct the problems pointed out by the Fed earlier.	
Deutsche Bank					Problems with projections in the capital plan, and internal controls.
Fifth Third Bank	$1.1 bln capital shortfall; Exposure to commercial real-estate.				
Goldman Sachs			More stringent risk weightings on capital markets assets due to large trading operations; Problems with the capital plan (i.e. measurement of revenues and losses in the stress case).		

Table A2 (*continued*)

HSBC				Problems with projections in the capital plan, weak governance, and internal controls.	
J.P. Morgan			Problems with the capital plan, (i.e. understating risks caused, deficiencies in internal control); Large trading operations.		
KeyCorp	$1.8 bln capital shortfall; Exposure to commercial real-estate.				
MetLife		5.1% Tier 1 in the stress case; Business model different from banking.			
Morgan Stanley	$1.5 bln capital shortfall; High risks and low revenue.			Disappointing distribution plan.	
PNC	$0.6 bln capital shortfall.				
Regions Financial	$2.5 bln capital shortfall; Exposure to commercial real-estate.				
Santander				Problems with projections in the capital plan, weak governance, and internal controls.	Problems with projections in the capital plan, weak governance, and internal controls.
SunTrust Banks	$2.2 bln capital shortfall.	4.8% Tier 1 in the stress case.			
Wells Fargo	$13.7 bln capital shortfall; Risky loans and securities from the acquisition of Wachovia - written off almost $40 bln of Wachovia's troubled loans.				
Zions Bancorp				Fell short of capital – 3.5% Tier 1 ratio in the stress case.	

Table A3
Market reactions to the 2009 SCAP stress test over extended windows. Notes: This table presents CARs for the 2009 SCAP stress test calculated using Eq. (1) over extended event windows. The final rows of the announcement and methodology sections in the table do not extend to +10 trading days due the occurrence of respectively the clarification and results events. Column 'All' shows the effects of events on the average CARs of all banks. Columns 'No-Gap' and 'Gap' separate the effects into banks with and without capital shortfalls and/or disapproval of capital distribution plans. Reported significance is based on corrected t-statistics. Statistical significance is denoted *** − 1% ** − 5%, * − 10%.

Event window	All	No-Gap	Gap	All	No-Gap	Gap
	Stock market (in %)			Credit market (in bp)		
Announcement						
(0)	−8.602	−4.016*	−13.19	−4.615	−5.069	−4.049
(−1,+1)	−.4203	−.2027	−.6378	−13.04	−10.81	−15.83
(−1,0)	−5.682	−3.327*	−8.038	−16.15*	−15.06**	−17.52
(0,+1)	−3.340	−.8917	−5.788	−1.507	−.8228	−2.363
(−2,+2)	4.709	−1.650	11.07	−26.87**	−21.41***	−33.69*
(−2,0)	2.728	−1.117	6.627	−26.40**	−21.16***	−32.96*
(0,+2)	−6.621	−4.495	−8.747	−5.082	−5.319	−4.785
(−3,+3)	2.050	−4.256	8.357	−28.76*	−30.89***	−26.10
(−3,0)	3.303	−.9386	7.544	−32.05**	−31.34***	−32.93
(0,+3)	−9.854	−7.333	−12.38	−1.325	−4.617	2.790
(−10,+3)	−1.726	1.386	4.838	−45.37*	−53.99***	−34.60
(−10,0)	−.4734	4.703	−5.650	−48.66**	−54.44***	−41.44
Clarification						
(0)	8.750***	.7335***	10.17***	10.51	15.42	4.372
(−1,+1)	21.13**	10.66*	31.60**	18.65	32.15	1.762
(−1,0)	15.32***	9.637***	21.01***	20.44	21.15	19.54
(0,+1)	14.56*	8.361*	20.75**	8.721	26.42	−13.41
(−2,+2)	29.37*	19.84*	38.91*	37.51	52.81	18.39
(−2,0)	15.87**	11.97**	19.76**	47.68*	40.97**	56.08
(0,+2)	22.26*	15.20	29.31*	.3420	27.26	−33.31
(−3,+3)	14.97	12.90	17.05	48.02	72.14	17.87
(−3,0)	9.403	8.109	10.70	64.14*	52.65*	78.50
(0,+3)	14.32	12.13	16.51	−5.610	34.91	−56.26
(−3,+10)	12.79	4.756	20.82	178.0	217.7*	128.4*
(0,+10)	12.14	3.981	20.29	124.4	180.4	54.31
Methodology						
(0)	1.244	2.324	.1649	−9.797	−11.34	−7.862
(−1,+1)	.3583	4.002	−3.285	−11.28	−19.72	−.7275
(−1,0)	3.922	7.018	.8250	−2.956	−5.241	−.1009
(0,+1)	−2.319	−.6926	−3.945	−18.12	−25.83	−8.488
(−2,+2)	−5.445	−.3120	−10.58	1.302	−12.67	18.77
(−2,0)	.1950	4.081	−3.691	5.265	4.514	6.205
(0,+2)	−4.396	−2.069	−6.722	−13.76	−28.53	4.699
(−3,+3)	.8916	7.978	−6.195	19.28	.1463	43.20
(−3,0)	4.675	9.999	−.6495	22.52	20.11	25.54
(0,+3)	−2.539	.3024	−5.380	−13.04	−31.31	9.803
(−10,+3)	8.398	11.29	5.507	−62.80	−89.86	−28.96
(−10,0)	11.72	12.94	10.49	−58.70	−69.96	−44.64
Result						
(0)	−1.213	−.4244	−2.001	−34.68*	−27.47	−43.70**
(−1,+1)	14.31	11.28	17.33	−81.76	−55.43**	−114.7
(−1,0)	6.536	5.724	7.347	−64.06	−44.26**	−88.82
(0,+1)	6.559	5.136	7.982	−52.38	−38.63**	−69.56*
(−2,+2)	8.067	3.270	12.86	−93.79	−61.38**	−134.3*
(−2,0)	5.171	3.456	6.883	−65.59	−45.43**	−90.79*
(0,+2)	1.683	−.6141	3.981	−62.88	−43.41**	−87.21*
(−3,+3)	11.99	5.093	18.90	−82.49	−53.12**	−119.2
(−3,0)	12.85	8.043	17.66	−58.69	−38.91	−83.42*
(0,+3)	−2.067	−3.374	−.7587	−58.48	−41.67*	−79.49
(−3,+10)	11.21	6.451	15.97	−116.3***	−94.19***	−144.0***
(0,+10)	−2.855	−2.017	−3.693	−92.33***	−82.74**	−104.3***

Table A4
Stock market reactions using alternative market index (in %). Notes: This table presents CARs for each bank following the publication of stress test results over the 2009–2015 period with a (-1,+1) event window using an alternative market index geared towards banks. The banks are divided into global SIFIs, domestic SIFIs, and non-SIFIs according to the classification of the Financial Stability Board (FSB, 2014).

Banks	2009	2011	2012	2013		2014		2015	
Global SIFIs	SCAP	CCAR	CCAR	DFAST	CCAR	DFAST	CCAR	DFAST	CCAR
Bank of Amer.	.0719	.0109	.0166	−.0048	−.0036	.0088	.0002	.0197	−.0152
BNY Mellon	.0122	.0182	−.0121	−.0029	.019***	.0037	.0067	−.0076	.0068
Citigroup	.0134	−.0120	−.0422	.0058	−.0125	.0123	−.0283	−.0064	.0122
Deutsche Bank								−.0018	−.0085
Goldman Sachs	−.0723	.0249	−.0189	.0187	−.05***	−.0093	.0025	−.0192	.0026
HSBC						−.0322	.0269	−.04***	−.024*
JPMorgan Ch.	−.0503	.0239	.0163	−.0160	.001	−.0005	.0015	−.0116	−.0101
Morgan Stanley	−.1299	.0089	−.0552	−.0049	−.03***	−.0134	−.0239	−.0026	.0285*
Santander						−.0168	.0394	−.0306	−.033*
State Street	.0623	.0038	.0159	−.0028	−.025	−.0055	−.0044	−.031**	−.0075
Wells Fargo	.0229	−.0016	−.0024	−.0086	.0150	−.0190	.024***	−.0127	.0092
Domestic SIFIs									
American Expr.	−.0326	.0242	.0087	.0023	−.0003	−.0182	.0058	−.0129	.0080
BB&T	−.0811*	−.0082	−.0155	.0010	−.0019	−.0052	.0080	.0132	.0052
Capital One	.343***	.001	.002	.044*	−.0209	−.0166	.027*	.0011	.0124
Fifth Third	.437***	.0156	−.0144	−.0132	−.0094	−.0026	−.0183	.0065	−.0171
PNC	.0781	.0051	−.0116	.0188	.0168	.0003	−.0004	.02**	.015*
Regions Fin.	−.0453	−.0172	−.0142	−.0025	−.0030	.01	−.0009	.0229	.007
SunTrust Banks	.0317	.0220	−.0121	.0143	.002	−.006	−.008	.019*	.0075
U.S. Bancorp	−.096**	−.0024	.0150	.0133	−.04***	.001	−.0112	.0031	−.015*
Non-SIFIs									
BBVA Compass						−.0239	−.0082	−.0122	−.015
BMO						−.0177	.0185	−.0109	−.007
Comerica						.0090	−.0141	.036***	−.01
Discover						−.0198	.0081	−.0145	.007
Huntington						−.0078	.0047	.0144	.003
KeyCorp	−.145	−.024	−.004	.0157	−.0003	−.005	.0044	029**	.0116
MetLife	.1219	.0317	−.09***						
M&T						−.0136	.005	.018**	.0034
Northern Trust						.009	−.0007	.006	−.002
Zions Bancorp						−.0133	.0109	.0202	.0162

Table A5
CDS spreads reactions using alternative market index (in bp). Notes: This table presents CARs for each bank following the publication of stress test results over the 2009–2015 period with a (-1,+1) event window using an alternative market index geared towards banks. The banks are divided into global SIFIs, domestic SIFIs, and non-SIFIs according to the classification of the Financial Stability Board (FSB, 2014).

Banks	2009	2011	2012	2013		2014		2015	
Global SIFIs	SCAP	CCAR	CCAR	DFAST	CCAR	DFAST	CCAR	DFAST	CCAR
Bank of Amer.	−80.06	−5.73	−19.47	−.95	−1.75	−1.454	2.053	−1.19	.793
Citigroup	−168***	−3.49	2.032	−7.36	−5.23	−1.617	2.341	−3.28	1.262
Goldman Sachs	12.08	−4.44	−14.36	−1.24	−3.35	.554	−1.97	−2.78	1.901
JPMorgan Ch.	−25.75**	−2.92	−7.461	−.73	−2.29	−1.99	−1.71	−1.24	1.103
Morgan Stanley	189*	−6.40	−13.84	−.76	−4.18	−.619	−2.27	−1.81	1.353
Wells Fargo	−71***	−1.34	−4.94	−2.55	−1.84	.909	−3.08	−1.08	−.05
Domestic SIFIs									
Ally Financial	−143.5	−4.98	−29.8	−5.42	−11.99	−5.99	−.59	2.461	2.85
American Expr.	−56.8**	−.44	−.94	−1.36	−3.67	.95	−.18	−.86	−.13
Capital One	−40.6	1.74	−2.80	−2.3	−4.18	−.76	−.92	−1.43	−.099
Non-SIFIs									
MetLife	−13.51	−5.61	−1.015						

Table A6
Systematic risk using alternative market index. Notes: This table presents the estimation results for Eq. (3) over the period 2009–2015 using an alternative market index geared towards banks. Robust standard errors in parentheses. Statistical significance is denoted as follows: *** − 1%, ** − 5%, * − 10%.

	2009	2011	2012	2013	2014	2015
Market β	.9635***	.9212***	1.059***	1.081***	1.017***	1.098***
	(.0151)	(.0191)	(.0180)	(.0285)	(.0264)	(.0269)
$D^A * R_m$	−.0642**	.0248	.0090	−.0271	−.0381	.0422
	(.1491)	(.0445)	(.0462)	(.0485)	(.0426)	(.0406)
$D^M * R_m$		.1361***				
		(.0252)				
$D^R * R_m$	−.0407		.0459	−.0294	−.1118***	−.0960**
	(.1267)		(.0485)	(.0454)	(.0432)	(.0462)
Number of id	18	18	18	17	28	29
Trading days	597	406	334	445	367	363
R^2	.6186	.7137	.7190	.5686	.5188	.5342

Table A7

Systemic risk using alternative market index. Notes: This table presents the estimation results for Eq. (5) over the period 2009–2015 using an alternative market index geared towards banks. Robust standard errors in parentheses. Statistical significance is denoted as follows: *** - 1%, ** - 5%, * - 10%.

	2009	2011	2012	2013	2014	2015
Market ρ	.7778***	.8300***	.8774***	.8016***	.7328***	.7242***
	(.0163)	(.0159)	(.0168)	(.0217)	(.0193)	(.0165)
$D^A * \tilde{R}_m$	.0584	−.0491*	−.0571*	−.0556*	.0111	.0525*
	(.0357)	(.0276)	(.0320)	(.0334)	(.0311)	(.0277)
$D^M * \tilde{R}_m$		.0611***				
		(.0225)				
$D^R * \tilde{R}_m$	.0061		−.0462*	−.0263	−.0119	.0514
	(.0206)		(.0281)	(.0298)	(.0296)	(.0354)
Number of id	18	18	18	17	28	29
Trading days	597	406	334	445	367	363
R^2	.6232	.7154	.7316	.6032	.5353	.5325

Table A8

Systematic risk gap and no-gap banks using alternative market index. Notes: This table presents the estimation results for Eq. (3) over the period 2009–2015 using an alternative market index geared towards banks. Columns '+' and '-' show the results for banks without and with capital shortfalls and/or disapproval of capital distribution plans, respectively. Robust standard errors in parentheses. Statistical significance is denoted as follows: *** − 1%, ** − 5%, * − 10%.

	2009		2012		2013		2014		2015	
	(+)	(−)	(+)	(−)	(+)	(−)	(+)	(−)	(+)	(−)
Market β	.9710***	.9474***	1.065***	1.060***	1.067***	1.084***	.9972***	.9884***	1.075***	1.080***
	(.0143)	(.0142)	(.0176)	(.0167)	(.0262)	(.0229)	(.0249)	(.0208)	(.0264)	(.0222)
D^A*R_m	−.0717***	−.0481*	.0029	.0080	−.0118	−.0288	−.0176	−.0088	.0649	.0597
	(.0249)	(.0250)	(.0461)	(.0457)	(.0479)	(.0462)	(.0417)	(.0395)	(.0404)	(.0378)
$D^R_{No-gap} * R_m$	−.1540***		.0021		.0211		−.0669*		−.0313	
	(.0404)		(.0458)		(.0423)		(.0390)		(.0471)	
$D^R_{Gap} * R_m$		.0812*		.2333***		−.1173**		−.2286***		−.6448***
		(.0434)		(.0779)		(.0485)		(.0614)		(.1281)
R^2	.6193	.6186	.7189	.7195	.5646	.5646	.5181	.5187	.5335	.5362
Number of id	18		18		17		28		29	
Trading days	597		334		394		367		363	

Table A9

Systemic risk gap and no-gap banks using alternative market index. Notes: This table presents the estimation results for Eq. (5) over the period 2009–2015 using an alternative market index geared towards banks. Columns '+' and '-' show the results for banks without and with capital shortfalls and/or disapproval of capital distribution plans, respectively. Robust standard errors in parentheses. Statistical significance is denoted as follows: *** - 1%, ** - 5%, * - 10%.

	2009		2012		2013		2014		2015	
	(+)	(−)	(+)	(−)	(+)	(−)	(+)	(−)	(+)	(−)
Market ρ	.7785***	.7828***	.8730***	.8628***	.7856***	.7911***	.7168***	.7381***	.7185***	.7399***
	(.0108)	(.0119)	(.0157)	(.0135)	(.0188)	(.0152)	(.0179)	(.0146)	(.0164)	(.0149)
$D^A * \tilde{R}_m$	.0577*	.0534	−.0527*	−.0425	−.0435	−.0490	.0271	.0059	.0582**	.0369
	(.0336)	(.0339)	(.0314)	(.0304)	(.0320)	(.0300)	(.0303)	(.0284)	(.0276)	(.0268)
$D^R_{No-gap} * \tilde{R}_m$	.0101		−.0410		−.0034		.0294		.0826**	
	(.0187)		(.0256)		(.0251)		(.0271)		(.0368)	
$D^R_{Gap} * \tilde{R}_m$		−.0036		−.0359		−.0557*		−.1692***		−.3082***
		(.0161)		(.0343)		(.0304)		(.0395)		(.1024)
R^2	.6232	.6231	.7314	.7312	.5976	.5977	.5354	.5366	.5328	.5330
Number of id	18		18		17		28		29	
Trading days	597		334		394		367		363	

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