Stressed Banks[*]

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Abstract

We investigate the risk-taking of *stressed banks*, that is the large financial institutions that have faced unprecedented regulatory supervision and capitalization requirements. We take steps toward identifying how supervision affects risk-taking in the banking system. In the Dodd–Frank Act, supervision distinctly improves borrowers' ratings by 0.7 rating classes. Banks respond to supervision heterogeneously, depending on the capital charges associated with their investments. Ignoring the confounding effect of capital requirements leads to the erroneous conclusion that supervision under the Dodd–Frank Act is ineffective. Our results indicate that stressed banks improve financial stability because they are better capitalized and engage in safer lending.

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1 Introduction

In the aftermath of the Great Recession, the Dodd–Frank Act of 2010 bases its modern approach to the prudential regulation of U.S. banks on two tenets: *capital regulation* and *regulatory supervision*. Capital regulation requires banks to hold equity buffers to absorb losses from their risky assets. Regulatory supervision goes hand in hand with capital regulation.[1] Supervision involves the monitoring and oversight of banks to detect unsafe practices that might lead to the buildup of excessive risks compared to their capital buffers. The Dodd–Frank Act imposes unprecedented restrictions on large banks in addition to capital requirements, such as regulatory stress tests, on-site and off-site examinations, and bail-in provisions to reduce the social costs of firms that are "too-big-to-fail". Large banks have become stressed banks in an effort to comply with such stringent restrictions while pursuing profit maximization.

This paper addresses the question of how the equity requirements and regulatory supervision of large banks affect risk-taking in the banking system. Even 10 years after the Financial Crisis, there is an open debate on whether stressed banks help maintain financial stability while carrying out their financial intermediation function. A recent regulatory proposal, the Financial CHOICE Act, includes provisions to relax bank supervision, such as the exemption from stress tests for banks with capital greater than 10% of assets and the abrogation of the bail-in provisions in the Dodd–Frank Act. Sarin and Summers (2016) observe that financial market measures of risk for large U.S. financial institutions did not decline after the Dodd–Frank Act compared to pre-Crisis levels. Is supervision effective in limiting bank risk-taking? Do banks respond differently to supervision depending on their capital requirements? And, overall, do stressed banks help mitigate risk-taking in the financial system?

To convincingly answer these questions, we take steps to identify the effect of supervision on bank risk-taking. The Dodd–Frank Act offers a natural setting in which banks with more than USD 50 billion in assets (i.e., *stressed banks*) are subject to a stricter supervisory regime than a control group of smaller banks (the *non-stressed banks*). However, two major identification challenges must be addressed.

First, if capital requirements are not observed for all banks at all times, an omitted variable bias arises, which can confound the effect of supervision. The restrictions that capital regulation imposes on capitalization at the bank level effectively vary over time. Capital charges are not only indexed to the riskiness of bank assets; importantly, they are also affected by the supervision of stressed banks under the Dodd–Frank Act. In particular, regulatory stress tests impose higher capital charges on banks that the Federal Reserve deems riskier under an economically adverse stress scenario. As we detail in Section 2, we collect data disclosed in regulatory stress tests to back out the effective capital requirement for each bank. Measuring the effective capital requirement serves as a control to isolate the direct effect of supervision on bank risk-taking, as Figure 1 illustrates.

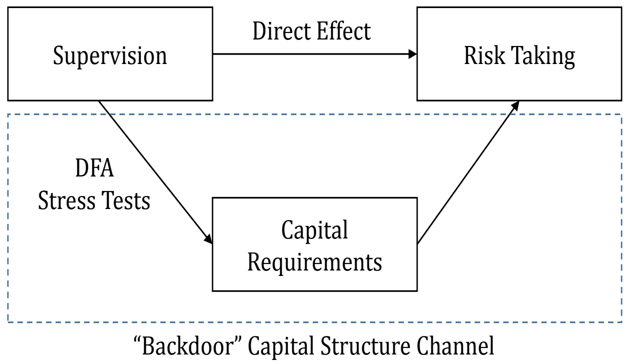

Figure 1. Capital requirements and the direct effect of supervision. "DFA" denotes the Dodd–Frank Act.

Second, the Dodd–Frank Act, as is typical with banking regulation, is not a randomized trial. The treatment, albeit based on a fixed bank size threshold, inevitably raises the concern of non-comparability between stressed and non-stressed banks. This produces a selection bias on the estimated effect of supervision. To mitigate concerns about selection bias, we rely on micro-level loan data from the syndicated loan market. Syndicated loans serve as a laboratory to identify the effect of strict supervision because, in a given loan syndicate, we observe several banks lending to the same firm at the same time. We take advantage of this data structure and implement an identification strategy similar to Jiménez, Ongena, Peydró, and Saurina (2012) and Jiménez, Ongena, Peydró, and Saurina (2014). Accordingly, we include bank∗time and firm∗time fixed effects, which fully absorb bank-specific variations in credit supply and firm-specific variations in credit demand that could affect bank risk-taking in each period. Section 3 describes our data sources and our empirical specifications to deal with both omitted variable bias and selection bias.

Our results show that supervision is effective in mitigating bank risk-taking. We estimate that the direct effect of the supervision initiatives in the Dodd–Frank Act improves the average borrower's credit rating by roughly 0.7 rating classes. Backing out the effective capital requirement each bank faces is key to avoid neglecting the "backdoor capital structure channel" shown in Figure 1 and introducing a severe omitted variable bias. This backdoor capital structure channel counteracts the direct effect of supervision. Stressed banks take on more risk than non-stressed banks when they operate at high effective capital requirements after the Dodd–Frank Act. The overall effect of the Dodd–Frank Act on bank risk-taking is an improvement of the average borrower rating of 0.3 rating classes in correspondence to the minimum regulatory capital requirement of 3%, and null in correspondence to the median effective capital requirement in our sample. Section 4 presents our main results, while Section 5 reports additional analyses and an extensive series of robustness checks.

To interpret our results, we formalize the following intuition using a stylized model described in the Appendix. When external equity is scarce, banks must generate internal equity to invest in risky assets and comply

[1]As Eisenbach, Lucca, and Townsend (2016) highlight, supervision and regulation of banks are intertwined, but distinct, despite the two terms often being used interchangeably in the academic debate.

with their risk-sensitive capital requirements. Empirically, after the Dodd–Frank Act, supervision drives stressed banks to build up equity by retaining a larger portion of their profits (e.g., due to restrictions on dividend payouts). In addition, the Dodd–Frank Act is accompanied by a profitability drop for all banks, which affects the riskier portfolios of non-stressed banks in particular. Overall, stressed banks generate more internal equity than the control group of non-stressed banks to cover the capital charges imposed by capital regulation and to support their risky investments. Accordingly, the risk-taking of stressed banks after the Dodd–Frank Act is relatively more responsive to capital requirements.

Section 4 includes an analysis of bank risk-taking in the secondary loan market based on mark-to-market pricing data from the Loan Syndications and Trading Association (LSTA). Secondary market data play an important role in our analysis because banks often resell their syndicated loan shares on the secondary market, and they do not retain part of the risk of these syndicated loans on their balance sheet (see, for example, Dahiya, Puri, and Saunders (2003); Dahiya, Saunders, and Srinivasan (2003); Drucker and Puri (2009); Saunders and Steffen (2011); and Gande and Saunders (2012)). Our findings suggest that stressed banks also respond to supervision in their secondary market activity by reselling loans to riskier borrowers faster and by reducing their participation in illiquid loan shares.

Crucially, ignoring the confounding effect of capital requirements can be misleading when assessing the effectiveness of supervision. Our findings show that the Dodd–Frank Act does not significantly encourage prudent lending despite supervision being effective. The confounding effect of capital requirements suppresses the direct effect of supervision on asset risk-taking, but higher capital requirements are not associated with riskier banks. Rather, stressed banks must preserve additional internal equity to support risky lending in compliance with stricter risk-sensitive capital requirements than in the pre-Crisis period. Overall, stressed banks are beneficial for financial stability because supervision mitigates their risk-taking compared to the pre-Crisis period, but these banks are better capitalized. As a consequence, regulatory proposals calling for lax supervision, such as the Financial CHOICE Act, potentially threaten financial stability.

This paper offers contributions to three strands of the literature. First, because we focus on large and systemically important institutions, this work relates to the extensive literature on the effects of financial stability policies. A non-exhaustive list includes papers that focus on the bank lending and risk-taking channels of monetary policy (Maddaloni and Peydró (2011); Jiménez, Ongena, Peydró, and Saurina (2012); Jiménez, Ongena, Peydró, and Saurina (2014); Heider, Saidi, and Schepens (2019)), macroprudential policies (Jiménez, Ongena, Peydró, and Saurina (2017); Acharya, Bergant, Crosignani, Eisert, and McCann (2020)), and supervisory practices (Peek, Rosengren, and Tootell (1999); Delis and Staikouras (2011); Agarwal, Lucca, Seru, and Trebbi (2014); Goldsmith-Pinkham, Hirtle, and Lucca (2016); Granja and Leuz (2017); Colliard (2019); Bonfim, Cerqueiro, Degryse, and Ongena (2020); Kandrac and Schlusche (forthcoming); Hirtle, Kovner, and Plosser (forthcoming)). Compared to previous studies, this paper shows that the effectiveness of policies designed to promote financial stability is heterogeneous with respect to the capital requirements that banks face. Government guarantees, such as deposit insurance or "too-big-to-fail" subsidies, create a moral hazard problem for banks, which have incentives to take risks they do not internalize and thus boost their expected profits. This creates a rationale for capital regulation, which goes hand in hand with other financial stability policies. Banks react to capital requirements (Behn, Haselmann, and Vig (2016); Behn, Haselmann, and Wachtel (2016); Gropp, Mosk, Ongena, and Wix (2019); Martynova, Ratnovski, and Vlahu (2019); Bahaj and Malherbe (2020)). Thus, backing out the effective capital requirements banks face is crucial to assess other financial stability policies. Unlike previous studies on supervision, our empirical strategy does not rely on confidential regulatory data to isolate its effect. Although we focus on supervision in the Dodd–Frank Act, our strategy can be applied to the evaluation of financial stability policies whenever the latter are accompanied by changes in capital regulation.

Second, our analysis relies on an identification strategy based on the inclusion of firm∗time and bank∗time fixed effects to absorb unobserved heterogeneity in loan demand and supply. This empirical strategy has been pioneered in the cross-sectional study by Khwaja and Mian (2008) and extended to dynamic panel data by Jiménez, Ongena, Peydró, and Saurina (2012); Jiménez, Ongena, Peydró, and Saurina (2014); Jiménez, Ongena, Peydró, and Saurina (2017); Paligorova and Santos (2018); De Jonghe, Dewachter, Mulier, Ongena, and Schepens (2020); and Altavilla, Boucinha, Peydró, and Smets (2020). As in these studies, we rely on bank–firm matched data in which firms borrow from multiple banks. Most of these studies rely on credit registries or confidential data. Instead, we use the syndicated loan market as a laboratory for studying banks' response to supervision and capital regulation and assessing how a major regulatory innovation (i.e., the Dodd–Frank Act) affects banks' risk-taking.

Third, our main analyses are based on syndicated loan data in line with several studies in the banking literature, including: Ivashina and Scharfstein (2010); Bharath, Dahiya, Saunders, and Srinivasan (2011); Chodorow-Reich (2014); Berg, Saunders, and Steffen (2016); Berg, Saunders, Steffen, and Streitz (2017); Schwert (2017); Acharya, Berger, and Roman (2018); Acharya, Eisert, Eufinger, and Hirsch (2018); Giannetti and Saidi (2019); Grosse-Rueschkamp, Steffen, and Streitz (2019); Heider, Saidi, and Schepens (2019); and Gustafson, Ivanov, and Meisenzahl (forthcoming). We deviate from these papers in that we do not restrict our attention to the lead arranger of a syndicated loan; rather, we retain all participating banks in the syndicate. To do so, we hand-collect data on roughly 45,000 bank subsidiaries, then we create an extensive linking table in which lenders from DealScan are matched to bank identifiers. In our sample, loans from non-lead arrangers represent approximatively 76% of the syndicated loan market. The linking table we provide could enable a novel set of studies in which the syndicated loan data of all participating banks are matched to their financial reports and effective capital requirements, as well as studies whose identification strategies rely on the inclusion of fixed effects.

2 Institutional Background and Testable Hypotheses

2.1 Institutional Background

2.1.1 Dodd–Frank Act and Stressed Banks

The Dodd–Frank Wall Street Reform and Consumer 29 Protection Act (Pub.L. 111–203, H.R. 4173), or the "Dodd–Frank Act" (DFA), was signed into law on July 21, 2010, as a response to the Financial Crisis of 2008.

The DFA requires enhanced prudential standards for bank holding companies "... with total consolidated assets of USD 50 billion or more and any nonbank financial firms that may be designated systemically important companies by the FSOC."[2] We refer to these as *stressed banks*.

The Act imposes restrictions on stressed banks in two main aspects: (i) it reinforces regulatory monitoring of bank activities to prevent bank failures ex ante, and (ii) it requires banks to contribute to an ordinary liquidation fund (the Ordinary Liquidation Authority) to deal with ex post bank failures.[3] It is likely that banks' risk-taking incentives are affected by the additional scrutiny on banks' actions brought by the new ex ante monitoring and ex post resolution provisions, which we broadly refer to as *supervision*.

The ex ante monitoring of stressed banks under DFA is invasive. The Act imposes annual stress tests conducted by the regulator in addition to stress tests conducted by the banks (DFA, Section 165(i)). These annual stress tests, called Dodd–Frank Act Stress Tests (DFASTs), are the quantitative component of a broader supervisory exercise called the Comprehensive Capital Analysis and Review (CCAR). This review demands that banks both submit their capital plans for regulatory review and also undergo a qualitative assessment of their risk management and capital planning processes. The Federal Reserve then assesses banks' ability to pursue such capital plans and to maintain post-stress equity capital ratios that meet or exceed the regulatory capital requirements in effect during each quarter of the planning horizon. If a bank does not meet the supervisory criteria (either quantitative or qualitative), the Federal Reserve can object to the bank's capital plans and forbid any capital distribution until the next CCAR.[4]

The ex post resolutions in the DFA are triggered when stressed banks are in danger of default. If triggered, the Orderly Liquidation Authority converts shareholders' and junior debtholders' claims into equity capital, thus implementing a de facto bail-in. Compared to the pre-Crisis period, market participants are more likely to internalize a reduction of implicit "too big to fail" government guarantees and impose market discipline on stressed banks.

In sum, stressed banks face (a) higher equity capital requirements from stress tests and (b) additional scrutiny from the Federal Reserve and market participants. We refer to the latter as the *direct effect of supervision*. This term describes how more intensive monitoring affects the investment and financing decisions of stressed banks. Importantly, higher capitalization does not systematically go hand in hand with the level of scrutiny of stressed banks. For example, stressed banks that failed the CCAR for qualitative reasons were better capitalized than 75% of stressed banks. These banks also maintained capital buffers in addition to their

[2] Financial Stability Oversight Council.

[3] See Bouwman, Hu, and Johnson (2018) for a review of the main DFA provisions applying to banks above the USD 50 billion of total assets threshold.

[4] In their capital plans, bank holding companies describe all capital issuances and distributions (e.g., issuance of capital instruments, dividend payments, share repurchases) they would undertake under a baseline scenario defined by the banks for the next nine quarters. Since 2013, the Federal Reserve can give an objection, a conditional non-objection, or a non-objection to a bank's capital plans. The decision of the Federal Reserve is publicly disclosed in the CCAR summary report. In the Appendix (Table A1), we report the number of banks failing stress tests, i.e., the banks that received an objection or a conditional non-objection to their capital plans. Source: https://www.federalreserve.gov/bankinforeg/stress-tests/CCAR/201503-comprehensive-capital-analysis-review-capital-plan-assessment-framework-and-factors.htm, visited on 17/07/2020.

effective capital requirements that were larger than 50% of stressed banks. Thus, supervisory attention does not appear to be concentrated among less capitalized banks.[5]

2.1.2 Effective Capital Requirements

The simplest equity capital requirement of a bank at a given point in time imposes a limit on its leverage. This requirement determines the minimum equity capital (*Equity*) a bank must hold as a percentage of its total assets (*Assets*):

$$Equity \geq k * Assets, \quad k \in [0,1],$$

where k is a regulatory threshold. However, the capital requirement that a bank effectively faces may deviate from a simple leverage constraint for two reasons.

First, the regulator imposes minimum capital ratios as a fraction of *risk-weighted assets*, which are computed by multiplying individual asset holdings by measures of their assessed risk (i.e., regulatory *risk weights*).

$$Equity \geq k' * \sum_a \rho_a * w_a * Assets, \quad k', \rho_a, w_a \in [0,1],$$

where $k' > k$ is a regulatory threshold,[6] ρ_a is the regulatory risk weight assigned to asset a, and w_a is the fraction of the bank's total assets invested in asset a. For example, if the risk weight of Treasury securities is lower than the risk weight of risky loans ($\rho_{treasury} < \rho_{loan}$), a bank with large holdings of Treasury securities is required to hold less equity capital than a bank holding primarily risky loans. In the presence of regulatory requirements on both unweighted and risk-weighted capital ratios, the bank is *effectively* required to hold

$$Equity \geq \max\left(k * Assets, k' * \sum_a \rho_a w_a * Assets\right),$$

and the *effective* capital requirement as a percentage of the bank's total assets is

$$\frac{Equity}{Assets} \geq \max\left(k, k' \sum_a \rho_a w_a\right). \tag{1}$$

As a result, the effective capital requirement of a bank is a function of two prudential thresholds (k and k'), regulatory risk weights (ρ_a), and the bank's own portfolio weights (w_a). Importantly, the effective capital requirement is bank-specific and depends on the average risk weight of the bank ($\sum_a \rho_a w_a$), which is a function of its past investment decisions (w_a).

Second, for stressed banks subject to the CCAR, stress tests impose higher capital requirements because banks must hold an additional capital buffer to withstand the hypothetical losses they would suffer in a

[5]Some studies have focused on the effect of stress tests on bank lending outcomes (e.g., Acharya, Berger, and Roman (2018), Doerr (2019), Cortés, Demyanyk, Li, Loutskina, and Strahan (2020)).

[6]Because risk weights ρ_a do not exceed 1, $k' > k$ to avoid continually slack capital constraints on risk-weighted assets.

stress scenario. The projected losses under the stress scenario contain a "surprise component" because they are estimated by the Federal Reserve using a methodology unknown to the bank. The effective capital requirement of any bank can be expressed as

$$\frac{Equity}{Assets} \geq Cap\,req, \tag{2}$$

where $Cap\,req$ =max $(k * \sum_a s_a w_a, k' * \sum_a s'_a \rho_a w_a)$, with $s_a, s'_a = 1$ if banks are not subject to stress tests, and $s_a, s'_a \geq 1$ otherwise. The variable $Cap\,req$ considers all minimum capital ratio requirements that the bank faces, including capital ratios based on risk-weighted assets. For banks subject to stress tests, s_a and s'_a can be strictly larger than 1, and they increase in proportion to the depletion of unweighted (s_a) and risk-weighted (s'_a) capital ratios by the losses on asset a projected under the adverse stress scenario.[7] Therefore, the effective capital requirements of stressed banks increase not only because of their average regulatory risk weights, but also because of the effect of stress tests.

Overall, the effective capital requirement of a bank reflects variations in bank asset risk, and it captures how much equity capital (as a percentage of bank total assets) is absorbed by all the regulatory requirements a bank is subject to (including stress tests). In the Appendix (Section B), we detail how we measure effective capital requirements from publicly available data.

Figure 2 shows the average effective capital requirements of the largest banks in the U.S. (with end-2010 total consolidated assets above USD 10 billion) from 2001 until mid-2016. The solid line shows the average effective capital requirement (Eq. (2)), while the dashed line shows the average capital requirement without the effect of stress tests (i.e., $s_a = s'_a = 1, \forall a$, as in Eq. (1)). The average capital requirement of all banks increases from 4.5% before the DFA to a maximum of 6.5% in 2015. The figure also shows that the average capital requirements in 2015 and 2016 would be roughly 2 percentage points (pp) lower if stressed banks were not required to use more equity to absorb potential losses under the stress scenario in the CCAR.[8]

2.2 Testable Hypotheses

Notably, the DFA introduced higher capital requirements and stricter supervision simultaneously for the same group of banks. Depending on the direction in which capital requirements and supervision influence bank risk-taking, *their effects might confound each other.* There is consensus in the theoretical literature that deviations from the Modigliani–Miller paradigm result in a dependence of bank investment decisions on bank capital structure. As a consequence, capital requirements are an important driver of investment and risk-taking decisions.[9]

[7] Regulatory capital ratios are typically defined as a measure of regulatory capital (e.g., Tier 1 capital) divided by a measure of assets (i.e., total assets or risk-weighted assets). See the Appendix, Section B, for exact definitions of these ratios.

[8] Table A2 in Section B of the Appendix shows the effect of the stress test on the capital requirement of stressed banks only. On the subsample of banks subject to stress tests, the average capital requirement reached a maximum of 7.8% in 2015.

[9] Despite the consensus on capital requirements affecting bank portfolio allocations, different theories disagree about their effect on bank investment behavior. Several studies show that tighter capital requirements increase banks' cost of funding and possibly lead to an increase in risk-taking, including Koehn and Santomero (1980), Kim and Santomero (1988), Rochet (1992),

As Figure 2 shows, the introduction of stress tests by the DFA strongly affects the capital requirements of stressed banks that might alter their risk-taking responses to capital constraints. As Figure 1 illustrates, stress tests act as the "backdoor capital structure channel" of the DFA, and this might confound the direct effect of supervision on risk-taking. If capital requirements mediate the relationship between supervision and risk-taking, then omitting the effect of this capital structure channel can result in severe bias and may mute or amplify the effect of supervision on risk-taking. This yields two key testable hypotheses, which respectively pertain to the direct effect of supervision and to the overall effect of the DFA (i.e., supervision and higher capital requirements) on bank risk-taking.

H1: Supervision is effective in reducing risk-taking.

The direction and the magnitude of the "backdoor capital structure channel" leads to the following three testable hypotheses:

H2A: High effective capital requirements dampen the effect of supervision on risk-taking.

H2B: High effective capital requirements amplify the effect of supervision on risk-taking.

H2C: Effective capital requirements do not change the effect of supervision on risk-taking.

From a theoretical perspective, the interpretation of banks' responses to high effective capital requirements is not directly comparable with most existing studies (e.g., Rochet (1992); Admati, DeMarzo, Hellwig, and Pfleiderer (2013)), which focus on changes in the regulatory threshold k. In the presence of risk-sensitive capital requirements, banks may respond not only to the *level* but also to the *composition* of their capital constraints. Eq. (2) highlights two sources of variation in capital requirements at the bank level, namely (i) the average risk weight of the bank ($\sum_a \rho_a w_a$), which is based on the bank's past investment decisions (w_a), and (ii) the effect of stress tests (s_a, s'_a), which translates into an upward "correction" to regulatory risk weights.

In Section C of the Appendix, we develop a model that, albeit stylized, offers a benchmark to evaluate how the two components of capital requirements affect bank risk-taking. In this model, banks invest by trading off risks and expected returns, and they are constrained by capital regulation. Capital requirements limit banks' capacity to invest in riskier assets and gain higher expected returns. First, the model formalizes the intuition that a large fraction of risky assets on a bank's balance sheet (and thus high risk weights) boosts the bank's profits in good times and dampens them in bad times. Thus, a larger fraction of risky legacy assets helps banks build up capital to be reinvested in new risky assets in periods of high realized profitability, and vice versa in periods of low realized profits.

H3: risk-taking increases with risk weights when bank profitability is high.

and more recently, the general equilibrium model of Gale (2010). Other studies, such as Cooper and Ross (2002) and Admati, DeMarzo, Hellwig, and Pfleiderer (2013); instead argue that tighter capital requirements provide shareholders with a larger equity stake in a bank (i.e., "skin in the game"), and reduce their incentives to engage in risky lending. Finally, two recent studies, Harris, Opp, and Opp (2020) and Bahaj and Malherbe (2020); predict a hump-shaped relationship between the amount and the riskiness of lending and capital requirements.

Second, in line with Cooper and Ross (2002) and Admati, DeMarzo, Hellwig, and Pfleiderer (2013); our model predicts that the corrections to regulatory risk weights associated with stress tests (s_a, s'_a) have a prudential effect. As in Cooper and Ross (2002) and Admati, DeMarzo, Hellwig, and Pfleiderer (2013); higher risk weights increase the equity stake that bank insiders must retain in order to fund asset a, and that they can lose in case of default (i.e., their "skin in the game"). Banks optimally respond to these higher risk weights by engaging in more prudent lending.

H4: Stressed banks reduce risk-taking as a result of the upward correction of their capital requirements in stress tests.

3 Empirical Strategy and Data

3.1 Empirical Strategy

Our empirical strategy addresses two key challenges to narrow the scope of alternative interpretations of our findings. First, an *omitted variable bias* may result in confounding the effect of supervision with the effect of capital requirements on bank risk-taking. The only available control group of banks (i.e., the non-stressed banks) are neither subject to higher capital requirements from stress tests nor subject to the strictest form of supervision under the DFA. Thus, a textbook difference-in-differences analysis may lead to misguided conclusions about the effectiveness of supervision and the DFA for some banks. Second, the assignment to the treatment group is based on bank size and is therefore not random. This produces a *selection bias* on the estimated effect of supervision. We detail how we address these two challenges below.

3.1.1 Omitted Variable Bias: The Direct Effect of Supervision

As Figure 1 suggests, taking the capital structure channel to the data is key to identify the direct effect of supervision on bank risk-taking. The following bank-level specification, in which banks face different capital constraints, tests the differential effect of the DFA on the risk-taking behavior of stressed versus non-stressed banks:

$$\begin{aligned} risk\,taking_{bt} \quad = \quad & \alpha_b + \delta_t + \beta_1 stressed_b * DFA_t + \beta_2 stressed_b * DFA_t * Cap\,req_{bt} \\ & + \beta_3 Cap\,req_{bt} + \beta_4 stressed_b * Cap\,req_{bt} + \beta_5 DFA_t * Cap\,req_{bt} + \epsilon_{bt}, \end{aligned} \tag{3}$$

where $risk\,taking_{bt}$ is a measure of risk-taking for bank b in quarter t, α_b are bank fixed effects, δ_t are time (quarter) fixed effects, $stressed_b$ is a binary variable equal to 1 if bank b belongs to the group of stressed banks as defined in Section 3.2.2, DFA_t is a binary variable equal to 1 if quarter t is after the fourth quarter of 2010, and $Cap\,req_{bt}$ is the effective capital requirement of bank b in quarter t as described in Section 2.1.2 and in Section B of the Appendix.

Observe that all the variables on the right-hand side of Eq. (3) are denoted by the subscript t, but they are determined before the realization of the dependent variable. In particular, the effective capital requirement

($Cap\,req_{bt}$) of a bank varies over time for two reasons. First, requirements are updated each quarter based on information provided by the bank at the end of the *previous* quarter, and we use these data to derive the bank's average regulatory risk weight. Second, for stressed banks, we take advantage of the regulatory stress test timeline. We measure $risk\,taking_{bt}$ only *after* stressed banks are informed of their new capital requirement based on the regulatory stress test. Section B of the Appendix provides a detailed description of the procedure we use to derive $Cap\,req_{bt}$.

The specification (3) estimates four sensitivities of bank risk-taking to capital requirements for stressed banks before versus after the DFA (i.e., $\beta_3 + \beta_4$ versus $\beta_2 + \beta_3 + \beta_4 + \beta_5$), and for non-stressed banks before versus after the DFA (i.e., β_3 versus $\beta_3 + \beta_5$). There are economic reasons for allowing the marginal effects of capital requirements on risk-taking to differ across the two groups of banks in the two sub-periods. As discussed in Section 2.1.2, the DFA had a different effect on stressed versus non-stressed banks in terms of altering the relationship between absorbed regulatory capital and risk-taking. Before the DFA, the Basel I capital requirement regime only imposed regulatory risk weights for broad asset classes. After the DFA, general risk-based capital rules applicable in the U.S. still relied primarily on Basel I risk weights until the adoption of Basel III standards in 2014. After the adoption of Basel III, the largest stressed banks were required to use the advanced approach based on internal ratings, while non-stressed banks used the risk weights of the standard approach. The relationship between risk-taking and capital requirements is likely altered by banks relying on their own models to derive regulatory risk weights (the advanced approach) rather than relying on predetermined risk weights (the standard approach). In addition, as highlighted in Appendix B, stress tests largely affected the capital requirement regime imposed on stressed banks. Finally, non-stressed banks, as the descriptive statistics in Section 3.2.2 show, operated at significantly higher capitalization levels than stressed banks before the DFA. This potentially altered the relative sensitivity to capital requirements of the two groups of banks when making portfolio choices.

After accounting for differences in capital requirement responses across banks and time, the remaining differential response of stressed versus control banks to the DFA (β_1) plausibly captures the direct effect of supervision that Figure 1 illustrates. Unlike the overall effect of the DFA, which depends on capital requirements, the direct effect of supervision reflects only the initiatives in the DFA that target stressed banks but do not directly affect the effective capital requirements.

We notice that the specification (3) does not require supervision to be uncorrelated with capital requirements. Instead, it requires that differences in regulatory supervision between stressed and non-stressed banks are not *perfectly* correlated with the quantity of bank capital absorbed by regulatory requirements. Although supervision and capital requirements are intertwined in practice, they generally do not go hand in hand. For example, as mentioned in Section 2.1.1, banks often fail the CCAR regardless of their capital requirements or capitalization levels. Since 2014, the Federal Reserve has objected 10 times to stressed banks' capital plans as a result of the CCAR. All objections were due to qualitative reasons, while, in all cases, objected banks had capital ratios above their capital requirements in the stress test.

Formally, the omitted variable bias on β_1 that results from omitting the capital structure channel in Eq. (3) is

$$\beta_2 \frac{\text{Cov}(stressed_b * DFA_t, stressed_b * DFA_t * Cap\,req_{bt})}{\text{Var}(stressed_b * DFA_t)} + \beta_3 \frac{\text{Cov}(stressed_b * DFA_t, Cap\,req_{bt})}{\text{Var}(stressed_b * DFA_t)}$$

$$+\beta_4 \frac{\text{Cov}(stressed_b * DFA_t, stressed_b * Cap\,req_{bt})}{\text{Var}(stressed_b * DFA_t)} + \beta_5 \frac{\text{Cov}(stressed_b * DFA_t, DFA_t * Cap\,req_{bt})}{\text{Var}(stressed_b * DFA_t)}.$$

This omitted variable bias disappears if the supervision treatment ($stressed_b * DFA_t$) is uncorrelated with $Cap\,req_{bt}$, in which case a textbook difference-in-differences analysis around the DFA would provide a consistent estimate of the direct effect of supervision, β_1. However, the positive correlation between supervision and capital requirements in the current implementation of the DFA induces a bias. Its sign is determined by $\beta_2, \beta_3, \beta_4$, and β_5, which in turn depend on the direction and the magnitude of the risk-taking response to capital requirements of the two groups of stressed and non-stressed banks, before and after the DFA.

3.1.2 Selection Bias: The Counterfactual

We do not adopt the bank-level specification (3) as our main specification. Specification (3) accounts for omitted variable bias after measuring the effective capital requirements imposed on banks, but this specification is susceptible to a selection bias driven by bank size. Because the DFA targets banks with more than USD 50 billion in assets, banks are not randomly assigned to the treatment group. Selecting smaller banks as a control group inevitably raises the concern of non-comparability between the two groups. In particular, heterogeneity in credit demand and supply are likely important drivers of bank risk-taking. For example, the control groups might include regional banks that target specific areas and are exposed to regional credit demand shocks. On the supply side, instead, smaller banks are less active on the syndicated loan market, as we describe in Section 3.2.3.

To mitigate this selection bias, we design an empirical strategy that takes advantage of available data to construct a plausible counterfactual, which describes the level of risk that stressed banks would have assumed in the absence of supervision. We take three main steps towards this goal.

First and foremost, we use micro-level loan data on the syndicated loan market. As Sufi (2007) documents, syndicated loans are a critical part of lending to U.S. corporations, and they comprise up to 50% of all corporate financing. Syndicated loans serve as a laboratory to identify the effect of supervision because, in a given loan syndicate, we observe several banks (some are stressed and some are not) lending to the same firm at the same time, both before and after the DFA. With this data structure, we combine a difference-in-differences setup using the identification strategy described in the seminal paper by Khwaja and Mian (2008), and subsequently applied to dynamic panel data by Jiménez, Ongena, Peydró, and Saurina (2012) and Jiménez, Ongena, Peydró, and Saurina (2014).[10] Thus, we consider the following saturated regression

[10] An alternative identification strategy could rely on a regression discontinuity design (RDD) around the bank size threshold. However, a challenge of implementing RDD is the limited number of bank holding companies in our sample.

with both bank∗quarter (α_{bt}) and firm∗quarter (α_{ft}) fixed effects:

$$\begin{aligned}\log(amount_{fbt}) \quad = \quad & \alpha_{bt} + \alpha_{ft} + \beta_1 stressed_b * DFA_t * Firm\,risk_{ft} \\ & +\beta_2 stressed_b * DFA_t * Cap\,req_{bt} * Firm\,risk_{ft} \\ & +\beta_3 Cap\,req_{bt} * Firm\,risk_{ft} \\ & +\beta_4 stressed_b * Cap\,req_{bt} * Firm\,risk_{ft} \\ & +\beta_5 DFA_t * Cap\,req_{bt} * Firm\,risk_{ft} \\ & +\beta_6 stressed_b * Firm\,risk_{ft} + \gamma' controls_{fbt} + \epsilon_{fbt},\end{aligned} \tag{4}$$

where the dependent variable $\log(amount_{fbt})$ is the logarithm of the USD amount bank b lends to firm f in a syndicated loan issued at date t, $Firm\,risk_{ft}$ is a measure of the riskiness of borrower f at date t, and $controls_{fbt}$ are contemporaneous loan-level control variables and lagged bank-level control variables ($controls_{bt}$) interacted with firm risk. Section D of the Appendix specifies how all variables are measured.

The inclusion of firm∗time and bank∗time fixed effects absorbs the heterogeneity in loan demand (firm∗time) and loan supply (bank∗time) that could explain the various risk-taking outcomes between stressed and non-stressed banks. After saturating the regression with fixed effects, the remaining variation in loan amounts comes from the bank∗firm dimension in a given quarter. Firms generally do not actively choose the banks that participate in the syndicate, aside from the lead arranger; therefore, the bank–firm matching reflects a bank's decision to lend to a firm.[11] In addition, bank size might also influence a bank's decisions to bid for a certain syndicated loan. Therefore, we interact bank-level variables with firm risk in $controls_{fbt}$ to control for bank characteristics (including bank size) in the bank–firm matching process.

The outcome of interest of our analysis, namely risk-taking, is the partial derivative with respect to $Firm\,risk_{ft}$ of the conditional expectation function $\mathbb{E}_t[\log(amount_{fbt})]$ (defined as $\log(amount_{fbt}) = \mathbb{E}_t[\log(amount_{fbt})] + \epsilon_{fbt}$):

$$\begin{aligned}\frac{\partial \mathbb{E}_t[\log(amount_{fbt})]}{\partial Firm\,risk_{ft}} \quad = \quad & \beta_1 stressed_b * DFA_t + \beta_2 stressed_b * DFA_t * Cap\,req_{bt} + \beta_3 Cap\,req_{bt} \\ & +\beta_4 stressed_b * Cap\,req_{bt} + \beta_5 DFA_t * Cap\,req_{bt} + \beta_6 stressed_b + \gamma' controls_{bt}.\end{aligned} \tag{5}$$

Second, we choose a control group of banks—the *non-stressed banks*—that are the most comparable to the stressed banks. This control group includes public U.S. bank holding companies that have consolidated assets between USD 10 billion and USD 50 billion and have never been subject to a regulatory stress test. Non-stressed banks are the second largest bank holding companies that are active in the syndicated loan market.

Third, although our strategy attempts to restore the comparability of the treatment and control groups by including a strict set of controls, we consider additional analyses to ensure our results are not driven by the residual lack of comparability between these two groups of banks. In Section 5.1, we apply a saturation

[11] As in Jiménez, Ongena, Peydró, and Saurina (2014); bank∗time fixed effects control for the level of supply for each bank in each quarter, and this makes the size of the syndicated loan portfolios comparable. Thus, by including α_{bt}, we effectively compare the bank portfolio shares allocated to different firms.

strategy to assess the severity of selection bias on unobservables (Altonji, Elder, and Taber (2005) and Oster (2017)); and we replicate our difference-in-difference analysis on alternative samples of treated and control banks, including a specification only within stressed banks.

3.2 Data

3.2.1 Data Sources

We use five different data sources in our analysis. Two key data sources for our identification strategy are Refinitiv LPC DealScan, which contains information on syndicated loans,[12] and the mark-to-market pricing database of Refinitiv LPC / LSTA (Loan Syndications and Trading Association), which tracks loans sold in the secondary market and reports daily quotations from dealers and traders. Secondary market data play an important role in our analysis. As several studies document,[13] banks often resell their syndicated loan shares on the secondary market. By selling loans before the end of the quarter of origination, banks may not retain part of the risk of the syndicated loans on their balance sheet.

To take the capital structure channel to the data and compute the effective capital requirements as described in Section 2.1.2 and Section B of the Appendix, we manually collect data from publicly available CCAR summary reports and complement them with quarterly regulatory accounting data on bank holding companies from the SNL dataset (originally collected from FR-Y9C reports). SNL also contains additional bank-level variables that we use in several analyses. Finally, we obtain information regarding borrowers from the Compustat Files. Accounting information comes from the Quarterly Industrial Files, and borrower ratings are collected from the Rating Files. We restrict our sample period to 2001–2016. After 2016, the supervision of stressed banks weakens with the exemption of banks from the qualitative component of the CCAR.

The following three sections provide summary statistics and additional details on our samples of banks, syndicated loans, and secondary market loans.

[12] Carey and Hrycray (1999), estimate that the share of corporate loans covered by DealScan in the U.S. is between 50% and 75% of the value of all commercial loans during the early 1990s, although biased towards larger loans (Ippolito, Almeida, Orive, and Acharya (2019)). Chava and Roberts (2008) suggest that this fraction has been increasing in recent years. Section **??** inspects the external validity of our results outside the syndicated loan market.

[13] See, for example, Dahiya, Puri, and Saunders (2003); Dahiya, Saunders, and Srinivasan (2003); Drucker and Puri (2009); Saunders and Steffen (2011); and Gande and Saunders (2012). One motive for bank loan sales invoked in the theoretical literature (see, e.g., Pennacchi (1988)) is the possibility to reduce the effective capital requirement by selling loans associated with high regulatory risk weights.

3.2.2 Stressed and Non-stressed Banks

Our sample includes (a) the *stressed banks*, a treatment group of 18 bank holding companies that have participated in the CCAR from 2011 (the first CCAR) to 2016 and (b) the *non-stressed banks*, a control group of 21 bank holding companies (selected as described in Section 3.1.2). In Appendix A, we present a list of the stressed banks and non-stressed banks in our sample.

Panel A of Table 1 reports descriptive statistics on the capitalization, profitability, and payout policies of the stressed and non-stressed banks, before the 2008 Financial Crisis and after the DFA (i.e., after 2010). The effective capital requirements increased more for the group of stressed banks after the DFA as a result of stress tests, as the patterns in Figure 2 highlight. Notably, non-stressed banks had higher capitalization levels than stressed banks before 2008. Their average Tier 1 leverage ratio was 10.7%, compared to 7.2% for stressed banks. This pronounced difference in capitalization occurs despite the higher credit risk of stressed banks, as measured by the average risk weight (77.8% for stressed banks and 69.3% for non-stressed banks). After the DFA, the capitalization of both groups of banks increases, and their gap substantially narrows (the average Tier 1 leverage ratio is 9.1% for stressed banks and 10.8% for non-stressed banks).

Before 2008, non-stressed banks accumulated capital by retaining a larger fraction of their net income (69.1%) compared to stressed banks (34.7%). In addition, non-stressed banks were, on average, more profitable than stressed banks before 2008. The ratio of their net income to their total assets was 0.48% (versus 0.34% for stressed banks), the ratio of their net income to their total assets was 0.85% (versus 0.72% for stressed banks), and their ratio of loan interest income to total loans was 1.7% (versus 1.5% for stressed banks). After the DFA, the difference in reinvested profits between the two groups of banks vanishes. Stressed banks retain a larger portion of their net income (71.2%, compared to 65.8% for non-stressed banks), and non-stressed banks remain more profitable than stressed banks.

In sum, before 2008, stressed banks were less capitalized, they held portfolios with higher risk weights, they were less profitable, and they retained less profits than non-stressed banks. After the DFA, stressed banks are required to hold larger capital buffers than non-stressed banks, while the risk weights are similar between the two groups of banks. Also, after the DFA, stressed banks pay out a substantially smaller fraction of their income as dividends. All banks have become less profitable, with a more pronounced decline for non-stressed banks.

3.2.3 Syndicated Loan Market

Sample. Unlike most existing studies, we do not restrict our analysis to the lead arranger in syndicated loans for three reasons. First, our identification strategy hinges precisely on observing multiple banks lending to the same firm in a given loan syndicate. Second, from an economic perspective, a bank can engage in risky lending not only by originating a syndicated loan as the lead arranger but also by participating in it. Third, the risk exposure of non-lead arrangers in syndicated loans is significant. By retaining all participants in our analysis, we retain an average of 76% of the syndicated loan market.

Retaining all participating banks in the syndicated loan market requires a considerable data collection effort. First, we construct an exhaustive list of the bank holding companies' subsidiaries (controlled either directly or indirectly) using organization hierarchy data from the National Information Center (NIC).[14] We obtain a total of 44,578 unique lending companies in our sample period, from December 2000 to September 2016. Second, we create a linking table in which DealScan lenders (19,291 unique lending companies in our sample period) are manually matched to NIC lenders on name, time, and location. We exclude all deals whose status is not completed or that are syndicated outside the United States, for a total of 186,802 lender–borrower relationships, 65,103 syndicated loans, and a total amount of USD 33 trillion lent in all facilities over our sample period.

Third, we link syndicated loans to borrowers' information, including their most recent S&P long-term credit rating available from Compustat Ratings. The resulting subsample consists of 97,024 lender–borrower relationships, in which both the borrower's accounting information and rating information are available in the Chava and Roberts (2008) DealScan–Compustat linking file. As is well known, for around 75% of these lender–borrower relationships, DealScan does not report the amount each bank in a given syndicate has committed to each facility ($bankallocation_{bft}$). Nevertheless, because $bankallocation_{bft}$ is essential to measure banks' exposures in a given quarter, our main analysis of bank risk taking relies on the restricted sample for which this field is not missing. This restricted sample consists of 43,989 lender–borrower relationships. Further linking of this sample to Compustat results in 33,789 lender–borrower relationships.[15]

Summary Statistics. Panel B of Table 1 reports descriptive statistics on the portfolios of new syndicated loan exposures. Summary statistics are reported separately for stressed and non-stressed banks, before 2008 and after the DFA.

The top two rows of Table 1 report the average all-in-drawn spread (i.e., the average yield) from DealScan and the average rating from Compustat. The all-in-drawn spread measures ex ante how many basis points above the LIBOR rate (plus any annual, or facility-related, fee paid to the bank group) the borrower agrees to pay to the lenders for each borrowed dollar at loan origination. The reported average yield refers to the portfolio of new syndicated loans ("facilities" in DealScan) that bank b participates in a given quarter t, weighted by the bank's dollar loan amounts allocated to each borrower in that quarter. The average rating is derived using the same weights, where individual ratings are converted into numerical values (e.g., AAA=1, D=23).[16] Table 1 also shows that the pre-2008 portfolios of stressed banks have lower promised yields (97 bps and 147 bps, respectively) and better ratings (8.4 and 9.6, respectively) compared to non-stressed banks.

[14]Available at www.ffiec.gov/nicpubweb/nicweb/nichome.aspx (visited on November 2, 2107).

[15]Such sample selection contributes to an increase in the average amount with each syndicated loan. It also contributes to decreases in the average promised yield and the average maturity of loans kept in our sample. Additional filters exclude observations for which the promised loan spread $allindrawn_{ft}$ is missing, the capital requirement is missing, the bank's total assets reported in SNL are missing, or loan facilities that start before 2001. This leaves 37,892 lender–borrower relationships. On the sample linked to Compustat, the same additional filters restrict the sample to 28,735 lender–borrower relationships. Additional filters applied in our analyses reported in Sections 4 and 5 relate to the availability of control variables, as well as the exclusion of singleton observations when fixed effects are applied.

[16]The average portfolio yield and average rating are formally defined in Section D of the Appendix.

The post-DFA patterns in yields and ratings are similar between stressed and non-stressed banks, with an increase in yields and a worsening of ratings compared to the pre-2008 period.

The third and fourth rows report the average maturity and the percentage of secured loans. Before 2008, stressed banks issued loans with shorter maturities than non-stressed banks (39 and 45 months, respectively) and engaged less in secured lending (30% and 48% of loans, respectively). After the DFA, the two groups of banks exhibit similar qualitative trends, namely an increase in average maturity and a reduction in secured lending.

The next three rows of Table 1 describe the syndicates stressed and non-stressed banks are part of, before 2008 and after the DFA. Not surprisingly, larger stressed banks are more active in the syndicated loan market than non-stressed banks, which participate in 15% of the loan facilities in our sample. The fraction of loans for which the bank is a lead arranger is higher for stressed banks (12%) than for non-stressed banks (10%), and decreases sharply for non-stressed banks after the DFA. Stressed banks also participate in larger syndicated loans, which have an average size larger than its counterpart for non-stressed banks (USD 40 million and USD 14 million, respectively, before 2008). After the DFA, both groups of banks participate in larger loan facilities (USD 72 million versus USD 19 million). The average bank allocation within a syndicate is 11% for stressed banks and 13% for non-stressed banks before 2008. After the DFA, syndicates become less concentrated, with average bank allocations around 8% and 6%, respectively, for the two groups of banks.

Overall, Table 1 shows no evidence of a differential trend in the riskiness of the newly issued syndicated loans of stressed and non-stressed banks over our sample period;[17] however, the treatment and control groups differ dramatically in their participation in the syndicated loan market. Stressed banks participate more (i.e., they originate and participate in more deals), and participate in larger loans. These differences reinforce the importance of accounting for selection bias to plausibly identify the effect of supervision on bank risk-taking.

3.2.4 Secondary Loan Market

The literature studying monitoring incentives hints at sharp differences within lending syndicates. Lead arrangers typically keep a larger stake over the life of the syndicated loan, and they engage less in secondary market trading to signal commitment to due diligence and monitoring (see Leland and Pyle (1977), Hölmstrom (1979), and Holmstrom and Tirole (1997)) or for "relationship reasons" (Gorton and Pennacchi (1995)). In addition, as Gatev and Strahan (2009) indicate, the liquidity risk considerations associated with loan funding are of first importance for non-lead arranger banks that participate in syndicated loans, while lead arrangers are concerned primarily about credit risk. Irani and Meisenzahl (2017) also find that loan sale decisions are determined by bank capital constraints and the role of the bank in the loan syndicate.

[17] We formally examine in Section 4.1.3 the presence of a differential trend in the portfolio yield of stressed and non-stressed banks after controlling for their effective capital requirements, which is relevant for our empirical strategy.

Sample. In Section 4.2, we investigate the interplay between the supervision treatment and the secondary market activity of lead arrangers and participating lenders. Linking the LPC/LSTA mark-to-market pricing data to the 33,789 lender–borrower relationships from the syndicated loan market reveals that 2,285 of them have loans quoted on the secondary market. In particular, 16 stressed banks and 13 non-stressed banks originated deals that received a quote for a sale on the secondary market.[18] Note that all 29 banks in the 2,285 relationships do not necessarily sell their loan shares. Indeed, it is not possible to identify the bank selling shares from the LPC/LSTA dataset. Instead, we know only that these banks are exposed to loans whose shares are sold on the secondary loan market and for which we have measures of liquidity risk. As we use the rating as a measure of the bank's exposure to credit risk, we use the average bid–ask spread of the shares of a loan sold on the secondary market as a measure of the bank's exposure to liquidity risk.

Summary Statistics. Panel C of Table 1 reports descriptive statistics on the secondary market data. The loans that received a quote for a sale on the secondary market have, on average, higher yields, worse ratings (i.e., higher values on the numerical scale), and longer maturities than the full sample, for both groups of banks before 2008 and after the DFA. Before 2008, loans remained roughly 241 days, on average, on the balance sheets of stressed banks before being quoted on the secondary market. Meanwhile, the loans of non-stressed banks remained for only 127 days on their balance sheets. After the DFA, loans are sold more rapidly on the secondary loan market, with an average of 158 days for the loans of stressed banks and of an average of 92 days for those of non-stressed banks. Finally, before 2008, the liquidity of loans on the secondary market was comparable for the two groups of banks. On average, the deals that stressed banks participated in have a bid–ask spread of 0.94 bps, while the spread was 1.01 bps for the deals of non-stressed banks. After the DFA, non-stressed banks participate in loan facilities that are more liquid when quoted on the secondary market, with a bid–ask spread of 0.66 bps (versus 0.85 bps for stressed banks).

Overall, deals quoted on the secondary market appears to be riskier because they have worse ratings and higher required yields. The liquidity of deals improved after the DFA. In particular, this improvement was significant for the deals that non-stressed banks participate in. This motivates the investigation of whether supervision also affects the liquidity risk that banks take and whether banks treat liquidity risk and credit risk as substitutes.

4 Results

Is the regulatory supervision of banks effective in reducing bank risk-taking? What is the overall effect of the DFA on risk-taking? Do capital requirements confound the direct effect of supervision on risk-taking? Section 4.1 presents the main results on the direct effect of supervision and its interaction with capital requirements to determine the overall effect of the DFA following the empirical strategy described in Section 3.1. Section 4.2 applies the same empirical strategy to risk-taking in the secondary market for syndicated

[18] After applying the additional filters in footnote 15, 1,895 lender–borrower relationships out of 37,892 have deals appearing the on secondary market, of which 1,598 relationships have a borrower rating available from Compustat.

loans. Do supervision and capital requirements affect risk-taking in the secondary market as well? Do differences in the level of participation in the secondary market between stressed and non-stressed banks offer an alternative interpretation of the results presented in Section 4.1? Finally, Section 4.3 investigates whether the composition of capital requirements, rather than their level, mediates the effect of supervision on risk-taking. For stressed banks after the DFA, we can decompose the variation in the effective capital requirement into the variation in the average regulatory risk weight of the bank and the variation in the bank's exposure to stress tests.

4.1 Supervision and Risk-Taking

In Section 4.1.1, we present a suggestive graphical illustration of the interplay between supervision and capital requirements based on estimates from the bank-level regression (Eq. (3)). We then present our baseline results from the loan-level specification (Eq. (4)) in Section 4.1.2. Finally, in Section 4.1.3, we inspect the validity of the identification assumption of the absence of differential trends in risk-taking between stressed and non-stressed banks before the DFA.

4.1.1 Suggestive Graphical Illustration

Panel A of Figure 3 refers to estimates of the bank-level regression (Eq. (3)) in which the dependent variable $risk\,taking_{bt}$ is the average rating of borrowers that receive new syndicated loans from bank b in quarter t. In Panel B, the risk-taking measure is the average promised portfolio yield on the portfolio of new syndicated loans that bank b issues in quarter t. Estimates from the two bank-level regressions are reported in Table A3.

In both panels of Figure 3, the dashed lines represent the difference between the average risk-taking measures $risk\,taking_{bt}$ for stressed and non-stressed banks. We then decompose the dashed lines into the difference between the responses to capital requirements of the two groups of banks (dotted lines) and the difference between their residual responses, which might be associated with the effect of supervision (solid lines).[19]

Both Panel A and Panel B highlight a distinct trend between the risk-taking response to capital requirements and the residual risk-taking response. The dotted lines are negative before the DFA, indicating that stressed banks were taking on less risk than non-stressed banks as a response to their effective capital requirements (negative β_4). After the DFA, the differential response to capital requirements dampens (positive β_2). The

[19] Formally, denoting as S and NS the number of stressed and non-stressed banks banks, respectively, that are active in the syndicated loan market. We compute the differential response to capital requirements as

$$\frac{1}{S}\sum_{stressed=1} Cap\,req_{bt}\left[\beta_3+\beta_4+(\beta_2+\beta_5)\,DFA_t\right]-\frac{1}{NS}\sum_{stressed=0} Cap\,req_{bt}\left[\beta_3+\beta_5 DFA_t\right]$$

and the differential residual response as

$$\frac{1}{S}\sum\nolimits_{stressed=1}\left\{risk\,taking_{bt}-Cap\,req_{bt}\left[\beta_3+\beta_4+(\beta_2+\beta_5)\,DFA_t\right]\right\} \\ -\frac{1}{NS}\sum\nolimits_{stressed=0}\left\{risk\,taking_{bt}-Cap\,req_{bt}\left[\beta_3+\beta_5 DFA_t\right]\right\}.$$

solid lines indicate that the residual risk-taking response to the DFA follows the reverse trend. Stressed banks were taking on more risk than non-stressed banks before the DFA, as the positive values for the solid lines indicate. After the DFA, the residual response changes sign in Panel A (i.e., stressed banks take on less risk than non-stressed banks after the DFA) and falls to roughly zero in Panel B (i.e., both groups of banks assume the same level of risk). The post-DFA trend in the residual differential risk-taking response is suggestive of a prudential effect of supervision on stressed banks, and it aligns with the negative estimate of β_1 reported in Table A3 the average rating (Panel A) and for the average yield (Panel B) of the portfolio of new loans.

The evidence shown in Figure 3 and Table A3 is at best suggestive because, as discussed in Section 3.1.2, it is susceptible to selection bias. However, Figure 3 qualitatively illustrates a potentially severe omitted variable bias, which might confound the effect of supervision with the effect of capital requirements on bank risk-taking. The dashed lines indicate that the overall risk-taking response to the DFA does not noticeably differ between stressed and non-stressed banks, which is in line with the summary statistics presented in Table 1.

4.1.2 Baseline Results

Table 2 reports difference-in-differences estimates from the loan-level specification (Eq. (4)) saturated with bank$*$quarter and firm$*$quarter fixed effects. The variable $Firm\,risk_{ft}$ is the borrower's numerical rating in the syndicated loan available from Compustat ($rating_{ft}$). In all specifications presented in this table, standard errors are clustered at both the bank*quarter and firm*quarter levels, which are the levels at which our main interaction terms $Capreq_{bt}$ and $Firm\,risk_{ft}$ vary.[20] Following the logic of Figure 1, we discuss estimates of the overall effect of DFA supervision, its direct effect, and its confounding effect through capital requirements.

Overall Effect of DFA on Stressed Banks. The two leftmost columns of Table 2 report estimates of a restricted difference-in-differences specification in which capital requirements are omitted from the analysis (i.e., $\beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$). The second column also includes contemporaneous loan-level controls and lagged bank-level controls interacted with the firm rating. In both columns, the point estimates of β_1 are negative but not statistically significant at the conventional levels. This implies that the risk-taking response of stressed banks to the DFA is not significantly different than the risk-taking response of non-stressed banks. Thus, our estimates confirm that the overall effect of the DFA on bank risk-taking is roughly zero, as the dashed line in Figure 3 suggests.

Direct Effect of DFA Supervision. The two rightmost columns of Table 2 tabulate the estimates of β_1, β_2, β_3, β_4, β_5, and β_6 from the unrestricted loan-level regression (Eq. (4)). The rightmost column refers to our baseline specification, which includes loan-level controls and bank-level controls interacted with firm

[20]The results are robust to clustering at the bank*quarter level only (as in Jiménez, Ongena, Peydró, and Saurina (2012)). Clustering at the bank*quarter level is a sensible alternative given that there is more variation in $Capreq_{bt}$ than in $Firm\,risk_{ft}$ (measured as the borrower's rating).

risk. The estimate of β_1 in the rightmost column is -0.69 and is statistically significant at the 1% level. After accounting for the confounding effect of capital requirements, a coefficient of -0.69 indicates that, relative to non-stressed banks, stressed banks lend roughly 70% more to firms in one better rating class. Thus, our estimates suggest that the direct effect of DFA supervision is to improve the average borrower rating by roughly 0.7 classes (i.e., Hypothesis H1 can be retained). Intuitively, the direct effect of supervision is reflected by the fall of the solid line in Figure 3.

Confounding Effect of Capital Requirements. A comparison of the estimates of β_1 in Columns 1 and 3 and between those in Columns 2 and 4 indicates the presence of a confounding effect that counteracts the direct effect of supervision β_1 and suppresses it (i.e., Hypothesis H2A can be retained, while Hypotheses H2B and H2C cannot be retained). In our baseline specification shown in the rightmost column, we infer a point estimate of the confounding effect of 0.64, which is the difference between the estimates of β_1 in Columns 2 and 4.

Our estimate of the confounding effect is driven by the estimated β_2, β_3, β_4, and β_5 in the loan-level regression (Eq. (4)). These four parameters determine the sensitivity of banks' risk-taking to their effective capital requirements, reported in the "Sensitivities" panel of Table 2. The coefficient β_3 describes the relationship between risk-taking and capital requirements for non-stressed banks before the DFA. The estimate of β_3 in Column 4 is positive and statistically significant at the 1% level. The point estimate of 0.124 indicates that an increase of 1 percentage point (pp) in the effective capital requirement of a non-stressed bank before the DFA lowers the average borrower's rating by 0.124 classes. Adding β_4 to β_3 yields the sensitivity of the risk taking of stressed banks to their capital requirements before the DFA. The estimate of β_4 in Column 4 is -0.116, which is statistically significant at the 1% level. Stressed banks were less sensitive to their capital requirements than non-stressed banks. A 1 pp increase in the effective capital requirement worsens their average borrower rating by 0.008 ($= 0.124 - 0.116$) classes.

After the DFA, all banks have become less sensitive to capital requirements in their risk-taking. For non-stressed banks after the DFA, their sensitivity to capital requirements is $\beta_3 + \beta_5$. Its variation from the pre-DFA period is β_5, which is negative and significant, as estimated in Column 4. A 1 pp increase in the effective capital requirement therefore results in a mild improvement of the average borrower's rating by 0.016 ($=-(0.124 - 0.141)$) classes. Notably, after the DFA, there was a decline in the sensitivity of stressed banks to their capital requirements, but this decrease was smaller than the decrease for non-stressed banks. The key parameter driving this result is β_2, whose estimate in Column 4 is positive and statistically significant. Its estimated value is 0.137, which reveals a reduction from the pre-DFA period by 0.003 rating classes ($= -(\hat{\beta}_5 + \hat{\beta}_2) = -(-0.141 + 0.137)$), as opposed to 0.141 ($-\hat{\beta}_5$) for non-stressed banks. The parameter β_2 measures the differential reduction in the risk-taking response to their capital requirements of stressed versus non-stressed banks around the DFA, and it drives the rise of the dotted line in Figure 3. Thus, the indirect effect of the DFA through higher capital requirements (illustrated in Figure 1) is a suppressing one; the indirect effect of the DFA confounds the direct effect of supervision on risk-taking.

Economic Interpretation of the Response to Capital Requirements. The estimates in Table 2 suggest that, before the DFA, the sensitivity of risk-taking to capital absorbed by existing risky assets was higher for non-stressed banks (positive $\hat{\beta}_3$) than for stressed banks (negative $\hat{\beta}_4$). After the DFA, this sensitivity decreased more for non-stressed banks (negative $\hat{\beta}_5$) than for stressed banks (positive $\hat{\beta}_2$). As discussed in Section 2.2, the model in Appendix C predicts that riskier legacy assets, as measured by regulatory risk weights, help banks accumulate capital to be reinvested in new risky assets in good times, and vice versa in bad times.

The descriptive statistics in Table 1 are consistent with this prediction, and this offers a rationale for the results shown in Table 2. Panel A of Table 1 shows that, before the DFA, non-stressed banks had higher regulatory risk weights, they were more profitable, and they retained more profits than stressed banks. Thus, non-stressed banks generated more internal equity capital than stressed banks through profits, which were then reinvested in riskier assets in the syndicated loan market. This is reflected by the higher average yields and worse ratings shown in Panel B. As a consequence, in terms of risk-taking on new loans, non-stressed banks have become less responsive to the average risk weights on legacy assets. They are less sensitive to the capital absorbed by regulatory requirements (i.e., H3 is retained). In addition, the stress tests in the DFA impose restrictions on the dividend payments of stressed banks, which have reduced payouts drastically after the DFA (see Table 1, Panel A). Such an increase in retained profits for stressed banks potentially mitigates the negative effect of lower profitability on internally generated capital. Consistent with these findings, the estimated sensitivity of stressed banks' risk-taking to absorbed capital did not decline significantly, as shown in Table 2.

Economic Magnitude: The Heterogeneous Effect of the DFA. Importantly, the overall effect of the DFA on risk-taking is heterogeneous with respect to banks' levels of effective capital requirements. As the bottom panel of Table 2 reports, corresponding to an effective capital requirement equal to the regulatory minimum of 3%, the effect of the DFA on stressed banks is an improvement in the average rating of borrowers of new loans by 0.28 classes. For the median bank (i.e., effective capital requirement around 5%), the effect of the DFA is roughly zero, which implies no change in the average rating class of new loans.

Overall, the results in Table 2 reconcile (a) the effectiveness of regulatory supervision in reducing bank risk-taking with (b) the small overall effect of the DFA on the risk taking of systemically important financial institutions. The higher capital requirements imposed on stressed banks after the DFA do not translate into more prudent lending. Instead, these requirements offset the direct effect of supervision on risk-taking that correspond to empirically observed capital requirements. We further investigate banks' risk-taking response to capital requirements in Section 4.3.

4.1.3 Parallel Trends Assumption

Despite the inclusion of bank∗time and firm∗time fixed effects in our baseline regressions, a potential selection bias problem might still arise in the bank–firm matching dimension. The summary statistics in Panel B of Table 1 show that both the average portfolio yield and the average portfolio rating of stressed banks were lower than non-stressed banks before 2008. Nevertheless, the necessary underlying assumption in our difference-in-differences analysis requires the absence of differential trends, rather than levels, in risk-taking between stressed and non-stressed banks before the DFA, while holding the level of the effective capital requirement of a bank constant. Figure 3 does not highlight any differential trend between the treatment and the control group at the bank level. However, in Table A4 in the Appendix, we implement a statistical test to detect the presence of differential pre-trends for all specifications in Table 2 for the period before the DFA.

The first row of Table A4 reports coefficient estimates and t-statistics for the term $stressed_b * trend_t * Firm\,risk_{ft}$, which accounts for a differential linear trend in risk-taking ($trend_t * Firm\,risk_{ft}$) for stressed banks ($stressed_b = 1$) and non-stressed banks ($stressed_b = 0$).[21] For all specifications, including our baseline specification in the rightmost column, this term is not statistically different from zero at the 10% significance level. Thus, these tests corroborate the intuition that stressed and non-stressed banks will show no differential trend in loan portfolio allocations to risky firms before the DFA. We provide additional analyses to address the potential residual selection bias in Section 5.1.

4.2 Risk-Taking in the Secondary Market

Lender Roles within a Syndicate and Secondary Market Participation. Panel A of Table 3 investigates two possible drivers of the results shown in Table 2. The first possible driver is the nonrandom assignment of the supervision treatment to lead arrangers, which are more common among stressed banks (see Table 1). The second potential driver is the higher likelihood that participating lenders other than the lead arranger (more common among non-stressed banks) will sell loan shares on the secondary market.

The two leftmost columns replicate the baseline loan-level regression shown in Panel A of Table 2 for a subsample of non-lead arrangers. The second column includes all loan-level controls and bank controls interacted with firm risk as our baseline specification. This shows that the effect of removing lead arrangers from the sample reduces the estimate of the direct effect of supervision β_1 from -0.69 to -0.64. The two rightmost columns instead consider a subsample that excludes all syndicated loans quoted on the secondary market after origination. In the specification in the rightmost column, which includes all controls, our estimate of β_1 increases from -0.69 to -0.62. In all specifications, the direct effect of supervision is significant at the 1% level and the reduction in the coefficient is economically negligible compared to the baseline specification. Overall, the results in Panel A provide no support to concerns that our results are driven by lead arrangers, who are more common among stressed banks.

Credit and Liquidity Risk in the Secondary Market. In Panel B of Table 2, we exploit secondary market data to build additional measures of $Firm\,risk_{ft}$ for the subsample of loans whose secondary market

[21]Observe that the term $trend_t * Firm\,risk_{ft}$, which accounts for the common part of the trend between stressed and non-stressed banks, is absorbed by firm∗quarter fixed effects.

quotes are reported in the LPC dataset. Using these measures, we re-estimate the loan-level specification (Eq. (4)) to investigate whether supervision and capital requirements influence risk-taking in the secondary market. In the two leftmost columns, we measure $Firm\,risk_{ft}$ as the firm rating multiplied by the time period before a syndicated loan is listed on the secondary market. This captures the "total" quantity of risk the bank assumes over the lifetime of a loan.[22] In the most stringent specification, in the second column, the direct effect of supervision translates into an improvement in the average borrower rating class of roughly 0.03 for a loan that remains one more day on the balance sheet of the bank. Thus, treated banks reduce risk-taking by retaining loans extended to borrowers who have worse ratings for shorter periods on their balance sheets. As in the baseline specification, capital requirements offset the direct effect of supervision. The sensitivity of the "total" quantity of risk to capital requirements *decreases* more around the DFA for non-stressed banks ($\hat{\beta}_5 = -0.010$ in Column 2) compared to stressed banks ($\hat{\beta}_5 + \hat{\beta}_2 = -0.010 + 0.012 \simeq 0$ in Column 2).

In the two middle columns, we implement a placebo test that replaces the total quantity of risk with the product of the firm rating and the standard amount of time a loan stays on the balance sheet (i.e., its maturity). The estimate of the effect of supervision is not significant when using the placebo measure. The results in Columns 3 and 4 hint that banks actively sell shares of risky syndicated loans on the secondary market. The results do not suggest that stressed banks invest in risky loans with shorter maturities than those of non-stressed banks.

Finally, the two rightmost columns focus on liquidity risk in the secondary market. We set $Firm\,risk_{ft}$ equal to the average loan bid–ask spread of secondary market quotes for a given syndicated loan.[23] We find that stressed banks also take on less liquidity risk as the direct result of supervision, although the effect is only significant at the 10% level. Economically, the point estimate in the rightmost column indicates that the average bid–ask spread on the syndicated loans of stressed banks is 1.19 bps lower as the direct effect of strict supervision after the DFA. The sensitivity of liquidity risk-taking to capital requirements exhibits the same qualitative patterns as the estimates in Table 2.

Overall, the results shown in Table 3 show that the results in Table 2 cannot be explained by systematic differences between stressed banks and non-stressed banks in terms of their roles within loan syndicates and participation in the secondary market. Furthermore, the previously documented effects of supervision and capital requirements are visible in the secondary market. Stressed banks also respond to supervision in the secondary market, by selling loans to riskier borrowers faster and participating less in illiquid loan shares than non-stressed banks.

[22] Precisely, because not all banks participating in a given syndicate sell their shares on the secondary loan market, the difference between the first date a quote appears in the LPC dataset and the loan origination date is the *minimum* time a syndicated loan share remains on the balance sheet of a bank.

[23] The number of observations slightly increases when this measure is considered, as we do not require borrowers in this sample to be rated.

4.3 Dissecting the Effect of Capital Requirements on risk-taking

In this section, we decompose the sources of variation in the effective capital requirements to economically interpret the four parameter estimates ($\hat{\beta}_2$, $\hat{\beta}_3$, $\hat{\beta}_4$, $\hat{\beta}_5$), which govern the risk-taking response of banks to their capital requirements. As discussed in Section 2.1.2, the effective capital requirement of a bank varies with its average regulatory risk weight ($\sum_a w_a \rho_a$) and with the effect of stress tests (s_a, s'_a) for stressed banks after the DFA. First, we establish that the different estimates of sensitivities to capital requirements between the two groups of banks in the two sub-periods are driven largely by banks responding to the different amounts of capital absorbed by their average regulatory risk weights. Second, for stressed banks after the DFA, we decompose the variation in effective capital requirements into (a) variation in average regulatory risk weights (*risk weight exposure*) and (b) variation in stress tests (*stress test exposure*). We show that stressed banks take on more risk as a result of increases in their average regulatory risk weight, while the correction of capital requirements from stress tests has a mild prudential effect. Importantly, this result does not imply that stress tests (and their qualitative exercise in particular) contribute only slightly to the direct effect of supervision. Rather, the effect of the correction to capital requirements in stress tests is relatively small to account for different risk-taking outcomes among stressed banks.

Capital Absorbed by Regulatory Risk Weights. In Table 4, we report estimates from the loan-level regression (Eq. (4)) in which we replace the effective capital requirement $Capreq_{bt}$ with the capital requirement in the absence of stress tests $Capreq^*_{bt}$ (i.e., imposing $s_a, s'_a = 1, \forall a$, as shown in Columns 1 and 2), with the average regulatory risk weight RWA_{bt}/TA_{bt} (i.e., the ratio of the risk-weighted assets of a bank to its total assets, shown in Columns 3 and 4), and with the average rating of the portfolio of syndicated loans originated in the previous quarter (Columns 5 and 6). Columns 1, 3, and 5 tabulate results with firm∗quarter and bank∗quarter fixed effects. Columns 2, 4, and 6 also include loan-level controls and lagged bank-level controls interacted with firm risk.

The estimates in Columns 1 and 2 are close to the baseline estimates in Table 2. The results in Columns 3 and 4 are qualitatively similar to those in Columns 1 and 2, since $\hat{\beta}_3$ and $\hat{\beta}_2$ are positive, $\hat{\beta}_4$ and $\hat{\beta}_5$ are negative, and $\hat{\beta}_5 \simeq -\hat{\beta}_2$.[24] This suggests that the variation in the average regulatory risk weight largely drives the results shown in Table 2. The sensitivity of risk-taking to capital absorbed significantly decreased for non-stressed banks after the DFA. This was not the case for stressed banks.

Finally, the estimates of $\hat{\beta}_2$, $\hat{\beta}_3$, $\hat{\beta}_4$, and $\hat{\beta}_5$ in Columns 5 and 6, in which capital requirements are replaced by the previous average borrower rating of the bank, are not statistically significant. This suggests that the estimated sensitivities are not simply driven by banks that persistently lend to firms in similar rating categories; rather, they are driven by the risk-taking response to capital absorbed at the bank level.

[24] The estimates $\hat{\beta}_2$, $\hat{\beta}_3$, $\hat{\beta}_4$, and $\hat{\beta}_5$ in Columns 3 and 4 are larger in absolute value because a 1 pp. increase in the average regulatory risk weight translates into a smaller increase in $Capreq^*_{bt}$, which is a fraction of the average risk weight.

Prudential Effect of Stress Tests. Focusing on stressed banks after the DFA (i.e., $stressed_b = 1$, $DFA_t = 1$) provides an additional source of variation in effective capital requirements to test whether higher capital requirements provide shareholders with more "skin in the game" and reduce their incentives to engage in risky lending, as predicted by several studies.

First, we define $Risk\,weight\,exposure_{bt}$ as the percentage deviation of the effective capital requirement of bank b at time t from a simple leverage constraint

$$Risk\,weight\,exposure_{bt} = 100 \times \frac{(Cap\,req_{bt} - Lvg\,constraint_{bt})}{Cap\,req_{bt}} \in [0, 100]\,,$$

where $Lvg\,constraint_{bt}$ is the capital requirement of bank b at time t considering only the regulatory requirements (including stress tests requirements) on the capital ratio defined as a percentage of the bank's total assets (i.e., the Tier 1 leverage ratio, which is the ratio of Tier 1 capital to the bank's total assets).

Second, we define $Stress\,test\,exposure_{bt}$ as the percentage deviation of the effective capital requirement from $Cap\,req^*_{bt}$, i.e., the effective capital requirement a stressed bank would face in the absence of stress tests:

$$Stress\,test\,exposure_{bt} = 100 \times \frac{(Cap\,req_{bt} - Cap\,req^*_{bt})}{Cap\,req_{bt}} \in [0, 100]\,.$$

In Table 5, we consider the sample of stressed banks after the DFA. We include the two measures of the sources of variation in capital requirements described above in order to investigate stressed banks' risk-taking. In the two leftmost columns, we find a positive effect of the capital requirements of stressed banks on risk-taking, although the coefficient is only significant at the 10% level for the specification that includes all controls (second column). Note that the reported coefficients in Table 5 are multiplied by 1,000 for readability. For example, the estimate of 4.79 in Column 2 of Table 5 is close to the estimate of 0.005 (=5/1,000) in Column 4 of Table 2. This describes the sensitivity of stressed banks' risk-taking to a 1 pp increase in the effective capital requirements after the DFA. In Columns 3 and 4 of Table 5, we observe that the positive effect of capital requirements on risk-taking is due primarily to the risk weight exposure. Holding the effective capital requirement constant, the average borrower rating of a bank worsens by 0.00131 (=1.31/1,000) rating classes for a 1 pp increase in the risk weight exposure (Column 4). This is in line with hypothesis H3.

The effect of the correction to the capital requirement from stress tests (Columns 5 and 6) is negative. We find that, holding the capital requirement constant, banks tilt their loan portfolio towards safer firms when their stress test exposure is large. The average borrower rating of a stressed bank improves by 0.00009 (=0.09/1,000) rating classes for a 1 pp increase in the stress test exposure of the bank (Column 6). In the two rightmost columns, we jointly report the effect of the level of the effective capital requirement, the risk weight exposure, and the stress test exposure on stressed banks' risk-taking. We find that only the bank's average risk weight significantly explains risk-taking with the same economic magnitude as previously described, after holding the capital requirement level and the stress test exposure constant.

Overall, the results in Table 5 suggest that banks only mildly reduce risk-taking as a response to an increase in their capital requirement from regulatory stress tests (i.e., H4 cannot be retained). Instead, banks react to the effective capital requirement increase associated with the average regulatory risk weights of their portfolios.

5 Additional Analyses and Robustness

5.1 Selection Bias

This section discusses additional tests conducted to mitigate the concern that our results are driven by selection bias. First, we use a stepwise saturation strategy to make inference about selection on bank-level and loan-level unobservables. Second, we replicate our difference-in-differences analysis on different samples of treated and control banks.

5.1.1 Selection on Unobservables and Coefficient Stability

Although the specification of Table 2 captures a large share of observed and unobserved heterogeneity, we further investigate the effect of selection bias on the estimate of β_1 due to unobserved variables that influence the matching between banks and firms. To do so, we follow the approach in Altonji, Elder, and Taber (2005) and in Oster (2017). We report the results of this analysis in Table A5. The estimates of β_1 in the four rightmost columns are stable between -0.74 and -0.95 over specifications adding fixed effect describing the role of a bank in the syndicated loan and bank$*$firm fixed effects. At the same time, this additional set of controls contributes to the increase in R^2 from 75% to 85%. Thus, as in Oster (2017), to the extent that selection on the added covariates is informative about selection on residual unobserved heterogeneity, a stable coefficient accompanied by an increase in the R^2 after the inclusion of controls can be interpreted as selection bias, based on residual unobservables being limited.

5.1.2 Samples of Treated and Control Banks

Large and Small Banks. To address concerns about the comparability of the treated and control groups, Table A6 replicates our analysis on a different sample with less pronounced differences in bank size distribution. Specifically, we exclude the largest banks (i.e., the top tercile of the size distribution, which includes Bank of America Corporation, JPMorgan Chase & Co., Citigroup Inc., Wells Fargo & Company, Goldman Sachs Group Inc., Morgan Stanley). We also exclude the smallest banks (i.e., banks with less than USD 20 billion in assets) from the baseline sample. The results shown in Table A6 suggest that our baseline results are not driven by the tails of the size distribution of banks.

Supervision Treatment within Stressed Banks. Basel III allows some banks to use their own models to derive regulatory risk weights under an "advanced approach" internal rating-based system. We restrict our attention to stressed banks after the DFA, and we exploit the advanced approach introduced in 2014 to assess whether supervision reduces risk-taking within stressed banks. The use of the advanced approach capital rules is usually accompanied by more intense supervision compared to banks that use the alternative standardized approach. In Table A7, we select the 12 stressed banks using the advanced approach as the treatment group and the remaining stressed banks as the control group. The results, which cannot be attributed to the non-comparability between stressed and non-stressed banks, indicate that treated banks respond directly to additional supervision by lending to safer borrowers.

5.2 External Validity, Alternative Interpretations, and Supplementary Analyses

The Online Appendix reports an additional set of analyses and robustness checks. First, we explore the external validity of our results. We consider alternative measures of firm risk that do not require firms to have available ratings from credit rating agencies. Then, we show that our key results extend to asset returns on the entire bank portfolio. As Meiselman, Nagel, and Purnanandam (2018) point out, high asset income in good times reflects systematic tail risk exposure. From these tests, we conclude that our results are not specific to credit ratings or syndicated loans.

Second, we explore alternative interpretations of our results. We show that our results are not driven by persistence in the riskiness of the set of borrowers of each bank. Instead, risk-taking is a response of the bank to supervision and its effective capital constraints. We then inspect the possibility that our findings might not be driven by banks' response to the DFA, but rather by banks' response to changes in investors' expectations about implicit government guarantees after the Financial Crisis as the evidence in Berndt, Duffie, and Zhu (2019) indicates. We show in a placebo test that the reduction in the risk-taking of stressed banks after the DFA is not simply driven by larger banks. Instead, the reduction in the risk-taking of stressed banks appears to be related specifically to the predetermined size threshold in the DFA. Finally, we consider a last alternative interpretation, which attributes banks' risk-taking response to the Financial Crisis rather than a response to DFA provisions. We decompose the supervision effect β_1 after the DFA into the contributions from each post-DFA year. We find that the direct effect of supervision is concentrated in years related to major supervisory changes in stress tests. The results confirm that the supervision effect is more than the reaction of stressed banks to the Financial Crisis; rather, this effect also captures important changes in the supervision of large banks in the post-DFA years.

Third, we document the robustness of our results on a variety of alternative samples: (a) a sample that includes only new (i.e. first-time) borrowers, (b) a sample that includes loans syndicated outside the U.S., (c) a sample that excludes Financial Crisis observations, and (d) a sample that includes the "new entrants" (i.e., banks that participated in the CCAR after 2013) in the group of stressed banks. Finally, we show that the direct effect of supervision is not significant when we relax the bank∗quarter fixed effects (while retaining firm∗quarter fixed effects). Thus, the direct effect of supervision is a reallocation of stressed banks' portfolios from riskier firms to safer firms, and not the result of additional credit supplied to safer firms.

6 Conclusion

We study the risk-taking behavior of stressed banks. These large financial institutions have faced unprecedented regulatory supervision and capitalization requirements after the passage of the Dodd–Frank Act. Our results underscore that large banks differ in the effective capital requirements they face. This heterogeneity confounds the effect of supervision on bank risk-taking. Measuring the effective capital requirements of banks from publicly available data is a crucial step toward identifying the direct effect of supervision under the DFA.

One major empirical challenge we face is the lack of a counterfactual scenario in which we can evaluate the risk-taking behavior of stressed banks after the DFA while banks simultaneously behave as if they did not face such unprecedented restrictions. To deal with this issue, we exploit the peculiar data structure of the syndicated loan market, where we can observe both stressed and non-stressed banks lending to the same firm at the same time, both before and after the DFA. This strategy allows us to retain banks that are not lead arrangers but participate in loan syndication. It also allows us to implement an identification strategy (in line with Jiménez, Ongena, Peydró, and Saurina (2012) and Jiménez, Ongena, Peydró, and Saurina (2014)) to mitigate concerns about the non-comparability of the two groups of stressed and non-stressed banks. Banks that are not lead arrangers comprise 76% of the lending in syndicated loan markets, on average. These banks are often overlooked in the literature, since it focuses on the monitoring and screening incentives of lead arrangers.

We estimate that the direct effect of supervision in the DFA is an improvement in the average borrower rating by 0.7 rating classes. Banks respond to supervision heterogeneously depending on the capital charges associated with their investments. The overall effect of the DFA on bank risk-taking is an improvement in the average borrower rating of 0.3 rating classes in correspondence to the minimum regulatory capital requirement of 3%, and null in correspondence to the average effective capital requirement in our sample. Importantly, we find that failing to account for the confounding effect of capital requirements leads to the incorrect conclusion that supervision under the DFA is not effective. Our results indicate that stressed banks are beneficial to financial stability because they are better capitalized and engage in safer lending.

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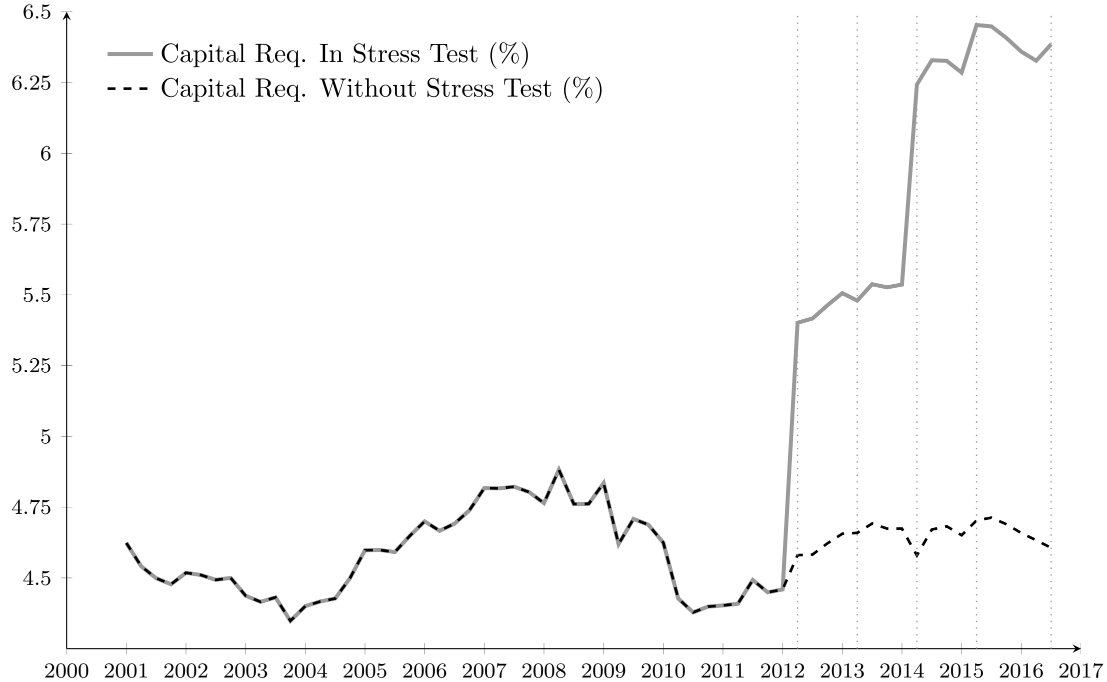

Figure 2: Average Effective Capital Requirement. The figure shows the evolution of the effective capital requirement as defined in the Appendix (Section B) and described in Section 2.1.2. The solid thick line refers to the average capital requirement for the entire sample of banks, while the dashed line refers to the average capital requirement that banks would face if they were not subject to stress tests after the Dodd–Frank Act. The vertical dotted lines indicate the stress-test disclosure dates. Our sample is selected as described in Section 3.2.2.

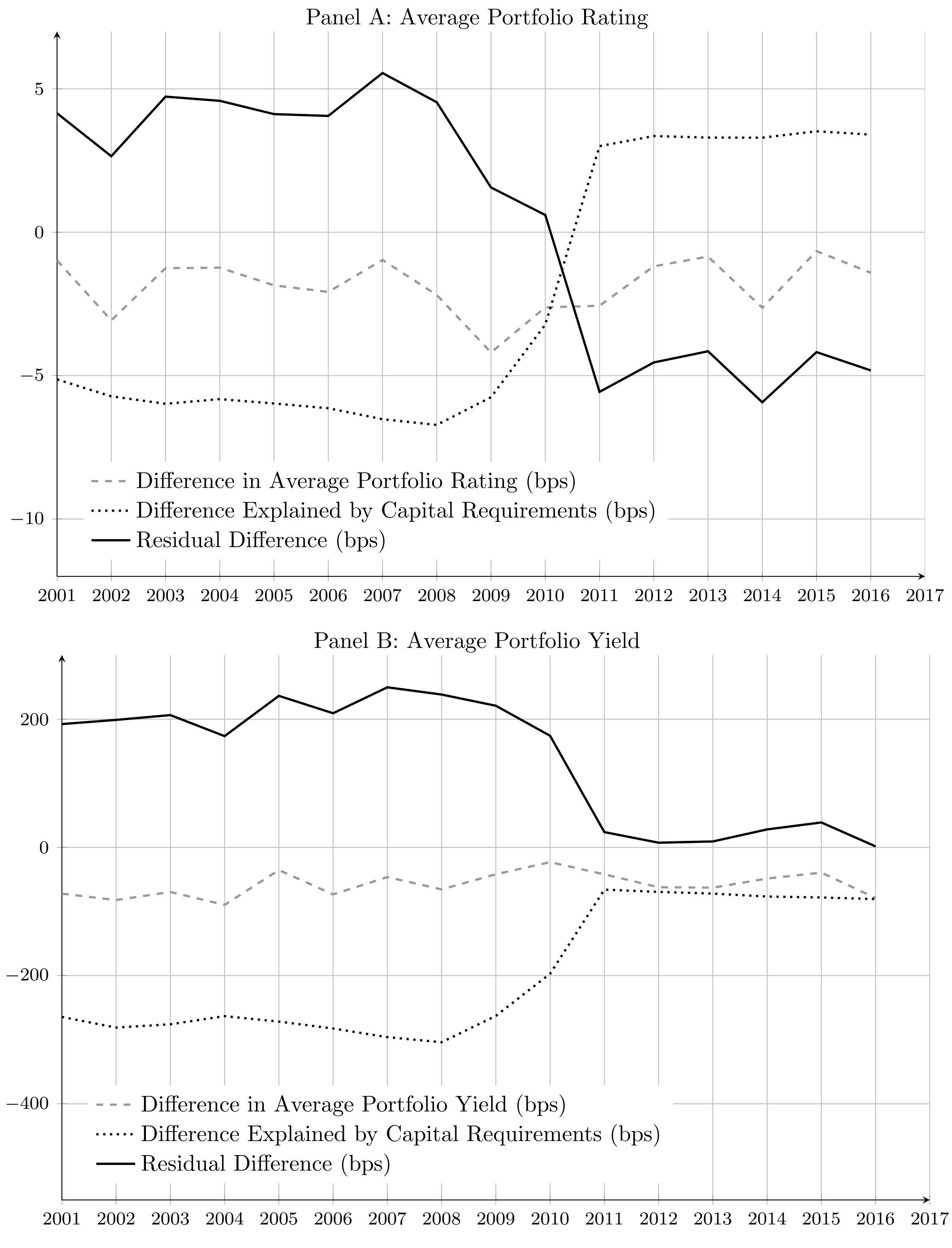

Figure 3: Graphical Illustration of the Omitted Variable Bias. The figure shows the average portfolio rating (Panel A) and the average portfolio yield (Panel B) on new syndicated loans of stressed banks and non-stressed banks. The dashed line in Panel A (Panel B) shows the difference between the average rating (yield) of stressed banks and the average rating (yield) of non-stressed banks. The dotted line in Panel A (Panel B) shows the difference between the average rating (yield) explained by the capital requirements of stressed banks and the average rating (yield) explained by the capital requirements of non-stressed banks. The solid line in Panel A (Panel B) shows the difference between the average residual rating (yield) not explained by the capital requirements of stressed banks and the average residual rating (yield) not explained by the capital requirements of non-stressed banks. Our sample is selected as described in Section 3.2.2.

Table 1
Descriptive Statistics: Before 2008 and After Dodd–Frank Act

The table presents descriptive statistics for stressed banks compared to non-stressed banks before the Crisis ("before 2008") and after the Dodd–Frank Act ("after DFA"). Panel A summarizes the bank capitalization, profitability, and payout policies. Panel B reports descriptive statistics of syndicated loan characteristics. Panel C reports descriptive statistics on loans sold on the secondary market. Statistics reported in Panel B and Panel C include all loans for which a bank is a member bank (not only lead arranger), and are weighted by the percentage of the facility loan amount allocated by the bank. All variables are defined in Section D of the Appendix. Our sample includes 18 stressed banks that participated in all CCARs, and 21 non-stressed banks, selected as described in Section 3.2.

Panel A: Bank Capitalization, Profitability, and Payout Policies

	Stressed Banks			Non-Stressed Banks		
	Before 2008	After DFA	Change	Before 2008	After DFA	Change
$Capreq_{bt}$ (%)	4.42	6.66	2.24	4.60	4.61	0.01
T1/TA (%)	7.20	9.11	1.91	10.72	10.78	0.06
RWA/TA (%)	77.79	69.68	-8.11	69.27	69.06	-0.21
Retained Net Income/Net Income (%)	34.71	71.16	36.45	69.09	65.76	-3.33
Net Income/TA (%)	0.34	0.26	-0.08	0.48	0.31	-0.17
Net Interest Income/TA (%)	0.72	0.59	-0.13	0.85	0.68	-0.17
Loan Income/Loans (%)	1.53	1.11	-0.42	1.71	1.16	-0.54

Panel B: Bank Portfolios of Syndicated Loans

	Stressed Banks			Non-Stressed Banks		
	Before 2008	After DFA	Change	Before 2008	After DFA	Change
Average Yield (bps)	92.00	154.77	62.77	147.17	194.52	47.35
Average Rating (numerical, AAA=1; D=23)	8.38	9.14	0.76	9.57	10.75	1.18
Average Maturity (Months)	39.47	50.13	10.65	44.61	55.64	11.03
Proportion of Secured Loans (%)	29.60	27.75	-1.85	48.07	49.52	1.45
Proportion of Lead Bank Loans (%)	12.17	9.85	-2.32	10.37	0.44	-9.93
Average Loan Amount (USD Millions)	39.51	72.24	32.73	13.83	18.95	5.11
Average Bank Allocation (%)	10.88	8.25	-2.62	13.30	5.64	-7.67

Panel C: Bank Portfolios of Syndicated Loans Sold on the Secondary Loan Market

	Stressed Banks			Non-Stressed Banks		
	Before 2008	After DFA	Change	Before 2008	After DFA	Change
Average Yield (bps)	155.68	187.05	31.37	189.36	208.74	19.38
Average Rating (numerical, AAA=1; D=23)	10.79	10.27	-0.52	12.33	11.13	-1.20
Average Time on Balance Sheet (days)	240.91	158.44	-82.47	126.73	92.25	-34.47
Average Bid–Ask Spread (bps)	0.94	0.85	-0.09	1.01	0.66	-0.35

Table 2
Supervision, Capital Requirements, and Bank Risk-Taking

The table reports estimates from a regression saturated with bank∗quarter (α_{bt}) and firm∗quarter (α_{ft}) fixed effects:

$$\begin{aligned}\log(amount_{fbt}) \quad = \quad & \alpha_{bt} + \alpha_{ft} + \beta_1 stressed_b * DFA_t * Firm\,risk_{ft} + \beta_2 stressed_b * DFA_t * Cap\,req_{bt} * Firm\,risk_{ft} \\ & + \beta_3 Cap\,req_{bt} * Firm\,risk_{ft} + \beta_4 stressed_b * Cap\,req_{bt} * Firm\,risk_{ft} \\ & + \beta_5 DFA_t * Cap\,req_{bt} * Firm\,risk_{ft} + \beta_6 stressed_b * Firm\,risk_{ft} + \gamma' controls_{fbt} + \epsilon_{fbt},\end{aligned}$$

where $\log(amount_{fbt})$ is the logarithm of the USD amount lent by bank b to firm f in a loan issued at date t, $stressed_b$ is a binary variable equal to 1 if bank b belongs to the group of stressed banks as defined in Section 3.2.2, DFA_t is a binary variable equal to 1 if quarter t is after 2010, $Firm\,risk_{ft}$ is the numerical rating of firm f in quarter t (1 is AAA; 23 is D), and $Cap\,req_{bt}$ is the effective capital requirement of bank b in quarter t. All variables are defined in Section D of the Appendix. The "Sensitivities" panel reports the sensitivities of bank risk-taking to capital requirements for stressed banks before vs. after the DFA (i.e., $\hat{\beta}_3 + \hat{\beta}_4$ vs. $\hat{\beta}_2 + \hat{\beta}_3 + \hat{\beta}_4 + \hat{\beta}_5$), and for non-stressed banks before vs. after the DFA (i.e., $\hat{\beta}_3$ vs. $\hat{\beta}_3 + \hat{\beta}_5$). The "Overall Effect" panel reports the effect of the DFA for an effective capital requirement of 3%, 5%, and the sample average before and after the DFA. The sample is described in Section 3.2.2. t-statistics based on clustered standard errors at the bank*quarter and firm*quarter level are in parentheses.

	log(amount)				
	$stressed_b * DFA_t * Firm\,risk_{ft}$ (β_1)	-0.093	-0.047	-1.469	-0.691
		(-1.31)	(-0.94)	(-4.72)	(-3.16)
	$stressed_b * DFA_t * Cap\,req_{bt} * Firm\,risk_{ft}$ (β_2)			0.301	0.137
				(4.56)	(3.01)
	$Cap\,req_{bt} * Firm\,risk_{ft}$ (β_3)			0.139	0.124
				(4.30)	(3.25)
	$stressed_b * Cap\,req_{bt} * Firm\,risk_{ft}$ (β_4)			-0.116	-0.116
				(-3.56)	(-2.96)
	$DFA_t * Cap\,req_{bt} * Firm\,risk_{ft}$ (β_5)			-0.316	-0.141
				(-4.81)	(-3.10)
	$stressed_b * Firm\,risk_{ft}$ (β_6)	0.062	0.092	0.596	0.628
		(1.26)	(2.25)	(3.70)	(3.18)
	Loan-Level Controls	N	Y	N	Y
	Bank-Level Controls*Firm risk	N	Y	N	Y
	Firm*Time FE	Y	Y	Y	Y
	Bank*Time FE	Y	Y	Y	Y
	Loan Characteristics FE	N	Y	N	Y
	R^2 (%)	73.04	74.50	73.25	74.54
	Adjusted R^2 (%)	66.92	68.64	67.17	68.68
	Observations	21174	21174	21174	21174
	Bank*Time	894	894	894	894
	Firm*Time	3018	3018	3018	3018
Sensitivities:	Non-Stressed - before the DFA (β_3)			0.139	0.124
				(4.30)	(3.25)
	Stressed - before the DFA ($\beta_3 + \beta_4$)			0.023	0.008
				(4.45)	(1.25)
	Non-Stressed - after the DFA ($\beta_3 + \beta_5$)			-0.177	-0.016
				(-3.10)	(-0.62)
	Stressed - after the DFA ($\beta_2 + \beta_3 + \beta_4 + \beta_5$)			0.007	0.005
				(2.36)	(1.51)
Overall Effect:	$Cap\,req_{bt} = 3\%$			-0.567	-0.280
	$Cap\,req_{bt} = 5\%$			0.035	-0.004
	Average $Cap\,req_{bt}$			0.194	-0.020

Table 3
Lender Roles, Secondary Market, and Liquidity Risk

The table reports estimates from the regression:

$$\begin{aligned}\log(amount_{fbt}) \quad = \quad & \alpha_{bt} + \alpha_{ft} + \beta_1 stressed_b * DFA_t * Firm\,risk_{ft} + \beta_2 stressed_b * DFA_t * Cap\,req_{bt} * Firm\,risk_{ft} \\ & + \beta_3 Cap\,req_{bt} * Firm\,risk_{ft} + \beta_4 stressed_b * Cap\,req_{bt} * Firm\,risk_{ft} \\ & + \beta_5 DFA_t * Cap\,req_{bt} * Firm\,risk_{ft} + \beta_6 stressed_b * Firm\,risk_{ft} + \gamma' controls_{fbt} + \epsilon_{fbt},\end{aligned}$$

where $Firm\,risk_{ft}$ is the numerical rating of firm f in quarter t (1 is AAA; 23 is D) in Panel A. In Panel B, $Firm\,risk_{ft}$ is the rating multiplied by the length of time before a syndicated loan facility is listed on the secondary market (Columns 1–2), the rating multiplied by the maturity of the syndicated loan facility (Columns 3–4), and the average loan bid–ask spread of secondary market quotes for a given syndicated loan (Columns 5–6). All variables are defined in Section D of the Appendix. In Panel A, we replicate the baseline regression from Panel A of Table 2 for a subsample of non-lead arrangers (Columns 1-2) and for a subsample that excludes syndicated loans quoted on the secondary market after origination (Columns 3-4). The "Sensitivities" panel reports the sensitivities of bank risk-taking to capital requirements for stressed banks before vs. after the DFA (i.e., $\hat{\beta}_3 + \hat{\beta}_4$ vs. $\hat{\beta}_2 + \hat{\beta}_3 + \hat{\beta}_4 + \hat{\beta}_5$), and for non-stressed banks before vs. after the DFA (i.e., $\hat{\beta}_3$ vs. $\hat{\beta}_3 + \hat{\beta}_5$). The sample is described in Section 3.2.2. t-statistics based on clustered standard errors at the bank*quarter and firm*quarter level are in parentheses. For readability, the coefficients in Columns 1-4 of Panel B are multiplied by 100.

	Panel A: log(amount)				
	Sample:	Excl. Lead Arranger		Excl. Secondary Market	
	$stressed_b * DFA_t * Firm\,risk_{ft}$ (β_1)	-1.170	-0.637	-1.410	-0.621
		(-3.89)	(-2.68)	(-4.38)	(-2.54)
	$stressed_b * DFA_t * Cap\,req_{bt} * Firm\,risk_{ft}$ (β_2)	0.233	0.120	0.296	0.129
		(3.62)	(2.39)	(4.29)	(2.48)
	$Cap\,req_{bt} * Firm\,risk_{ft}$ (β_3)	0.109	0.115	0.133	0.116
		(3.51)	(2.63)	(3.26)	(2.58)
	$stressed_b * Cap\,req_{bt} * Firm\,risk_{ft}$ (β_4)	-0.088	-0.122	-0.106	-0.106
		(-2.80)	(-2.74)	(-2.59)	(-2.33)
	$DFA_t * Cap\,req_{bt} * Firm\,risk_{ft}$ (β_5)	-0.251	-0.115	-0.317	-0.136
		(-3.90)	(-2.30)	(-4.62)	(-2.62)
	$stressed_b * Firm\,risk_{ft}$ (β_6)	0.468	0.688	0.523	0.561
		(3.06)	(3.13)	(2.70)	(2.57)
	Loan-Level Controls	N	Y	N	Y
	Bank-Level Controls*Firm risk	N	Y	N	Y
	Firm*Time FE	Y	Y	Y	Y
	Bank*Time FE	Y	Y	Y	Y
	Loan Characteristics FE	N	Y	N	Y
	R^2 (%)	75.52	77.06	74.16	75.60
	Adjusted R^2 (%)	67.55	69.48	68.02	69.73
	Observations	14542	14542	19649	19649
	Bank*Time	889	889	875	875
	Firm*Time	2678	2678	2890	2890
Sensitivities:	Non-Stressed - before the DFA (β_3)	0.109	0.115	0.133	0.116
		(3.51)	(2.63)	(3.26)	(2.58)
	Stressed - before the DFA ($\beta_3 + \beta_4$)	0.021	-0.007	0.027	0.010
		(4.06)	(-1.13)	(7.09)	(1.95)
	Non-Stressed - after the DFA ($\beta_3 + \beta_5$)	-0.142	0.000	-0.184	-0.021
		(-2.51)	(0.00)	(-3.32)	(-0.71)
	Stressed - after the DFA ($\beta_2 + \beta_3 + \beta_4 + \beta_5$)	0.004	-0.002	0.006	0.003
		(0.92)	(-0.51)	(2.03)	(1.07)

Panel B: log(amount)							
	Sample:	Secondary Market Only					
	$Firm\,risk_{ft} =$	Rating*Time on Balance Sheet		Rating*Maturity (Placebo)		Bid-Ask Spread	
	$stressed_b * DFA_t * Firm\,risk_{ft}$ (β_1)	-0.020	-0.029	-0.291	0.289	-0.721	-1.186
		(-1.70)	(-2.56)	(-1.18)	(0.97)	(-1.03)	(-1.69)
	$stressed_b * DFA_t * Cap\,req_{bt} * Firm\,risk_{ft}$ (β_2)	0.010	0.012	0.171	0.043	0.708	0.741
		(4.56)	(5.40)	(2.83)	(0.62)	(2.28)	(2.28)
	$Cap\,req_{bt} * Firm\,risk_{ft}$ (β_3)	-0.001	0.003	0.172	0.478	0.011	-0.046
		(-3.87)	(0.68)	(3.92)	(4.47)	(0.19)	(-0.31)
	$stressed_b * Cap\,req_{bt} * Firm\,risk_{ft}$ (β_4)	0.001	-0.007	-0.154	-0.467	0.045	-0.029
		(0.66)	(-1.25)	(-3.09)	(-4.03)	(0.63)	(-0.15)
	$DFA_t * Cap\,req_{bt} * Firm\,risk_{ft}$ (β_5)	-0.010	-0.010	-0.141	-0.014	-0.640	-0.568
		(-10.94)	(-7.59)	(-2.92)	(-0.23)	(-2.21)	(-1.86)
	$stressed_b * Firm\,risk_{ft}$ (β_6)	-0.005	0.041	0.074	1.755	-0.362	0.172
		(-0.77)	(1.25)	(0.49)	(3.10)	(-1.12)	(0.15)
	Loan-Level Controls	N	Y	N	Y	N	Y
	Bank-Level Controls*Firm risk	N	Y	N	Y	N	Y
	Firm*Time FE	Y	Y	Y	Y	Y	Y
	Bank*Time FE	Y	Y	Y	Y	Y	Y
	Loan Characteristics FE	N	Y	N	Y	N	Y
	R^2 (%)	82.51	83.48	82.47	84.02	80.70	81.72
	Adjusted R^2 (%)	71.66	72.27	71.60	73.18	69.34	70.08
	Observations	1354	1354	1354	1354	1615	1615
	Bank*Time	320	320	320	320	360	360
	Firm*Time	193	193	193	193	233	233
Sensitivities:	Non-Stressed - before the DFA (β_3)	-0.001	0.003	0.172	0.478	0.011	-0.046
		(-3.87)	(0.68)	(3.92)	(4.47)	(0.19)	(-0.31)
	Stressed - before the DFA ($\beta_3 + \beta_4$)	-0.000	-0.004	0.018	0.011	0.056	-0.075
		(-0.24)	(-2.44)	(0.67)	(0.36)	(0.66)	(-0.70)
	Non-Stressed - after the DFA ($\beta_3 + \beta_5$)	-0.011	-0.007	0.031	0.464	-0.629	-0.614
		(-12.24)	(-1.33)	(1.49)	(3.90)	(-2.23)	(-1.77)
	Stressed - after the DFA ($\beta_2 + \beta_3 + \beta_4 + \beta_5$)	-0.000	-0.003	0.047	0.041	0.124	0.098
		(-0.22)	(-1.16)	(2.25)	(1.99)	(1.94)	(1.75)

Table 4

Dissecting the Effect of Capital Requirements: Capital Requirements Without Stress Tests, Regulatory Risk Weights, and Past Ratings

The table reports estimates from the regression:

$$\begin{aligned}\log(amount_{fbt}) = \; & \alpha_{bt} + \alpha_{ft} + \beta_1 stressed_b * DFA_t * Firm\,risk_{ft} + \beta_2 stressed_b * DFA_t * Cap\,charge_{bt} * Firm\,risk_{ft} \\ & + \beta_3 Cap\,charge_{bt} * Firm\,risk_{ft} + \beta_4 stressed_b * Cap\,charge_{bt} * Firm\,risk_{ft} \\ & + \beta_5 DFA_t * Cap\,charge_{bt} * Firm\,risk_{ft} + \beta_6 stressed_b * Firm\,risk_{ft} + \gamma' controls_{fbt} + \epsilon_{fbt},\end{aligned}$$

where $Cap\,charge_{bt}$ is the capital requirement in the absence of stress tests $Cap\,req^*_{bt}$ in Columns 1–2, the average regulatory risk weight RWA_{bt}/TA_{bt} in Columns 3–4, and the average rating on the portfolio of syndicated loans originated in the previous quarter in Columns 5–6. All variables are defined in Section D of the Appendix. In the "Sensitivities" panel, we report the sensitivities of bank risk-taking to $Cap\,charge_{bt}$ for stressed banks before vs. after the DFA (i.e., $\hat{\beta}_3 + \hat{\beta}_4$ vs. $\hat{\beta}_2 + \hat{\beta}_3 + \hat{\beta}_4 + \hat{\beta}_5$) and for non-stressed banks before vs. after the DFA (i.e., $\hat{\beta}_3$ vs. $\hat{\beta}_3 + \hat{\beta}_5$). The sample is described in Section 3.2.2. t-statistics based on clustered standard errors at the bank*quarter and firm*quarter level are in parentheses.

		log(amount)					
	$Cap\,Charge_{bt} =$	$Cap\,req^*_{bt}$		RWA_{bt}/TA_{bt}		Avg. $Firm\,risk_{ft-1}$	
	$stressed_b * DFA_t * Firm\,risk_{ft}$ (β_1)	-1.525	-0.714	-1.606	-0.823	-0.790	-0.213
		(-5.01)	(-3.28)	(-5.76)	(-3.82)	(-1.90)	(-1.06)
	$stressed_b * DFA_t * Cap\,req_{bt} * Firm\,risk_{ft}$ (β_2)	0.316	0.144	2.149	1.080	0.071	0.019
		(4.88)	(3.19)	(5.70)	(3.75)	(1.88)	(1.03)
	$Cap\,req_{bt} * Firm\,risk_{ft}$ (β_3)	0.137	0.115	1.019	0.915	0.027	0.024
		(4.21)	(3.07)	(7.77)	(3.78)	(1.52)	(1.68)
	$stressed_b * Cap\,req_{bt} * Firm\,risk_{ft}$ (β_4)	-0.114	-0.099	-0.883	-0.847	-0.018	-0.022
		(-3.48)	(-2.53)	(-6.54)	(-3.32)	(-0.97)	(-1.54)
	$DFA_t * Cap\,req_{bt} * Firm\,risk_{ft}$ (β_5)	-0.316	-0.141	-2.157	-1.053	-0.071	-0.018
		(-4.92)	(-3.13)	(-5.76)	(-3.68)	(-1.88)	(-1.01)
	$stressed_b * Firm\,risk_{ft}$ (β_6)	0.592	0.538	0.692	0.698	0.224	0.292
		(3.64)	(2.72)	(6.32)	(3.47)	(1.19)	(1.91)
	Loan-Level Controls	N	Y	N	Y	N	Y
	Bank-Level Controls*Firm risk	N	Y	N	Y	N	Y
	Firm*Time FE	Y	Y	Y	Y	Y	Y
	Bank*Time FE	Y	Y	Y	Y	Y	Y
	Loan Characteristics FE	N	Y	N	Y	N	Y
	R^2 (%)	73.26	74.53	73.25	74.53	73.10	74.49
	Adjusted R^2 (%)	67.20	68.67	67.18	68.67	67.00	68.63
	Observations	21164	21164	21164	21164	21164	21164
	Bank*Time	890	890	890	890	890	890
	Firm*Time	3018	3018	3018	3018	3018	3018
Sensitivities:	Non-Stressed - before the DFA (β_3)	0.137	0.115	1.019	0.915	0.027	0.024
		(4.21)	(3.07)	(7.77)	(3.78)	(1.52)	(1.68)
	Stressed - before the DFA ($\beta_3 + \beta_4$)	0.023	0.016	0.136	0.068	0.010	0.002
		(4.45)	(2.23)	(4.00)	(1.33)	(3.46)	(0.64)
	Non-Stressed - after the DFA ($\beta_3 + \beta_5$)	-0.179	-0.026	-1.138	-0.138	-0.043	0.006
		(-3.23)	(-0.94)	(-3.25)	(-0.79)	(-1.32)	(0.53)
	Stressed - after the DFA ($\beta_2 + \beta_3 + \beta_4 + \beta_5$)	0.023	0.020	0.128	0.095	0.010	0.003
		(4.99)	(2.91)	(5.13)	(2.34)	(2.82)	(0.82)

Table 5
Dissecting the Effect of Capital Requirements: Prudential Effect of Stress Tests

The table reports estimates from the regression:

$$\log(amount_{fbt|DFA_t=1,stressed_b=1}) = \alpha_{bt} + \alpha_{ft} + \beta_1 Cap\,req_{bt} * Firm\,risk_{ft} + \beta_2 Risk\,weight\,exposure_{bt} * Firm\,risk_{ft} + \beta_3 Stress\,test\,exposure_{bt} * Firm\,risk_{ft} + \gamma' controls_{fbt} + \epsilon_{fbt},$$

where $Risk\,weight\,exposure_{bt}$ is the percentage deviation of the effective capital requirement of bank b at time t from a simple leverage constraint, $Stress\,test\,exposure_{bt}$ is the percentage deviation of the effective capital requirement from $Cap\,req^*_{bt}$, i.e., the effective capital requirement a stressed bank would face in the absence of stress tests. All variables are defined in Section D of the Appendix. Note that the reported coefficients in this table are multiplied by 1,000 for readability. The sample is restricted to stressed banks after the DFA. The sample of stressed banks is described in Section 3.2.2. t-statistics based on clustered standard errors at the bank*quarter and firm*quarter level are in parentheses.

	log(amount)							
$Cap\,req_{bt} * Firm\,risk_{ft}$	6.27	4.79	-3.52	-1.93	11.81	10.23	-3.42	-1.20
	(1.89)	(1.50)	(-0.81)	(-0.49)	(3.16)	(2.39)	(-0.48)	(-0.18)
$RiskWeightExposure_{bt} * Firm\,risk_{ft}$			1.47	1.31			1.46	1.26
			(3.80)	(3.03)			(2.56)	(2.27)
$StressTestExposure_{bt} * Firm\,risk_{ft}$					-1.29	-0.97	-0.01	-0.09
					(-3.46)	(-2.33)	(-0.02)	(-0.16)
Loan-Level Controls	N	Y	N	Y	N	Y	N	Y
Bank-Level Controls*Firm risk	N	Y	N	Y	N	Y	N	Y
Firm*Time FE	Y	Y	Y	Y	Y	Y	Y	Y
Bank*Time FE	Y	Y	Y	Y	Y	Y	Y	Y
Loan Characteristics FE	N	Y	N	Y	N	Y	N	Y
R^2 (%)	69.47	71.53	69.57	71.58	69.52	71.55	69.57	71.58
Adjusted R^2 (%)	63.67	65.99	63.77	66.04	63.73	66.01	63.77	66.04
Observations	8728	8728	8728	8728	8728	8728	8728	8728
Bank*Time	354	354	354	354	354	354	354	354
Firm*Time	1040	1040	1040	1040	1040	1040	1040	1040

Appendix

A. Sample of Banks

Table A1
Stressed Banks

The table lists the banks subject to annual regulatory stress tests in the U.S. A cross indicates whether a bank participated in a regulatory stress test exercise for a given year (SCAP 2009, CCAR 2011, 2012, 2013, 2014, 2015, and 2016). Banks in the treatment group (the stressed banks) are the 18 banks that participated in all CCARs. "Fail" indicates the number of banks that did not satisfy the regulatory criteria in each regulatory stress test exercise (except for CCAR 11, for which bank-specific results are not available).

Bank	2009	2011	2012	2013	2014	2015	2016
Ally Financial Inc.	×	×	×	×	×	×	×
American Express Company	×	×	×	×	×	×	×
Bank of America Corporation	×	×	×	×	×	×	×
BB&T Corporation	×	×	×	×	×	×	×
The Bank of New York Mellon	×	×	×	×	×	×	×
Capital One Financial Corporation	×	×	×	×	×	×	×
Citigroup Inc.	×	×	×	×	×	×	×
Fifth Third Bancorp	×	×	×	×	×	×	×
The Goldman Sachs Group, Inc.	×	×	×	×	×	×	×
JPMorgan Chase & Co.	×	×	×	×	×	×	×
KeyCorp	×	×	×	×	×	×	×
MetLife, Inc.	×	×	×				
Morgan Stanley	×	×	×	×	×	×	×
The PNC Financial Services Group, Inc.	×	×	×	×	×	×	×
Regions Financial Corporation	×	×	×	×	×	×	×
State Street Corporation	×	×	×	×	×	×	×
SunTrust Banks, Inc.	×	×	×	×	×	×	×
U.S. Bancorp	×	×	×	×	×	×	×
Wells Fargo & Company	×	×	×	×	×	×	×
BBVA Compass Bancshares, Inc.					×	×	×
BMO Financial Corp.					×	×	×
Comerica Incorporated					×	×	×
Discover Financial Services					×	×	×
HSBC North America Holdings Inc.					×	×	×
Huntington Bancshares Incorporated					×	×	×
M&T Bank Corporation					×	×	×
Northern Trust Corporation					×	×	×
Citizens Financial Group, Inc.					×	×	×
Santander Holdings USA, Inc.					×	×	×
MUFG Americas Holdings Corporation					×	×	×
Zions Bancorporation					×	×	×
Deutsche Bank Trust Corporation						×	×
BancWest Corporation							×
TD Group US Holdings LLC							×
Sample	19	19	19	18	30	31	33
Fail	10	-	4	4	5	3	3

The non-stressed banks in our sample are: Associated Banc-Corp, BOK Financial Corporation, Bank of Hawaii Corporation, CIT Group Inc., Charles Schwab Corporation, Commerce Bancshares Inc., Cullen/Frost Bankers Inc., East West Bancorp Inc., First Citizens BancShares Inc., First Horizon National Corporation , Franklin Resources Inc., Fulton Financial Corporation, Hancock Holding Company, New York Community Bancorp Inc., Popular Inc., Prosperity Bancshares Inc., SVB Financial Group, Synovus Financial Corp., TCF Financial Corporation, Webster Financial Corporation, BancorpSouth Inc., BankUnited Inc., Cathay General Bancorp, First BanCorp., First National of Nebraska Inc., IBERIABANK Corporation, International Bancshares Corporation, People's United Financial Inc., PrivateBancorp Inc., Raymond James Financial Inc., UMB Financial Corporation, Umpqua Holdings Corporation, Valley National Bancorp, Washington Federal Inc., and the Wintrust Financial Corporation.

B. Capital Requirements

In this section, we describe how the effective capital requirement of a bank holding company is determined. We first describe how regulatory capital requirements for all banks, stressed and non-stressed, are set. Then, we examine how the post-stress capital requirements for each bank subject to stress tests can be backed out using the bank-level data disclosed in regulatory stress tests. Finally, to the extent that banks simultaneously face multiple minimum capital requirements based on different capital ratios, we show how all the requirements can be expressed in terms of a single accounting ratio and made comparable. Ultimately, all capital requirements can be combined in a unique measure that captures the tightest capital constraint each bank is subject to in each quarter.

Capital Requirements of Bank Holding Companies. In a given quarter, the capital requirements of U.S. bank holding companies are based on four regulatory capital ratios:

$$\begin{array}{rcll} CET1R: & \frac{CET1_b}{RWA_b} & \geq & k_1, \\ T1R: & \frac{T1_b}{RWA_b} & \geq & k_2, \\ TotalR: & \frac{Total_b}{RWA_b} & \geq & k_3, \\ LVGR: & \frac{T1_b}{Assets_b} & \geq & k_4, \end{array} \tag{A1}$$

where, for bank b, $CET1_b$ is common equity Tier 1 capital, $T1_b$ is Tier 1 capital, $Total_b$ is total regulatory capital, RWA_b denotes risk-weighted assets, and $Assets_b$ denotes total assets. In Table A2 (Panel A), we report the four regulatory thresholds (k_1, k_2, k_3, k_4) for each capital ratio in each CCAR exercise. These thresholds are collected from annual CCAR summary reports available on the Federal Reserve website.

Capital Requirements of Stressed Banks. Stressed banks generally face higher capital requirements than non-stressed banks. To assess capital adequacy for all banks subject to the CCAR, the regulator uses as a capital ratio the minimum projected capital ratio over the nine quarters of the supervisory stress scenario. This minimum capital ratio is lower than the bank's actual capital ratio.[25] Under adverse economic conditions, the decline in value of a bank's assets translates into a hypothetical loss under the stress scenario. As a result, the buffer of post-stress capital is reduced by this hypothetical loss for each quarter of the stress test horizon, as if the bank had less equity capital available under severe economic conditions. In addition, the riskiness of the bank's assets increases in the hypothetical stress scenario, resulting in higher regulatory risk weights assigned to risky exposures and lower post-stress capital ratios defined as a percentage of risk-weighted assets.[26]

[25] In principle, it might be the case that the stress scenario loosens capital requirements, but this situation is never empirically observed.

[26] A bank's capital ratios can also decrease when the bank has planned net capital distributions over the planning horizon.

Denote as $CET1R_{b,stress}$, $T1R_{b,stress}$, $TotalR_{b,stress}$, and $LVGR_{b,stress}$ the minimum projected capital ratios of bank b under the supervisory stress scenario, as available in the data disclosed in regulatory stress tests. These projected ratios can be used to back out thresholds that are applicable to the actual capital ratios of each bank, as follows:

$$\begin{aligned} k^s_{1b} &= \frac{k_1}{1+\frac{CET1R_{b,stress}-CET1R_b}{CET1R_b}}, \\ k^s_{2b} &= \frac{k_2}{1+\frac{T1R_{b,stress}-T1R_b}{T1R_b}}, \\ k^s_{3b} &= \frac{k_3}{1+\frac{TotalR_{b,stress}-TotalR_b}{TotalR_b}}, \\ k^s_{4b} &= \frac{k_4}{1+\frac{LVGR_{b,stress}-LVGR_b}{LVGR_b}}. \end{aligned} \tag{A2}$$

Therefore, a bank subject to the regulatory stress test equivalently faces bank-specific capital requirements, in which thresholds are determined based on the bank's riskiness under the stress scenario. Because $CET1R_{b,stress} \leq CET1R_b$, $T1R_{b,stress} \leq T1R_b$, $TotalR_{b,stress} \leq TotalR_b$, and $LVGR_{b,stress} \leq LVGR_b$, the denominators used to define the thresholds of stressed banks in Eq. (A2) are expected to be lower than 1, and the bank-specific post-stress thresholds of stressed banks are expected to be higher than the regulatory thresholds (k_1, k_2, k_3, k_4).

Importantly, the difference between post-stress thresholds and the regulatory thresholds is a function of the sensitivity of the bank assets to the supervisory stress scenario as assessed by the Federal Reserve. The capital requirement of a stressed bank increases by the extent to which the bank is vulnerable to the supervisory stress scenario. This increase is a "surprise component" of the capital requirement since, by opposition to stress tests conducted by the banks, the increase in the capital requirement from regulatory stress tests is determined by the Federal Reserve using its own confidential model, and revealed at the disclosure of stress tests results. A comparison of the regulatory thresholds in Panel A to the average post-stress thresholds in Panel B of Table A2 shows the higher capital requirements imposed on stressed banks.

The Effective (i.e., Most Stringent) Capital Requirement. To describe the capital requirements of non-stressed banks with a single measure, we rewrite the capital requirement based on the four regulatory capital ratios of Eq. (A1) as a single Tier 1 leverage ratio requirement, i.e., a Tier 1 capital requirement as a percentage of average total assets. To do so, we recognize that the effective (i.e., most stringent) capital constraint can be written as

$$\frac{T1_b}{Assets_b} \geq Cap\,req_b,$$

where, after some algebraic manipulation of the regulatory capital requirements in Eq. (A1),

$$Cap\,req_b = \max(k_{1b}, k_{2b}, k_{3b}, k_4), \tag{A3}$$

with $k_{1b} = \left[k_1 - \frac{CET1_b - T1_b}{RWA_b}\right] \frac{RWA_b}{Assets_b}$, $k_{2b} = k_2 \frac{RWA_b}{Assets_b}$, and $k_{3b} = \left[k_3 - \frac{Total_b - T1_b}{RWA_b}\right] \frac{RWA_b}{Assets_b}$. The capital shortfall, i.e., the amount of Tier 1 capital a bank must raise in order to meet the capital requirement of Eq. (A3), is $\max(0, Cap\,req_b * Assets_b - T1_b)$.

Similarly, the effective requirement for the subset of stressed banks is

$$Cap\,req_b = \max(k_{1b}, k_{2b}, k_{3b}, k_4, k'_{1b}, k'_{2b}, k'_{3b}, k'_{4b}), \tag{A4}$$

where $k'_{1b} = \left[k^s_{1b} - \frac{CET1_b - T1_b}{RWA_b}\right] \frac{RWA_b}{Assets_b}$, $k'_{2b} = k^s_{2b} \frac{RWA_b}{Assets_b}$, $k'_{3b} = \left[k^s_{3b} - \frac{Total_b - T1_b}{RWA_b}\right] \frac{RWA_b}{Assets_b}$, and $k'_{4b} = k^s_{4b}$. Note that, by definition, $CET1_b$ is part of $T1_b$, which is part of $Total_b$, such that k_{1b} and k^s_{1b} remain constant when the bank raises additional CET1. However, k_{1b} and k^s_{1b} can change if the stock of non-CET1 Tier 1 capital (e.g., convertible bonds) of the bank changes. If the bank raises convertible bonds, k_{1b} and k^s_{1b} increase such that the requirements for the CET1R ratio might become more stringent than the requirements for other capital ratios. A similar observation applies to k_{3b} and k^s_{3b}, which vary with the stock of non-Tier 1 total capital (e.g., long-term debt that qualifies as Tier 2 or Tier 3 capital). If the bank raises additional long-term debt, k_{3b} and k^s_{3b} decrease, and the requirements for the total capital ratio become less stringent than the other capital ratio requirements.[27] In the last column of Panel B of Table A2, we report the cross-sectional average effective capital requirement ($Capreq_b$) of stressed banks.

In our empirical analyses, we update the effective capital requirement of a bank $Capreq_{bt}$ every quarter t to reflect changes in (i) the average regulatory risk weight of the bank, and (ii) the effect of the latest stress test on the effective capital requirements for stressed banks. First, we update the capital requirements of all banks each quarter with information provided by the bank at the end of the *previous* quarter $(t-1)$: the bank's average total assets, risk-weighted assets, and the various measures of equity capital required to compute $Capreq_{bt}$.[28]

Second, for stressed banks, we take advantage of the regulatory stress test timeline and measure banks' risk-taking outcomes *after* stressed banks learn their new capital requirements from the regulatory stress test. From 2012 to 2016, we collect the bank-specific stress test data disclosed in each annual CCAR summary report available from the Federal Reserve website.[29] The post-stress bank-specific thresholds (k^s_{1b}, k^s_{2b}, k^s_{3b}, k^s_{4b}) of Eq. (A2) are updated after each CCAR disclosure. Specifically, k^s_{1b}, k^s_{2b}, k^s_{3b}, k^s_{4b} are held constant between the quarter of the CCAR disclosure until the quarter before the next CCAR disclosure. Thus, the surprise component of the capital requirement determined by the Federal Reserve is revealed at the disclosure date of the stress test, while the risk-taking response that we measure occurs in the following quarters until the disclosure of the next regulatory stress test.

[27]In unreported results, we analyze the effect of the adjustment for the "quality" of capital $\frac{CET1_b - T1_b}{RWA_b}$ and $\frac{Total_b - T1_b}{RWA_b}$ on bank risk-taking. We find no significant association between this part of the effective capital requirement and bank risk-taking.

[28]Given the change in the regulatory definition of the common Tier 1 ratio and the various thresholds used in the CCARs, we do not consider k_{1b} and k'_{1b} when deriving the effective capital requirement in Eq. (A3) and Eq. (A4).

[29]In November 2011, the Federal Reserve proposed a rule to implement the DFA requirements specifying that a summary of the stress tests results should be made public. Only for the 2011 CCAR, the Federal Reserve did not disclose any bank-specific result from the stress test.

Table A2
Capital Requirements of Stressed Banks

The table reports regulatory thresholds used for each regulatory ratio in the CCAR (Panel A), the cross-sectional average post-stress bank-specific thresholds (Panel B), and the cross-sectional average actual capital ratios (Panel C). $Capreq_b$ is the effective capital requirement as defined in Eq. (A4). k^s_{1b}, k^s_{2b}, k^s_{3b}, k^s_{4b} are the bank-specific capital requirements for the CET1R, T1R, TotalR, and LVGR, respectively, as defined in Eq. (A2). T1CR is the ratio of common equity Tier 1 capital to risk-weighted assets (Basel I definition), CET1R is the ratio of common equity Tier 1 capital to risk-weighted assets (Basel III definition), T1R is the ratio of Tier 1 capital to risk-weighted assets, TotalR is the ratio of Total capital to risk-weighted assets, and LVGR is the ratio of Tier 1 capital to average total assets. Our sample is selected as described in Section 3.2.2.

Panel A: CCAR Regulatory Thresholds (%)					
	T1CR (k_1)	CET1R (k_1)	T1R (k_2)	TotalR (k_3)	LVGR (k_4)
2016	-	4.5	6	8	4
2015	5	4 to 4.5	5.5 to 6	8	3 to 4
2014	5	4 to 4.5	4 to 6	8	3 to 4
2013	5	-	4	8	3 to 4
2012	5	-	4	8	3

Panel B: Average Bank-Specific Thresholds (%)						
	T1CR (k^s_{1b})	CET1R (k^s_{1b})	T1R (k^s_{2b})	TotalR (k^s_{3b})	LVGR (k^s_{4b})	$Capreq_b$
2016	-	7.6	9.5	11.5	6.4	7.5
2015	7.8	-	9.9	12.1	6.2	7.8
2014	8.1	-	9.4	11.5	5.9	7.6
2013	9.1	-	6.8	12.2	5.3	6.9
2012	8.5	-	6.8	11.9	5.1	6.8

Panel C: Average Actual Capital Ratios (%)					
	T1CR	CET1R	T1R	TotalR	LVGR
2016	-	12.5	13.6	15.8	9.8
2015	12.7	-	14.1	16.6	9.9
2014	11.7	-	13.1	15.7	9.7
2013	11.3	-	13.1	15.6	8.8
2012	10.4	-	12.7	15.6	8.7

C. Model

In this section, we propose a stylized partial equilibrium model designed to highlight some key features of our empirical setting.

Setup. We consider an economy with three dates $t \in \{0, 1, 2\}$ and no discounting, i.e., the gross risk-free interest rate is normalized to 1. At $t = 0$, a risk-neutral bank has an existing balance sheet with legacy assets in the amount $A = I + M$, where I is the amount invested in risky assets and M is the amount invested in safe assets. Legacy risky assets yield a realized gross return R at $t = 1$, where R is a random variable with positive support, and its probability and cumulative density functions are $f(\cdot)$ and $F(\cdot)$, respectively. Safe assets earn the gross risk-free rate on the same date. Thus, the realized flow of profits (or losses) at $t = 1$ is $\pi \equiv (R - 1) \cdot I$. We assume the existence of a tradeoff between risk and expected returns. Ex ante, at $t = 0$, the expected return on the risky assets exceeds the return on the safe assets.

Assumption 1 [Risk-Expected Return Tradeoff]. $E[R] > 1$.

The bank's assets are financed with equity E and deposits D, that is, $A = D + E$. We assume that deposits are fully covered by deposit insurance in case of bank default. Therefore, they are priced at the risk-free rate.

Assumption 2 [Deposit Insurance]. Deposits D are risk-free.

In order to study the bank's risk-taking decision at $t = 1$ and relate it to net profits from legacy assets π, we focus on the case in which, after the profit realization at $t = 1$, the bank remains solvent and active.

Assumption 3 [The Bank is Active]. $A + \pi \geq D$.

At $t = 1$, after receiving the profits π, the bank makes investment decisions and chooses the new amount of risky assets I' and safe assets M'. Our empirical setting focuses on bank risk taking on the asset side. Therefore, for simplicity, we assume that equity and deposits are in fixed supply, i.e., we assume that at $t = 1$, the bank cannot issue external equity and repay or receive additional deposits. Thus, at $t = 1$, the bank faces the following budget constraint: $A' \equiv A + \pi$, where $A' = I' + M' + \delta$, where $\delta \geq 0$ is an intertemporal dividend.[30]

Finally, at $t = 2$, profits $\pi' \equiv (R' - 1) \cdot I'$ are realized, where R' is the gross return on assets between $t = 1$ and $t = 2$. R' is a random variable with the same support, the same p.d.f., and the same c.d.f. as R. After the realization of profits at $t = 2$, the bank ends its operations. Deposits are repaid, and shareholders receive a liquidating dividend δ'. If the bank is solvent at $t = 2$, i.e., if $A' + \pi' - D \geq 0$, then $\delta' = A' + \pi' - D$. We assume that bank shareholders are protected by limited liability.

Assumption 4 [Limited Liability]. $\delta' = \max\{A' + \pi' - D, 0\}$.

When making investment decisions at $t = 1$, the bank must comply with risk-sensitive equity capital requirements. In computing capital requirements, the regulator applies risk weights equal to $\rho \in (0, 1]$ to risky assets I' and risk weights of zero to safe assets. Because investment decisions occur after the realization of profits at $t = 1$, the bank's ratio of equity $E' \equiv E + \pi - \delta$ to risk-weighted assets $\rho \cdot I'$ must not exceed a regulatory threshold $k \in (0, 1]$.

Assumption 5 [Capital Requirements]. $\frac{E'}{\rho \cdot I'} \geq k$.

[30] It is straightforward to show that, in this stylized setup, banks never optimally pay dividends at $t = 1$, i.e., $\delta = 0$. Intuitively, because of risk neutrality and risky assets being more profitable ex ante than safe assets, the bank is never better off paying out early.

The Bank's Optimization Problem. The bank maximizes its market value of equity, i.e., the discounted expected value of cash flows at $t = 1$, that is

$$\max_{I',M'} \int_0^\infty \big(\delta + \max\{A' + \pi' - D, 0\}\big)\, dF(R'), \tag{A5}$$

subject to capital requirements $\frac{E'}{\rho \cdot I'} \geq k$ and to the budget constraint $A' = A + \pi$. The following lemma establishes that the bank objective can be restated as "searching for yield", i.e., investing as much as possible in the risky asset to maximize the expected return on the bank's portfolio.

Lemma 1 [Search for Yield]. The objective function can be rewritten as

$$\max_{w'} E' \cdot \int_{R'_{LL}}^{\infty} \left(1 + \frac{r'_P}{\frac{E'}{A'}}\right) dF(R') \tag{A6}$$

where $w' \equiv \frac{I'}{A'} \in [0, 1]$ is the portfolio weight in risky assets, $R'_{LL} \equiv 1 - \frac{E'}{I'}$ is the maximum realized gross return that triggers bank default, and $r'_P \equiv w'(R' - 1)$ is the realized net rate of return on the bank portfolio.

Lemma 1 highlights the key economic tradeoff of the model. The benefit of risk-taking (high w') is to yield high average expected returns, but it absorbs the scarce equity capital necessary to satisfy capital requirements. The definition of R'_{LL} reflects limited liability, which protects shareholders from realizations of R' at $t = 2$ that deplete the entire buffer of equity capital E'.

Leverage Policy. As the bank's objective in (A6) highlights, the bank maximizes the expected levered return on equity in the solvency states. Because of deposit insurance, the interest rate on deposits is not sensitive to risk-taking. Leverage boosts returns on assets in good times, while in bad times, the bank is protected by limited liability, and its cost of funding does not increase because of deposit insurance. The following proposition shows that capital requirements are always binding, i.e., the bank chooses the minimum capital ratio to comply with capital regulation.

Proposition 1 [Maximum Leverage]. Capital requirements are never slack in correspondence of the optimal choice of w', i.e., $\frac{E'}{\rho \cdot I'} = k$.

Risk-Taking Behavior. Although risky assets can perform badly in some states of the world, ex ante risky investments maximize the market value of the bank for equityholders due to the risk–return tradeoff. As several models in the banking literature predict, deposit insurance creates a moral hazard problem that leads bankers to take risks because they do not fully internalize their cost. This moral hazard problem ultimately provides a rationale for risk-sensitive capital regulation. The following proposition characterizes the optimal bank risk-taking behavior.

Proposition 2 [Risk-Taking]. The portfolio weight w' in the risky asset:

i) increases in the capital E' available before investment at time $t = 1$;

ii) increases in the realized return (profitability) of legacy assets R; and

iii) decreases with risk-absorbed capital $\rho \cdot k$, with risk weights ρ, and with the threshold k, thus indicating that higher capital requirements have a prudential effect.

Part i) establishes that, because capital is a scarce resource, the capital available at the time of investment determines the bank's capacity to take risks in the presence of capital constraints. Part ii) shows that risk-taking increases with the performance of legacy risky assets, in that profits from existing investments help the bank build scarce internal equity to support risky investments. Finally, part iii) establishes that higher capital requirements in this partial equilibrium setting provide shareholders with more "skin in the game", which increases the losses they internalize in bad times and thus has a prudential effect. Observe that higher capital requirements can be driven both by the threshold k and by asset-specific risk weights ρ. In this stylized context, to the extent that stress tests increase risk weights from ρ to $s \cdot \rho$, $s > 1$, they increase the capital absorbed by risky investments and thus have a prudential effect.

Finally, Proposition 3 describes how the fraction of legacy risky assets, i.e., initial fraction of risky assets over assets $w \equiv \frac{I}{A}$, affects bank risk-taking. Proposition 3 maps onto the information set of the econometrician in our empirical analyses, in which differences in average risk weights between stressed and non-stressed banks before the DFA confound the direct effect of supervision.

Proposition 3 [Risk-Taking Response to Risk-Weighted Assets]. The portfolio weight w' in the risky asset

i) increases with the fraction of risky legacy assets w if legacy risky assets are profitable, i.e., for $R > 1$;

ii) decreases with the fraction of risky legacy assets w if legacy risky assets are not profitable, i.e., for $R < 1$.

The previous proposition shows that riskier assets (i.e., higher w) boosts bank income in good times ($R > 1$) and depresses it in bad times ($R < 1$). As long as existing risky assets are profitable, riskier assets help banks build internal equity and support their "business model" with additional risk-taking.

Proof of Lemma 1. It is straightforward to verify that $A' + \pi' - D = E'\left(1 + \frac{r'_P}{\frac{E'}{A'}}\right)$. Since $A' + \pi' - D$ is strictly increasing in R', R'_{LL} is the maximum value of R' for which the bank defaults, in correspondence of which $A' + \pi' - D = 0$. Because $\forall R' \leq R'_{LL}$, $\delta' = 0$, and $\forall R' > R'_{LL}$ $\delta' = E'\left(1 + \frac{r'_P}{\frac{E'}{A'}}\right)$, the integral in (A5) can be rewritten as in (A6). Finally, notice that $\delta = 0$. If $\delta > 0$, then the bank could invest δ in risky assets without violating budget constraints and capital requirements and obtain $\delta \cdot E[R] > \delta$, which contradicts the optimality of $\delta > 0$. ■

Proof of Proposition 1. First, we establish that the objective function (A6) is monotone in w'. Differentiating (A6) with respect to w' and applying the Liebniz integral rule yields $\int_{R'_{LL}}^{\infty} (R' - 1) \cdot A' \cdot dF(R')$, which can be rewritten as

$$A' \left(\int_0^{\infty} R' \cdot dF(R') - \int_0^{R'_{LL}} R' \cdot dF(R') - \int_{R'_{LL}}^{\infty} dF(R') \right). \tag{A7}$$

Since $\int_0^{R'_{LL}} R' \cdot dF(R') \geq \int_0^{R'_{LL}} R'_{LL} \cdot dF(R')$, (A7) is greater than or equal to

$A'\left(\int_0^{\infty} R' \cdot dF(R') - R'_{LL} \int_0^{R'_{LL}} dF(R') - \int_{R'_{LL}}^{\infty} dF(R')\right)$, which, using the definition of R'_{LL}, can be expressed as

$$A' \left(\int_0^{\infty} R' \cdot dF(R') + F(R'_{LL}) \frac{E'}{I'} - 1 \right) \geq A' \left(\int_0^{\infty} R' \cdot dF(R') - 1 \right),$$

where the inequality follows from $F(R'_{LL})\frac{E'}{I'} \geq 0$ because, by the capital requirement $\frac{E'}{I'} \geq \rho \cdot k > 0$. Thus,

$$\frac{\partial}{\partial w'} E' \int_{R'_{LL}}^{\infty} \left(1 + \frac{r'_P}{\frac{E'}{A'}}\right) dF(R') \geq A' \left(E[R] - 1\right),$$

which establishes the monotonicity of (A6) in w' by Assumption 1. Now let us suppose that capital requirements were not binding, i.e., $\exists\, \widetilde{w'} \in [0,1]$, such that the capital constraint is slack. Then, the bank could increase w' above $\widetilde{w'}$ and increase its objective function without violating the capital constraint, thus contradicting the optimality of $\widetilde{w'}$. ■

Proof of Proposition 2. Because at the optimum, capital constraints are never slack, then

$$w' = \frac{\frac{E'}{A'}}{\rho \cdot k} = \frac{E + \pi}{\rho \cdot k \cdot A'} = \frac{E + (R-1) \cdot I}{\rho \cdot k \cdot A'},$$

from which i), ii) and iii) clearly follow. ■

Proof of Proposition 3. The optimal portfolio weight w' can be rewritten as

$$w' = \frac{E + \ (R-1) \cdot \ w \cdot (D+E)}{\rho \cdot \ k \cdot (D + E + (R-1) \cdot w \cdot (D+E))}.$$

Differentiating with respect to w yields

$$\frac{\partial}{\partial w} \frac{E + \ (R-1) \cdot \ w \cdot (D+E)}{\rho \cdot k \cdot (D + E + (R-1) \cdot w \cdot (D+E))} = \frac{D}{\rho \cdot k \cdot (D+E)} \frac{R-1}{(w(R-1)+1)^2},$$

which is increasing in R, positive for $R > 1$, and negative for $R < 1$. ■

D. Variable Definitions

- $Advanced_b$: a binary equal to 1 if bank b uses the advanced internal rating based approach to determine its regulatory risk weights. Data source: annual CCAR reports.
- $allindrawn_{ft}$: the spread, in basis points, paid by borrower f over the LIBOR rate (plus any annual, or facility-related, fee paid to the bank group) to the bank for each dollar drawn down in a facility issued at date t. Data source: DealScan.
- $amount_{fbt}$: the USD amount lent by bank b to firm f in a facility issued at date t, where $amount_{fbt} = bankallocation_{bft} * facilityamount_{ft} * exchangerate_{ft}$. Data source: DealScan.
- Asset Income: net income plus interest expenses divided by the total assets of bank b in quarter t. Data sources: quarterly FR Y-9C reports from SNL.
- Assets: Average total assets. Data source: quarterly FR Y-9C reports from SNL.
- Average Bank Allocation: the average fraction of the loan amount allocated by a bank in a syndicated loan facility on the portfolio of new syndicated loans (new facilities) that a bank participates in in a given quarter. Data source: DealScan.
- Average Maturity: the weighted average maturity (in months) of the portfolio of new syndicated loans (new facilities) that a bank participates in in a given quarter, with weights given by the bank's loan amounts (in USD) to each firm within the quarter. Data source: DealScan.

- Average Rating: the weighted average firm's numerical rating (1 is AAA; 23 is D) on the portfolio of new syndicated loans (new facilities) that a bank participates in in a given quarter, with weights given by the bank's loan amounts (in USD) to each firm within the quarter. Data sources: DealScan and Compustat.
- Average regulatory risk weight: the ratio of the bank's risk-weighted assets to its bank total assets. Data source: quarterly FR Y-9C reports from SNL.
- Average Yield: the weighted average all-in-drawn spread (in bps) of the portfolio of new syndicated loans (new facilities) that a bank participates in in a given quarter, with weights given by the bank's dollar loan amounts to each firm within the quarter. Formally, the portfolio yield on new loans of bank b in quarter t is defined as

$$portfolio\,yield_{bt} = \sum_{f,\tau \in t} \frac{bankallocation_{bf\tau} * facilityamount_{f\tau} * exchangerate_{f\tau} * allindrawn_{f\tau}}{\sum_{f,\tau \in t} bankallocation_{bf\tau} * facilityamount_{f\tau} * exchangerate_{f\tau}},$$

  where, for all dates $\tau \in t$ (DealScan item "FacilityStartDate"), $bankallocation_{bf\tau}$ is the fraction of the loan amount allocated by bank b in the syndicated loan to firm f, $facilityamount_{f\tau}$ is the total amount the syndicate lends to firm f at date τ, $exchangerate_{f\tau}$ is the exchange rate applied to the amount lent to firm f at date τ (equal to 1 if the loan is denominated in USD), and $allindrawn_{f\tau}$ is the all-in-drawn spread charged to firm f at date τ. Data source: DealScan.
- $bankallocation_{bft}$: the fraction of the loan amount allocated by bank b in the syndicated loan to firm f issued at date t. Data source: DealScan.
- Bank-level control variables ($controls_{bt}$): bank-specific control variables include the logarithm of the bank's total assets, the ratio of liquid assets to total assets, the ratio of bank net income to total assets, the ratio of trading assets to total assets, the weighted average portfolio maturity, and the percentage of secured loans of the bank. Data source: quarterly FR Y-9C reports from SNL.
- Bid–Ask Spread: the average bid–ask spread of a facility on the secondary loan market. Data source: Loan Syndications and Trading Association (LSTA).
- $Cap\,req_{bt}$: the effective capital requirement of bank b at time t as a percentage of the total assets of bank b, considering all minimum capital ratio requirements the bank faces. It is the amount of capital a bank effectively must set aside to comply with all regulations and supervisory exercises (*including* stress tests) as a percentage of the bank's total assets. Data sources: quarterly FR Y-9C reports from SNL, annual CCAR reports.
- $Cap\,req^*_{bt}$: the effective capital requirement of bank b at time t as a percentage of the total assets of bank b, considering all minimum capital ratio requirements the bank faces while ignoring the effect of stress tests on the effective capital requirement. It is the amount of capital a bank effectively must set aside to comply with all regulations and supervisory exercises (*excluding* stress tests) as a percentage of the bank's total assets. Note that for stressed banks before the DFA and for non-stressed banks, $Cap\,req^*_{bt} = Cap\,req_{bt}$. Data sources: quarterly FR Y-9C reports from SNL, annual CCAR reports.
- CET1: Common equity Tier 1 capital. Data source: quarterly FR Y-9C reports from SNL.
- $CET1R$: ratio of common equity Tier 1 capital to risk-weighted assets. Data sources: quarterly FR Y-9C reports from SNL, annual CCAR reports.
- $CET1R_{stress}$: minimum ratio of common equity Tier 1 capital to risk-weighted assets over the stress scenario horizon. Data sources: annual CCAR reports.
- $controls_{fbt}$: includes the loan-level control variables and bank-level control variables (as defined above) interacted with $Firm\,risk_{ft}$. Data sources: quarterly FR Y-9C reports from SNL, Compustat.
- DFA_t: a binary variable equal to 1 if quarter t is after the fourth quarter of 2010.
- $exchangerate_{ft}$: the exchange rate applied to the amount lent to firm f at date t (equal to 1 if the loan is denominated in USD). Data source: DealScan.
- $facilityamount_{ft}$: the total amount the syndicate lends to firm f in a facility issued at date t. Data source: DealScan.

- $Firm\,risk_{ft}$: a measure describing the risk of borrower f at date t. In most specifications, it is the firm's numerical rating (1 is AAA; 23 is D). Data source: Compustat.
- Lender Role FE: fixed effects that indicate the role of the bank (participant, co-agent, admin agent, documentation agent, arranger, agent, syndications agent, mandated lead arranger, managing agent, senior managing agent, manager co-arranger, lender packager, lead manager, senior lead manager, co-syndications agent, funding bank, collateral agent, or bookrunner) in the syndicated loan facility. Data source: DealScan.
- Loan Characteristics FE: fixed effects that indicate the loan type (364-day facility, revolver/line $<$ 1 yr., revolver/line $>=$ 1 yr., term loan A,B,C, or D; delay draw term loan, bridge loan, synthetic lease, revolver/term loan, acquisition facility, other loan) and the primary purpose of the loan. Data source: DealScan.
- Loan Income: Interest and fee income on loans. Data source: quarterly FR Y-9C reports from SNL.
- Loan-level control variables: these variables include the loan maturity, a binary variable that indicates whether the loan is secured, and fixed effects for loan types and purposes. Data source: DealScan.
- Loans: total loans. Data source: quarterly FR Y-9C reports from SNL.
- $Lvg\,constraint_{bt}$: the capital requirement of bank b at time t considering only the minimum required regulatory capital ratio defined as a percentage of the bank's total assets (i.e., the Tier 1 leverage ratio, which is the ratio of Tier 1 capital to the bank's total assets). For stressed banks, $Lvg\,constraint_{bt}$ also incorporates the additional amount of capital a bank must set aside to pass the stress test based on the Tier 1 leverage ratio requirement. Data source: annual CCAR reports.
- $LVGR$: the ratio of Tier 1 capital to the average total assets. Data source: quarterly FR Y-9C reports from SNL.
- $LVGR_{stress}$: the minimum ratio of Tier 1 capital to average total assets over the stress scenario horizon. Data sources: annual CCAR reports.
- Net Interest Income: interest income minus interest expenses. Data source: quarterly FR Y-9C reports from SNL.
- Proportion of Lead Bank Loans: the proportion of loans for which the bank has a major role in the syndicate (reported in DealScan as "admin agent", "lead bank", "agent", "arranger", "lead manager", "bookrunner", or "lead arranger") on the portfolio of new syndicated loans (new facilities) a bank participates to in a given quarter. Data source: DealScan.
- Proportion of Secured Loans: the proportion of loans that are collateralized on the portfolio of new syndicated loans (new facilities) a bank participates in in a given quarter. Data source: DealScan.
- Rated: a binary variable that indicates whether the firm has a rating assigned in Compustat. Data source: Compustat.
- Retained Net Income: Net income minus total dividends declared. Data source: quarterly FR Y-9C reports from SNL.
- $risk\,taking_{bt}$: a measure of risk-taking for bank b in quarter t. Data sources: Compustat, DealScan.
- $Risk\,weight\,exposure_{bt}$: the percentage deviation of the effective capital requirement $Cap\,req_{bt}$ of bank b at time t from its leverage constaint $Lvg\,constraint_{bt}$. Data sources: quarterly FR Y-9C reports from SNL, annual CCAR reports.
- RWA: Risk-weighted assets. Data source: quarterly FR Y-9C reports from SNL.
- $stressed_b$: a binary variable equal to 1 if bank b belongs to the group of stressed banks as defined in Section 3.2.2.
- $Stress\,test\,exposure_{bt}$: the percentage deviation of the effective capital requirement $Cap\,req_{bt}$ of bank b at time t from the effective capital requirement $Cap\,req^*_{bt}$ that a stressed bank would face in the absence of stress tests. Data sources: quarterly FR Y-9C reports from SNL, annual CCAR reports.
- T1: Tier 1 capital. Data source: quarterly FR Y-9C reports from SNL.

- $T1R$: the ratio of Tier 1 capital to risk-weighted assets. Data sources: quarterly FR Y-9C reports from SNL, annual CCAR reports.
- $T1R_{stress}$: the minimum ratio of Tier 1 capital to risk-weighted assets over the stress scenario horizon. Data sources: annual CCAR reports.
- TA: total assets. Data source: quarterly FR Y-9C reports from SNL.
- Time on Balance Sheet: the difference between the date a facility loan is listed on the secondary market for the first time and the date the facility is issued. Data source: Loan Syndications and Trading Association (LSTA).
- Total: Total capital. Data source: quarterly FR Y-9C reports from SNL.
- $TotalR$: the ratio of total capital to risk-weighted assets. Data sources: quarterly FR Y-9C reports from SNL, annual CCAR reports.
- $TotalR_{stress}$: the minimum ratio of total capital to risk-weighted assets over the stress scenario horizon. Data sources: annual CCAR reports.
- $trend_t$: a linear trend variable, defined as $trend_t = \{1, 2, ..., t, ..., T\}$, where T is the number of quarters in the sample.
- $zScore_{ft}$: the Altman's Z-score of firm f. Data source: Compustat.

E. Supplementary Tables

Table A3
The Direct Effect of Supervision: Bank-Level Specifications

The table reports estimates from the regression:

$$
\begin{aligned}
risk\,taking_{bt} \;=\; & \alpha_b + \delta_t + \beta_1 stressed_b * DFA_t + \beta_2 stressed_b * DFA_t * Cap\,req_{bt} \\
& + \beta_3 Cap\,req_{bt} + \beta_4 stressed_b * Cap\,req_{bt} + \beta_5 DFA_t * Cap\,req_{bt} + \gamma' controls_{bt} + \epsilon_{bt},
\end{aligned}
$$

where $risk\,taking_{bt}$ is a measure of risk-taking for bank b in quarter t (i.e., the average rating of the bank portfolio of new loans in Panel A and the average yield of the bank portfolio of new loans in Panel B), α_b represent bank fixed effects, δ_t represents time (quarter) fixed effects, $stressed_b$ is a binary variable equal to 1 if bank b belongs to the group of stressed banks as defined in Section 3.2.2, DFA_t is a binary variable equal to 1 if quarter t is after 2010, and $Cap\,req_{bt}$ is the effective capital requirement of bank b in quarter t. Control variables include the logarithm of the bank's total assets, the ratio of liquid assets to total assets, the ratio of bank net income to total assets, the ratio of trading assets to total assets at the end of quarter $t-1$, as well as the weighted average portfolio maturity, and the percentage of the bank's secured loans in quarter t. All variables are defined in Section D of the Appendix. The sample is described in Section 3.2.2. t-statistics based on clustered standard errors at the bank level are in parentheses.

Panel A: Portfolio Rating				
$stressed_b * DFA_t$ (β_1)	0.716	0.696	-8.105	-7.063
	(1.33)	(1.62)	(-2.48)	(-1.76)
$stressed_b * DFA_t * Cap\,req_{bt}$ (β_2)			1.957	1.736
			(2.74)	(1.98)
$Cap\,req_{bt}$ (β_3)			1.502	1.518
			(1.64)	(1.54)
$stressed_b * Cap\,req_{bt}$ (β_4)			-1.273	-2.015
			(-1.41)	(-2.27)
$DFA_t * Cap\,req_{bt}$ (β_5)			-2.201	-1.242
			(-3.08)	(-1.29)
Controls	N	Y	N	Y
Bank and Time FE	Y	Y	Y	Y
R^2 (%)	53.84	64.98	55.52	66.38
Adjusted R^2 (%)	49.29	61.25	50.89	62.62
Observations	925	925	925	925
Banks	27	27	27	27

	Panel B: Portfolio Yield			
$stressed_b * DFA_t$ (β_1)	9.697	8.312	-196.748	-192.773
	(1.15)	(1.16)	(-4.16)	(-3.69)
$stressed_b * DFA_t * Capreq_{bt}$ (β_2)			42.959	42.224
			(4.18)	(3.60)
$Capreq_{bt}$ (β_3)			62.117	60.512
			(4.47)	(3.81)
$stressed_b * Capreq_{bt}$ (β_4)			-59.195	-57.036
			(-4.32)	(-3.74)
$DFA_t * Capreq_{bt}$ (β_5)			-46.175	-45.950
			(-4.60)	(-3.70)
Controls	N	Y	N	Y
Bank and Time FE	Y	Y	Y	Y
R^2 (%)	69.49	72.23	71.17	73.63
Adjusted R^2 (%)	66.89	69.68	68.59	71.09
Observations	1084	1084	1084	1084
Banks	29	29	29	29

Table A4
Parallel Trend Assumption: Inspection

The table reports estimates from the regression:

$$\begin{aligned}\log(amount_{fbt|DFA_t=0}) \quad = \quad & \alpha_{bt} + \alpha_{ft} + \beta_1 stressed_b * trend_t * Firm\,risk_{ft} \\ & + \beta_2 stressed_b * Firm\,risk_{ft} \\ & + \beta_3 Cap\,req_{bt} * Firm\,risk_{ft} \\ & + \beta_4 stressed_b * Cap\,req_{bt} * Firm\,risk_{ft} + \gamma' controls_{fbt} + \epsilon_{fbt},\end{aligned}$$

where the dependent variable $\log(amount_{fbt})$ is the logarithm of the USD amount lent by bank b to firm f in a loan issued at date t, α_{bt} represent bank$*$quarter fixed effects, α_{ft} represent firm$*$quarter fixed effects, and $trend_t$ is a linear trend variable, defined as $trend_t = \{1, 2, ..., t, ..., T\}$. $Firm\,risk_{ft}$, $Cap\,req_{bt}$, $stressed_b$, as well as loan-level and bank-level control variables are defined in Appendix D. The sample is described in Section 3.2.2. t-statistics based on clustered standard errors at the bank*quarter and firm*quarter level are in parentheses.

	log(amount) (before the DFA)			
$stressed_b * trend_t * Firm\,risk_{ft}$	0.002	0.003	0.005	0.006
	(0.32)	(0.75)	(1.06)	(1.27)
$stressed_b * Firm\,risk_{ft}$	0.022	0.021	0.504	0.291
	(0.15)	(0.17)	(2.58)	(1.13)
$Cap\,req_{bt} * Firm\,risk_{ft}$			0.144	0.088
			(4.41)	(2.23)
$stressed_b * Cap\,req_{bt} * Firm\,risk_{ft}$			-0.122	-0.072
			(-3.69)	(-1.71)
Loan-Level Controls	N	Y	N	Y
Bank-Level Controls*Firm Risk	N	Y	N	Y
Firm*Time FE	Y	Y	Y	Y
Bank*Time FE	Y	Y	Y	Y
Loan Characteristics FE	N	Y	N	Y
R^2 (%)	74.01	75.46	74.27	75.51
Adjusted R^2 (%)	67.49	69.17	67.80	69.23
Observations	12253	12253	12253	12253
Bank*Time	480	480	480	480
Firm*Time	1977	1977	1977	1977

Table A5
Selection Bias: Selection on Unobservables and Coefficient Stability

The table is a replica of Table 2, in which we include additional controls and fixed effects, and study the stability of estimated parameters using the approach described by Altonji, Elder, and Taber (2005) and by Oster (2017).

	log(amount)				
$stressed_b * DFA_t * Firm\,risk_{ft}$ (β_1)	-1.753	-0.773	-0.742	-0.948	-0.951
	(-9.02)	(-3.17)	(-3.15)	(-3.18)	(-3.29)
$stressed_b * DFA_t * Cap\,req_{bt} * Firm\,risk_{ft}$ (β_2)	0.353	0.148	0.140	0.229	0.188
	(8.52)	(2.92)	(2.82)	(3.15)	(2.67)
$Cap\,req_{bt} * Firm\,risk_{ft}$ (β_3)	0.150	0.144	0.126	0.264	0.234
	(5.57)	(3.38)	(3.04)	(3.23)	(3.29)
$stressed_b * Cap\,req_{bt} * Firm\,risk_{ft}$ (β_4)	-0.129	-0.140	-0.129	-0.252	-0.226
	(-4.63)	(-3.11)	(-3.00)	(-3.04)	(-3.14)
$DFA_t * Cap\,req_{bt} * Firm\,risk_{ft}$ (β_5)	-0.369	-0.149	-0.139	-0.240	-0.197
	(-9.06)	(-2.98)	(-2.81)	(-3.33)	(-2.81)
$stressed_b * Firm\,risk_{ft}$ (β_6)	0.689	0.786	0.711	0.627	0.665
	(5.05)	(3.43)	(3.27)	(2.07)	(2.36)
Loan-Level Controls	N	Y	Y	Y	Y
Bank-Level Controls*Firm risk	N	Y	Y	Y	Y
Firm*Time FE	Y	Y	Y	Y	Y
Bank*Time FE	Y	Y	Y	Y	Y
Loan Characteristics FE	N	Y	Y	Y	Y
Lender Role FE	N	N	Y	N	Y
Bank*Firm FE	N	N	N	Y	Y
R^2 (%)	73.28	74.66	79.87	82.98	84.92
Adjusted R^2 (%)	66.88	68.51	74.96	68.04	71.65
Observations	18144	18144	18144	18144	18144
Bank*Time	840	840	840	840	840
Firm*Time	2658	2658	2658	2658	2658
Bank*Firm	-	-	-	4940	4940

Table A6
Selection Bias: Removing the Largest Treated Banks and the Smallest Control Banks

The table is a replica of Table 2, in which the largest and smallest banks in our sample have been excluded. Specifically, we exclude banks with more than USD 800 billion in assets at the end of 2010 (Bank of America Corporation, JPMorgan Chase and Co., Citigroup Inc., Wells Fargo and Company, Goldman Sachs Group, Inc., and Morgan Stanley), and we also exclude banks with total assets below USD 20 billion.

	log(amount)	
$stressed_b * DFA_t * Firm\,risk_{ft}$ (β_1)	-1.114	-1.115
	(-3.98)	(-4.66)
$stressed_b * DFA_t * Cap\,req_{bt} * Firm\,risk_{ft}$ (β_2)	0.245	0.249
	(3.97)	(4.68)
$Cap\,req_{bt} * Firm\,risk_{ft}$ (β_3)	0.159	0.266
	(10.38)	(5.58)
$stressed_b * Cap\,req_{bt} * Firm\,risk_{ft}$ (β_4)	-0.163	-0.265
	(-9.60)	(-5.54)
$DFA_t * Cap\,req_{bt} * Firm\,risk_{ft}$ (β_5)	-0.231	-0.240
	(-3.74)	(-4.51)
$stressed_b * Firm\,risk_{ft}$ (β_6)	0.740	1.253
	(10.42)	(5.52)
Loan-Level Controls	N	Y
Bank-Level Controls*Firm risk	N	Y
Firm*Time FE	Y	Y
Bank*Time FE	Y	Y
Loan Characteristics FE	N	Y
R^2 (%)	73.36	74.84
Adjusted R^2 (%)	60.13	62.07
Observations	6997	6997
Bank*Time	541	541
Firm*Time	1776	1776

Table A7
Selection Bias: Supervision Treatment Among Stressed Banks

This table reports estimates from the regression:

$$\log(amount_{fbt|DFA_t=1,stressed_b=1}) = \alpha_{bt} + \alpha_{ft} + \beta_1 Advanced_b * Firm\,risk_{ft} + \beta_2 Advanced_b * Cap\,req_{bt} * Firm\,risk_{ft} + \beta_3 Cap\,req_{bt} * Firm\,risk_{ft} + \gamma' controls_{fbt} + \epsilon_{fbt},$$

where $Advanced_b$ is equal to 1 for a bank that uses the advanced internal rating-based approach to determine its regulatory risk weights. The sample is restricted to post-DFA observations for stressed bank holding companies that participated in all CCARs. t-statistics based on clustered standard errors at the bank*quarter and firm*quarter level are in parentheses.

	log(amount)		
$Advanced_b * Firm\,risk_{ft}$	-0.03	-0.11	-0.48
	(-2.95)	(-1.70)	(-2.28)
$Advanced_b * Cap\,req_{bt} * Firm\,risk_{ft}$		0.01	0.00
		(1.35)	(0.35)
$Cap\,req_{bt} * Firm\,risk_{ft}$		-0.01	0.00
		(-0.66)	(0.21)
Loan-Level Controls	N	N	Y
Bank-Level Controls*Firm risk	N	N	Y
Firm*Time FE	Y	Y	Y
Bank*Time FE	Y	Y	Y
Loan Characteristics FE	N	N	Y
R^2 (%)	69.48	69.53	71.69
Adjusted R^2 (%)	63.68	63.72	66.14
Observations	8728	8728	8728
Bank*Time	354	354	354
Firm*Time	1040	1040	1040