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Bank Profitability, Solvency and Risk in the Context of Stress Tests, Payout Policy and Bank Cost Structures

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Pamplona, 05 de diciembre de 2020

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Memoria presentada por Dª Sylvia B. Sadakova para aspirar al grado de Doctor por la Universidad de Navarra

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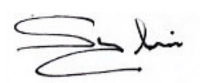

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Contents

List of Tables

List of Figures

To my family.

Скъпо мое семейство,

Без Вас, вашите обич, подкрепа и жертви, този момент не би бил възможен.

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0

Introduction

"Bank Risk" is a term we have come to associate with crises, and one we have become accustomed to often hearing in recent years. And while not always the villain it is portrayed to be, risk-taking within financial institutions is an important component and a strong determinant of how economies evolve.

Risk-taking in the banking sector is a key decision-making strategy and is essential for enhancing bank profitability and value (Stulz, 2015). However, excessive or unhealthy risk appetite levels could quickly become problematic for the bank itself, and if such practices are wide-spread enough for the increasingly connected global economy. Such undue risk-taking threatens the safety and soundness of individual institutions as well as the stability of the entire financial sector (Srivastav and Hagendorff, 2016). The Global Financial Crisis is a perfect example of just how important risk-governance mechanisms really are. A well-governed bank will have mechanisms to identify its optimal level of risk and make sure that there is not an excessive divergence from this figure. These mechanisms will support managers in making important, value-maximizing, risk/reward trade-offs while ensuring that they comply with all banking regulations (Stulz, 2015). Yet still, despite central banks' countless efforts (and large successes) in improving risk practices and controls and the overall health of the financial systems they govern, excessive risk-taking has not been fully mitigated. If there is one lesson to walk away with following the Global Financial Crisis, it should be that banks can wreak unimaginable havoc via the decision-making within their boards. But, competition, the macroeconomic environment, market pressure, bank-specific factors, and business model characteristics have all played a part in forcing banks to develop creative strategies to improve profitability while at the same inhibiting banks' ability to do so. Ultimately, few viable options remain, one being increasing risk-taking oftentimes to levels far beyond manageable.

While bank risk is by no means the sole focus of my work, through various measures and interpretations, it forms the basis for all three chapters that follow. This thesis's primary focus is to explore the drivers of risk-taking strategies. In particular, throughout the chapters that follow, we explore profitability, solvency, risk-taking, and lending quality implications in the context of the (1) US supervisory stress-testing framework, (2) dividend payout policies, and (3) business model characteristics. This thesis aims to shed light on how fairly recent developments in the U.S. regulatory framework, financial system, and bank business models influence bank decision-making and whether and how such decisions impact the financial system's overall stability and resiliency. The chapters that follow provide ample evidence that bank-specific characteristics, along with regulatory and macroeconomic conditions, play a crucial role in the financial industry's overall health and, consequently, of the real economy.

Chapter 1 explores how the US stress testing framework and the - extensively prevalent around most of the world - low-interest-rate policies play into the greater scope of financial stability and system-wide resiliency. In particular, we examine the impact of the Federal Reserve's Stress Tests on future risk-taking and bank solvency using data on US Bank Holding Companies spanning 1994 to 2016 with emphasis on the period after 2009.

Our results suggest that stress tests do not hinder the risk-appetites of ex-ante risk-tolerant banks and that the ex-ante safer banks primarily drive the positive effects of stress tests on bank solvency. We find that the projected capital buffers under the stress test exercises influence how financial soundness and risk-taking evolve. In particular, our results indicate that banks with capital shortfalls exhibit higher future risk-taking in comparison with banks with projected capital levels that are considered adequate by Regulatory and Supervisory agencies; We further extend these analyses to include the impact of the interest rate environment under which banks operate and find that safer banks are more likely to mitigate decreased profitability by increasing risk-taking when interest rates are low. We also find that Bank liquidity risk, market risk, and the loan portfolio size are negatively associated with stress test results. The results are consistent with previous studies and provide evidence that banks' risk appetite is not fully mitigated under the stress testing framework. To the best of our knowledge, this is the first empirical evaluation of how bank risk-taking and solvency evolve in the context of stress-testing and the monetary environment under which banks operate. Our study further examines how banks have adjusted to higher capital requirements and is the first to document different adjustment channels among banks with different stress test results.

While we find that the stress-testing framework has substantially contributed to strengthening the financial system since the onset of the Global Financial Crisis, our analyses suggest that more regulatory and supervisory effort is needed, especially for banks with generally weak financial conditions and/or overly ambitious risk-taking strategies; and especially now, in a period characterized by deficient profitability levels stemming from, on one side excessively low-interest rates, and competition on the other. And while banks have managed to develop creative solutions to surpass the monetary policy roadblocks, the predominant answer for many seems to be in bearing more risks. While the debate on monetary policy swings from one extreme to the other, chapter 1 adds to the fine print on the potential costs of the prevalent low-interest-rate stances worldwide.

Chapter 2 extends the analyses of risk-taking, solvency, and bank profitability into the managerial decision-making sphere. In particular, we aim to explain payout policy decisions in the context of future performance. In a comparative framework, using a sample of US Bank Holding Companies, Commercial Banks, and Credit Unions, spanning 1994-2017, we investigate the relationship between Dividend Policy with Future Profitability, Risk-Taking, and Solvency. Our results suggest that: (1) Banks keep dividends even when future profitability is expected to be poor. (2) Dividends are high when future risk-taking is high. (3) Dividends are negatively associated with future solvency. (4) Dividend changes and initiations in BHCs seem to be made only in extreme circumstances. Our findings primarily point to managerial overconfidence or market pressure, both of which lead to risk-shifting and increase information asymmetry among banks.

Despite the post-crisis efforts to improve payout practices among banks, our results suggest key areas of the dividend decision-making still lag. Given the deficient profitability levels and the recent history of risk-shifting, chapter 2 adds value for policy-making concerned with dividends within banks, especially in light of these recent practices, debate, and restrictions on bank payouts.

In the final chapter of this text, and motivated by the ongoing media coverage surrounding cost-cutting as one of few saviors for the predominantly low profitability across the banking sector, we analyze whether cost-cutting is in itself a cost to be, eventually, bore by banks. In Chapter 3, we rely on a sample of US Bank Holding Companies, spanning 1997 to 2010, to examine the determinants of lending quality. In particular, we analyze: (1) Whether bank cost structure influences the relation between lending growth and lending quality. (2) Whether lending growth dynamics influence lending quality and (3) What are the determinants of bank efficiency. Our findings suggest that cost structure affects lending quality via two primary channels: (1a) while lending growth is associated with increases in non-performing loans, this relation is lower among banks with more rigid cost structures; (1b) while short-run cost increases reduce non-performing loans, this relation is stronger among banks with more rigid cost structures; (2) lending growth in more recent years have a greater negative impact on lending quality, especially in periods of rapid lending growth; and (3) short-run cost changes harm operational efficiency. To the best of our knowledge, this is the first empirical evaluation of how bank cost characteristics influence the relation between lending growth and lending quality and how lending growth dynamics influence lending quality.

As history is known for repeating itself, cost-cutting, in the form of reductions in fixed assets (branches and staff) could have severe implications for financial stability; once the current credit expansion comes to a halt and the amount of non-accrual loans begin to accumulate, as is generally the case during recessions. Furthermore, the online banking market, which relies on a much lower proportion of fixed cost than its traditional counterparts, has been steadily gaining traction in the last several years. While data is scarce for online banks, chapter 3 suggests that such business models, which rely on few, if any, operational premises, would have relatively high levels of non-performing loans in the financial system. The low-interest rate and bank profitability environment is forcing banks to rethink their business models. It would not be surprising if, in the near future, a large proportion of physical banks either merge or go digital to survive. As the proportion of online banks catches up to or surpasses the proportion of traditional banks, their lending strategies would naturally have a tremendous impact on system-wide stability. Sub-par lending practices in such institutions will come at the expense of the real economy.

While the three analyses that form the basis of this dissertation take approaches from vastly distinct angles, the conclusions are much the same: Bank characteristics and decision-making play a crucial role in the economy's overall health. The current macroeconomic conditions, competition, ever-evolving smarter business models, and increasing market pressure have forced banks to grasp for survival. Still, all-too-familiarly, this could come at the expense of the health of entire economies.

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1

Supervisory Stress Tests and Bank Risk-Taking

with Dr. Germán López Espinosa

1.1 Introduction

In the midst of the financial crisis of 2007, Ben Bernanke testified that 12 of the 13 most influential U.S. financial institutions faced an imminent threat of failure. Ultimately, 13 of the 25 largest institutions either failed, required government assistance, merged or changed their business structure to avoid failure (Gorton, 2015). The surge in bank failures, coupled with an unstable economic environment, led to rising concerns that a few large banks' failures could cause the failure of the entire financial system. This rekindled the controversy over bank capital adequacy and heightened the urgency for regulatory improvements, especially at the largest banking institutions.

In the aftermath of these events, policy-makers, both in the U.S. and Europe, realized that existing prudential regulation mechanisms were insufficient. As a result, a set of key capital and other regulations have been enacted, including the Basel III capital and liquidity frameworks and the various Federal Reserve stress-testing programs. Stress tests, one of many risk management tools until then, took center stage in the bank regulatory and supervisory toolkit. Stress-testing provides a mechanism through which the performance and viability of large and systematically important financial institutions and the resilience of the financial system can be assessed and reinforced. These exercises' aim was twofold: First, they would anticipate, limit the severity and frequency of and, ultimately, prevent future adverse episodes; and second, they would provide a means of assessing and communicating to the public the health of the financial system.

In the U.S., stress tests comprise three different exercises. The Supervisory Capital Assessment Program (SCAP) was conducted in 2009. Following SCAP's success, the Comprehensive Capital Analysis and Review (CCAR) was implemented in 2011, and the Dodd-Frank Stress Tests (DFAST), a complement of CCAR, was implemented in 2013. Both CCAR and DFAST became the prominent elements in the supervisory arsenal and have been conducted annually since their inception[1]. Both CCAR and DFAST rely on similar processes, data, supervisory exercises, and requirements (Federal Reserve, 2014). They are implemented to address the requirements set forth by the Dodd-Frank Act (DFA) and the associated Capital Plan Rule (CPR).

Our analysis' primary focus is on the CCAR stress tests[2]. It is conducted by the Federal Reserve to quantitatively determine whether the largest bank holding companies (BHCs) can withstand a severe downturn and whether sufficient capital and continuous lending would persist under adverse, but plausible, future macroeconomic developments and scenarios (such as another crisis, equal to, or worse than, in relative magnitude to the financial crisis of 2007-2009); and to qualitatively assess whether banks have adequate, forward-looking risk management strategies and whether the bank's planned dividend payments would erode its capital (Federal Reserve, 2015). CCAR stress tests are considered the most stringent capital requirement that acts to constrain the capital allocation decisions of banks with insufficient capital levels.

The exercises are based on a forward-looking, hypothetical, severe, economic downturn spanning nine quarters (the first being the one directly preceding the stress test horizon) that play a critical role in ensuring effective risk management and understanding how economic cycles affect risk-based capital requirements, assets, and liabilities across business lines. The annual exercises help estimate the likely losses that financial institutions may suffer under exceptional but plausible scenarios. They are intended to improve the overall financial stability, enhance transparency, and increase

[1] The original Federal Reserve CCAR stress test was applied to the 19 largest banks with assets exceeding $100 billion. The 2016 round of Federal Reserve stress tests included 33 bank holding companies with assets of at least $50 billion. Also, the Dodd-Frank Act Stress Testing (DFAST) requires that all federally-regulated financial institutions with assets above $10 billion conduct annual company-run stress tests.

[2] DFAST is complementary to the CCAR exercise and serves to inform the Federal Reserve, the financial companies, and the general public, how these institutions' capital ratios might change in case of adverse economic conditions. It relies on the same set of information, and the results are identical to those of CCAR. However, DFAST is adapted as an informative tool, rather than as an enforcement mechanism.

market discipline (Tarullo, 2010; Bernanke, 2013; Goldstein and Sapra, 2014). It is important to note that, although these exercises are instrumental in the recapitalization of weak banks, whether they are successful in meeting stability objectives would not become fully apparent absent any adverse conditions or crisis. However, an evaluation of the consequences, or effects, of these exercises on bank variables, characteristics, and behavior is plausible. Such is the scope of our analysis.

Motivated by the crisis-ignited controversy over the risk portfolios of banks, the regulatory changes that these developments invoked, and the importance of the financial sector for the macro-economy, the purpose of this study is to empirically explore: (1) How the presence of prudential regulation affects the risk-taking decisions and financial soundness objectives of banks in the U.S.; (2) Whether stress-test projected capital levels influence risk-taking and financial stability objectives; (3) To what extent bank characteristics could explain stress test outcomes; (4) Whether monetary policy influences bank behavior; and (5) What are the channels through which banks adjust to higher capital needs imposed by increasing regulatory requirements. Our interest in banks' risk-taking behavior and financial viability stems primarily from the social costs associated with bank failures, especially those concerning the largest and most important financial institutions and their associated industry and economy-wide implications. We acknowledge that disentangling the effect of stress tests from the many other regulatory actions, government programs, and market events that occur around the same period is a complex task.

Stress tests have become a prominent topic among academics and policy-makers. The literature is similarly abundant. Hirtle et al. (2016); Guerrieri and Welch (2012); Kupiec et al. (2017); Greenwood et al. (2017); Bolotnyy et al. (2014) focus on how stress tests should be conducted. Morgan et al. (2010); Glasserman and Wang (2011); Petrella and Resti (2013); Morgan et al. (2014); Candelon and Sy (2015); Fernandes (2015); Igan and Pinheiro (2015); Gerhardt and Vander Vennet (2016); Flannery et al. (2017); Bird et al. (2018) in turn, focus on the market reaction to stress test results and disclosures and the informativeness of these disclosures for market participants. More closely related to our analysis are studies associated with the reaction of balance sheet variables to stress tests (Shahhosseini, 2014; Acharya et al., 2017; Lambertini and Mukherjee, 2016; Mésonnier and Monks, 2014; Eber and Minoiu, 2016; Gropp et al., 2016), such as, for example, lending and credit supply implications of stress tests (Mésonnier and Monks, 2014; Fernandes, 2015; Berger et al., 2019; Eber and Minoiu, 2016; Lambertini and Mukherjee, 2016; Gropp et al., 2016; Calem et al., 2020; Chen et al., 2017; Covas, 2018; Flannery et al., 2017). Noticeably lacking, however, is a detailed consideration of the impact of such regulation on the risk-taking behavior and solvency objectives of banks. Only a handful of studies address bank risk and banks' risk-taking behavior in the context of stress tests. Acharya et al. (2017) provide an extensive study documenting the impact of stress tests on credit availability and risk-taking. They find that bank risk is statistically lower for stress-tested banks, but most of the risk reductions are driven by safer banks. The authors further analyze the channels through which banks increase capital ratios and find that Loan Loss Provisions and Net Charge-off reductions are the major mechanisms in meeting required capital levels. This finding is consistent with Shahhosseini (2014), who suggests that such reductions improve bank performance and ultimately increase bank safety. Similarly, Acharya et al. (2014) point out that banks remain quite risky despite strict prudential capital requirements. Ignatowski and Korte (2014) also suggest that mega-banks have not reduced risk-taking. Neretina et al. (2015) study the effects of stress test disclosures on market returns and risk and find that stress tests have been a useful tool in mitigating systematic and/or systemic risks. They find evidence for a decline of systematic risk in 2009, 2013, 2014, and 2015, while evidence for 2012 was mixed. In 2011, when the stress test results were not published, systematic (and "systemic risk") seem to have increased. "Systemic risk" declined in 2009, 2012, and 2015 following the release of stress test results. They further find that the 2009 SCAP stress test results determine the direction of market betas; Banks with capital shortfalls and capital plan objections did not exhibit differences in betas following the result disclosures, while the betas of banks with no capital shortfalls or supervisory objections decreased significantly.

Our findings are consistent with the studies mentioned above. In line with Ignatowski and Korte (2014); Neretina et al. (2015); Acharya et al. (2017), we find that among banks with high past ROA volatility and those with insufficient projected capital levels, past and future risk-taking and solvency are positively related. The results of our analysis suggest that, although banks subject to stress tests generally take on less risk, those results are primarily driven by safer, better-capitalized banks. The results further suggest that the capital restrictions inherent in the stress-testing framework have not effectively contained risk-taking and improved solvency among BHCs with low-risk aversion and in the presence of insufficient projected capital levels. The finding is important because it carries moral hazard implications for deposit insurance. Furthermore, they uncover an unintended consequence of increases in risk exposure amongst the riskiest stress-tested institutions as a mechanism to meet future stress test requirements. Our findings suggest that the stress test results influence risk-taking and solvency. We find that risk-tolerant banks with low projected capital ratios and risk-averse banks with high projected capital ratios exhibit higher risk-taking characteristics. In addition, we uncover that several bank characteristics seem to explain the stressed capital positions and respective stress test results, which provides information on the determinants of bank safety and soundness. In particular, we find that liquidity, short-term wholesale funding, and the loan portfolio size are negatively related to meeting projected capital levels above required regulatory minimums. We find strong relations across a large number of bank characteristics, both with having a capital buffer and the size of those buffers. Our findings also suggest that monetary policy, particularly the low-interest-rate environment that characterizes the post-crisis era, leads stress-tested entities to take on more risk as a mechanism to compensate for declining net interest margins. This result is relatively strong among banks with projected capital buffers. The risk-taking environment in which banks operate also plays a role in risk-taking and solvency across ST banks. ST banks exhibit higher risk-taking when interest rates are low. The finding carries important policy implications for financial instability, especially in light of the current monetary policy stance adopted by numerous economies, such as Japan and the EU, where interest rates have remained close to zero or negative over an extended period. Finally, a descriptive analysis of how banks meet regulatory capital increases suggests healthy increases in equity, coupled with significant risk-weighted asset reductions were the primary means of achieving higher capital ratios. However, asset increases counteract the positive effects of the reductions in risk-weighted assets. We observe different strategies in achieving higher capital ratios among banks with projected capital shortfalls, where we observe asset stagnation. Our findings are consistent with prior empirical research on the effects of stress tests on bank behavior and the theoretical literature on bank capital regulation.

The remainder of the paper is organized as follows: Section 2 provides an overview of the literature related to stress tests and capital regulation in the context of bank risk-taking and an overview of the institutional background of stress-testing in the U.S. Banking Industry. Section 3 describes the empirical setup, data sources, variable selection, and methodology. Section 4 discusses our empirical findings and Section 5 concludes.

1.2 Background

1.2.1 Institutional Setting: Prudential Regulation in the U.S.

Stress testing refers to a process that provides a forward-looking assessment of the potential impact of various adverse economic and financial market events and circumstances (scenarios) on the consolidated earnings, losses, and capital of banking organizations over a set planning horizon. These exercises consider the current conditions, risk exposures, business strategies, and activities within each company. Although this concept is not entirely new within the supervisory and financial risk management tool packs[3], stress tests have increasingly been relied upon as an essential part of the overall supervisory regime since the recession and the associated financial crisis of 2007-2009. They were primarily implemented as an aggressive regulatory response in addressing the substantial market concerns of the time. The crisis exposed severe deficiencies in risk management and measurement practices and in the resiliency of large, systematically important institutions, which, at the time, were both inadequately capitalized as well as plagued by unsustainable market and credit risk losses across their portfolios. As a result, those institutions proved unprepared and unable to cope with the severity of the macroeconomic distress. This managerial and supervisory lack of attention to low probability, high impact adverse macroeconomic events, and the continuation of capital distribution well into the crisis made clear the need for more robust supervisory and internal capital adequacy assessment processes and the need for better firm-wide risk identification and measurement practices.

In their current form, stress tests are distinguished from traditional risk management's routine scenario-based analysis by the pessimistic nature of the underlying scenarios. Whereas traditional supervision is characterized by an emphasis on firm processes, an important innovation of the current stress tests is that, given their quantitative nature[4], they provide useful tools for the prudential supervision of large banks through limiting supervisory discretion and enhancing the credibility of the supervisory regime. This allows for the possibility of supervision by rule rather than discretion. Furthermore, tying firms' quantitative results to specific actions offers a potential mechanism to increase the credibility of the regulatory regime and improve communication with market participants. A detailed review of the history and goals of stress testing conducted in the U.S. and Europe can be found in Hirtle and Lehnert (2015). For the purpose of this paper, we present an overview

[3] Stress Tests have been performed for years in global banks across specific functions that deal with risk to assess firm-wide capital adequacy in times of stress.

[4] The result of an exercise is a quantitative view of the value of a portfolio or even the value of an entire firm under a particular scenario.

of the supervisory stress test programs implemented in the U.S. in the years following the financial crisis.

1.2.1.1 SCAP (2009): The Beginning of Modern Stress-Testing

In February 2009, shortly after the collapse of Lehman Brothers and during a period characterized by extreme stress in the U.S. banking industry, the first coordinated supervisory stress tests of large BHCs were implemented. The Supervisory Capital Assessment Program (SCAP) stress tests were conducted by the Federal Reserve and other federal banking agencies as part of the U.S. Treasury's Capital Assistance Program.[5] SCAP was intended to (1) avert further financial distress and (2) reduce uncertainty and promote confidence both at the individual bank level (micro-prudential assessment) and at the industry level (macro-prudential assessment).[6] The program involved the nineteen largest BHCs with at least $100 Billion in total assets, which, at the time, held approximately two-thirds of total assets in the US Banking System. The program's goal was to estimate the amount of capital necessary for withstanding a worse-than-expected macroeconomic downturn. It was crucial that BHCs maintain status as viable financial intermediaries and continue lending to credit-worthy borrowers despite the severity of adverse events. In other words, SCAP allowed supervisors to quantify the potential effect on capital and the extent of capital needs across a range of economic outcomes that characterize a further deterioration in the economic environment and to assess whether BHCs had sufficient capital to absorb losses while continuing to operate as if in "normal" times.

SCAP stress tests consisted of two Federal Reserve-run, hypothetical scenarios that assessed BHCs' net income and capital over a two-year forward-looking horizon, where the "baseline" scenario re-

[5] Under the Capital Assistance Program, the U.S. Treasury provided a capital backstop to the qualifying BHCs unable to raise equity in the market. Ultimately, only one of the ten banks with capital shortfalls, Ally Financial, took advantage of the capital backstop (Flannery et al., 2017).

[6] (Table A.4 (p.183) of this paper provides a comparison of Micro-prudential vs. Macro-prudential regulation objectives.)

flected consensus expectations of the path of the economy and the ”more adverse” scenario reflected more pessimistic than anticipated macroeconomic outcomes that would essentially provoke a longer and deeper recession than expected at the time. Net income and capital projections were obtained through a combination of supervisory judgment and models, internal bank models, and historical data and benchmarks. Capital ratios for each of the 19 BHCs were calculated under each of the two scenarios and compared to a minimum target level. Those BHCs with post-stress capital ratios below minimum target levels were required to raise a dollar amount of capital sufficient to eliminate the shortfall between their post-stress ratio and minimum target levels within six months and develop a detailed capital plan within one month following the disclosure of the stress test results.[7] In addition, restrictions on capital payouts were in effect for the BHCs with poor stress test results in an effort to meet target capital levels through retained earnings. Ultimately, ten of the nineteen stress-tested BHCs were identified as having significant capital shortfalls, an aggregate of $185 billion [8], nearly all of which represented a common equity deficit relative to SCAP established target levels. These ten BHCs, along with several others, were able to raise $100 billion in common equity following SCAP (Hirtle and Lehnert, 2015). The stress tests results were published in May 2009 (Federal Reserve, 2009a,b). The disclosure provided unprecedented confidential supervisory information (Flannery et al. (2017)). It was viewed as critical in achieving SCAP's goal of reducing uncertainty about the banking system and enhancing confidence in the capitalization of BHCs (Federal Reserve, 2009b).

The forward-looking nature of SCAP stress tests, compared to static capital ratios that had been previously implemented, provided supervisors with an analytical tool to evaluate current capital positions against possible future stress, and to distinguish among BHCs which were likely to contract

[7] A critical element of SCAP was the restriction of increasing the capital ratio through decreased lending or balance sheet contractions.

[8] Ex-post capital restructuring and assets sales lead to a decreased, albeit substantial, net capital shortfall of $75 billion.

lending should conditions worsen, providing credible evidence in support of the supervisory insistence on raising additional equity capital (Hirtle and Lehnert, 2015). Following SCAP's success, stress-testing formally became an indispensable part of the US supervisory toolkit in assessing individual BHCs' as well as system-wide capital adequacy. The Federal Reserve and Congress (through the enactment of the Dodd-Frank Wall Street Reform and Consumer Protection Act (Dodd-Frank Act), introduced two separate stress tests that have been conducted annually since. The Comprehensive Capital Analysis and Review (CCAR), a supervisory program, which assesses the internal capital planning processes and capital positions within large BHCs, was implemented by the Federal Reserve in 2011, and the Dodd-Frank Act Stress Test (DFAST) provisions were enacted at the beginning of 2013. Both exercises' objective is to test financial institutions' resilience by simulating banks' balance sheet performance and losses in a hypothetical severe economic downturn over a nine-quarter, forward-looking planning horizon. Although the two exercises, which are simultaneously performed, rely on similar processes, data, supervisory exercises, and requirements, each follows a distinct objective. We discuss the two exercises in detail in the section that follows.

1.2.1.2 Capital Analysis and Review (CCAR (2011)) and Dodd-Frank Act Stress Tests (DFAST (2013))

2011 marked a time of increased pressure by financial firms to resume dividend payments and share repurchases that had previously been significantly decreased or suspended as a consequence of the financial crisis. As a result, and following the Capital Plan Rule of 2011, CCAR was implemented as an annual exercise aiming to provide the Federal Reserve with the tools and authority to determine whether the participating BHCs have sufficient capital to either resume or increase payouts or conversely, to restrict capital distributions at individual BHCs in cases where such actions might erode the financial position of the company (Flannery et al., 2017). Under CCAR, BHCs with total assets over $50 billion are subject to a quantitative assessment of post-stress capital levels. For

BHCs with assets above $250 billion, the exercise adds additional qualitative layers.[9]. The exercises are conducted over a nine-quarter forward-looking horizon under baseline and stressed economic conditions.

The Capital Plan Rule requires each BHC to develop and submit a detailed formal capital plan comprising detailed internal capital planning processes and governance over those processes, capital policies governing capital distribution decisions, and planned capital actions, including specifying the circumstances under which these distributions can be increased or might be curtailed. The Federal Reserve reviews these capital plans and evaluates their processes and governance against a set of supervisory expectations and the Capital Plan Rule's requirements. This review consists of both a qualitative assessment of the internal capital planning processes and a quantitative assessment of the capital positions of each of the BHCs subject to the program. The two components allow supervisors to evaluate the prudence of capital accretion or distribution decisions and act as a counterweight to pressure in using dividends to capital strength (the same reason for which many poorly capitalized banks continued to pay dividends through the crisis). The capital plan allows for a more robust governance structure and enables supervisors to track whether BHCs adhere to their own policies as circumstances change. The capital plan review is intended to strengthen the supervisory assessment of capital adequacy (quantitative assessment) and the processes through which large BHCs internally assess their capital needs (qualitative review). All participating entities receive extensive supervisory feedback on their capital planning processes, identifying areas that require improvements and whether capital distributions are approved or objected. An objection to the plan (either due to capital shortfalls or deficiencies in the capital planning processes) may result in restrictions in all or some planned capital distributions (Flannery et al., 2017).

[9] Other participants in the CCAR exercises include those institutions subject to the Fed's Large Institutions Supervision Coordination Committee Framework (LISCC), other large and complex firms, as well as firms with non-bank assets above $75 Billion.

The exercise's quantitative component is based primarily on each firm's idiosyncratic, internal "BHC Stress" scenario (which is intended to reflect each firm's business focus, portfolio, and particular risk exposure) and on the Post-Stress Capital Analysis performed by the Federal Reserve. BHCs are expected to: (1) remain sufficiently capitalized (with Tier 1 common equity above 5%);[10] (2) continue to function as financial intermediaries and do not contract credit supply; and (3) continue to make their planned capital distributions (as indicated in the internally-run "BHC" scenario) during each of the nine quarters of the stress planning horizon. The goal of the exercise's quantitative component is to provide a rigorous test of firms' financial positions and ensure that each BHC remains financially robust, given a substantial and unexpected macroeconomic deterioration.

Institutions subject to the qualitative component of CCAR are required to submit information related to (1) Stress testing method, including the generation of the internal BHC scenarios, (2) Internal controls to ensure an accurate and robust capital plan, (3) Model governance, including documentation and model validation (4) Internal policies and procedures with clear and precise separation of responsibilities and approval processes. It involves (1) an assessment of the firms' internal processes (for determining how much capital they need to hold), and especially the processes used in developing and implementing the "BHC stress" scenarios, which help to identify firm-specific weaknesses arising from particular business strategies; (2) an examination of firms' capital policies (intended to provide a framework and governance structure for capital distribution decisions); and (3) an assessment of the firms' progress towards addressing previously identified internal processes and governance deficiencies. The review provides key inputs for the development of the Federal Reserve's supervisory strategy. The qualitative component emphasizes the self-identification of risks to capital (instead of reliance on static supervisory measures). It allows supervisors to evaluate key risk

[10]While other capital ratios are also used in the analysis, the emphasis on the Tier 1 Common Equity stems due to Common Equity's characteristics, such as its' higher absorption capacity, it's ability to minimize losses to higher tiers and ease of management in downturns (through reducing dividends, for instance).

measurement and management practices, capital planning practices, and internal controls and governance over these practices. The objective of the capital plan review, on the other hand, is to ensure thorough and robust capital planning processes for managing capital resources and that the submitted capital plan was created using strong risk-management, good governance, and proper internal controls and policies.

The Federal Reserve was not alone in recognizing the need for action in the wake of the financial crisis. Congress responded through the enactment of the Dodd-Frank Wall Street Reform and Consumer Protection Act (Dodd-Frank Act), which among other things, required the Federal Reserve and the Office of the Controller of the Currency (OCC) to conduct annual supervisory stress tests for institutions with more than $10 billion in total assets. Also, institutions above $50 billion in total assets were required to conduct stress testing on internally developed (company-run) projections using Federal Reserve-provided scenarios and capital plan assumptions.[11] Hence, there are two sets of stress tests associated with large BHCs, the supervisory (Fed-run) stress tests, which apply to all midsize and large institutions, as well as the company-run stress tests (which apply to large institutions only). The purpose of the DFAST stress tests is twofold: (1) they allow the Federal Reserve to evaluate how regulatory capital ratios would evolve under a set of stressed macroeconomic conditions (i.e., adverse scenarios) over a nine-quarter, forward-looking, planning horizon and whether supervised entities have sufficient capital to absorb losses and to continue operations by maintaining ready access to funding while meeting their obligations to creditors and other counter-parties and continuing to serve as a credit intermediary under adverse economic and financial conditions and (2), the disclosure of the DFAST results provides valuable information about the capital strengths at individual BHCs, as well as the overall financial system. The results help market participants and the public identify downside risks and the potential effect of adverse conditions on capital adequacy.

[11] After the DFAST 2016 submission, all DFAST institutions will be required to conduct these internal stress tests.

The public disclosure also enhances transparency and promotes market discipline. [12]

1.2.1.3 Stress-Tested Entities

For the purpose of this study, we focus on BHCs with total consolidated assets above $50 Billion that are subject to the CCAR (and DFAST) exercises and whose quantitative post-stress results are published by the Federal Reserve. Our analysis considers the capital position of each BHC following eight-quarters of a severe economic downturn (i.e., the severely adverse scenario) from the annual CCAR result disclosures. We choose to focus on this particular subgroup of banks and the CCAR exercise for a number of reasons. First, the CCAR exercise has been conducted over a longer time horizon than DFAST, which allows for a more comprehensive analysis, given the larger scope of available data. Second, CCAR is based on forward-looking capital actions, whereas DFAST assumes historical behavior. We believe the BHC-proposed capital actions provide for more accurate post-stress projections. Third, CCAR is associated with enforced supervisory restrictions, and significant capital action consequences, which we believe are more likely to influence bank behavior. Fourth, the quantitative stress capital results of the two differ only in the size of the projected capital buffers. Although several banks failed the CCAR stress tests (and passed the DFAST exercise), the results were fully due to qualitative and non-quantitative deficiencies. Therefore, the CCAR and DFAST projected capital buffers differ only in their magnitude and not in sign. It is unlikely that our findings would be different if we consider the DFAST capital buffers rather than the CCAR ones. Lastly, the disclosed results of both CCAR and DFAST focus on the same group of BHCs. Although we acknowledge the difficulty in attributing our findings to either CCAR or DFAST,

[12] The Dodd-Frank Act focused on large BHCs with assets over $10 billion and other complex financial institutions subject to Federal Reserve Supervision. It requires BHCs with $10 billion or more in assets to conduct annual stress tests based on scenarios provided by the Federal Reserve, and BHCs with assets over $50 billion are subject to internal bank-run stress tests, in addition to those of the Federal Reserve. The Dodd-Frank Act further required the Federal Reserve to generate stress scenarios to be published for those BHCs with $ 50 billion or more in total assets.

we can, nonetheless, try to analyze the behavior of BHCs in the presence of these stress tests. For comparative purposes, we include the SCAP exercise in several specifications. Table A.5 (p.184) includes a list of BHCs that have participated in the SCAP, CCAR and DFAST exercises. The table includes the name, RSSD IDs, ownership characteristics, and the initial stress-test incorporation year of banks subject to stress tests. Table A.6 (p.185) summarizes each entity's stress-test results by year. Table A.1(p.181) provides an overview of the requirements and objectives inherent in each of the annual DFAST and CCAR stress test exercises along with information about the number of participating banks as well as the number of banks who ultimately failed to meet the required regulatory minimum capital levels. Table A.2 (p.182) summarizes the differences between CCAR and DFAST.

1.2.2 Literature Review

1.2.2.1 Post-Crisis Prudential Regulation in the Literature

The introduction of stress tests, as a critical component of prudential supervision, has received considerable attention from regulators and academics alike. Regulators devoted substantial resources to stress test scenario design, modeling, and implementation (Connolly, 2017). Likewise, the academic literature is abundant in its scope of stress test model design, implementation, and governance implications and proposals (Hirtle et al., 2016; Guerrieri and Welch, 2012; Kupiec et al., 2017; Greenwood et al., 2017; Bolotnyy et al., 2014). While Hirtle et al. (2009) suggest that the SCAP exercise of 2009 effectively stabilized the banking system, there is much debate about the effectiveness, possible costs, and consequences of stress-testing financial institutions (Connolly, 2017). Schuermann (2016) and Gallardo et al. (2016), for instance, argue that stress tests are counterproductive and that tested entities would adjust their balance sheets and resolve to use similar models to pass the tests. The authors suggest that the lack of diversity in model approaches, or "Model Mono-Culture," may lead to an increase in systemic risk and ultimately set up the system for a subsequent crisis. Goldstein and Sapra (2014) provide further support in that direction. They suggest that despite regulators' positive view of stress test disclosure effects on market discipline, endogenous costs associated with these disclosures could lead to increased market inefficiencies.

Empirical work covering the effects of prudential regulation on bank financial variables is similarly extensive. One strand of this literature addresses market reactions around stress test announcements and result disclosures and the information content associated with them (Morgan et al., 2010; Glasserman and Wang, 2011; Petrella and Resti, 2013; Morgan et al., 2014; Candelon and Sy, 2015; Fernandes, 2015; Igan and Pinheiro, 2015; Gerhardt and Vander Vennet, 2016; Flannery et al., 2017; Bird et al., 2018). A second strand explores how balance sheet variables react to stress tests and whether such adjustments transmit to the real economy. Several studies provide evidence that stress-tested banks resort to artificially increasing capital ratios by adjusting their balance sheets to pass the tests. Consistent empirical evidence supports the notion that balance sheet adjustments such as restructuring, the removal of non-performing loans and net charge-offs (Shahhosseini, 2014; Acharya et al., 2017) and the flight to safer assets (Lambertini and Mukherjee, 2016) are routinely involved in achieving the target capital levels necessary for passing the U.S. stress test exercises. Comparable conclusions are echoed in studies focusing on the European stress test exercises performed around the same time (Mésonnier and Monks, 2014; Eber and Minoiu, 2016; Gropp et al., 2016)

A similarly large number of studies examine the effect of stress tests on credit supply and lending-related implications. The literature persistently suggests profound negative implications of stress tests on lending (Eber and Minoiu, 2016; Gropp et al., 2016; Covas, 2018), loans growth (Mésonnier and Monks, 2014; Fernandes, 2015), and syndicated loan prices (Lambertini and Mukherjee, 2016). This strand of the literature suggests that capital increases are primarily met through lending contractions (Gropp et al., 2016; Mésonnier and Monks, 2014) and asset (securities) reductions

(Eber and Minoiu, 2016). The studies point to the conclusion that weak banks resort to reducing the credit supply. Similarly, Calem et al. (2020) find decreased jumbo mortgage and speculative-grade term-loan origination due to stress tests. Chen et al. (2017) find significant cuts in small business lending for the four largest U.S. banks. In contrast, Flannery et al. (2017) find no evidence of any stress test effects on loans growth and portfolio composition, and Berger et al. (2019) suggest improved loan contract terms.

Despite the extensive research conducted on various aspects of stress tests, both in the U.S. and in Europe, the risk-taking behavior and solvency objectives of banks under prudential regulation remain a rather scarcely analyzed topic. Only a handful of studies address bank risk and banks' risk-taking behavior in the context of stress tests. Most closely related to our study is Acharya et al. (2018). They provide an extensive analysis documenting the impact of stress tests on credit availability and risk-taking. They find that entities subject to supervisory stress tests have reduced the supply of credit to relatively risky borrowers and that bank risk - as measured by five different capital ratios and risk-weighted assets - is statistically lower for stress-tested banks. They further show that most of the risk reductions are for safer banks[13]. The authors further analyze the channels through which banks increase capital ratios and find that Loan Loss Provisions and Net Charge-off reductions are the major mechanisms in meeting regulatory capital targets. This finding is consistent with Shahhosseini (2014), who suggests that such reductions improve bank performance and ultimately increase bank safety. Similarly, Acharya et al. (2014) point out that banks, especially those in Europe, remain quite risky despite strict prudential capital requirements. Their result could be attributed to Europe's, particularly, low-interest-rate environment. Ignatowski and Korte (2014) suggest that mega-banks have not reduced risk-taking. Neretina et al. (2015) study the effects of stress test disclosures on market returns and risk (represented by Market Betas). They find that stress test disclosures

[13]They point out that banks appear safer based on their regulatory risk measures, but the possibility of masked higher market risk cannot be ruled out.

have a negative effect on systematic and/or systemic risk. They further find that betas move in different directions depending on the stress test result of each bank. Banks with capital shortfalls and capital plan objections do not exhibit differences in betas, while betas of banks with no capital shortfalls or supervisory objections decreased significantly.

1.2.2.2 Capital Regulation and Risk-Taking: Theoretical Background

The relation between capital adequacy and banks' risk-taking behavior is a decades-long debate. This topic has been extensively analyzed before, and the literature comprises two strands that come to opposing conclusions. Furlong and Keeley (1989) report decreased incentives for asset risk-taking as a result of capital adequacy regulation. They note that a reduction in leverage achieved via retiring debt and shrinking assets would reduce the marginal gain from increasing asset risk. In other words, a bank would not be expected to respond to higher capital requirements by increasing the riskiness of its asset portfolio. Higher capital requirements will be met through increases in equity rather than retiring debt; they are likely to reduce the risk exposure of the deposit insurance fund, so long as regulators do not relax efforts to limit asset risk and size. A value-maximizing bank will not respond to more stringent capital requirements by increasing the riskiness of its assets. More stringent capital regulation unambiguously reduces the risk exposure of the deposit insurance system. Berger and Bouwman (2013) provide further support for the increased capital requirements' effects in reducing asset risk and increasing efficiency and profitability. Conversely, Flannery (1989) suggests that capital adequacy regulation leads insured banks to prefer relatively low-risk individual loans to maximize their deposit insurance put option value but pursue higher portfolio risk. Kahane (1977); Koehn and Santomero (1980); Kim and Santomero (1988) in a mean-variance framework, argue that capital regulation would have effects opposite to those intended by regulators. The authors reason that regulatory constraints on bank leverage cause leverage and asset risk to become substitutes, so banks that experience involuntary reductions in leverage (regulatory induced increases in capital) will achieve the desired total risk level by increasing asset risk. Likewise, as regulatory pressure allows reductions in capital, banks will reduce asset risk. This view implies that there will be a positive relationship between capital and risk among banks that operate at or near the regulatory minimum capital levels. Kim and Santomero (1988) state that in a utility-maximizing mean-variance framework, banks with relatively low-risk aversion will choose relatively high leverage (low capital) and relatively high asset risk. Rochet (1992) argue that although capital regulation can be effective in curbing risk-taking among utility-maximizing commercial banks, it may not prevent value-maximizing banks from choosing risky portfolios. Shrieves and Dahl (1992) empirically show the aforementioned theoretical predictions, and establish that risk exposure and capital levels are simultaneously related, and that most banks mitigate the effects of increases in capital levels by increasing asset risk posture, and vice versa. Besanko and Kanatas (1993); Boot and Greenbaum (1992) claim that capital adequacy reduces the quality of bank portfolios through reduced monitoring incentives. Blum (1999) further suggests that tightening restrictions lead to lower bank profits. Since banks have less to lose, and the probability of default is less costly, they ultimately have smaller incentives to avoid default and increase risk. In addition to this, the 'leverage effect' of capital rules raises the value of equity to the bank. An additional unit of equity tomorrow is more valuable. If raising equity is excessively costly, the only possibility (and optimal choice) would be to increase equity tomorrow is by increasing risk today.

Calem and Rob (1999) in a theoretical model and a supporting empirical test uncover a u-shaped relationship between capital and risk-taking. Their findings uncover a moral hazard problem for under-capitalized banks, which take excessive risks by exploiting the risk-shifting benefits of deposit insurance. Well capitalized banks exhibit a different behavior: as capital requirements increase, they react by increasing risk due to low probability of insolvency, suggesting that generally, banks do not reduce risk to comply with new capital requirements. Consistent with Calem and Rob (1999), Park

(1996) suggests that when regulators are concerned about the asset portfolio and the capital ratio, the optimal strategy for many banks is to maintain a capital ratio higher than the one required by regulators. He concludes that as capital levels increase above the required levels, riskiness increases as well. Gorton and Rosen (1995) suggest that excessive risk-taking behavior reflects conditions exogenous to portfolio decisions such as managerial competence and lack of lending opportunities. The authors further argue that the presence of deposit guarantees, which allows for riskier loans without a requirement for higher interest rates on deposits, exacerbates risk-taking, and moral hazard. Bhagat et al. (2015) imply that banks engage in excessive risk-taking primarily through leverage.

H1: In the presence of capital regulation, bank risk preferences influence future risk-taking. Ex-ante safer stress-tested banks, who prefer lower leverage and asset risk and high capital (Kim and Santomero, 1988), manage their risks more prudently. Because regulatory capital ratios are based on the amount of risk-weighted assets such banks would prefer to reduce the amount of risky assets than to raise equity to comply with regulatory capital increases.

H2: In the presence of capital regulation, projected capital levels influence future risk-taking. Safer Bank with sufficient capital positions, have substantially more to lose in the event of default. Furthermore, higher capital ratios raise banks' charter values via a reduction in leverage, which may also encourage reduced risk-taking. Consequently, such entities avoid excessive risk-taking. However, if banks are sufficiently distanced from default and do not risk losing their charter value, risk-taking could increase.

This study intends to make a number of contributions to the existing literature. We explore and provide a novel dimension to the literature related to stress tests, and more precisely, to the strand related to bank behavior in the presence of prudential regulation. We aim to provide empirical answers to theoretical predictions related to capital regulation and provide answers related to financial institutions' risk-taking behavior and solvency objectives. While other empirical studies have examined various aspects of stress tests, such as market reactions to stress test disclosures and outcomes and lending-related implications of stress tests, the link between capital regulation bank behavior has been largely overlooked. (Acharya et al., 2018) is the only study that includes a brief analysis comparing the risk-taking behavior among stress-tested and non-stress tested banks. However, his study primarily focuses on lending and credit-related implications. It does not consider a comparable non-stress tested sample or how projected capital levels might influence bank decision-making. To the best of our knowledge, this is the first study to exclusively consider an accounting-based analysis of stress-tests in the context of bank risk-taking and solvency.

1.3 Data and Methodology

1.3.1 Data Sources

Our empirical analysis is based on data obtained from The Federal Reserve Bank of Chicago's Commercial Banks and Bank Holding Company Regulatory Database. The data consists of quarterly accounting information submitted by regulated depository financial institutions for supervisory purposes to the respective regulatory supervisors (in the form of financial statements and regulatory reports)[14]. The filings provide balance sheet, income statement, and regulatory capital data, comprising an initial sample of 3,602 unique Bank Holding Companies (BHCs) and 116,943 bank-quarter observations. 34,899 of the observations correspond to banks listed on a stock exchange, and the remaining 82,044 observations correspond to private banks. In this analysis, we focus on Bank-Holding Company (BHC) top-holders for the period spanning 1994 to 2016. We exclude commercial banks from our analysis because such entities have not taken part in the stress-test exercises conducted to date.

State-level macroeconomic controls are obtained from the Federal Reserve Bank of St. Louis' FRED

[14]Information on BHCs is obtained from the FR Y-9C reports.

Dataset. In addition, and since several banks have been recapitalized during our sample period, recapitalization data is obtained from the Monthly Reports to Congress prepared by the US Department of Treasury.

Information on entities that have participated in the SCAP, DFAST, and CCAR programs, along with the associated result of each stress test, are obtained from the annual CCAR stress test result disclosures published by the Federal Reserve. The information is used in constructing the associated stress test-related variables in our analysis. The set of BHCs participating in the CCAR and DFAST programs has expanded since the inception of the original SCAP stress tests of 2009. The 19 BHCs originally part of the SCAP exercise participated in the 2011 to 2013 CCAR (and DFAST) stress-tests. Starting in 2014, the set of BHCs subject to CCAR (and DFAST) expanded to incorporate an additional 12 entities with assets above $50 billion. One BHC was incorporated in 2015, and two additional BHCs were incorporated in 2016. As of 2016, the last year in our analysis, a total of 33 BHCs participate in the CCAR (and DFAST) program. We have financial information for 24 of the participating BHCs. These entities are reflected by dummy variables, which represent whether a BHC is subject to stress tests.

Tables A.5 and A.6 provide an overview of the specific information extracted from the supervisory stress test disclosures for the purposes of this analysis.

1.3.2 Variables Used and Derived from Accounting Data

1.3.2.1 Dependent Variables

1. **ZScore_F3Y:** The Z-score measures banks' distance to default (Roy, 1952; Laeven and Levine, 2009; Dam and Koetter, 2012; Gropp et al., 2013). The Z-Score is based on the notion that the source of default lies in losses that are not covered by adequate equity. Hence, its value is determined by the capitalization ratio (ETA) and the level and stability of prof-

its. It measures the number of standard deviations by which a bank's ROA would have to fall to deplete the available capital. The higher the average ROA and ETA, the more stable the returns, and the higher the Z-score, the safer the bank.[15] Because the Z-Score is highly skewed, we follow Laeven and Levine (2009) in computing the natural logarithm of the Z-Score (which is assumed to be approximately normally distributed). We use this logarithmic transformation of the Z-Score throughout our analysis. For brevity, we use the "Z-Score" in referring to the natural logarithm of the z-score in the remainder of the paper. We calculate the forward-looking Z-Score measure over a 3-year (12-quarter) rolling window, such that:

$$ZScore\_F3Y = \ln \frac{ETA + \mu ROA\_F3Y}{\sigma ROA\_F3Y}$$

where μROA_3Y is the 12 quarter forward-looking average of ROA, ETA is the equity capital to asset ratio in the last quarter of the twelve-quarter time window, and σROA_F3Y is the standard deviation, or volatility, of ROA over the same twelve-quarter time horizon. We have data to calculate the forward-looking Z-scores for 2,717 banks across 21 years.

In an alternative, robustness specification, we calculate the Z-score (lnZScore_F5Y) over a 5-year (20-quarter) rolling window.[16]

2. **σROA_F3Y:** We implement the same ROA volatility measure implemented in constructing the Z-Score as a stand-alone risk-taking indicator. ROA volatility, measured as the standard deviation of ROA, captures the riskiness of returns on assets and allows for an analysis of

[15] Roy (1952) defines insolvency (or default) as a state where losses surmount equity (E $\geq \pi$) (where E is equity and π is profits), A is total assets, ROA (=π/A) is return on assets, σ(ROA) is the standard deviation of ROA, and ETA (= E/A) is the equity-asset ratio. The probability of insolvency can be expressed as prob (-ROA $\leq$ ETA). If profits are normally distributed, then the Z-score = (ROA+ETA)/σ(ROA).

[16] In this specification, the forward-looking horizon spans q=+1 to q=+20. As before, ETA is the equity capital to asset ratio in the last quarter of the time window. σ ROA_F5Y and μ ROA_F5Y are ROA volatility and average ROA over that same time horizon.

risks pertaining to the asset side of the balance sheet.

1.3.2.2 Independent Variables

1. **ZScore_L3Y:**[17] A proxy for backward looking bank solvency, calculated as:

$$lnZScore\_L3Y = \ln \frac{ETA_{q=0} + \mu ROA\_L3Y}{\sigma ROA\_L3Y}$$

2. **σROA_L3Y:** A proxy for past risk-taking and is calculated as specified above.

3. **CCAR and FedST Dummies:** We construct two separate dummies that either include or exclude the original SCAP exercise because of the differences in bank and macroeconomic conditions between the initial SCAP program and the subsequent CCAR exercises. SCAP was a one-off exercise conducted immediately following extreme financial distress and when most banks were severely under-capitalized. By contrast, CCAR was implemented as an annual exercise when banks had, to an extent, regained capital adequacy and financial robustness. We expect that the SCAP exercise would be associated with different bank behavior, given that many of the stress-tested entities failed to meet capital thresholds required for passing and also because the future of stress-testing at the time was uncertain.

   The dummy CCAR is equal to one for each quarter in which a particular BHC has been part of the CCAR (and DFAST) program, and zero for banks not subject to supervisory stress tests. The FedST dummy builds on the CCAR dummy to incorporate the initial SCAP exercise of 2009. We have 541 bank-quarter observations that correspond to BHCs subject to CCAR (and DFAST), and an additional 132 bank-quarter observations corresponding to the original SCAP exercise. The CCAR dummy consists of 500 bank-quarter

[17] For robustness purposes, we also calculate the Z-Score (lnZScore_L5Y) and ROA volatility (σROA_L5Y) over a longer, 20-quarter backward-looking horizon.

observations corresponding to listed BHCs, while the remaining 41 observations correspond to non-listed BHCs. The FedST dummy consists of 616 observations for listed BHCs, and the remaining 57 correspond to non-listed BHCs. We construct the CCAR and FedST dummies based on the 9-quarter forward-looking stress test horizon used in the stress test exercises (i.e., CCAR is equal to one from 2010Q4 to 2012Q4 if a given BHC is subject to the CCAR 2011 exercise; from 2011Q4 to 2013Q4 if the BHC is subject to the CCAR 2012 exercise, and so forth). We use the same method to obtain the FedSt dummy, which only differs from CCAR in its inclusion of the SCAP 2009 exercise that covers the period 2009Q1 to 2010Q4. Commercial banks are not part of the stress-test exercises in the U.S and have, therefore, been excluded from this analysis.[18] The entities for which we do not have balance sheet and income information are also excluded from our analysis.

4. **CCAR and FedST Projected Capital Buffers:** We also collect data on the minimum capital requirements inherent in each stress test exercise (in accordance with the Basel Capital Rules), as well as the projected capital levels from the severely adverse scenario published in the CCAR and SCAP disclosures. We use this information to construct the variable Buffer, which represents either the excess or shortfall in capital ratios with respect to the required regulatory minimums necessary for passing the quantitative assessment of the stress test in each quarter of the year in which the stress test exercises were conducted. The Buffer variable indicates the post-stress percentage Tier 1 Common Equity shortfall or buffer. It is calculated as the difference between projected Tier 1 Common Ratio of each bank, and the Required Regulatory Capital Minimum imposed in each quarter. The FedST version of Buffer incorporates the stress-capital results of the original SCAP exercise.

   To capture any non-linear dynamics of the projected capital buffers or shortfalls, we decom-

[18] In alternative analyses, the inclusion of Commercial Banks does not significantly alter our findings. Our results' overall significance remains unchanged, and the change in the size of the coefficient is negligent.

pose the CCAR and FedST buffer variables into CCAR_Pass and FedST_Pass binary variables. In both cases, Pass is equal to one in the presence of projected capital levels in excess of regulatory minimums; and zero when there are capital level deficiencies.

5. **Interaction Terms:** We are interested in observing how these past risk-taking indicators interact with our stress-test and the Pass dummy variables as well as with capital buffers. These interactions allow us to examine: (1) whether banks subject to stress test exercises conduct different risk-taking and financial soundness strategies, given their ex-ante ROA volatility and distance to default; (2) whether this behavior could be influenced by the projected capital buffers (i.e., whether the stress test results explain risk-taking and financial soundness objectives). We simultaneously check for non-linear effects among the stress-tested entities; (3) whether ex-ante bank characteristics explain stress test outcomes; and (4) what is the role of low-interest rates on bank risk-taking in the context of the stress-testing framework. We discuss these in more detail below.

   - The risk-taking behavior of banks subject to Stress Tests: Our first set of analysis analyzes the marginal effect on future risk-taking of ex-ante risky banks subject to stress tests. We achieve this by including interaction terms between Past Risk-taking and Dummies that indicate whether a given bank is subject to stress tests. The resulting interactions are: ZScore_L3Y*CCAR; ZScore_L3Y*FedST; σROA_L3Y*CCAR and σROA_L3Y*FedST, where CCAR is equal to 1 for all banks subject to the CCAR and 0 otherwise, and FedST is Equal to 1 for all banks subject to all stress tests conducted to date (i.e., incorporates the original SCAP exercise into the CCAR analysis). We implement the same interactions in a robustness analysis that spans a 20-quarter, 5-year rolling window.
   - The relationship between projected capital levels and the behavior of banks subject

to stress tests: In the second part of our analysis, we analyze whether and how the projected stressed capital buffers (or shortfalls) influence banks' behavior. This part of our analysis focuses solely on banks subject to stress tests and excludes any entity that is not associated with CCAR or SCAP. We calculate a number of interaction terms between Past Risk-Taking and Solvency and the amount of projected capital ratios in excess of required regulatory minimums. The resulting interactions are ZScore_L3Y*BufferCCAR; ZScore_L3Y*BufferFedST; σROA_L3Y*BufferCCAR and σROA_L3Y*BufferFedST, where BufferCCAR is equal to the difference between capital Ratios published in the CCAR Stress-Test Disclosures and the required regulatory capital ratios stipulated by Basel. The BufferFedST incorporates the projected capital levels published in the SCAP results disclosures. Since the capital buffers or shortfalls in the SCAP disclosures are based on levels and not ratios, we scale the reported values by Risk-Weighted Assets.

As a further robustness check, we decompose the BufferCCAR and BufferFedST variables into a dummy variable, Pass, where 1 indicates projected capital buffers and 0 indicates projected capital shortfalls. This allows us to better capture any non-linear dynamics related to the projected capital buffers, especially given the large number of banks that failed and passed by negligent excesses or shortages with respect to required ratios.

1.3.2.3 Macroeconomic and Bank-Specific Control Variables

In addition, we collect data on several bank-specific and macroeconomic characteristics that previous studies have pointed out as being potential drivers of bank risk-taking. At the bank level, several indicators related to the size, liquidity, profitability, capitalization, specialization, credit portfolio quality, and information on the market risk exposure and risk-policy of each bank are included to allow for the impact of standard bank characteristics. The set of bank-specific control variables include Size, which is computed as the Natural Logarithm of Total Assets (TA) to proxy for each bank's relative size. Larger banks tend to be listed and the most likely participants in supervisory stress tests; ETA, which is computed as the Shareholder's Equity to Total Assets to proxy for bank leverage; LTA, which is computed as Net Loans and Leases as a fraction of Total Assets to proxy for banks' specialization; LLP, which is computed as Quarterly loan loss provision, deflated by beginning of quarter total assets; NPLLTL, which is computed as Non-performing Loans and Leases to Total Loans to proxy for banks' risk exposure; NPLLTL_chg, which is computed as the quarterly change in non-performing loans and leases; STWSFTA, which is computed as Short-Term Wholesale Funding deflated by beginning of quarter total assets to proxy for Liquidity exposure; ROA, which is computed as Net income plus loan loss provision deflated by total assets to proxy for profitability; Recap, which is a Dummy equal to 1 if a given bank has been recapitalized; MS_TA, which is the sum of Available-for-Sale Securities and Trading Assets to proxy for banks' liquidity and exposure to market risk.

At the macro-economic level, we consider the change in Gross Domestic Product growth (GDP_chg), one-year ahead consensus expectations of the US unemployment rate (UnRate), and the implied volatility of S&P 500 Index options volatility (VIXCLS). These variables are available from the Federal Reserve Bank of St. Louis' FRED database.

All variables are winsorized to balance and bring extreme outlier values in each tail down to the 0.5% and 99.5% levels. All bank-specific control variables are scaled by Total Assets to allow for comparability. All independent variables are lagged one quarter to mitigate potential endogenous feedback effects, simultaneity problems, and contemporaneous correlations. Table 1.1 provides an overview of the variables used in our analysis.

1.3.2.4 Summary Statistics

In the first part of our analysis, where we examine the risk-taking behavior in the presence of stress tests, we focus on the entire sample, while in the second part of our analysis, we focus solely on those banks that take part in the supervisory stress test exercises. This second analysis spans the period of 2009 to 2016 and covers 26 unique banks. Table 1.2 provides the summary statistics of our variables. Table 1.2(a) provides summary statistics for the entire sample. Table 1.2(b) provides summary statistics for those banks subject to supervisory stress tests. The variable definitions are summarized in Table 1.1.

The Z-scores in all specifications exhibit high standard deviations, which suggests a considerable cross-sectional variation in the level of bank solvency. Since our Z-Score measure is right-skewed, we adopt a log-transformation, which has been previously implemented by Laeven and Levine (2009); Jiménez and Saurina (2004); Houston et al. (2010), to transform the Z-score into a more normally distributed one. On average, listed banks exhibit higher distance to default than non-listed banks regardless of whether they are subject to supervisory stress tests or not. In the full sample, the future (past) distance to default has a mean of 4.86 (4.95). For stress-tested banks, the average future (past) Z-Score is 5.02 (4.67). We further observe that although in the full sample, entities tend to, on average, exhibit lower future distance to default than the past distance to default, stress-tested entities exhibit the opposite characteristics. An important observation is that, although stress-tested BHCs exhibit lower past distance to default, their future distance to default is higher than in the full sample.

We observe no significant variation in past asset risk between the stress-tested and non-stress-tested.

With respect to banks' capital positions, we see that capital buffers are higher when we consider CCAR alone; this is not surprising given that during SCAP, the majority of stress-tested banks did not meet capital requirements but were subsequently able to raise their capital positions.

As expected, we observe a relatively high degree of heterogeneity among the majority of our bank-specific controls for stress-tested and non-stress-tested banks.

1.3.3 Methodology

1.3.3.1 The Risk-Taking Behavior and Solvency of Banks under Stress Tests

We examine the relationship between (1) past risk-taking and future risk-taking for top-holder[19] BHCs, (2) past and future risk-taking among stress-tested BHCs, and (3) past and future risk-taking among stress-tested BHCs with ex-ante high risk-taking [20] Our baseline regressions can be represented as follows:

$$\begin{aligned} Future \quad Risk-Taking &= \alpha + \beta_1 Past \quad Risk-Taking + \beta_2 Stress \quad Test \quad Dummy \\ &+ \beta_3 Past \quad Risk-Taking * Stress \quad Test \quad Dummy + \gamma Bank \quad Controls \\ &+ \delta Macroeconomic \quad Controls + \eta_i + \upsilon_q + \varepsilon_{iq} \end{aligned} \tag{1.1}$$

$$\begin{aligned} &Future \quad Solvency = \alpha + \beta_1 Past \quad Solvency + \beta_2 Stress \quad Test \quad Dummy + \beta_3 Past \quad Solvency \\ &* Stress \quad Test \quad Dummy + \gamma Bank \quad Controls + \delta Macroeconomic \quad Controls + \eta_i + \upsilon_q + \varepsilon_{iq} \end{aligned} \tag{1.2}$$

We analyze (1) two different stress horizons (CCAR (2011 to 2016) and FedST (2009 to 2016). While the latter takes into account the original SCAP exercise, the former only considers CCAR); and (2) Two different bank indicators: ROA Volatility (risk-taking proxy); and the Z-Score (solvency proxy).

[19] Top-holder entities refer to those banks who act as a parent entity within a group structure. Their consolidated financial statements contain aggregate information for the bank and all of its subsidiaries.

[20] We implement a dynamic panel model with Driscoll and Kraay robust standard errors. Given the length of our panel the inclusion of the dynamic term would have a negligible effect on our results (Wooldridge (2010)).

For robustness purposes, we implement the analysis mentioned above to reflect a longer, 20-quarter rolling-window time horizon.

In a further robustness analysis, we include Commercial Banks in our sample and run the above regressions for BHCs and Commercial Banks. Despite Commercial Banks exhibiting significantly different characteristics and risk profiles, we find that their inclusion does not distort our results.

1.3.3.2 Do Projected Capital Levels Influence Risk-Taking and Solvency?

Next, we analyze whether projected capital buffers or shortfalls affect future risk appetite. The theoretical literature argues that the capital position of each bank could influence risk-taking behavior. Blum (1999) suggests that banks whose projected capital levels fall short of meeting regulatory minimums have smaller incentives to avoid default. This, coupled with the high costs of raising equity, would force under-capitalized banks to seek higher risk today to improve their capital position tomorrow. Similarly, Calem and Rob (1999) suggest that such banks would exploit the risk-shifting benefits of deposit insurance. These studies further imply that among banks whose capital levels are above but close to the regulatory minimums, a desire to preserve charter value may lead to decreased risk-taking.

Our baseline specification can be represented as follows:

$$\begin{aligned} Future \quad Risk-Taking = \alpha + \beta_1 Past \quad Risk-Taking + \beta_2 Buffer + \beta_3 Past \quad Risk-Taking * Buffer \\ + \gamma Bank \quad Controls + \delta Macroeconomic \quad Controls + \varepsilon_{iq} \end{aligned} \tag{1.3}$$

$$\begin{aligned} Future \quad Solvency = \alpha + \beta_1 Past \quad Solvency + \beta_2 Buffer + \beta_3 Past \quad Solvency * Buffer \\ + \gamma Bank \quad Controls + \delta Macroeconomic \quad Controls + \varepsilon_{iq} \end{aligned} \tag{1.4}$$

.

As in the previous analysis, we implement two different specifications; one that considers the SCAP exercise and the second only covers the CCAR exercise.

Since stress-tested entities may behave differently given their projected stress-capital positions, we transform the Capital Buffer Variables into a binary variable, Pass, where 1 indicates positive buffers (i.e., capital above regulatory minimums) and ultimately indicates successful completion of the respective stress test. Pass is equal to zero for banks with projected capital ratios below the required regulatory minimums and represents the stress test exercises' failure. The dummy variable analysis aids in picking up any non-linear dynamics of the capital buffers previously analyzed.

1.3.3.3 Can Stress Test Results and Capital Buffers be Predicted?

We also analyze whether any of our independent variables influence or determine the stress test results and the respective capital buffers. The purpose of this analysis is twofold: First, it would flag potential drivers of future stress test outcomes and allow bank managers to anticipate and possibly improve their projected capital positions through a more active ex-ante management of these accounting metrics; second, it provides policy decision-makers with valuable insight about variables that could be implemented as additional performance metrics. We estimate a two-stage Heckmann selection model. In the first stage, we set up a selection (probit) equation in which we look at whether bank characteristics and past risk-taking predict the stress test results, such that:

$$Pass^* = \Phi(\beta Bank\_Fundamentals + \varepsilon_{iq}) \tag{1.5}$$

Where Pass* is either PassFedST* or PassCCAR*, which are binary variables that take values 0 or 1 depending on the stress test-projected capital position of each BHC. Φ follows a cumulative normal density function, $[0, \sigma^2]$. In addition to providing insight about the potential effects of our bank and macroeconomic control variables, we obtain the effect of unobserved factors on the likelihood of failure to meet required regulatory minimum capital ratios from the residual (λ) of the above probit regression. The residual is used to construct a selection bias control factor in the second stage of the selection model. In stage two of the Heckmann selection model, we set up an (OLS) observation equation for Buffer in which we look at the fundamental factors that influence the size of the capital buffer or shortfall while controlling for selection bias, such that:

$$Buffer = \alpha + \beta Bank\_Fundamentals + \lambda_{iq} + \varepsilon_{iq} \tag{1.6}$$

, where Buffer is either buffered or BufferCCAR.

1.3.3.4 Does the Interest Rate Environment Influence Bank Risk-Taking?

Finally, we analyze whether interest rates affect future risk appetite. Various empirical studies demonstrate significant effects of interest rates on bank risk-taking (Delis and Kouretas, 2011; Altunbas et al., 2012; Maddaloni and Peydró, 2011). We are interested in whether the effect differs based on the stress test designation and the stress exercises' outcomes.

We undertake this analysis by interacting interest rates with our main variables of interest ((1) CCAR or CCAR & Scap Dummy Variable; (2) the amount of capital buffer or shortfall under either the CCAR or FedST (CCAR & SCAP) stress test horizons; and (3) BHCs' stress test results (pass dummy variable). Our baseline specification can be represented as follows:

$$\begin{aligned} Future \quad Risk - Taking = \alpha + \beta_1 Past \quad Risk - Taking + \beta_2 IntRate + \beta_3 ST * IntRate \\ + \beta_4 ST + \gamma Bank \quad Controls + \delta Macroeconomic \quad Controls + \varepsilon_{iq} \end{aligned} \tag{1.7}$$

, where IntRate is the U.S. federal funds rate (FedFunds) or changes in the U.S. federal funds rate (FedFundsChg) and ST is either the stress test designation dummy (CCAR or FedST), the stress test quantitative results (CCAR Buffer or FedST Buffer), or the stress test outcome dummy (Pass).

1.4 Results

Table 1.3 reports sample correlations of the main variables of our analysis over the twelve-quarter forward-looking window.

1.4.1 Baseline Results

To test whether stress-tested banks exhibit different risk-taking and solvency characteristics than non-stress tested banks, we run a dynamic panel data regression with Driscoll-Kraay standard errors, in which we interact past risk-taking and financial soundness (proxied by σROA_L3Y and ZScore_L3Y, respectively) and the stress test dummies (CCAR and FedST). Table 1.4 provides the results of our analysis.

1.4.1.1 The Risk-Taking Behavior of Banks in the Presence of Stress Tests

Table 1.4(a) presents the estimation results for ROA Volatility, a standard in the literature measure of bank risk-taking. Columns (1) through (3) relate to banks subject to the CCAR exercises in a given quarter. Columns (4) through (6) also consider the original SCAP exercise of 2009.

Our results unveil a negative relation between the CCAR dummy (which takes a value of one for all banks subject to the Comprehensive Capital Analysis Review conducted since 2011) and Future ROA Volatility. The relation holds and is statistically stronger when we include the original SCAP exercise of 2009 into our analysis. These findings suggest that banks subject to stress tests exhibit lower risk-taking going forward. This reduction in future risk-taking suggests that stress tests have, in general, been able to mitigate excessive risk-taking behavior that had previously - and along with other adverse bank behaviors - proven to be a significant contributor to the crisis of 2008. Our results are consistent with previous empirical findings of reduced bank risk in the presence of stress tests (Acharya et al., 2018; Shahhosseini, 2014). The finding is also consistent with the theoretical notion that increases in capital ratio requirements are negatively related to bank risk-taking (Furlong and Keeley, 1989; Berger and Bouwman, 2013). The finding could be a result of the higher level of supervision and monitoring among stress-tested banks. Because the exercise impose more stringent restrictions and a more comprehensive monitoring among a specific sample of banks, and because previous literature suggests that markets react to the stress test outcomes (Neretina et al., 2015), perhaps bank managers feel pressure to comply with the imposed requirements. The publication of the stress test results reduces bank opaqueness and the informational asymmetry gap and as a result market participants could pressure such banks into "behaving." through the use of market discipline.

When we consider the interaction between the CCAR stress test dummy variable and past risk-taking (CCAR x σROA_L3Y), we observe a positive and statistically significant relation of 0.177 (t-statistic of 3.121) between CCAR x σROA_L3Y and Future Risk-Taking. These results are significant at the 99% level. The results suggest that, despite the overall reduction in risk-taking among banks subject to the CCAR exercises, entities exposed to higher ROA volatility ex-ante (i.e., risk-seeking banks) have significantly higher risk appetites going forward. Conversely, risk-averse CCAR banks (with low past ROA volatility) are likely to exhibit low ROA volatility going forward. The results suggest that the risk appetite of banks plays an important role in their risk-taking decisions. The results are in line with previous empirical research, which suggests that safer, more risk-averse entities have primarily driven risk-taking reductions among stress-tested banks, perhaps because they do not wish to jeopardize the increased charter values derived from increased regulatory capital requirements (Acharya et al., 2018; Ignatowski and Korte, 2014). The finding is also in line with the theoretical prediction of an inverse relation between capital regulation and bank risk-taking (Flannery, 1989; Kahane, 1977; Koehn and Santomero, 1980; Kim and Santomero, 1988; Rochet, 1992; Shrieves and Dahl, 1992). Perhaps the result could be explained by banks' desire to uphold a given risk or leverage threshold. The literature suggests that banks with low risk-aversion tend to favor high leverage (low capital) and high asset risk. When regulators forcefully augment desired leverage or risk thresholds through increased capital requirements, banks with relatively high-risk appetites would readjust the thresholds through an increase in asset risk. The results are consistent with previous literature, which concludes that CCAR has not effectively curbed risk-taking among value-maximizing banks.

The results are echoed when we incorporate the original SCAP exercise into our analysis. We observe a positively, albeit statistically weaker (significant at the 90% level) relation between FedST x σROA_L3Y and Future Risk-Taking.

Although incorporating the SCAP exercise into our analysis undermined our findings, the nature of this particular stress test is different from the annual exercises that have since replaced it. SCAP was implemented during the crisis, as a one-off exercise, without a clear outlook on how stress-testing would evolve. CCAR, on the other hand, has been implemented annually since its inception. Also, all CCAR exercises have been conducted in periods of expansion. Its repetitive implementation has made it possible for banks to adjust to the CCAR exercises, whereas adjusting to the SCAP exercise seems unlikely. While SCAP has been considered a success because of its role in strengthening banks' capital positions in the aftermath of the crisis, bank behavior around this particular stress test is characterized by an unusual macroeconomic setting and, therefore, provides little insight as to the general impact of stress tests on bank behavior. Given the macroeconomic implications as well as the element of surprise associated with SCAP, we believe the succeeding CCAR exercises are a much more reliable source for the sake of this analysis.

1.4.1.2 Bank Solvency in the Presence of Stress Tests

Table 1.4(b) presents the estimation results for the Z-Score, a measure that takes into account banks' distance to default and indicates financial soundness. As before, Columns (1) through (3) relate to banks subject to the CCAR exercises in a given quarter. Columns (4) through (6) also consider the original SCAP exercise of 2009.

We observe a statistically significant negative relation between the CCAR and FedST dummies and Future Solvency. The statistical significance of this relation is stronger when only CCAR banks are considered. The result suggests that banks subject to stress tests exhibit lower future distance to default (i.e., are closer to default) than other non-stress tested BHCs. The results suggest that banks subject to stress-tests are significantly more vulnerable than non-stress tested banks. Perhaps, as noted in the literature, their mere inclusion in the stress-testing framework provides the participating BHCs with a sense of entitlement to implicit guarantees in the event of default. Therefore their solvency positions are not necessarily viewed as the sole decisive factor for actual default in the presence of Too-Systematically-Important-To-Fail. This could trigger higher moral hazard incentives among stress-tested entities.

When we consider the interaction of the stress test dummies and past distance to default with the forward-looking distance to default, we observe a significant positive relation. The results are statistically significant at the 95% level among listed banks.[21] Under CCAR, the coefficient of listed banks is much larger (0.368 (t-statistic of (3.846)) in comparison with the full sample coefficient of 0.298 (t-statistic of (3.266)). The results are consistent when we include the SCAP exercise into our analysis. Our findings indicate that banks whose ex-ante distance to default is low tend to have a significantly lower Z-Score in the future. Conversely, those relatively more solvent banks and had

[21] Given the small sample size of non-listed BHCs subject to stress tests, we are less confident on the results of this particular sub-sample.

ex-ante higher z-scores tend to exhibit higher future distance to default. This finding is consistent with the literature that the safest banks have generally made the largest contribution in restoring overall stability in the financial system (Hirtle et al., 2009).

1.4.1.3 Robustness Check: Difference in Difference Analysis

As a way to ensure that our results are not merely driven by the size of stress-tested banks, which tend to be some of the largest (in terms of total assets) in our sample, we implement a difference-in-difference methodology. Based on propensity score matching, we select 100 large, non-stress tested banks for which we have full financial information in 2008Q3. We match those 100 banks to the 15 stress-tested banks for which we have full financial information in 2008Q3.[22] The sample is selected based on distance matrices that take into account a set of bank fundamentals (Equity to Asset Ratios, Non-performing Loans to Assets Ratios, Short-term wholesale funding to Assets Ratios, Deposits to Liabilities Ratios, and Risk-Taking). Banks with relatively similar characteristics exhibit a lower distance variance matrix rank. We use the rank of these entities to control for the number of non-stress tested banks to be included in the difference in difference analysis.

Table 1.5 provides the results of the difference-in-difference analysis. Table 1.5(a) presents the estimation results for ROA Volatility as a measure of bank risk-taking. Table 1.5(b) presents the estimation results for the Z-Score as an indicator of financial soundness. While Tables 1.5(c) and 1.5(d) provide the results for a time horizon prior to the implementation of stress tests. In each table: Column (1) takes into account all non-stress tested banks. Columns (2) considers the 100 banks that are most similar in characteristics to the stress-tested sub-sample. Column (3) takes into account the 50 most similar non-stress tested banks.

[22] We assume the stress-tested banks for which information was not available in that quarter to have similar characteristics and behavior.

The results of tables 1.5(a) and 1.5(b) point to statistically significant differences in risk-taking and solvency among stress-tested BHCs and entities that are not subject to the supervisory exercises after the implementation of the stress-testing framework (Post2009). In the first column of 1.5(a), we observe a negative and significant relation between the stress test dummy after 2009. This finding echoes the results obtained in Table 1.4(a) and suggests that BHCs subject to stress tests exhibit significantly lower ROA volatility than non-stress tested BHCs. In the second and third columns, we observe that these differences are not driven by bank characteristics, such as size, leverage, lending quality, etcetera, as non-stress-tested entities within these analyses seem to be very closely comparable to the sample of ST banks.

We also observe a statistically significant positive relation with future solvency in column 1 of Table 1.5(b). This result suggests that banks subject to stress tests are farther away from default than non-stress tested entities. However, this result contradicts the findings obtained in Table 1.4(b) and perhaps the contradiction stems from the fact that the difference in difference analysis takes into account only the original 19 banks that participated in SCAP and the subsequent CCAR exercises. Perhaps BHCs that were incorporated into the stress-testing framework after 2009 are influencing the results in Table 1.4. Furthermore, previous studies have emphasized that the original exercise of 2009 was detrimental in restoring bank safety. The 19 original banks have managed to quickly raise the necessary capital to meet the required regulatory minimums. In fact, only 3 of those 19 banks failed the subsequent CCAR exercise in 2012, and one of those 3 failed again in 2013. The inclusion of additional less-solvent banks later on in the stress-testing horizon could explain the differences in the results. In columns 2 and 3 of 1.5(b), we observe that this positive relation holds among ST banks and similar non-ST banks and is, therefore, not driven by differences in bank fundamentals.

Both results point to clear and statistically significant differences in risk-taking and solvency among banks subject to stress tests and similar banks that were not part of the exercise. However, we also implement an analysis to evaluate whether the differences observed in 1.5(a) and 1.5(b), and specifically columns 2 and 3, are due to variations which we fail to capture through our matching estimation. We do so by implementing a robustness test to check whether significant differences between the stress-tested and non-stress tested banks exist prior to implementing the first stress test exercise in 2009. If the differences in risk-taking and solvency exist before stress-tests, we could deduce that the banks in our sample are simply not comparable, at least in terms of risk appetite and solvency. If, however, these banks do not exhibit differences prior to 2009, it would be safe to assume that the divergence in risk-taking and solvency has emerged, at least partially, as a result of the implementation of the stress-testing framework.

Tables 1.5(c) and 1.5(d) present the results of this robustness check for the ROA Volatility and the Z-Score, respectively. In these analyses, we use the sample of matched non-stress-tested BHCs and their stress-tested counterparts, but instead of considering the stress test horizon, which began in 2009, we subset our sample to include several years directly preceding, and not including the SCAP exercise. We choose the period between 2005 and 2008 as our time frame. However, alternative time frame specifications yield little variation in the results obtained.

Our main variable of interest ST*Post2005, indicates no difference in terms of risk-taking and solvency during our sample period among stress-tested and non-stress tested banks. It seems the differences in risk-taking and solvency, which we observe in Tables 1.5(a) and 1.5(b) are not present in the years preceding the initiation of stress tests. As a result, we find no evidence that the two groups diverged in terms of risk-taking and solvency dynamics prior to the inception of SCAP (Post2005), and the two groups are, in fact, similar.

The robustness analyses suggest that stress-testing has influenced risk-taking and solvency in banks that were otherwise very similar prior to SCAP implementation.

1.4.2 Do Projected Capital Levels Influence Risk-Taking and Solvency?

The results presented thus far are independent of the stress test results and projected capital positions of each stress-tested BHC. To observe whether the projected stressed capital levels affect the risk-taking strategies of BHCs, we implement an analysis that considers the percentage of excesses or shortages in required regulatory capital ratios. In addition, we implement a complementary analysis, which intends to capture any non-linear trends in the capital buffers or shortfalls, by using a binary dummy variable, Pass, which is equal to one where the projected capital levels exceed regulatory minimums; and is zero when projected capital levels fall short of minimum regulatory requirements. While other studies have focused exclusively on BHCs' stress test designation, to the best of our knowledge, ours is the first study to analyze how capital levels obtained via the stress-testing framework and the associated binary results influence bank behavior.

Table 1.6 provides the results of our analysis. Table 1.6(a) presents the estimation results for ROA Volatility, while Table 1.6(b) presents the estimation results for the Z-Score. In each table: Columns (1) and (2) relate to banks subject to the CCAR exercises in a given quarter. Columns (3) and (4) also consider the original SCAP exercise of 2009. Columns (1) and (3) take into account the numeric value of the projected capital buffer or shortfall. Columns (2) and (4) consider the binary transformation or whether or not a bank passed a given stress exercise.

Calculated as the difference between the projected stressed capitalization ratios and the regulatory capital minimums inherent in each exercise, the Capital Buffer variable provides information on whether banks successfully met the minimum capital requirements inherent in the stress test exercises' quantitative segment. It is calculated as the exact amount of capital buffers in excess of regulatory minimums (for those banks that passed the quantitative part of stress testing exercises) and the capital shortfalls below those minimums (for those banks that failed the quantitative part of the stress-testing exercises). To check to what extent capital buffers influence risk-taking and solvency dynamics, we interact the projected capital buffers with past risk-taking and solvency. We run the analysis with and without considering the SCAP exercise. This analysis focuses solely on the subsample of those entities that take part in the stress-testing exercises. All non-stress-tested institutions are excluded.

In Table 1.6(a), we find a negative relation between the interaction of Capital Buffers and Past Risk-Taking (σROA_L3Y * Buffer) and future ROA Volatility with a coefficient of -0.037 (t-statistic of -6.418). We observe a similar result with a smaller coefficient of -0.027 (t-statistic of -5.752) when we include the SCAP exercise. The results are statistically significant at the 99% level when we consider both the CCAR and FedST specifications.

The results suggest that risk-taking among banks subject to stress tests is conditional on the projected capital levels derived from the stress-testing framework. In other words, ex-ante risk-tolerant, stress-tested BHCs, with inadequate capital levels, and ex-ante risk-averse banks with capital ratios exceeding regulatory minimums exhibit increased levels of ROA volatility in the future. The result provides another possible explanation as to why banks with ex-ante high-risk appetites may choose to increase future risk-taking. Since these banks' capital positions are relatively weak and less of their own funds are invested in their business, the probability of default is less costly. As a result, they may have smaller incentives to avoid default and increase risk. In addition, and since raising equity could be exceptionally costly, the only viable channel to increase future equity is through an increase in current risk-taking Blum (1999); Calem et al. (2020). Among ex-ante risk-averse banks with sufficient capital levels, the chance of default is generally low. Their charter values are not at risk, and supervisory monitoring could also be lower because such banks pass the exercises' quantitative portion. As a result, the bank has more freedom to engage in higher risk-taking without being penalized for doing so.

In Table 1.6(b), when we consider CCAR independently of the SCAP exercise, we find that the relation between the interaction between Solvency and Capital Buffers is positively related to Future Solvency. Banks with ex-ante high Z-scores (those further away from default) and high projected capital levels are more prone to have higher solvency in the future. Again we find that the evolution of solvency is conditional on the projected capital ratios from the stress testing framework.

1.4.3 Can Stress Test Results and Capital Buffers be Predicted?

We also analyze whether bank characteristics explain the projected capital adequacy of banks under prudential regulation. We do so by implementing Two-Stage Heckman Model Regressions based on (1) BHCs' stress test results (pass vs. fail dummy variable) and (2) the amount of capital buffer or shortfall. The analysis considers both the CCAR and FedST (CCAR + SCAP) stress test horizons. Table 1.7 provides the results of these analyses.

First, we analyze whether bank characteristics explain the stress test outcomes (Pass Dummy), independent of the capital levels. The results of this analysis are reported in Table 1.7, columns (1) and (4), for CCAR Banks, and SCAP + CCAR Banks, respectively. We find a statistically significant and negative relation between the CCAR Pass Dummy and the specialization (LTA), liquidity exposure (STWSF_TA), and Market Risk (column (1)). The inclusion of the SCAP exercise (column (4)) into our sample suggests that the quality of the loan portfolio (NPLLTL), short-term wholesale funding, and whether the bank was part of the wide-scale recapitalization effort (Recap'd) played an important role in whether or not a bank was able to pass the stress test exercise. The results are consistent with the events surrounding the SCAP exercise. Many of the banks subject to SCAP were recapitalized, and many suffered the negative effects of the sub-prime mortgage crises on the quality of their lending portfolios. However, in the more stable stress test horizon, liquidity and market risk seem to be better indicators of whether banks successfully pass the stress test exercises.

Next, in Table 1.7, columns (2) and (5), we analyze whether bank fundamentals could "predict" ex-ante the projected capital levels inherent in stress testing. The results suggest that past risk-taking, solvency, leverage, loan loss provisions, and profitability are positively associated with the projected capital levels under the stress-testing framework. All of these indicators measure bank soundness and performance and are obvious determinants of satisfactory capital outcomes. On the other hand, bank size, specialization, credit quality, liquidity, and market risk exhibit a statistically significant negative relation with the amount of projected capital levels. It seems intuitive that smaller banks that specialize in lending hold lower quality loan portfolios, exhibit significantly higher liquidity, and market risks are obvious candidates for unsatisfactory stress test outcomes.

The importance of the aforementioned variables in stress test outcomes provides information on the relevance of bank activities in meeting capital objectives. Effective regulation of bank activities related to these variables could provide additional mechanisms for managing and improving bank and financial system stability objectives.

1.4.4 Does the Interest Rate Environment Influence Bank Risk-Taking?

Finally, we analyze the effect of interest rates on bank risk-taking in the presence of stress tests. We do so by interacting interest rates with our main variables of interest ((1) CCAR or CCAR & SCAP Dummy Variable; (2) the amount of capital buffer or shortfall under either the CCAR or FedST (CCAR & SCAP) stress test horizons; and (3) BHCs' stress test results (pass dummy variable). Table 1.8 provides the results of these analyses. Table 1.8(a) provides the results for the interaction with the federal funds rate (FedFunds). Table 1.8(b) considers the quarterly change in the federal funds rate.

In table 1.8(a), under the CCAR horizon, we observe a negative relation between the interaction of FedFunds * ST (coefficient of -0.001) and Future Risk-Taking, the relation holds when we consider the interaction of FedFunds * Pass (coefficient of -0.007), the dummy variable which indicates whether a bank has successfully met stress test requirements. When incorporating SCAP into our sample period, we observe a negative relation between FedFunds * ST and Future Risk-Taking with a coefficient of -0.001.

The results suggest that interest rates are positively related to future risk-taking among non-stress tested BHCs. Among banks subject to stress tests, however, the relation is negative and statistically significant. In other words, banks subject to stress tests exhibit higher future risk-taking when interest rates are low. Various empirical studies (Delis and Kouretas, 2011; Altunbas et al., 2012; Maddaloni and Peydró, 2011) demonstrate that banks are willing to take on more risk when interest rates are low. These papers show that a low-interest-rate environment forces banks to find new ways of compensating for the reductions in their net interest margins. Our findings have important policy implications among risk-seeking banks subject to prudential regulation as the low-interest rates paradox could exacerbate financial instability. Maddaloni and Peydró (2011) demonstrate that the influence of low-interest rates on the softening of lending standards is amplified by securitization since higher securitization leads to softer lending standards—consequently, credit and liquidity risk increase, which in turn increases the likelihood of a financial crisis. If the crisis unfolds, the monetary authority could respond by further lowering the interest rate to support the economy and the banking system and avoid new credit crunches. The response of banks would, in turn, be to increase risk-taking even further and thus resulting in a vicious cycle that increases the likelihood of financial turmoil. Interestingly, we only observe this relation among stress-tested banks. One explanation for this finding could be that banks subject to stress tests are part of a subgroup of institutions whose performance plays a vital role in the entire financial system's performance. Thus, they may rely on implicit bailout guarantees purely because of their Stress Test designation. Under the CCAR test horizon, the result is predominantly driven by banks with sufficient capital buffers above regulatory minimums (i.e., those banks that have passed the respective stress test exercise). In other words, safer banks sufficiently distanced from default are more likely to respond to low-interest rates by increasing risk-taking. Conversely, higher interest rates increase banks' net interest margins, and as a result, allow for higher profitability and capital accumulation and, as a consequence, reduce the need for bank risk-taking. From a policy perspective, the results are favorable, as regulators would prefer risk-taking among safer banks with relatively high capital buffers rather than poorly capitalized banks. This, however, carries crucial implications for financial stability if interest rates become excessively low or negative.

In table 1.8(b), we observe that changes in interest rates influence risk-taking, and this relation is conditional on the level of capital buffer or shortfall across banks subject to stress tests. Under both the CCAR and CCAR + SCAP horizons, We observe e negative relation between FedFunds_Chg * Buffer and FedFunds_Chg * Pass. The results suggest that small changes in interest rates are associated with higher risk-taking across safer and generally better capitalized stress-tested banks.

1.4.5 Robustness Analyses

Our base sample consists of both listed as well as non-Listed bank holding companies. In our first set of analyses, we compare banks subject to stress tests against those that did not participate in the U.S. SCAP and subsequent CCAR exercises. In the second part of our analysis, we eliminate the sub-sample of non-stress tested banks and consider only banks that had participated in stress test exercises in a given quarter. In the stress-tested banks sub-sample, we have information on 3 non-listed banks and 23 listed banks.

To date, commercial banks have not been part of the U.S. stress-testing framework. For robustness purposes, we include commercial banks in the first set of analyses and find that their inclusion does not alter the results and significance of our findings.

Furthermore, given the small number of non-listed banks, throughout all of our analysis, we exclude non-listed banks from all samples, such that our final samples consist of listed BHCs or listed BHCs subject to stress tests. Our results remain persistent and largely unchanged, even when non-listed banks are considered.

1.5 Conclusions

Based on a sample of US Bank Holding Companies spanning 1994 to 2016, we study the Federal Reserve's Stress Tests' impact on future risk-taking and bank solvency. Our results suggest that stress tests do not hinder the risk-appetites of ex-ante risk-tolerant banks. The positive effects of stress tests on bank solvency are primarily driven by the banks who are ex-ante farthest away from default (i.e., the safest banks). We find that the projected capital buffers under the stress test exercises influence how financial soundness and risk-taking evolve. In particular, our results indicate that banks with capital shortfalls exhibit higher future risk-taking than banks with projected capital levels that are considered adequate by industry standards. We further extend these analyses to include the impact of the post-crisis prevalent low-interest-rate environment and find safer banks are more likely to mitigate decreased profitability by increasing risk-taking when interest rates are low. The finding provides evidence of how the interest rate environment could affect financial stability. This finding is particularly important, given that many central banks around the world seem to favor such policies, and it's likely that low-rate environments will persist well into the future. And while our analysis is based on data for the United States, we expect that the aforementioned results would be particularly strong across economies with much lower or negative interest rates such as Europe and especially Japan, whose interest rates hit a record low of -0.10 percent in January of 2016 and have remained at or near that level since.

Next, we observe that several bank proxies are associated with having a capital shortfall among the banks with capital shortfalls. In the case of the CCAR stress-tests, bank liquidity, market risk, and the loan portfolio size are positively related to not meeting projected capital levels above required regulatory minimums. Our results are consistent with previous studies that examine the effects of stress tests on bank balance sheet items and provide evidence that pre-existing bank conditions, such as banks' appetite for risk, are not fully mitigated. Our study contributes to the broader sets of studies related to bank risk-taking and stress-testing financial institutions. While the relation between changes in capital regulation and risk-taking has been extensively analyzed previously, to the best of our knowledge, this is the first empirical evaluation of how bank risk-taking and solvency evolve in the context of stress-testing, the respective stress test outcomes, and the monetary environment under which banks operate. Our study further examines how banks have adjusted to higher capital requirements and is the first to document different adjustment channels among banks with different stress test outcomes.

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Tables & Figures

Table 1.1: Variable Definitions

(a) Main Variables of Interest

Variable	Description	Operational Definition
Dependent Variable: Future Financial Soundness and Risk-Taking		
ZScore_F3Y	Financial Soundness	3-Year Future Distance to Default: The sum of Average Profitability (ROA) and Last Reported Shareholder's Equity scaled by ROA Volatility (standard deviation of ROA over the length of a 12-quarter forward-rolling window.
σ **ROA_F3Y**	Risk-Taking	3-Year Future ROA Volatility: Standard deviation of ROA over the length of a 12-quarter forward-rolling window.
Main Variables of Interest		
Stress Test Dummy		
CCAR	Bank subject to CCAR	Dummy 1 if a particular bank is subject to the CCAR stress tests in a given quarter; and 0 otherwise. This variable does not consider the original SCAP Exercise of 2009.
FedST	Bank subject to SCAP and CCAR	Dummy 1 if a particular bank is subject to either the SCAP or CCAR stress tests in a given quarter; and 0 otherwise.
Capital Position of Stress Tested Banks		
Buffer	Capital Position	Stressed Regulatory Capital Projections from severely adverse scenario less Regulatory Capital Minimum obtained from the CCAR Result Disclosures. Stressed Regulatory Capital Projections from severely adverse scenario less Regulatory Capital Minimum obtained from the CCAR and SCAP Result Disclosures.
Stress-Tested Banks' Capital Shortfall Dummy		
Pass	Favorable Stress Test Result	Dummy 1 if Buffer under CCAR is positive, indicating capital in excess of regulatory minimum; and 0 otherwise. Dummy 1 if Buffer under FedST is positive, indicating capital in excess of regulatory minimum; and 0 otherwise.
Past Financial Soundness and Risk-Taking		
ZScore_L3Y	Financial Soundness	3-Year Past Distance to Default: The sum of Average Profitability (ROA) and Last Reported Shareholder's Equity scaled by ROA Volatility (standard deviation of ROA over the length of a 12-quarter backward-rolling window.
σ **ROA_L3Y**	Risk-Taking	3-Year Past ROA Volatility: Standard deviation of ROA over the length of a 12-quarter backqard-rolling window.
Interaction Terms		
To isolate the performance of stress tested banks we interact Past Financial Soundness or Risk-Taking with CCAR or FedST To test to what extent capital buffers or shortfall influence performance we interact Past Financial Soundness or Risk-Taking with Buffer under the CCAR or FedST specification; and Risk-Taking with Pass under the CCAR or FedST specification, which are essentially a binary transformation of the projected capital shortfalls or excesses.		

(b) Firm-Specific and Macroeconomic Control Variables

Variable	Description	Operational Definition
Entity-Specific Control Variables		
Size	Relative Size	Natural Logarithm of Total Assets
ETA	Capitalization	Shareholders' Equity scaled by Total Assets
LTA	Specialization	Net Loans and Leases scaled by Total Assets
LLPTA	Level of Loss Provisions	Loan Loss Provisions scaled by Total Assets
NPLLTL	Credit Quality	Non-Performing Loans and Leases scaled by Total Loans
STWSFTA	Liquidity	Short-term Wholesale Funding scaled by Total Assets
ROA	Profitability	Net Income scaled by Total Assets*
MSTA	Market Risk	Marketable Securities (AFS Securities and Trading Assets) scaled by Total Assets
Recap	Recapitalization	Dummy equal to 1 if recapitalized; 0 otherwise
NPLLTL_Chg	Quality Change	Quarter-over-quarter change in the ratio of non-performing loans and leases.
Macroeconomic Control Variables		
UNRATE	Unemployment Rate	One-year-ahead consensus forecast of the US unemployment rate
GDP_Growth	GDP Growth Rate	Quarter-over-Quarter Percentage Change in GDP
VIXCLS	Market Volatility	Implied volatility of options on the S&P 500 Index

Note: All control variables are winsorized and lagged one quarter with respect to our dependent variable.

Table 1.2: Descriptive Statistics

(a) Full Sample

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
CCAR	112,611	0.00	0.07	0.00	1.00
FedST	112,611	0.01	0.08	0.00	1.00
σROA_F3Y	113,083	0.00	0.00	0.00	0.04
ZScoreF3Y	79,012	4.86	1.02	0.05	7.58
σROA_L3Y	107,999	0.00	0.00	0.00	0.04
ZScore_L3Y	107,516	4.95	1.05	-0.12	14.29
Size	112,611	13.45	1.37	5.96	21.67
ETA	112,611	0.09	0.04	0.03	0.84
LTA	112,610	0.65	0.13	0.00	0.99
STWSF_TA	111,475	0.05	0.06	0.00	0.45
MS_TA	112,611	0.19	0.12	0.00	0.80
Recap'd	112,611	0.03	0.16	0.00	1.00
NPLLTL	112,595	0.01	0.02	0.00	0.11
ROA	111,270	0.00	0.00	-0.02	0.03
QLLP_TA	111,197	0.00	0.00	0.00	0.02
NPLLTL_Chg	106,740	0.29	2.51	-1.00	54.75
UNRATE	112,611	5.78	1.50	3.90	9.90
VIXCLS	112,611	20.26	7.20	11.03	58.60
GDP_Chg	112,611	0.67	0.59	-2.11	1.89

(b) Stress Tested Banks

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
Buffer (CCAR)	414	2.34	1.89	-3.48	8.21
Buffer (FedST)	489	2.00	2.38	-7.29	8.21
σROA_F3Y	621	0.00	0.00	0.00	0.01
ZScoreF3Y	368	5.02	0.77	2.65	6.78
σROA_L3Y	641	0.00	0.00	0.00	0.01
ZScore_L3Y	641	4.67	1.01	2.07	11.26
Size	647	19.58	1.10	17.82	21.67
ETA	647	0.11	0.02	0.05	0.16
LTA	647	0.50	0.24	0.02	0.84
STWSF_TA	647	0.11	0.08	0.00	0.33
MS_TA	647	0.22	0.11	0.03	0.58
Recap'd	647	0.12	0.32	0.00	1.00
NPLLTL	647	0.02	0.02	0.00	0.08
ROA	646	0.00	0.00	-0.02	0.01
QLLP_TA	646	0.00	0.00	0.00	0.02
NPLLTL_Chg	630	0.09	2.17	-0.99	53.36
UNRATE	647	7.34	1.73	4.90	9.90
VIXCLS	647	19.40	6.81	12.74	45.00
GDP_Chg	647	0.46	0.50	-1.39	1.22

(c) Listed Banks

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
CCAR	34,510	0.01	0.12	0.00	1.00
FedST	34,510	0.02	0.13	0.00	1.00
σROA_F3Y	33,822	0.00	0.00	0.00	0.02
ZScoreF3Y	24,126	4.93	1.12	0.43	7.58
σROA_L3Y	33,526	0.00	0.00	0.00	0.04
ZScore_L3Y	33,505	5.06	1.10	0.05	11.54
Size	34,510	14.51	1.66	11.54	21.67
ETA	34,510	0.10	0.05	0.03	0.84
LTA	34,509	0.65	0.13	0.00	0.96
STWSF_TA	34,409	0.08	0.07	0.00	0.45
MS_TA	34,510	0.18	0.11	0.00	0.80
Recap'd	34,510	0.05	0.22	0.00	1.00
NPLLTL	34,497	0.01	0.02	0.00	0.11
ROA	34,310	0.00	0.00	-0.02	0.03
QLLP_TA	34,301	0.00	0.00	0.00	0.02
NPLLTL_Chg	33,230	0.18	1.89	-1.00	54.75
UNRATE	34,510	5.86	1.57	3.90	9.90
VIXCLS	34,510	20.13	7.41	11.03	58.60
GDP_Chg	34,510	0.63	0.61	-2.11	1.89

(d) Listed Stress Tested Banks

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
Buffer (CCAR)	386	2.46	1.77	-0.20	8.21
Buffer (FedST)	454	2.15	2.28	-7.29	8.21
σROA_F3Y	570	0.00	0.00	0.00	0.01
ZScoreF3Y	328	5.07	0.67	2.77	6.78
σROA_L3Y	591	0.00	0.00	0.00	0.01
ZScore_L3Y	591	4.73	0.95	2.46	11.26
Size	595	19.66	1.10	17.82	21.67
ETA	595	0.11	0.02	0.05	0.16
LTA	595	0.48	0.25	0.02	0.84
STWSF_TA	595	0.11	0.08	0.00	0.33
MS_TA	595	0.23	0.11	0.03	0.58
Recap'd	595	0.11	0.32	0.00	1.00
NPLLTL	595	0.02	0.02	0.00	0.08
ROA	595	0.00	0.00	-0.02	0.01
QLLP_TA	595	0.00	0.00	0.00	0.01
NPLLTL_Chg	579	0.10	2.26	-0.99	53.36
UNRATE	595	7.28	1.74	4.90	9.90
VIXCLS	595	19.34	6.83	12.74	45.00
GDP_Chg	595	0.46	0.50	-1.39	1.22

Notes: All variables are winsorized at the 0.5% level in each tail and lagged one quarter with respect to the dependent variable. Tables 1.1(a) reports a detailed description of each of the main variables of our analysis while 1.1(b) reports a detailed description of each of the bank-specific and macroeconomic control variables used in the regressions.

Table 1.3: Correlations

(a) Full Sample

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
CCAR	(1)	1	0.812	0.018	-0.037	1.000	0.813	-0.005	0.047	1.000	0.812
FedST	(2)	0.812	1	0.007	-0.059	0.812	1.000	0.009	0.069	0.812	1.000
Zscore_F3Y	(3)	0.020	0.012	1	0.417	0.018	0.007	-0.949	-0.354	0.018	0.007
Zscore_L3Y	(4)	-0.034	-0.057	0.421	1	-0.037	-0.059	-0.380	-0.947	-0.037	-0.059
Zscore_L3Y × CCAR	(5)	0.982	0.798	0.024	-0.024	1	0.813	-0.005	0.047	1.000	0.812
Zscore_L3Y × FedST	(6)	0.836	0.979	0.017	-0.043	0.851	1	0.009	0.069	0.813	1.000
σROA_F3Y	(7)	-0.013	-0.010	-0.813	-0.323	-0.015	-0.013	1	0.389	-0.004	0.009
σROA_L3Y	(8)	0.037	0.067	-0.320	-0.763	0.024	0.045	0.378	1	0.047	0.069
σROA_L3Y × CCAR	(9)	0.707	0.575	0.000	-0.055	0.577	0.491	0.001	0.081	1	0.812
σROA_L3Y × FedST	(10)	0.479	0.718	-0.008	-0.078	0.390	0.580	0.006	0.126	0.678	1

(b) CCAR Banks

		(1)	(2)	(3)	(4)	(5)	(6)	(7)
Buffer	(1)	1	0.200	0.317	0.991	-0.155	-0.210	0.885
Zscore_F3Y	(2)	0.119	1	0.395	0.218	-0.963	-0.297	0.126
Zscore_L3Y	(3)	0.231	0.510	1	0.410	-0.411	-0.963	-0.068
Zscore_L3Y × Buffer	(4)	0.979	0.108	0.304	1	-0.181	-0.305	0.829
σROA_F3Y	(5)	-0.237	-0.867	-0.507	-0.201	1	0.341	-0.063
σROA_L3Y	(6)	-0.239	-0.496	-0.865	-0.287	0.627	1	0.178
σROA_L3Y × Buffer	(7)	0.706	0.173	0.002	0.556	-0.337	-0.044	1

(c) CCAR and SCAP Banks

		(1)	(2)	(3)	(4)	(5)	(6)	(7)
Buffer	(1)	1	0.270	0.385	0.990	-0.264	-0.320	0.945
Zscore_F3Y	(2)	0.221	1	0.501	0.293	-0.975	-0.437	0.226
Zscore_L3Y	(3)	0.337	0.537	1	0.439	-0.494	-0.965	0.180
Zscore_L3Y × Buffer	(4)	0.975	0.204	0.397	1	-0.284	-0.367	0.906
σROA_F3Y	(5)	-0.179	-0.861	-0.416	-0.135	1	0.463	-0.216
σROA_L3Y	(6)	-0.297	-0.470	-0.864	-0.326	0.450	1	-0.110
σROA_L3Y × Buffer	(7)	0.775	0.259	0.152	0.628	-0.304	-0.217	1

Table 1.4: Stress Tests and Forward Looking Accounting Indicators

(a) Risk-Taking

	CCAR Exercises			SCAP and CCAR Exercises		
	All Banks	Listed	Non-listed	All Banks	Listed	Non-listed
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	σROA_F3Y	σROA_F3Y	σROA_F3Y	σROA_F3Y	σROA_F3Y	σROA_F3Y
σROA_L3Y	-0.066	-0.142*	-0.058	-0.066	-0.144*	-0.058
	(-1.098)	(-1.850)	(-1.164)	(-1.094)	(-1.845)	(-1.165)
σROA_L3Y × CCAR	0.177***	0.204**	0.209***			
	(3.121)	(2.604)	(3.386)			
CCAR	-0.001**	-0.001**	-0.001			
	(-2.401)	(-2.452)	(-1.637)			
σROA_L3Y × FedST				0.090*	0.118*	0.098
				(1.822)	(1.705)	(1.249)
FedST				-0.001***	-0.002***	-0.001
				(-2.928)	(-3.083)	(-1.425)
Constant	-0.006	-0.007	-0.005	-0.006	-0.007*	-0.005
	(-1.592)	(-1.653)	(-1.636)	(-1.604)	(-1.681)	(-1.636)
R^2	0.144	0.164	0.129	0.145	0.166	0.129
Observations	100,945	31,911	69,034	100,945	31,911	69,034
Number of groups	3,349	1,055	2,716	3,349	1,055	2,716
FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

(b) Financial Soundness

	CCAR Exercises			SCAP and CCAR Exercises		
	All Banks	Listed	Non-listed	All Banks	Listed	Non-listed
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	ZScore_F3Y	ZScore_F3Y	ZScore_F3Y	ZScore_F3Y	ZScore_F3Y	ZScore_F3Y
ZScore_L3Y	-0.026	-0.047	-0.030	-0.026	-0.049	-0.030
	(-0.899)	(-1.295)	(-1.174)	(-0.908)	(-1.334)	(-1.161)
ZScore_L3Y × CCAR	0.298***	0.368***	0.211			
	(3.266)	(3.846)	(1.397)			
CCAR	-0.584**	-0.943***	-0.290			
	(-2.109)	(-3.436)	(-0.531)			
ZScore_L3Y × FedST				0.273***	0.346***	0.129
				(3.345)	(3.906)	(1.167)
FedST				-0.399	-0.793**	0.085
				(-1.660)	(-2.586)	(0.167)
Constant	9.722***	10.605***	9.483***	9.746***	10.671***	9.479***
	(3.987)	(3.888)	(4.301)	(3.990)	(3.893)	(4.298)
R^2	0.170	0.180	0.168	0.171	0.180	0.168
Observations	70,263	22,745	47,518	70,263	22,745	47,518
Number of groups	2,455	788	1,970	2,455	788	1,970
FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Table 1.4(a) reports the results for equation (1). The dependent variable is future risk-taking measured as the volatility of average return on assets over a three year forward looking horizon (σROA_F3Y). Table 1.4(b) reports the results for equation (2). The dependent variable is future solvency measured over a three year forward looking horizon (ZScore_F3Y). The independent variables under both specifications are the Stress Test Dummy (CCAR or FedST) and the interaction between the stress test dummy variables with past risk-taking (1.4(a)) or past solvency (1.4(b)). Bank-specific controls include the variables Loans-to-Total Assets (LTA), Equity-to-Asset Ratios (ETA) Size, Profitability (ROA), Loan Loss Provisions as a Proportion of Total Assets (LLPTA), Non-Performing Loans and Leases as a proportion of Total Loans (NPLLTL), Equity as a proportion of Total Assets (ETA), Short-Term Wholesale Funding as a proportion of Total Assets (STWSFTA), Marketable Securities as proportion of Total Assets (MSTA), and whether a bank has been recapitalized (Recap). Macroeconomic controls include the unemployment rate (UnRate), the risk-free rate (TB3MS), Market Volatility (VIXCLS) and GDP Growth. Tables 1.1(a) and 1.1(b) report detailed descriptions of the variables employed and Table 1.2 reports descriptive information on each variable. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. Standard errors are reported in parentheses. All variables are winsorized at the 0.5% level in each tail. Independent and control variables are lagged one quarter.

Table 1.5: Do Stress-Tested Banks Exhibit Different Risk-Taking and Financial Soundness Characteristics?

(a) Risk-Taking

VARIABLES	**Original Sample** (1) σROA_F3Y	**100 Similar Banks** (2) σROA_F3Y	**50 Similar Banks** (3) σROA_F3Y
Post2009	-0.001***	-0.001**	-0.002***
	(-3.539)	(-2.254)	(-2.701)
ST × Post2009	-0.001***	-0.001***	-0.001***
	(-3.822)	(-4.094)	(-3.803)
σROA_L3Y	-0.047	0.069	-0.077
	(-0.849)	(0.714)	(-1.118)
Constant	-0.011***	-0.012*	-0.012**
	(-2.682)	(-1.887)	(-2.361)
R^2	0.161	0.213	0.223
Observations	100,945	8,145	5,007
Number of groups	3,349	118	69
FE	Yes	Yes	Yes
Controls	Yes	Yes	Yes

(b) Risk-Taking: Robustness

VARIABLES	**Original Sample** (1) σROA_F3Y	**100 Similar Banks** (2) σROA_F3Y	**50 Similar Banks** (3) σROA_F3Y
Post2005	0.001***	0.002***	0.002***
	(3.077)	(7.188)	(6.886)
ST × Post2005	0.001***	0.000	0.000
	(3.248)	(0.003)	(0.090)
σROA_L3Y	-0.068	0.036	-0.084
	(-1.143)	(0.321)	(-0.983)
Constant	-0.004	-0.000	0.000
	(-1.423)	(-0.054)	(0.109)
R^2	0.175	0.317	0.322
Observations	100,945	8,145	5,007
Number of groups	3,349	118	69
FE	Yes	Yes	Yes
Controls	Yes	Yes	Yes

(c) Financial Soundness

VARIABLES	**Original Sample** (1) ZScore_F3Y	**100 Similar Banks** (2) ZScore_F3Y	**50 Similar Banks** (3) ZScore_F3Y
Post2009	0.635***	0.887***	0.973***
	(3.790)	(3.313)	(3.740)
ST × Post2009	0.671***	0.435***	0.228*
	(4.730)	(3.940)	(1.929)
ZScore_L3Y	-0.022	0.048	-0.006
	(-0.648)	(0.852)	(-0.109)
Constant	11.803***	11.397***	12.288***
	(4.312)	(3.337)	(4.044)
R^2	0.170	0.178	0.207
Observations	70,263	6,993	4,317
Number of groups	2,455	116	68
FE	Yes	Yes	Yes
Controls	Yes	Yes	Yes

(d) Financial Soundness: Robustness

VARIABLES	**Original Sample** (1) ZScore_F3Y	**100 Similar Banks** (2) ZScore_F3Y	**50 Similar Banks** (3) ZScore_F3Y
Post2005	-0.758***	-1.184***	-1.093***
	(-6.524)	(-9.291)	(-10.689)
ST × Post2005	-0.388**	-0.013	-0.069
	(-2.324)	(-0.098)	(-0.779)
ZScore_L3Y	-0.021	0.037	0.002
	(-0.701)	(0.761)	(0.033)
Constant	6.414***	3.819**	3.895***
	(3.698)	(2.134)	(3.396)
R^2	0.226	0.318	0.324
Observations	70,263	6,993	4,317
Number of groups	2,455	116	68
FE	Yes	Yes	Yes
Controls	Yes	Yes	Yes

Notes: Table 1.5 reports the results of a difference in difference analysis that takes into account stress-tested BHCs and a set of similar non-stress tested banks in terms of fundamental firm-specific characteristics. In Table 1.5(a) the dependent variable is future risk-taking (σROA_F3Y). In Table 1.5(b) the dependent variable is future solvency (ZScore_F3Y). The independent variables under both specifications are the Stress Test Dummy (CCAR or FedST) and the Post2009 dummy variable, which is equal to 1 in each year following the initial SCAP exercise and indicates the beginning of the stress-testing framework that is periodically conducted since. Table 1.5(c) and Table 1.5(d) provide a robustness test to panels (a) and (b) in those specifications we compare the banks comprising this sub-sample in a period different than the one where regulation diverges between the stress-tested and non-stress tested groups (Post2005) before the commencement of stress-testing. Bank-specific controls include the variables Loans-to-Total Assets (LTA), Equity-to-Asset Ratios (ETA) Size, Profitability (ROA), Loan Loss Provisions as a Proportion of Total Assets (LLPTA), Non-Performing Loans and Leases as a proportion of Total Loans (NPLLTL), Equity as a proportion of Total Assets (ETA), Short-Term Wholesale Funding as a proportion of Total Assets (STWSFTA), Marketable Securities as proportion of Total Assets (MSTA), and whether a bank has been recapitalized (Recap). Macroeconomic controls include the unemployment rate (UnRate), the risk-free rate (TB3MS), Market Volatility (VIXCLS) and GDP Growth. Tables 1.1(a) and 1.1(a) report detailed descriptions of the variables employed and Table 1.2 reports descriptive information on each variable. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. Standard errors are reported in parentheses. All variables are winsorized at the 0.5% level in each tail. Independent and control variables are lagged one quarter.

Table 1.6: Do Projected Capital Levels Influence Risk-Taking and Solvency?

(a) Risk-Taking

	CCAR Exercises		SCAP and CCAR Exercises	
	Buffer	Pass	Buffer	Pass
	(1)	(2)	(3)	(4)
VARIABLES	σROA_F3Y	σROA_F3Y	σROA_F3Y	σROA_F3Y
σ ROA_L3Y	0.237***	0.387***	0.095***	0.196***
	(6.966)	(9.426)	(4.273)	(6.819)
σ ROA_L3Y × Buffer	-0.037***		-0.027***	
	(-6.418)		(-5.752)	
Buffer	0.000		0.000	
	(1.376)		(1.138)	
σ ROA_L3Y × Pass		-0.377***		-0.278***
		(-8.813)		(-7.276)
Pass		0.000		0.000*
		(1.447)		(1.788)
Constant	-0.032***	-0.015*	-0.022***	-0.013**
	(-3.789)	(-1.922)	(-3.914)	(-2.236)
R^2	0.444	0.538	0.564	0.588
Observations	387	387	453	453
Number of entity	26	26	26	26
FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes

(b) Financial Soundness

	CCAR Exercises		SCAP and CCAR Exercises	
	Buffer	Pass	Buffer	Pass
	(1)	(2)	(3)	(4)
VARIABLES	ZScore_F3Y	ZScore_F3Y	ZScore_F3Y	ZScore_F3Y
ZScore_L3Y	-0.490***	0.070	-0.103	0.311***
	(-5.760)	(0.379)	(-1.492)	(2.838)
ZScore_L3Y × Buffer	0.072***		-0.005	
	(4.400)		(-0.370)	
Buffer	-0.285***		0.057	
	(-3.619)		(0.867)	
ZScore_L3Y × Pass		-0.326		-0.609***
		(-1.633)		(-4.519)
Pass		1.676*		2.935***
		(1.865)		(4.903)
Constant	60.317***	28.693*	24.596***	5.370
	(3.900)	(1.740)	(3.179)	(0.649)
R^2	0.497	0.421	0.608	0.654
Observations	144	144	209	209
Number of entity	18	18	19	19
FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes

Notes: Table 1.6(a) reports the results for equation (3). The dependent variable is future risk-taking measured as the volatility of average return on assets over a three year forward looking horizons. (σROA_F3Y). Table 1.6(b) reports the results for equation (4). The dependent variable is future solvency measured over a three year forward looking horizons. (ZScore_F3Y). The independent variables under both specifications are the Stress Test Projected Capital Buffers (under the CCAR or FedST specification), calculated as the shortage or excess of projected capital in comparison to required regulatory minimums, and the interaction between the Stress Test Capital Buffer variables with past risk-taking (1.6(a)) or past solvency (1.6(b)). Bank-specific controls include the variables Loans-to-Total Assets (LTA), Equity-to-Asset Ratios (ETA) Size, Profitability (ROA), Loan Loss Provisions as a Proportion of Total Assets (LLPTA), Non-Performing Loans and Leases as a proportion of Total Loans (NPLLTL), Equity as a proportion of Total Assets (ETA), Short-Term Wholesale Funding as a proportion of Total Assets (STWSFTA), Marketable Securities as proportion of Total Assets (MSTA), and whether a bank has been recapitalized (Recap). Macroeconomic controls include the unemployment rate (UnRate), the risk-free rate (TB3MS), Market Volatility (VIXCLS) and GDP Growth. Tables 1.1(a) and 1.1(b) report detailed descriptions of the variables employed and Table 1.2 reports descriptive information on each variable. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. Standard errors are reported in parentheses. All variables are winsorized at the 0.5% level in each tail. Independent and control variables are lagged one quarter.

Table 1.7: Can Stress Test Results and Capital Buffers be Predicted?

	CCAR Exercises			SCAP and CCAR Exercises		
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Pass	Buffer	Mill's	Pass	Buffer	Mill's
σROA_L3Y	28.067	661.228***		-91.645	669.964***	
	(0.09)	(3.68)		(-0.42)	(5.23)	
ZScore_L3Y	1.309	0.534***		0.780	0.540***	
	(1.54)	(3.02)		(1.58)	(3.88)	
Size	-0.545	-0.277**		-0.079	-0.285***	
	(-0.99)	(-2.12)		(-0.36)	(-2.70)	
ETA	-5.326	20.370***		14.884	22.262***	
	(-0.29)	(3.05)		(1.50)	(4.21)	
LTA	-24.020**	-7.797***		-3.849	-8.281***	
	(-2.21)	(-8.22)		(-1.55)	(-11.25)	
QLLP_TA	-57.745	281.757***		21.749	242.697***	
	(-0.27)	(2.91)		(0.29)	(4.69)	
NPLL_TL	-3.242	-22.483***		-26.627**	-23.643***	
	(-0.21)	(-2.99)		(-2.56)	(-3.76)	
NPLL_Chg	-0.118	-0.068**		0.329	-0.071***	
	(-0.07)	(-2.34)		(0.39)	(-2.80)	
STWSF_TA	-23.453**	-9.106***		-7.309**	-9.053***	
	(-2.34)	(-5.18)		(-2.08)	(-6.27)	
ROA	24.652	157.233***		-8.926	135.579***	
	(0.27)	(2.67)		(-0.22)	(3.97)	
Recap'd	4.195	-0.441		-1.429***	-0.408	
	(.)	(-0.46)		(-3.10)	(-0.94)	
MS_TA	-35.308**	-4.681**		-0.098	-5.261***	
	(-2.14)	(-2.54)		(-0.02)	(-3.61)	
λ			1.542**			1.293**
			(2.05)			(2.38)
Constant	31.465*	7.725***		2.138	8.101***	
	(1.79)	(2.92)		(0.36)	(3.68)	
Observations	437	437	437	499	499	499

Notes: Table 1.7(1) and 1.7(4) reports the results for equation (5) for the CCAR and FedST samples, respectively. The dependent variable is the Pass dummy variable, which indicates stress test outcomes. (Pass_CCAR; Pass_FedST). Table 1.7(2) and 1.7(4)reports the results for equation (6). The dependent variable is the Projected Capital Buffer variable (under the CCAR or FedST specification), which indicates the projected capital in excess or below the required regulatory minimum. The independent variables under both specifications are the ank-specific controls, which include the variables Loans-to-Total Assets (LTA), Equity-to-Asset Ratios (ETA) Size, Profitability (ROA), Loan Loss Provisions as a Proportion of Total Assets (LLPTA), Non-Performing Loans and Leases as a proportion of Total Loans (NPLLTL), Equity as a proportion of Total Assets (ETA), Short-Term Wholesale Funding as a proportion of Total Assets (STWSFTA), Marketable Securities as proportion of Total Assets (MSTA), and whether a bank has been recapitalized (Recap). Macroeconomic controls include the unemployment rate (UnRate), the risk-free rate (TB3MS), Market Volatility (VIXCLS) and GDP Growth. Tables 1.1(a) and 1.1(b) report detailed descriptions of the variables employed and Table 1.2 reports descriptive information on each variable. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. Standard errors are reported in parentheses. All variables are winsorized at the 0.5% level in each tail. Independent and control variables are lagged one quarter.

Table 1.8: Interest Rate Implications

(a) Risk-Taking and Interest Rates

	CCAR Exercises			SCAP and CCAR Exercises		
	CCAR	Buffer	Pass	FedST	Buffer	Pass
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	σ ROA_F3Y	σ ROA_F3Y	σ ROA_F3Y	σ ROA_F3Y	σ ROA_F3Y	σ ROA_F3Y
σROA_L3Y	-0.058	0.108***	0.100***	-0.058	0.058***	0.052**
	(-1.012)	(3.690)	(3.587)	(-1.013)	(2.603)	(2.314)
FedFunds	0.000**	-0.001	0.006**	0.000**	-0.001	-0.000
	(2.397)	(-1.581)	(2.257)	(2.404)	(-1.596)	(-0.107)
FedFunds × ST	-0.001**			-0.001*		
	(-1.995)			(-1.717)		
ST	-0.001**			-0.001***		
	(-2.141)			(-3.013)		
FedFunds × Buffer		-0.000			0.000	
		(-0.290)			(0.386)	
Buffer		-0.000*			-0.000*	
		(-1.867)			(-1.694)	
FedFunds × Pass			-0.007**			-0.000
			(-2.476)			(-0.136)
Pass			0.000			-0.000
			(0.578)			(-0.874)
Constant	-0.012**	-0.060***	-0.046***	-0.012**	-0.035***	-0.032***
	(-2.467)	(-7.550)	(-5.767)	(-2.478)	(-6.184)	(-5.593)
R^2	0.168	0.397	0.455	0.168	0.535	0.540
Observations	100,945	387	387	100,945	453	453
FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

(b) Risk-Taking and Interest Rate Changes

	CCAR Exercises			SCAP and CCAR Exercises		
	CCAR	Buffer	Pass	FedST	Buffer	Pass
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	σ ROA_F3Y	σ ROA_F3Y	σ ROA_F3Y	σ ROA_F3Y	σ ROA_F3Y	σ ROA_F3Y
σ ROA_L3Y	-0.064	0.123***	0.086***	-0.064	0.069***	0.059***
	(-1.072)	(4.157)	(3.082)	(-1.072)	(3.120)	(2.691)
FedFundsChg	-0.000*	0.000**	0.001***	-0.000*	0.000	0.001***
	(-1.686)	(2.295)	(4.012)	(-1.686)	(1.612)	(3.611)
FedFundsChg × ST	0.000			0.000**		
	(1.191)			(2.082)		
ST	-0.001**			-0.001***		
	(-2.304)			(-3.295)		
FedFundsChg × Buffer		-0.000***			-0.000***	
		(-2.779)			(-3.736)	
Buffer		-0.000**			-0.000**	
		(-2.154)			(-2.197)	
FedFundsChg × Pass			-0.001***			-0.001***
			(-3.967)			(-4.019)
Pass			-0.000***			-0.000***
			(-4.202)			(-2.912)
Constant	-0.006	-0.053***	-0.042***	-0.006*	-0.037***	-0.035***
	(-1.659)	(-6.820)	(-5.500)	(-1.671)	(-6.629)	(-6.084)
R^2	0.148	0.392	0.459	0.149	0.546	0.553
Observations	100,945	387	387	100,945	453	453
FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Table 1.8(a) reports the results for altered versions of equations (1) through (3). As in the previous analysis, the dependent variable is future risk-taking measured as the volatility of average return on assets over a three year forward looking horizon (σROA_F3Y). The independent variables are the interaction of the federal funds rate (FedFunds) with ST, which is the CCAR or FedST Dummy Variable (Columns (1) and (4)); the capital buffer or shortfall under CCAR or SCAP & CCAR (Columns (2) and (5)); and the Pass Dummy under CCAR or SCAP & CCAR (Columns (3) and (6)). Table 1.8(b) reports the results of an alternative analysis in which we interact the change in the federal funds rate (FedFundsChg) with the independent variables. Bank-specific controls include the variables Loans-to-Total Assets (LTA), Equity-to-Asset Ratios (ETA) Size, Profitability (ROA), Loan Loss Provisions as a Proportion of Total Assets (LLPTA), Non-Performing Loans and Leases as a proportion of Total Loans (NPLLTL), Equity as a proportion of Total Assets (ETA), Short-Term Wholesale Funding as a proportion of Total Assets (STWSFTA), Marketable Securities as proportion of Total Assets (MSTA), and whether a bank has been recapitalized (Recap). Macroeconomic controls include the unemployment rate (UnRate), Market Volatility (VIXCLS) and GDP Growth. Tables 1.1(a) and 1.1(b) report detailed descriptions of the variables employed and Table 1.2 reports descriptive information on each variable. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. Standard errors are reported in parentheses. All variables are winsorized at the 0.5% level in each tail. Independent and control variables are lagged one quarter.

2

The Puzzle of Dividend Payouts: BHCs, Commercial Banks and Credit Unions

with Dr. Germán López Espinosa & Dr. Andrés Mesa Toro

2.1 Introduction

Historically, banks have both paid and increased dividends more often than industrial and non-financial firms (Dickens et al., 2002; Guntay et al., 2015). The literature largely points to banks' reluctance to cut dividends (Lintner, 1956), and desire to keep increasing such payouts indefinitely (Acharya et al., 2011), since markets react negatively to dividend decreases (Pettit, 1972). In fact, banks continued to pay dividends well into the financial crisis of 2007-2008, despite their inadequate capital positions (Acharya et al., 2011; Rosengren, 2010; Scharfstein and Stein, 2008). Those banks' payout practices ultimately led to a further exacerbation of the crisis and have since been labeled as one of the main culprits for the financial instability that ensued. Hence, supervisors and regulators are since fervently working towards improving the resiliency of the financial sector through various payout policy restrictions.

While there has been a surge in recent studies that investigate bank dividend policy, the literature related to the determinants of dividend policy in banks remains sparse. This paper attempts to explain bank dividend policy decisions in the context of managerial expectations. In a sample of US bank holding companies (BHCs), commercial banks (CBs), and credit unions (CUs)[1] spanning 1994 to 2017, we implement a dynamic panel data model to gauge the effect of dividend decisions on future profitability (μROA), financial soundness (Z-Score), and risk-taking (σROA). We attempt to answer whether dividend decisions are based on firm-specific expectations about profitability, risk-taking, and solvency.

Our analysis, especially in light of the current debate on the need for banks to avoid paying large dividends, carries crucial implications for policymakers aiming to mitigate the impact of moral haz-

[1] The inclusion of credit unions in the analysis allows us to gauge whether managers of firms in which the interests of debt-holders and shareholders are intertwined, pursue dividend strategies different from other financial institutions.

ard on bank safety. The comparison of BHCs, CBs, and CUs adds an important dimension to the payout policy literature, given the strong impact of dividends on bank soundness and due to the importance of bank safety for the real economy. Moreover, these questions are key to understanding the dynamics of the relationship between dividend payouts and profitability, risk-taking, and solvency for industries where regulators and creditors are important stakeholders. Therefore, answering these questions is of interest to banking and corporate finance academics, as well as policymakers and regulators.

Our analysis further supports the previous findings of a misalignment between payout policy decisions and expectations about future profitability among banks. While in credit unions, we observe a positive relation between dividends and future profitability, the relationship among listed and non-listed BHCs and CBs is negative. We find that dividends are positively associated with future risk-taking and negatively associated with future solvency. The results are most pronounced among credit unions followed by listed banks, suggesting that payout policy within these institutions, especially within credit unions, is more reactive to future performance. In addition, we find that dividend changes are very conservative among BHCs. Whereas in credit unions, we observe dividend changes in line with expected future performance, dividend changes in BHCs are largely unrelated to future profitability, solvency, and risk-taking. Our results suggest that, while payout policy within CUs is strongly related to future performance, dividends within banks provide a signal which is largely inconsistent with the future outlook in terms of profitability and solvency, perhaps due to managerial overoptimism. This leads to increased informational asymmetries between insiders and market participants.

It could also be that that financial firms do not reduce dividends despite expectations of poor future performance (and in the process, exploit funds that are likely to be needed to cover debts in the future (risk-shifting)) to avoid negative market reactions. As market reactions carry important consequences for share prices, managerial compensation is likely to be affected by dividend policy. Further analysis suggests that BHCs are extremely wary of dividend initiations and only enact such policies in times of prolonged and stable high solvency prospects.

Payout policy decisions within credit unions more accurately relay managerial expectations, and signaling through dividends is more strongly pronounced than in banks.

Our analysis contributes to the literature on the determinants of the dividend payout ratio, the information content of dividends, and risk-shifting. It extends the findings of studies on the interaction of risk-taking and dividend policy to the financial sector. It is also directly related to the literature on bank dividend policy and tightening monetary policy implications for banks.

The remainder of this paper is organized as follows. The next section provides background on dividend policy in banks and credit unions and a survey of the literature. In Section 3, we describe the data sources, relevant variables, and methodology. In Section 4, we present our findings, and Section 5 concludes this paper.

2.2 Background

2.2.1 Institutional Setting: Business Model Implications for Dividend Policy

2.2.1.1 Dividends in Bank Holding Companies and Commercial Banks

For decades banks have been adopting relatively generous dividend policies. The banking sector has traditionally been among the industries with the largest payout ratios. In 2000, 92% of US banks paid dividends compared with only 49% of non-financial firms (Dickens et al., 2002; Forti and Schiozer, 2015). Furthermore, in the fifteen years preceding the financial crisis, banks have paid dividends four times as often as industrial firms and thirty-three percent more frequently than non-bank financial firms. During the same period, banks have continuously increased dividends. Among banks, dividend increases are three to four times higher than industrial firms and non-bank financial firms. These increases are also and thirty-five to fifty percent more frequent. (Guntay et al., 2015).

Post-2007 dividend practices, however, have come under scrutiny because they drained capital from individual banking companies and from the banking system in a time of extreme stress (Hirtle, 2014), consequently exerting a severe impact on the soundness of the financial system and the real economy (Acharya et al., 2017; Rosengren, 2010; Scharfstein and Stein, 2008). Despite accumulating losses and public injections of liquidity and emergency capital, many banks continued to pay dividends inconsistent with their performance and capital levels. The largest twenty-one banks distributed $130 billion of equity in the form of dividends (Acharya and Richardson, 2009), which lead to excessive leverage, inadequate capital ratios, and risk-shifting from shareholders to debt-holders[2]. Many of these same banks ultimately relied on the public safety net for their survival not long thereafter (Guntay et al., 2015). They accounted for more than half of the Troubled Asset Relief Program (TARP) funds provided to all US institutions through 2008 (Acharya and Richardson, 2009). Also, Acharya et al. (2011) document the positive link between dividend payouts and the risk of default. The authors find that banks tend to sell their safer assets to accommodate dividend distributions while leaving the riskier assets on their balance sheets. Several other authors have also argued that continued dividend payments were a means of shifting value from debt holders and creditors (including other banking companies) to equity holders (Srivastav et al., 2014; Acharya et al., 2014). The phenomenon was striking enough that bank supervisors subsequently adopted regulations and supervisory programs intended to limit dividend payments and other capital distributions when

[2]One of the main reasons the economic and financial crisis became so severe was that the banking sectors of many countries had built up excessive leverage. This was accompanied by a gradual erosion of the level and quality of the capital base (BCBS, 2009)

capital comes under stress. These measures include Basel III's capital conservation buffer and the Federal Reserve's Comprehensive Capital Analysis and Review (CCAR).

As a result, academic and policy interest in bank dividend policy has increased because of the importance of retaining earnings for bank soundness, especially during times of distress (FSB, 2009; Abreu and Gulamhussen, 2013; Hirtle, 2014; Srivastav et al., 2014). To mitigate the aforementioned moral-hazard driven deviations, which allow bank owners and managers to extract wealth from their creditors and insurers for the sake of their shareholders, recent developments in banking regulation impose stringent restrictions on dividends for under-capitalized and otherwise risky banks (Caruana, 2014)[3]. Regulators introduced capital adequacy requirements proportional to banks' risky assets, forcing banks to internalize the adverse consequences of excessive risk-taking. This is necessary because banks can transfer default risk to their creditors and (when bailouts take place) to the taxpayer, a phenomenon known as risk-shifting (Acharya et al., 2011; Kanas, 2013; Onali, 2014). For this reason, the government has incentives to monitor bank dividend policy.

2.2.1.2 Dividends in Credit Unions

Dividends in credit unions exhibit vastly different characteristics than dividends within banking companies. In fact, dividends in credit unions are essentially the interest rate paid on deposits, although not all deposits are entitled to a dividend (Gómez-Biscarri et al., 2020). The distinction with banks is that banks have shareholders who are entitled to dividends regardless of whether they hold monetary deposits within the same institution. Bank depositors may receive interest on their holdings, regardless of whether they hold stock in the same entity. In banks, there is a clear distinc-

[3] In the US, regulators have the authority to restrict the capital policies of banks and have the prudential regulatory authority of systematically important financial institutions. The Financial Stability Oversight Council (FSOC) - established under the Dodd-Frank Wall Street Reform and Consumer Protection Act (signed into law on July 21, 2010) provides, for the first time, comprehensive monitoring of the stability of the US financial system. Once a firm is designated as "Systematically Important" by the FSOC, then it is regulated by the Federal Reserve Board (Guntay et al., 2015).

tion between shareholders and debt-holders. Typically, in the case of liquidation, interest payments should precede dividends, such that the claim of debt-holders over the firms' assets comes before the claim of shareholders, who tend to be further down the line for any remaining assets of the company. Sometimes, however, managers do not always value the priority of debt-holders over that of shareholders. The payout policy literature has extensively addressed these moral hazard implications.

In credit unions, the interests of debt-holders and shareholders are largely intertwined. Account-holders are, in many cases, provided with shares that are not necessarily proportionally tied to the value of their deposits. In most cases, each account is entitled to a singular share. Nonetheless, this setup should, in theory, reduce moral hazard incentives since the debt-holders are also the shareholders. Therefore, managers are not faced with a choice whether to protect the interests of one group versus the other, as is the case in banks. Furthermore, each credit union member is entitled to one vote, and as a result, members have a significant say in decision-making processes. This notable distinction between the two types of institutions could provide further insight into how the moral hazard incentives to pay dividends are influenced within the financial industry.

In the credit union analysis, we consider the payment associated with regular shares. In a separate analysis, the payment associated with share certificates is considered, rather than the dividend expense as our dividend variable. We do so for a number of reasons. First, regular shares and share certificates account for the largest proportion of shareholdings within credit unions. Second, as dividend expenses in credit unions also include dividend payments pertaining to executive compensations schemes, retirement accounts, and others of similar nature, restricting the dividend ratio to regular share or share certificates removes such special-purpose effects shareholdings. Third, regular shares and share certificates are likely to exhibit characteristics more in line with bank shareholdings. For both banks and credit unions, we assume dividends to be declared in the same year in which they are paid.

2.2.2 Literature Review

This section briefly reviews the literature on dividend policy of non-financial firms and banks and develops the hypotheses.

2.2.2.1 Dividend Policy: A Brief Overview

Dividend policy is a key topic in the financial economics literature. Most of the literature on dividend policy is concerned with the importance of dividend policy for firm value.

Miller and Modigliani (1961) developed a theoretical model in which they introduce the idea of dividends' irrelevance for firm value, known as the "Irrelevance Theorem." The authors suggest that, despite dividends' irrelevance for firm and investor value, managers can use dividend changes to signal managerial expectations about firms' future prospects. However, their theory is grounded upon the concept of 'perfect' capital markets with rational investors.

Given the imperfections in real financial markets, the dividend irrelevance claim has largely been refuted. The Miller and Modigliani (1961) model has been modified to include varying market imperfections (Lease et al., 1999) such as different tax rates on dividends and capital gains, information asymmetries (Bhattacharya, 1979; Miller and Rock, 1985) and agency costs (Easterbrook, 1984); the role of the legal framework of the country of origin (La Porta et al., 2000); catering incentives (Baker and Wurgler, 2004); Stage of the life-cycle of the firm (DeAngelo et al., 2006). Baker and Wurgler (2004) provide a useful survey of seminal contributions in the dividend policy literature. The empirical literature has produced mixed results with regard to the impact of tax clienteles, signalling effects, and life-cycle factors (Farrar et al., 1967; Brennan, 1970; Healy and Palepu, 1988; Grullon et al., 2005; DeAngelo et al., 2006; Denis and Osobov, 2008; Von Eije and Megginson, 2008; De Cesari, 2012). Exploiting a unique historical setting, Turner et al. (2013) provide evidence that the information content of dividends is more important than agency, catering, or behavioral determinants of dividend policy.

These studies, however, have largely focused on industrial and non-financial firms. Significant differences in agency problems, capital structures, and regulatory environments raise questions about the extent to which the aforementioned theories apply to the financial industry. In fact, Foerster and Sapp (2005) suggest that a direct comparison between financial and non-financial firms is hindered due to the specificity of financial firms' leverage and reporting norms. In the banking literature, studies have focused primarily on the signaling power of dividend cuts and omissions (Keen, 1980; Bessler and Nohel, 1996, 2000).

Given that dividend policy played an important role in how the crisis evolved, regulators have significantly increased their interest in the topic. As a result, the circumstances under which financial institutions pay dividends has become a prominent research area in the years following the global recession. The recent proposals to increase oversight of the dividend payouts by the Federal Reserve Board (FRB, 2011) and the Basel Committee on Banking Supervision (BCBS, 2011) point towards the increasing regulatory relevance of banks' dividend payout policy. Furthermore, the fraction of dividend payers, their aggregate dollar amounts, and frequency in financial firms far surpass those of industrial and non-financial firms. One strand of the literature examines the distinctive nature and characteristics of payout policy within financial firms. Acharya et al. (2011) examine payout policies of several large commercial banks during the crisis and the years directly preceding it. They find that despite nominal assets' tremendous growth, the largest banks' collective equity has steadily decreased between 2000 and 2006. They further document that these banks continued to pay dividends throughout the crisis, some of which ultimately failed or relied on government assistance. Floyd et al. (2015) compare the payout policies of industrial, financial, and non-financial firms in the U.S. over a thirty-year period and covering the crisis. Their findings indicate that banks have a higher propensity to pay dividends and increase them at higher and more frequent rates than both industrial and non-financial firms. They provide additional evidence of the behavior of large banks during the crisis, which was previously documented by Acharya et al. (2011).

In the meantime, others have looked at the factors that influence dividend decisions. For instance, Abreu and Gulamhussen (2013) suggest that size, profitability, growth opportunities, and agency costs are important determinants of bank dividend policy before and during the financial crisis of 2007-2008. Hirtle (2014) finds that there is a difference in the payout policy behavior of small and large bank holding companies. She finds that institutions with high repurchases fail to reduce dividends earlier than their counterparts with lesser repurchases. However, there is no significant difference between high and low repurchase banks in the size of the reductions.

There is a particular academic interest in dividend decisions in the period surrounding the crisis. Oliveira (2015) proposes that when informational asymmetry and risk aversion are more pronounced, as they were during the 2008 financial crisis, Brazilian banks maintain or even increase dividend payments, even if they suffer deposit losses. Hoshi and Kashyap (2004) further emphasize that paying dividends reduces the equity of banks. During a financial crisis, doing so exacerbates the well-known pro-cyclical characteristic of regulatory capital requirements (Forti and Schiozer, 2015). And so, if banks decrease their target leverage during a crisis, dividend payments imply a further reduction in lending during an economic downturn.

Another strand of the payout literature addresses the managerial incentives behind dividend payout decisions. Two prominent sub-strands relate to the signaling power of dividends and the risk-shifting mechanism enabled by them. In the paragraphs that follow, we provide an overview of the two in the context of both the literature on financial institutions and studies based on non-financial firms. These two problems, signaling and risk-shifting, are among the key determinants of corporate financial policy.

Dividend Signaling Hypothesis

Bhattacharya (1979) and Miller and Rock (1985) contend the symmetric information condition in Miller's (1961) model and argue that information gaps exist between managers and investors. They formalize this claim by developing models of dividend signaling, which indicate that, in a world of asymmetric information, better-informed insiders use the dividend policy as a costly signal to convey their firm's future prospect to less informed outsiders such that a dividend increase conveys managerial optimism about a firm's future prospects. In contrast, a dividend decrease suggests managers are expecting substandard firm performance in the future. Consequently, a dividend increase (decrease) should be followed by an improvement (reduction) in a firm's profitability, earnings, and growth. Moreover, there should be a positive relationship between dividend changes and subsequent share price reaction. The literature suggests that firms are eager to signal favorable private information about their prospects to outside parties to avoid mispricing (Brealey et al., 1977; Ross, 1977).

The majority of the empirical research on the signaling effect of dividends uses stock price responses to dividend changes, initiations, and omissions to gauge the informational content of dividends (Forti and Schiozer, 2015). A number of studies document that stock returns positively follow dividend change announcements (Aharony and Swary, 1980; Asquith and Mullins Jr, 1983; Bajaj and Vijh, 1990; Kalay and Loewenstein, 1985). Studies with similar findings focus specifically on banks. Bessler and Nohel (1996, 2000) document that decreases or omissions of dividends result in significant declines in stock prices.

Above and beyond the impact on share price, banking companies may have been particularly sensitive to the negative market signal in a dividend decrease during the stressed market conditions and heightened uncertainty prevailing during the financial crisis. Abreu and Gulamhussen (2013), for instance, find that signaling was a significant determinant of dividend payout rates for BHCs during the financial crisis, though not in the years before the crisis. Furthermore, Kauko (2012) claims that, during financial crises, depositors are particularly sensitive to bank liquidity due to the potential negative effects of bank runs and fire sales. Therefore, banks may choose to increase dividends to keep depositors calm and prevent bank runs during periods of financial turmoil. Wholesale financiers (institutional investors) are more prone to engage in runs. They are more sensitive to information (such as dividend payments) than retail deposits in periods of high information asymmetries (asset opaqueness) (Huang and Ratnovski, 2011; Oliveira, 2015). Institutional investors are more reactive to information because they have internal risk-management systems and funding requirements that force them to revise their asset allocations periodically. Kauko (2012) claims that dividends are an essential source of information for depositors since they signal both profitability and liquidity (i.e., profitable and liquid banks can pay larger dividends).

Filbeck and Mullineaux (1993); Collins et al. (1995); Boldin and Leggett (1995) test the signaling hypothesis and the evidence largely indicates that dividends are used as a signaling mechanism by banks.

Risk-Shifting Hypothesis

The risk-shifting hypothesis suggests that dividends may be paid and/or increased, despite performance that renders such payouts inadequate, to expropriate debt-holders.

Jensen and Meckling (1976); Easterbrook (1984) suggest that dividends are paid to avoid a Free Cash-Flow problems, where unless dividends are distributed, earnings may be diverted by insiders for personal use, committed to unprofitable projects, or during a financial downturn. Risk-shifting arises from Bondholder-Shareholder Conflicts. Shareholders—or managers acting in the shareholders' interest (who generally favor higher dividends)—can profit at the expense of creditors whose wealth is eroded by higher payouts in the case of default. Firms may engage in risk-shifting by paying excessive dividends, increasing the risk of their assets, or loading up on debt. Because shareholders are protected by limited liability, such actions lead to wealth transfers between shareholders and creditors (Jensen and Meckling, 1976). While an important concern for many corporations, risk-shifting incentives are especially strong in banking, partly because of the opaqueness of banks and in part because of government guarantees (Becht et al., 2011). Easterbrook (1984) further suggests that such incentives are particularly strong if a bank is in impending distress and when the charter value is low – conditions that are more likely to occur during financial crises, as Acharya and Steffen (2013) note.

A large part of the risk-shifting literature points to the influence of different classes of investors in dividend decisions. Since bank deposits are generally demandable, they could be withdrawn with any sign of expropriation, and since institutional investors are much more reactive to information than other investors, expropriation and the violation of the preference of debt over equity is implausible at banks with large proportions of institutional investors (Ben-David, 2010). Furthermore, debt-holder expropriation would be easily detected by institutional investors, who would then withdraw their funds. If banks engage in debt-holder expropriation, higher dividends should be observed at banks with large proportions of non-institutional debt-holders (i.e., information-insensitive retail investors.) Short-term wholesale funding in dividend models captures institutional debt-holdings.

In the banking literature, several recent empirical studies examine dividend payouts in the context of debt-holder expropriation and conclude that dividend payments by banking companies are a means of risk-shifting and that continued high dividend payments during the financial crisis were an attempt to shift value from creditors to shareholders. Acharya et al. (2017) develop a model in which they study the negative externalities of bank dividend payouts and find that one banking company's dividend payments affect the risk of default and equity values of other banking companies, who are creditors of the first bank. Srivastav et al. (2014) examine dividend payments by U.S. BHCs that received capital under the Troubled Asset Relief Program (TARP) and found that those with CEOs who held more inside debt relative to inside equity were more likely to reduce dividends. Their interpretation is that these CEOs had less incentive to shift value from creditors to shareholders. Onali (2014) and Kanas (2013) also find evidence of risk-shifting by banking companies in that higher dividends are associated with a higher risk in the cross-section, both before and during the financial crisis. Kanas (2013) concludes that banks that are subject to higher risk have exercised larger dividend payouts, while Onali (2014) finds a positive relation between dividend payout ratios and risk of default.

2.3 Data and Methodology

2.3.1 Data Sources

We rely on Commercial Bank, Bank Holding Company, and Credit Union data spanning 1994 to 2017. In all analyses, we exclude all observations associated with net losses and where dividend ratios are above 100% of the previous year's net income. We do so because, in both scenarios, net income alone is insufficient in covering the respective payouts. Therefore, dividend decisions relating to such payouts might differ significantly. Our sample considers only top-holder banks. Removing non-top-holder banks from our sample eliminates the double-counting of intra-group transactions.

2.3.1.1 Bank Holding Company and Commercial Banks Data

Our empirical analysis is based on data obtained from The Federal Reserve Bank of Chicago's Commercial Bank and Bank Holding Company Regulatory Database. The data consists of quarterly accounting information submitted by regulated depository financial institutions for supervisory purposes to the respective regulatory supervisors (in the form of financial statements and regulatory reports)[4]. The filings provide balance sheet, income statement, and regulatory capital data. In this analysis, we focus on listed and non-listed Commercial Banks (CBs) and Bank-Holding Company (BHC) top-holders for the period spanning 1994 to 2017. BHCs comprise an initial sample of 29,469 bank-year observations corresponding to 3,550 unique entities[5]. 8,960 of the observations correspond to 1,098 unique banks listed on a stock exchange, and the remaining 20,509 observations correspond to 2,986 unique, private, non-listed banks. After excluding all observations with net losses or observations for which the respective dividend ratios are above 100% of the previous year's net income, around 6 percent of the total annual observations (5.9% for non-listed BHCs and 7.2% of listed BHCs), the final sample is comprised of 27,602 observations, 8,311 of which correspond to listed and the remaining 19,291 correspond to private BHCs. CBs comprise an initial sample of 51,238 bank-year observations corresponding to 6,394 unique entities. 387 of the observations correspond to 88 unique banks listed on a stock exchange, and the remaining 50,851 observations correspond to 6,306 unique, private, non-listed banks. After excluding all observations with net losses or observations for which the respective dividend ratios are above 100% of the previous year's net income, around 12.4 percent of the total annual observations (12.4% for non-listed CBs and 12.9% of listed CBs), the final sample is comprised of 44,883 observations, 337 of which correspond to listed and the remaining 44,546 correspond to private CBs. Since we implement a rolling-window analysis, the final regression size depends on the length of the rolling window.

2.3.1.2 Credit Union Data

Quarterly Credit Union data is obtained from the call reports collected by the National Credit Unions Administration (NCUA). As in banks, the data contains balance-sheet and income state-

[4]Information on BHCs is obtained from the FR Y-9C reports and information on Commercial Banks is obtained from the FFIEC 031/041 reports.

[5]Our panel sample is unbalanced and reflects significant changes in the number and consolidation of banking organizations. The number of unique entities decreases from year-to-year

ment information and spans from 1994 to 2017. Our sample excludes CUs with assets below $50 million since the reporting frequency of such entities is inconsistent across our sample period[6]. After excluding all observations with net losses or observations for which the respective dividend ratios are above 100% of the previous year's net income (3% of observations), the final sample comprises 43,481 entity-year observations, which correspond to 2,822 distinct credit unions.

2.3.1.3 Macroeconomic Conditions and Recapitalization Data

State-level macroeconomic controls are obtained from the Federal Reserve Bank of St. Louis' FRED Database. In addition, and since several banks have been recapitalized during our sample period, recapitalization data is obtained from the Monthly Reports to Congress prepared by the US Department of Treasury.

2.3.2 Variables Used and Derived from Accounting Data

2.3.2.1 Dependent Variables

The main dependent variables of our analysis are:

1. Future Profitability: Average Profitability levels are proxied by mean Returns on Assets (μROA_FXY) over X-Year forward-looking rolling-windows, where X is either 3 or 5 Years. In robustness analysis, we also analyze year-over-year percentage changes in Profitability, which we compute in the following manner:

$$ROA\_\%Chg = \frac{ROA_t - ROA_{t-1}}{ROA_{t-1}}; \quad and \quad ROE\_\%Chg = \frac{ROE_t - ROE_{t-1}}{ROE_{t-1}}$$

[6]Prior to 2002Q3 only CUs with assets in excess of $50 million reported financial statement information on a quarterly basis, while their smaller counterparts reported on a semiannual basis.

2. Future Risk-Taking: The volatility of ROA (σROA_FXY) levels are computed by taking the standard deviations of ROA over an X-Year forward-looking rolling-window, where X is either 3 or 5 Years.

3. Future Solvency is proxied by the Z-Score. We construct the Z-Score on rolling window bases of three and five years (denoted by F3Y and F5Y postscripts, respectively). The Z-score measures banks' distance to default (Roy, 1952; Laeven and Levine, 2009; Dam and Koetter, 2012; Gropp et al., 2013). The Z-Score is based on the notion that the source of default lies in losses that are not covered by adequate capital. Hence, its value is determined by the capitalization ratio (ETA) and the level and stability of profits. It measures the number of standard deviations by which a bank's ROA would have to fall to deplete the available capital. The higher the average ROA and ETA, the more stable the returns, and the higher the Z-score, the safer the bank[7]. Because the Z-Score is highly skewed, we follow Laeven and Levine (2009) in computing the natural logarithm of the Z-Score (which is assumed to be approximately normally distributed). We use this logarithmic transformation of the Z-Score throughout our analysis. For brevity, we use the "Z-Score" in referring to the natural logarithm of the z-score in the remainder of the paper. We calculate the forward-looking Z-Score measure over a 3-year (12-quarter) rolling window, such that:

$$ZScore\_F3Y = \ln \frac{ETA_{q=12} + \mu ROA\_F3Y}{\sigma ROA\_F3Y}$$

where μROA_3Y is the 12 quarter forward-looking average of ROA, ETA is the equity capital to asset ratio in the last quarter of the twelve-quarter time window, and σROA_F3Y is the

[7] Roy (1952) defines insolvency (or default) as a state where losses surmount equity ($E \geq \pi$) (where E is equity and π is profits), A is total assets, ROA (=π/A) is the return on assets, σ(ROA) is the standard deviation of ROA, and ETA (= E/A) is the capital-asset ratio. The probability of insolvency can be expressed as prob (-ROA $\leq$ ETA). If profits are normally distributed, then the Z-score = (ROA+ETA)/σ(ROA), which is the inverse of the probability of insolvency.

standard deviation, or volatility, of ROA over the same twelve-quarter time horizon. In this specification, the forward-looking horizon spans q=1 to q=12 such that:

$$\mu ROA\_3Y = \frac{1}{Q} * \sum_{q=1}^{Q=12} ROA; \quad \sigma ROA\_3Y = \sqrt{\frac{1}{N-1} \sum_{q=1}^{Q=12} \sum_{i=1}^{N} (ROA_i - \overline{ROA})^2}.$$

2.3.2.2 Independent Variables

Our main independent variables are the 1-year lagged values of the Dividend Payout Ratio and various measurements that consider the change in the level of payouts.

1. Dividend Payout Ratios

   DivNI: For banks, we scale dividends declared by the previous year's net income. In contrast, we scale dividend expenses pertaining to regular shares or share certificates by the previous year's net income for credit unions. The distinction in these transformations is due to differences in the accounting treatment between the two types of institutions.

2. Dividend Changes

   DPS_%Chg: We calculate Dividends per Share by scaling Dividends Declared by the total number of shares outstanding in the case of BHCs and CBs, while for Credit Unions, we scale Regular Share or Share Certificate Dividend Expense by the total number of shares outstanding. We then calculate the year-over-year percentage change in Dividends-per-share such that:

$$DPS\_\%Chg = \frac{DPS_t - DPS_{t-1}}{DPS_{t-1}}$$

While the above analysis is implemented for listed banks and credit unions, we do not have enough data for the number of shares outstanding to conduct this analysis for non-listed banks. For this reason, we implement the year-over-year percentage change in total dividend payout ratios to allow for comparison with non-listed banks.

DivNI_%Chg: We include an alternative dividend changes specification primarily to be able to capture dividend change effects among non-listed banks for which we do not have data on shares outstanding. This secondary specification also acts as a robustness complement to the DPS Change specification above. We calculate the year-over-year percentage change in Dividend Payout Ratios (DivNI) from above such that:

$$DivNI\_\%Chg = \frac{DivNI_t - DivNI_{t-1}}{DivNI_{t-1}}$$

2.3.2.3 Macroeconomic and Bank-Specific Control Variables

In addition to the lagged values of the dependent variables, we control for a wide array of macroeconomic and entity-specific variables that previous studies have pointed out as being potential drivers of bank profitability, risk-taking, and solvency. At the firm level, several indicators related to the size, liquidity, profitability, loans growth, leverage, specialization, credit portfolio quality as well as information on the market risk exposure and risk-policy of each BHC, CB, or CU are included to allow for the impact of standard bank characteristics. At the macro-economic level, we consider the rate of unemployment, GDP growth, the three-month Treasury bill rate, and the near-term expected level of price fluctuation in the S&P 500 VIX Index options market.

All continuous variables are winsorized at the 0.5% level in each tail. All independent variables are lagged to mitigate potential endogenous feedback effects, simultaneity problems, and contemporaneous correlations. Table 2.1 provides an overview of all variables used in our analysis. Table

2.1(a) describes the main variables of interest, while Table 2.1(b) provides a list of bank-specific and macroeconomic control variables.

2.3.2.4 Summary Statistics

Table 2.2 provides descriptive statistics for the different types of entities covered in our analyses.

In terms of bank characteristics, we find considerable variation among the five types of entities considered in the analysis. Credit unions are more profitable in comparison to banks. Loans Growth within credit unions is, on average lower than in listed and non-listed banks. The year over year change in loans is 4% in listed banks and listed and non-listed CBs, compared to 2% percent and 1% for non-listed banks and credit unions, respectively. On average, credit unions are smaller in terms of total assets (166 million) compared to non-listed BHCs (438 million) and listed CBs. In contrast, listed BHCs are significantly larger (2,084 million) and non-listed CBs are much smaller (106 million). Bank equity tends to be quite similar to the average net-worth within credit unions, except for Non-listed CBs who tend to hold slightly higher equity to asset balance sheet proportions (14%) in comparison to other entities (10%-11%). The reliance on short-term wholesale funding as a proportion of total assets in listed BHCs is much higher than in non-listed BHCs, CBs, and credit unions - at 8%, compared to 4%, 2%, and 1%, respectively. The proportion of marketable securities in BHCs is more than twice as high compared to credit unions, with CBs following closely behind BHCs. Finally, Credit unions are not as well capitalized as banks. The Total Capital in excess of regulatory minimums is 300 basis points, compared to 700 basis points for listed BHCs, 700 basis points for non-listed BHCs, 600 basis points for listed CBs, and 2300 basis points for non-listed CBs.

Dividend Ratios (under the Regular Shares specification) are lowest in credit unions and average around 15% of net income, compared to 23% and 19% in listed and non-listed BHCs, respectively. However, when we consider share certificates, the associated dividend ratio is the largest in our sample at 27%. Non-listed CB ratios average 22% (the highest among banks), and listed CBs' dividend ratios average 21%. This ratio is slightly lower than both listed BHCs and non-listed CBs, but higher than Non-listed BHCs. The average year-over-year percentage change in dividends-per-share is -8% compared to 11% for listed BHCs and 41%[8] for non-listed BHCs. Among CBs, while listed banks average increases of 19%, no further inference can be drawn from this variable given the small sample size. While credit union share certificates are on average prone to increases in dividends per share, they tend to be much smaller than the increases across banking firms. The statistic is in line with other dividend dynamics already observed within credit unions. This statistic likely points to the general trend of decreasing interest rates paid on deposits across both banks and credit unions. BHCs, however, are, as emphasized in the literature (Lintner, 1956), reluctant to cut dividends. Managerial remuneration and institutional differences are likely drivers of this observation. And so, managerial remuneration and institutional differences are the highly probable drivers of this observation.

When we look at the average year-over-year change in dividend payout ratios, we find consistent evidence that while banks increase dividends, credit unions do so at a significantly lower rate. For credit unions, the average year-over-year total dividend payout ratio change (DivNI_%Chg) is 6%t with respect to the previous year, for listed and non-listed BHCs, the mean DivNI_%Chg are 9% and 10% respectively. Among listed and non-listed CBs, the mean DivNI_%Chg are 16% and 3%, respectively. From the table, Listed CBs seem to exhibit slightly more dynamic upward dividend changes than the rest of the institutions in our sample. However, these statistics may not be fully representative given the small sample size. The observation is likely driven by the institutional structure of credit unions and market pressure among banks.

Profitability seems to be highest among credit unions, followed by non-listed and listed BHCs, and

[8] The representativeness of this statistic is debatable, given that we have very few observations for DPS changes in non-listed BHCs.

non-listed and listed CBs in that order. The observation is expected as credit unions have gained considerable efficiency in meeting the basic financial needs of their members (Kaushik and Lopez, 1996). A slight decrease in profitability with respect to past levels is observed among all sub-samples. The observation is likely due to the low-interest-rate environment in more recent years (Bikker and Vervliet, 2018).

From a risk-taking perspective, CUs seem to exhibit a higher risk appetite, as measured by σROA_FXY in comparison to banks, while BHCs, non-listed BHCs in particular, seem to be the most risk-averse of all, followed by listed BHCs and CBs. This observation is consistent with the higher regulatory oversight among banks. The second reason is based on the institutional nature of credit unions (Toews, 2015), where risk managers' overall goal is to optimize the risk-return ratio by maximizing profit while accepting reasonable levels of risk (Tiplea, 2011). In general, risk-taking is higher among BHCs in the forward-looking horizon, suggesting an upward trend in risk-appetite, while the opposite is true among credit unions. This increase among BHCs might be provoked by increased competition (Boyd and De Nicolo, 2005) and low-interest rates (Delis and Kouretas, 2011). CBs seem to exhibit small and sporadic changes in risk-taking dynamics. A clear pattern in the evolution of risk-taking could not be determined for this specific sample.

The Z-Score tends to be, on average, highest among listed BHCs, followed by non-listed BHCs, listed CBs, non-listed CBs, and credit unions, in that order. This observation indicates that Credit Unions tend to be closer to default while listed BHCs tend to be relatively more financially stable than the remaining institutions in our sample. The observation is expected and in line with policies, such as the Dodd-Frank Act. The more recent CCAR and DFAST stress testing frameworks, focused on more stringent capital requirements among larger and more systematically important banks (Haubrich, 2020). Throughout our sample, large and significantly important institutions tend to be exchange-listed BHCs.

Table 2.3 reports sample correlations of the main variables of our analysis for Non-Listed and Listed BHCs followed by Non-listed and Listed CBs, CUs Regular Shares, and CUs Share Certificates, in that order.

2.3.3 Methodology

We rely on a dynamic panel model framework with Driscoll and Kraay standard errors[9] to examine the relationship between dividends and profitability; solvency; and risk-taking.

Dividend Policy is represented by several indicators in our analysis. We implement the dividends-to-net income ratio (DivNI) as well as various specifications for dividend changes: Dividends-per-share annual percentage changes (DPS_%Chg)[10]; and (2) Dividend Ratio Annual Percentage Changes (DivNI_%Chg).

For Banks, we consider dividends declared. For Credit Unions, we consider dividends expenses pertaining to ordinary shares or share certificates as the numerator and previous years' net income as the denominator in constructing the dividend ratios. The distinction is important because dividend payout policies within Credit Unions differ vastly from those of banks. The characteristics of the dividend expense within the two kinds of entities are also different, so looking at the regular shares and share certificates separately from the remaining classes of shares on CUs' balance sheets allows for a more precise analysis. Given that credit unions and banks exhibit significant differences in their income statement and balance sheet structures, we make a number of adjustments to the variables associated with credit unions. One significant adjustment is the net income figure, which is reported net of dividends, while for banks, net income is reported before deducting any dividend payouts.

[9] Given the length of our panel the inclusion of the dynamic term would have a negligible effect on our results (Wooldridge, 2010).

[10] Due to lack of information on shares outstanding, we do not have a sufficient sample size to analyze Dividend-Per-Share changes for the sub-sample of non-listed banks.

2.3.3.1 Dividends and Profitability

In our first set of regressions, we examine the relationship between (1) future profitability and dividend payout policy for top-holder BHCs, CBs, and CUs; in alternative analysis we also consider (2) the interaction of dividends with non-performing loans and leases over a three and five year rolling window specifications. Our baseline regression can be represented as follows:

$$\begin{aligned} Future \quad Profitability_{it} &= \alpha + \beta_1 Past \quad Profitability_{it-1} + \beta_2 Dividend \quad Ratio_{it-1} \\ &+ \gamma^{'} Bank \quad Controls_{it-1} + \delta^{'} Macroeconomic \quad Controls_{t-1} + \varepsilon_{it} \end{aligned} \tag{2.1}$$

Where, for all analysis, i=1, 2, ..., N labels panel units (banks or credit unions) and t= 1, 2, ..., T labels time periods (quarters or years)[11].

In addition, we implement a separate analysis in which we examine the relationship between annual changes in profitability and dividends. In alternative analyses, we replace the payout ratio with the dividend change indicators (DPS_%Chg & DivNI_%Chg).

2.3.3.2 Dividends and Risk-Taking

We also examine the relationship between (1) future risk-taking - proxied by the standard deviation of ROA (or ROE), and the dividend payout policy indicators for top-holder BHCs, CBs, and CUs over a three and five year rolling window specifications. As before, in alternative analysis we also consider (2) the interaction of dividends with non-performing loans and leases. Our baseline regression can be represented as follows:

$$\begin{aligned} Future \quad Risk - Taking_{it} &= \alpha + \beta Past \quad Risk - Taking_{it-1} + \beta Dividend \quad Ratio_{it-1} \\ &+ \gamma^{'} Bank \quad Controls_{it-1} + \delta^{'} Macroeconomic \quad Controls_{t-1} + \varepsilon_{it} \end{aligned} \tag{2.2}$$

[11] For robustness purposes, we run both quarterly and annual-based analyses throughout the span of this study.

We also examine the relationship between future risk-taking and dividend changes (expressed in terms of DPS_%Chg[12], and DivNI_%Chg over a three and five-year rolling window specification.

2.3.3.3 Dividends and Solvency

Next, we examine the relationship between the (1) future Z-Score - an indicator of financial soundness, and dividend payout policy for top-holder BHCs, CBs, and CUs over a three and five year rolling window specifications. As before, in alternative analysis we also consider (2) the interaction of dividends with non-performing loans and leases. Our baseline regression can be represented as follows:

$$\begin{aligned} Future \quad Solvency_{it} &= \alpha + \beta_1 Past \quad Solvency_{it-1} + \beta_2 Dividend \quad Ratio_{it-1} \\ &+ \gamma' Bank \quad Controls_{it-1} + \delta' Macroeconomic \quad Controls_{t-1} + \varepsilon_{it} \end{aligned} \tag{2.3}$$

In this segment of our analysis, in addition to the aforementioned dividend indicators, we also examine the relationship between future solvency and dividend initiations for top-holder banks and credit unions, such that:

$$\begin{aligned} Future \quad Solvency_{it} &= \alpha + \beta_1 Past \quad Solvency_{it-1} + \beta_2 Dividend \quad Initiations_{it-1} \\ &+ \gamma' Bank \quad Controls_{it-1} + \delta' Macroeconomic \quad Controls_{t-1} + \varepsilon_{it} \end{aligned} \tag{2.4}$$

As before, in alternative analyses, we replace the dividend payout ratio indicator with the respective dividend change indicators.

[12] Due to lack of information on shares outstanding, we do not have a sufficient sample size to analyze Dividend-Per-Share changes for the sub-sample of non-listed banks.

2.4 Results

2.4.1 Profitability Implications

2.4.1.1 Dividend-to-Net Income Ratios and Profitability

Table 2.4 provides the regression results for the relation between dividend-to-income ratios (DivNI) and profitability (μROA). The table provides separate analyses based on whether BHCs and CBs are listed or non-listed, as well as Credit Unions' Regular Shares and Share Certificates. Regressions (1)-(2) represent Listed BHCs or CBs; (3)-(4) represent non-listed BHCs or CBs; in the case of Credit Unions, regressions (1)-(2) represent Regular Shares; and (3)-(4) represent Share Certificates.

We observe a negative relation between dividend ratios and future profitability among banks. The results are significant for both listed and non-listed BHCs as well as non-listed CBs at the 95% and 99% levels for the 3-year and 5-year forward-looking horizons, respectively. Among Listed CBs, we observe a strong relation only in the longer 5-year specification. The coefficient is largest among listed CBs, at -0.004, compared to listed BHCs at -0.001 and non-listed BHCs. The higher coefficients among listed banks may point out to more demanding shareholder demands and stronger market discipline. In credit unions, the relation is positive and significant at the 99% level and with coefficients of 0.003 and 0.002 for the 3-year and 5-year forward-looking specifications, respectively, under the Regular shares specification. When considering Share certificates, the results are positive and significant at the 95% level in the medium-term, 3-year specification.

The results indicate a significant deviation between payout policy banks' future performance, such that higher dividends are associated with lower future profitability. This finding provides evidence that payouts are not necessarily adequately conveying insiders' information about future performance to market participants within banks. Such payout dynamics exacerbate the information asymmetry between managers and external stakeholders. The result could be driven by managerial over-optimism about future profitability. Alternatively, the result could indicate managerial desire to avoid negative market reactions. Furthermore, our finding suggests that managers could implement dividend payouts for debt expropriation purposes. To give an example, a bank whose management has internal information indicating that long-term profitability levels are expected to be low or that the viability of the institution is in jeopardy, the bank would be faced with two choices: (a) convey this information to market participants through the signaling power of dividends (e.g., dividend reduction); or (b) increase dividends to avoid negative market reactions (and as a result benefit shareholders to the detriment of bondholders) or convey overoptimistic managerial perceptions about future profitability to market participants. Our results conclude that managers undertake payout policy decisions consistent with the notion that dividend policy does not necessarily reflect performance expectations and could, therefore, be driven by managerial overoptimism and/or risk-shifting arising from market pressure.

In the case of Credit Unions, we observe a positive and stronger than in BHCs effect. The result suggests that, unlike in banks, dividend policy in credit unions fully conveys managerial profitability expectations.

However, because expectations of low profitability levels are generally associated with already poor performance indicators, one may argue that our results are driven by decreases in income levels rather than increases in dividends. To address this, we implement a robustness analysis (unreported) in which we replace the dividend-to-net income ratios (DivNI) with the dividends-to-equity ratios (DivEq), where using equity as the denominator provides a more stable depiction of dividend ratios over time. The results of this (unreported) analysis are consistent with our finding and emphasize the negative relation between dividend ratios and profitability expectations regardless of income dynamics in the case of banks.

2.4.1.2 Dividend Changes and Profitability

We also analyze the relation between dividend changes and profitability, where we focus on two different dividend change specifications: (1) dividends-per-share percentage changes (DPS_%Chg) and (2) dividend-to-net income ratio percentage changes (DivNI_%Chg) as a supplemental analysis. One limitation of using the dividend-per-share variable is that we are constrained in analyzing the sample of listed banks since we have no information on shares outstanding in private banks. Table 2.8(a) and reports the results of these analyses, while Table B.1 in the appendix provides a complementary view. While listed BHC and CB-related results are insignificant, we find a positive relation between dividend-per-share changes and future profitability for credit unions. The results are statistically strong and consistent with the findings related to the previously discussed dividend ratio analysis. The non-significant results among banks reinforce previous studies on bank dividend changes, which state that banks are reluctant to change dividends particularly because doing so would force them into a higher payout bracket in the long run. If these higher payouts become unsustainable at some point, a subsequent decrease in dividends would lead to an exceptionally strong negative market reaction that could ultimately have severe share price consequences. As a result, banks would be reluctant to make increases unless they can predict with absolute certainty that they would maintain the increase in the long run. Perhaps banks only engage in dividend increases when future expectations are extremely favorable, and when they are certain that they would be able to maintain the increased dividend going forward. On the other hand, perhaps dividend decreases happen only when keeping constant payouts is unsustainable in the long run, and they are essentially forced to reduce or eliminate said payouts. In the absence of enforced dividend reductions, banks on the brink of default may seem to prefer significant payouts despite the debt-to-equity violations which such payouts invoke. Market reactions and subsequent negative market price consequences seem to be a severe constrain in dividend policy changes. From the descriptive statistics, we can see that banks rarely reduce dividends-per-share. Credit Unions, however, reduce dividends at a far greater rate, and perhaps that is the reason why their dividend policies are much more reactive to future expectations. Furthermore, credit union dividends are of an entirely different concept in comparison to bank dividends. While bank dividends are largely enjoyed by shareholders who are not necessarily customers of said bank, credit union members are directly awarded dividends. In addition, and given the institutional setting, market fluctuations do not exert influence on Credit Unions, and thus, naturally, their relationship and payout expectations differ from those of bank shareholders.

From the supplementary analysis in Table B.1(a) we observe that dividend ratio changes in non-listed CBs are positively associated with future profitability. This result is in line with previous hypotheses that market perceptions and reactions affect dividend policy decision-making. As non-listed Commercial Banks' payout policy decisions are independent of such market-related implications, changes to dividends would thus have no likely long-term implications on stock price and future payouts. And while the results for BHCs are not significant, the higher t-statistic among non-listed BHCs with respect to listed BHCs may provide some proof of the lower impact of market perceptions and reactions among non-listed banks in general.

2.4.2 Risk-Taking Implications

To analyze the relationship between dividends and risk-taking, we implement the ROA volatility measure implemented in constructing the Z-Score indicators as a stand-alone risk proxy. Measured as the standard deviation of ROA, this indicator captures the riskiness of returns on assets. It allows for an analysis of risks pertaining to the asset side of the balance sheet. In additional analyses, we implement ROE Volatility and market returns volatility for listed banks. We calculate each risk-taking indicator on a rolling window basis to capture intermediate (X = 3 Years) and long-term (X=5 Years) effects throughout these analyses. The findings of this analysis are consistent with the remaining analyses in this paper. We also observe very similar results for ROA and ROE Volatility. For brevity and to conserve space, we do not report the ROE and Market Returns volatility analyses.[13]

2.4.2.1 Dividend-to-Net Income Ratios and Risk-Taking

Table 2.5 provides the results of Equation (2.2) in which we consider the relation between dividend ratios and risk-taking, measured as the volatility of ROA (σROA_FXY).

We find a strong positive relation between dividend ratios and risk-taking across both listed BHCs and CBs, CUs Regular Shares, and CUs Share Certificates. We find a weaker, albeit significant positive relation among non-listed BHCs when considering an intermediate, 3-year horizon. The relation is predominantly stronger among listed banks. Consistent with other analyses of this paper, the relation points to a slightly greater influence of market participants in payout policy decision-making. The relation indicated that higher dividend ratios, particularly among listed banks and credit unions, are associated with higher future risk-taking. The result suggests that managers seem to consider the upward profit potential of their risk strategies in their dividend decisions. Furthermore, as finance theory states, investors require higher returns to compensate for the higher risk involved.

2.4.2.2 Dividend Changes and Risk-Taking

We also analyze the relation between dividend changes (DPS_%Chg & DivNI_%Chg) and risk-taking. Table 2.8(b) and the supplementary analysis in Table B.1(b) report the results of these analyses.

We observe a negative relation between future ROA Volatility and dividend changes for listed BHCs. However, among non-listed BHCs, listed CBs, and Credit Unions, we observe a positive

[13] Additional Analysis not reported in the main body of the paper are available upon request.

relation. The negative results among listed BHCs are consistent with our prior findings that banks are reluctant to change dividend policy, even when managerial expectations of higher risk-taking (i.e., higher upward profitability potential) exist. Thus far, prior literature has provided extensive evidence of stagnant dividend policy in banks, and our results are in line with such findings. Another view is that perhaps managers are also acknowledging the effect of potential future losses that may arise from higher risk-taking. Exposure to such losses could lead to inevitable dividend cuts, which in turn could be met with severe market reactions. In short, and in line with the empirical and theoretical literature, banks will not increase dividend payouts unless managers have absolute certainty of the ability to maintain the increase over time to avoid share price reductions arising from dividend cuts. Among credit unions, the positive relation indicates that dividend changes are aligned with higher risk-taking. The result could likely be due to the interest-like nature of such payouts. While the sample size among commercial banks is small, the negative relation is highly significant.

2.4.3 Solvency Implications

2.4.3.1 Dividend-to-Net Income Ratios and Solvency

Table 2.6 provides the results for the relation between dividend ratios and future solvency. As before, the different parts of the table take into account ordinary share dividends in listed and non-listed BHCs and CBs, as well as ordinary share dividends and share certificates in credit unions.

We observe a strong negative relation between dividend ratios (DivNI) and future solvency (Z-Score) across all specifications. The result within CUs and CBs are highly significant at the 99% level for both the medium (3-year) and longer (5-year) horizons. In contrast, for BHCs, the results are significant only in the 3-year specification at the 99% level for listed BHCs and the 95% level for non-listed BHCs. The coefficients are the largest among Listed CBs and CUs Share certificates at -2.355 and -1.253, respectively. The results suggest that dividend payouts play a greater role in future solvency in credit unions and Listed CBs. For CUs, the results could point to managerial over-optimism or the existence of deposit discipline (see Gómez-Biscarri et al. (2020)). For BHCs, the results are only significant at the 99% level for the medium-term 3-year specification with coefficients of -0.687 for listed BHCs and -0.244 for non-listed BHCs. The results are in line with the previous analyses in this paper and suggest that dividend ratios do not adequately relay managerial expectations about the future to market participants. The results suggest that higher dividends imply lower future z-scores (high future probability of default). In other words, managers with insider information about future insolvency do not constrain dividends to reduce the probability of default in the future. Again, perhaps the observation is due to either managers' overoptimism or their desire to avoid negative market reactions. The result ties into the signaling power of dividends, depriving external stakeholders of valuable information about future conditions. The result also ties into the literature on managerial remuneration as market reactions carry share price implications, which are oftentimes reflected in bonus compensation schemes.

2.4.3.2 Dividend Changes and Solvency

We also analyze the relation between dividend changes and solvency, and once again, we focus on: (1) dividends-per-share percentage changes (DPS_%Chg) and (2) dividend-to-net income ratio percentage changes (DivNI_%Chg). Table 2.8(c) and reports the results of these analyses. The alternative version of this analysis is found in Table B.1(c).

We observe a positive relation between DPS changes and future solvency among listed BHCs. Among CUs and listed CBs, we observe a more strongly pronounced negative relation between DPS changes and future solvency. In the alternative analyses, we also observe a negative relation between (DivNI_%Chg) and Solvency among non-listed BHCs.

The results indicate that dividend changes within credit unions and relatively smaller banks have a greater impact on future solvency. Given the small sample size of commercial banks, the significance of these results is debatable, yet the negative result is intriguing.

For Credit unions, however, we have to take into account that dividends are predominantly treated as interest on deposits. Therefore, any change in dividends may directly affect the financing side (shares and deposits). Moreover, given the existence of depositor discipline in credit unions (Gómez-Biscarri et al., 2020), a credit union with potential solvency issues may decide to increase dividends on shares to avoid a run of deposits. Therefore, the negative relation in credit unions may indicate that when managers detect potential solvency issues in the future, they decide to keep dividends to avoid deposit (share) withdrawals.

In contrast, listed BHCs would be penalized by investors in the long run (in the form of stock price reductions) if they choose to implement a dividend increase that could not be feasible to maintain in the future (Martinez Peria and Schmukler, 2001). The results for listed BHCs suggest increases in dividends only when managers are confident in the increase's future viability. Dividend increases are enacted only when it would not erode the capital position of the bank. The result is in line with our previous predictions that dividend changes are conservative and are implemented in the presence of exceptionally favorable expectations about the viability of the bank.

The negative relation, which indicates that higher dividends today lead to lower solvency in the future, is consistent with debt expropriation or cheating among commercial banks.

2.4.3.3 Dividend Initiations and Solvency

Additionally, we analyze the relation between dividend initiations and solvency. Table 2.7 provides the results of this analysis. We implement a main dummy variable of interest where Div_Init is equal to one if an entity (Bank or Credit Union) begins to make dividend distributions for the first time. We find a strong positive relation between dividend initiations and solvency for both listed and non-listed BHCs. The coefficients are much larger among listed BHCs.

The findings support our hypotheses from the preceding analyses, mainly that BHCs tend to adapt relatively conservative policies when it comes to significant changes in their dividend payout policy. The findings suggest that BHCs, both listed and private, initiate dividends solely in the presence of favorable solvency expectations.

We find no significant coefficients among Credit Unions and Commercial Banks. The results suggest that such institutions are likely to initiate dividends when the timing is right, or the need arises without giving relevance to future implications of such decisions. The result is consistent with the debt-like nature of dividends within credit unions and the absence of market pressure in commercial banks, most of which are not listed on a stock exchange.

2.4.4 Robustness Analyses

We implement several specifications of dividend ratios and changes. Furthermore, we consider all of the dividend variables as binary (dummy) variables. We also consider various measures of profitability (μROA and μROE); annual changes in profitability; risk-taking (σROA, σROE, and σMRet); and solvency. All aforementioned specifications present a clear and consistent pattern in the interrelation between dividend payout policy and profitability, risk-taking, and solvency.

2.5 Conclusions

In a sample of U.S. Bank Holding Companies, Commercial Banks, and Credit Unions, spanning 1994 to 2017, we analyze the relation between dividend payout policy and (1) profitability, (2) risk-taking, and (3) solvency.

When analyzing the relation between dividend ratios and profitability, we find a strong negative relation among banks and a positive relation among CUs. The relation is strongest among CUs, followed by listed banks. The results seem to indicate that, within banks, dividend policy does not adequately reflect performance expectations and could be driven by managerial overoptimism and/or risk-shifting arising from market pressure. Further analyses into dividend-to-net-income ratios and changes in dividend-per-share ratios emphasize that BHCs are not prone to changes in their payout policy. The result is in line with previous research, which suggests such moves carry significant share price implications. Dividends and dividend changes within Credit Unions, on the other hand, seem to be strongly aligned with future profitability. Under the assumption that managers have expectations regarding how profitability will evolve in the future, we deduce that while banks are not prone to increasing dividends when managers have information about increased future profitability, credit union management is much more prone to react to such information by increasing dividend ratios and making upward dividend changes. We find a strong positive relation between dividend ratios and future risk-taking among listed BHCs, CBs, and CUs. The finding emphasizes that dividends likely increase risk-taking because bank managers are interested in keeping their remunerations. When analyzing dividend ratios and solvency, we find a negative relation across both BHCs, CBs, and CUs. The results suggest that managers do not constrain dividends to reduce the z-score or the distance to default. The result could be driven by managerial overoptimism or market pressure. These findings are important, especially given the relevance of solvency during and since the financial crisis.

To the best of our knowledge, this is the first study to analyze payout policy within BHCs, CBs, and CUs simultaneously. The results point to significant variation in payout policy within the three types of institutions. The significant deviation in our findings among BHcs and CUs seems primarily influenced by the different nature of dividends among the two types of financial institutions. While dividends in banks are similar to common shareholdings within other institutions, dividends in credit unions are akin to a bonus to CU deposit-holders. The two types of stakeholders have clearly distinctive expectations and reactions to dividend payouts. Managers of financial firms seem to place serious emphasis on stakeholders in their payout policy decisions.

The study adds value for policy-making concerned with dividends within banks, especially in light of the recent practices, debate, and restrictions on bank payouts. We show that dividends within banks are associated with information asymmetry. We deduce that market participants have a strong influence on dividend policy-making. However, while shareholders are a vital component of the financial industry, we believe dividends should more closely convey managerial (insider) expectations about banks' future prospects.

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Tables & Figures

Table 2.1: Variable Definitions

(a) Main Variables of Interest

Variable	Description	Operational Definition
Dependent Variables		
Profitability		
μROA_FXY	Forward-Looking Profitability	Average Return on Assets over the length of forward-rolling window of X-Years
Risk-Taking		
σROA_FXY	Forward-Looking Risk-Taking	Standard Deviation of ROA over the length of forward-rolling window of X-Years.
Solvency		
ZScore_FXY	Forward-Looking Distance to Default	The sum of Average Profitability (ROA) and Last Reported Shareholder's Equity scaled by ROA Volatility (standard deviation of ROA over the length of forward-rolling window of X-Years)
Main Variables of Interest		
Dividends		
DivNI	Dividend-to-Net Income Ratio	Total Dividend Payout scaled by Previous Year's Net Income.
DPS_%Chg	DPS Change	Year-over-Year Percentage Change in Dividends-Per-Share
DivNI_%Chg	Payout Ratio Change	Year-over-Year Percentage Change in Dividends-to Net Income Ratio
Div_Init	Dividend Initiations	Dummy Variable is 1 when dividend payment is made for the first time and 0 otherwise.

(b) Firm-Specific and Macroeconomic Control Variables

Variable	Description	Operational Definition
Entity-Specific Control Variables		
Size	Relative Size	Natural Logarithm of Total Assets
ETA	Leverage	Shareholders' Equity scaled by Total Assets
LTA	Specialization	Net Loans and Leases scaled by Total Assets
LLPTA	Provisions (Cost of Risk)	Loan Loss Provisions scaled by Total Assets
NPLLTL	Credit Quality	Non-Performing Loans and Leases scaled by Total Loans
STWSFTA	Liquidity	Short-term Wholesale Funding scaled by Total Assets
ROA	Profitability	Net Income scaled by Total Assets*
MSTA	Market Risk	Marketable Securities (AFS Securities and Trading Assets) scaled by Total Assets
Recap	Recapitalization	Dummy equal to 1 if recapitalized; 0 otherwise
TCBuffer	Regulatory Total Capital Position	The excess of Total Capital over the regulatory minimum
Loans_Chg	Loans Growth	
Macroeconomic Control Variables		
UNRATE	Unemployment Rate	One-year-ahead consensus forecast of the US unemployment rate
TB3MS	Risk-Free Rate	Three-Month Treasury Bill Rate
VIXCLS	Market Volatility	Implied volatility of options on the S&P 500 Index
GDP_Chg	GDP Growth Rate	

Table 2.2: Descriptive Statistics

(a) Bank-specific and Macroeconomic Control Variables

	Non-Listed BHCs					Listed BHCs				
VARIABLES	N	mean	sd	min	max	N	mean	sd	min	max
ROA	17370	0.01	0.01	-0.05	0.07	7933	0.01	0.01	-0.05	0.07
Recap'd	17374	0.01	0.1	0.00	1.00	7933	0.05	0.22	0.00	1.00
LLPTA	17361	0.00	0.00	0.00	0.03	7932	0.00	0.00	0.00	0.03
NPLLTL	17374	0.01	0.01	0.00	0.11	7931	0.01	0.01	0.00	0.11
Loans_Chg	16897	0.02	0.06	-0.41	1.55	7855	0.04	0.1	-0.41	1.55
Size	17374	12.99	0.89	10.1	20.12	7933	14.55	1.67	11.73	21.67
ETA	17374	0.09	0.03	0.03	0.83	7933	0.1	0.04	0.03	0.84
LTA	17374	0.64	0.13	0.00	0.99	7933	0.65	0.14	0.00	0.96
STWSFTA	17135	0.04	0.05	0.00	0.45	7910	0.08	0.07	0.00	0.45
MSTA	17374	0.19	0.12	0.00	0.79	7933	0.19	0.11	0.00	0.76
TCBuffer	13311	0.07	0.06	-0.13	1.2	5649	0.07	0.06	-0.07	1.52
Unemployment	17374	5.66	1.37	3.97	9.61	7933	5.71	1.41	3.97	9.61
VIXCLS	17374	20.67	5.58	12.39	32.69	7933	19.94	5.82	12.39	32.69
GDP_Chg	17374	2.87	1.51	-2.54	4.75	7933	2.75	1.53	-2.54	4.75
TB3MS	17374	2.86	2.05	0.03	5.82	7933	2.74	2.13	0.03	5.82

	Non-Listed CBs					Listed CBs				
VARIABLES	N	mean	sd	min	max	N	mean	sd	min	max
ROA	32450	0.01	0.01	-0.05	0.07	308	0.01	0.01	-0.05	0.04
Recap'd	39512	0.00	0.04	0.00	1.00	308	0.04	0.19	0.00	1.00
LLPTA	32449	0.00	0.00	0.00	0.03	308	0.00	0.00	0.00	0.03
NPLLTL	34970	0.00	0.01	0.00	0.11	308	0.00	0.00	0.00	0.03
Loans_Chg	37473	0.04	0.21	-0.41	1.55	305	0.04	0.05	-0.22	0.39
Size	39144	11.58	1.7	2.3	19.02	308	12.9	1.25	8.84	17.56
ETA	32467	0.14	0.11	0.03	0.84	308	0.1	0.05	0.03	0.67
LTA	39135	0.55	0.23	0.00	0.99	308	0.68	0.13	0.12	0.94
STWSFTA	39073	0.02	0.06	0.00	0.45	308	0.02	0.04	0.00	0.27
MSTA	39144	0.16	0.17	0.00	0.8	308	0.15	0.11	0.00	0.52
TCBuffer	26758	0.23	1.44	-0.06	170.47	260	0.06	0.08	0.00	1.32
Unemployment	39512	5.76	1.44	3.97	9.61	308	5.53	1.25	3.97	9.61
VIXCLS	39512	19.9	5.85	12.39	32.69	308	20.1	5.75	12.39	32.69
GDP_Chg	39512	2.89	1.55	-2.54	4.75	308	3.06	1.42	-2.54	4.75
TB3MS	39512	3.24	2.04	0.03	5.82	308	3.46	1.88	0.05	5.82

	CU Regular Shares					CU Share Certificates				
VARIABLES	N	mean	sd	min	max	N	mean	sd	min	max
ROA	40944	0.02	0.01	-0.01	0.05	38800	0.02	0.01	-0.01	0.05
Recap'd	41736	0.00	0.01	0.00	1.00	39591	0.00	0.01	0.00	1.00
LLPTA	41736	0.01	0.00	0.00	0.03	39591	0.01	0.00	0.00	0.03
NPLLTL	41736	0.01	0.01	0.00	0.06	39591	0.01	0.01	0.00	0.06
Loans_Chg	40881	0.01	0.03	-0.07	0.16	38737	0.01	0.03	-0.07	0.16
Size	41736	12.02	0.99	10.82	18.19	39591	12.02	0.99	10.82	18.19
ETA	41736	0.11	0.03	0.05	0.24	39591	0.11	0.03	0.05	0.24
LTA	41736	0.63	0.15	0.17	0.92	39591	0.63	0.15	0.17	0.92
STWSFTA	41736	0.01	0.02	0.00	0.12	39591	0.01	0.02	0.00	0.12
MSTA	41736	0.09	0.12	0.00	0.6	39591	0.08	0.12	0.00	0.6
TCBuffer	33690	0.03	0.03	-0.07	0.42	31857	0.03	0.03	-0.07	0.42
Unemployment	41736	6.04	1.63	3.97	9.61	39591	6.05	1.62	3.97	9.61
VIXCLS	41736	20.09	6.01	12.39	32.69	39591	20.08	5.98	12.39	32.69
GDP_Chg	41736	2.39	1.62	-2.54	4.75	39591	2.4	1.61	-2.54	4.75
TB3MS	41736	2.15	2.1	0.03	5.82	39591	2.12	2.1	0.03	5.82

Notes: All variables are winsorized at the 0.5% level in each tail. Table 2.1 reports a detailed description of each variable in the regressions.

(b) Dividend Policy-related Independent Variables

	Non-Listed BHCs					Listed BHCs				
VARIABLES	N	mean	sd	min	max	N	mean	sd	min	max
DivNI	14377	0.19	0.25	0.00	1.00	7039	0.23	0.24	0.00	1.00
DivNI_%Chg	5657	0.10	1.08	-1.00	13.24	3551	0.09	0.82	-1.00	13.24
DPS_%Chg	30	0.41	1.08	-0.62	5.08	3787	0.11	0.60	-1.00	5.08
Div_Init	19291	0.05	0.22	0.00	1.00	8311	0.05	0.21	0.00	1.00

	Non-Listed CBs					Listed CBs				
VARIABLES	N	mean	sd	min	max	N	mean	sd	min	max
DivNI	27150	0.22	0.27	0.00	1.00	275	0.21	0.22	0.00	0.95
DivNI_%Chg	13177	0.03	0.83	-1.00	13.24	150	0.16	1.24	-1.00	13.24
DPS_%Chg	1	-0.15	-	-0.15	-0.15	150	0.19	0.78	-1.00	5.08
Div_Init	44546	0.02	0.14	0.00	1.00	337	0.06	0.23	0.00	1.00

	CU Regular Shares					CU Share Certificates				
VARIABLES	N	mean	sd	min	max	N	mean	sd	min	max
DivNI	38115	0.15	0.16	0.00	1.00	35970	0.27	0.20	0.01	1.00
DivNI_%Chg	34820	0.06	0.86	-1.00	10.05	32860	0.11	0.82	-1.00	9.29
DPS_%Chg	38830	-0.08	0.34	-0.84	2.47	36580	0.04	0.57	-0.83	4.12
Div_Init	43481	0.00	0.02	0.00	1.00	41336	0.00	0.03	0.00	1.00

Notes: All variables are winsorized at the 0.5% level in each tail. Table 2.1 reports a detailed description of each variable in the regressions.

(c) Analysis 1: Dividends and Future Profitability

	Non-Listed BHCs					Listed BHCs				
VARIABLES	N	mean	sd	min	max	N	mean	sd	min	max
μROA_F3Y	19286	0.25	0.21	-2.33	3.02	8311	0.21	0.26	-2.33	3.02
μROA_F5Y	19286	0.24	0.21	-2.33	3.02	8311	0.20	0.26	-2.33	3.02
μROA_L3Y	17028	0.27	0.17	-2.33	3.02	7866	0.26	0.19	-2.28	3.02
μROA_L5Y	17115	0.27	0.16	-2.33	2.87	7866	0.26	0.18	-2.28	3.02

	Non-Listed CBs					Listed CBs				
VARIABLES	N	mean	sd	min	max	N	mean	sd	min	max
μROA_F3Y	36899	0.21	0.33	-2.33	3.02	337	0.20	0.27	-1.73	1.05
μROA_F5Y	36903	0.21	0.32	-2.33	3.02	337	0.20	0.25	-1.73	0.93
μROA_L3Y	32047	0.22	0.37	-2.33	3.02	307	0.23	0.25	-2.33	1.08
μROA_L5Y	32054	0.21	0.37	-2.33	3.02	307	0.20	0.28	-2.33	1.08

	CU Regular Shares					CU Share Certificates				
VARIABLES	N	mean	sd	min	max	N	mean	sd	min	max
μROA_F3Y	43481	0.25	0.22	-1.03	2.70	41160	0.32	0.21	-0.97	2.22
μROA_F5Y	43481	0.24	0.20	-1.03	2.70	41182	0.30	0.20	-0.97	2.22
μROA_L3Y	41089	0.30	0.22	-1.03	2.70	38800	0.36	0.20	-0.97	1.85
μROA_L5Y	41109	0.32	0.22	-1.03	2.70	38820	0.37	0.20	-0.97	1.85

Notes: All variables are winsorized at the 0.5% level in each tail. Table 2.1 reports a detailed description of each variable in the regressions.

(d) Analysis 2: Dividends and Future Risk-Taking

	Non-Listed BHCs					Listed BHCs				
VARIABLES	N	mean	sd	min	max	N	mean	sd	min	max
σROA_F3Y	19089	0.11	0.16	0.00	2.67	8159	0.12	0.19	0.00	1.91
σROA_F5Y	19093	0.13	0.17	0.00	2.67	8159	0.15	0.21	0.00	1.91
σROA_L3Y	16574	0.09	0.13	0.00	2.09	7783	0.09	0.14	0.00	2.60
σROA_L5Y	16667	0.10	0.13	0.00	1.64	7785	0.10	0.14	0.00	2.60
	Non-Listed CBs					**Listed CBs**				
VARIABLES	N	mean	sd	min	max	N	mean	sd	min	max
σROA_F3Y	36106	0.16	0.22	0.00	3.24	326	0.14	0.23	0.00	1.41
σROA_F5Y	36111	0.17	0.23	0.00	3.24	326	0.15	0.23	0.00	1.42
σROA_L3Y	31626	0.15	0.21	0.00	3.79	304	0.13	0.21	0.01	1.74
σROA_L5Y	31631	0.18	0.22	0.00	3.79	304	0.17	0.25	0.01	1.74
	CU Regular Shares					**CU Share Certificates**				
VARIABLES	N	mean	sd	min	max	N	mean	sd	min	max
σROA_F3Y	43358	0.26	0.23	0.00	2.64	41047	0.32	0.23	0.00	2.13
σROA_F5Y	43363	0.25	0.21	0.00	2.64	41072	0.32	0.22	0.00	2.13
σROA_L3Y	40887	0.31	0.25	0.00	1.91	38582	0.35	0.23	0.00	1.64
σROA_L5Y	40907	0.33	0.24	0.00	1.91	38602	0.38	0.20	0.00	1.64

Notes: All variables are winsorized at the 0.5% level in each tail. Table 2.1 reports a detailed description of each variable in the regressions.

(e) Analysis 3: Dividends and Future Solvency

	Non-Listed BHCs					Listed BHCs				
VARIABLES	N	mean	sd	min	max	N	mean	sd	min	max
ZScore_F3Y	14008	4.89	0.94	0.19	7.54	6022	5.00	1.09	0.49	7.43
ZScore_F5Y	10949	4.69	0.93	-0.08	6.94	4728	4.71	1.04	0.66	7.20
ZScore_L3Y	16522	4.97	0.88	0.48	12.28	7779	5.18	0.96	0.08	9.25
ZScore_L5Y	16529	4.87	0.86	0.58	12.28	7783	5.00	0.93	0.08	9.25
	Non-Listed CBs					**Listed CBs**				
VARIABLES	N	mean	sd	min	max	N	mean	sd	min	max
ZScore_F3Y	24627	4.71	0.95	-0.62	9.12	171	4.83	1.16	0.47	7.21
ZScore_F5Y	19252	4.59	0.90	0.71	9.38	116	4.61	1.09	0.72	6.65
ZScore_L3Y	31552	4.80	0.90	0.18	9.57	304	4.91	1.02	0.89	7.21
ZScore_L5Y	31566	4.66	0.91	0.18	9.57	304	4.63	1.05	0.89	7.16
	CU Regular Shares					**CU Share Certificates**				
VARIABLES	N	mean	sd	min	max	N	mean	sd	min	max
ZScore_F3Y	37789	4.00	0.87	1.57	7.15	35719	3.72	0.84	1.46	7.13
ZScore_F5Y	32904	3.88	0.75	1.58	6.78	31031	3.57	0.73	1.55	9.73
ZScore_L3Y	40816	3.90	0.88	1.19	10.04	38513	3.68	0.83	1.06	11.54
ZScore_L5Y	40825	3.74	0.77	1.19	10.04	38522	3.54	0.72	1.06	11.54

Notes: All variables are winsorized at the 0.5% level in each tail. Table 2.1 reports a detailed description of each variable in the regressions.

Table 2.3: Correlations

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Non-listed BHCs										
DivNI	(1)		0.27	0.32	0.10	0.08	0.01	0.00	-0.06	-0.15
DPS_%Chg	(2)	0.21		0.38	0.01	0.05	0.30	0.22	-0.06	0.14
DivNI_%Chg	(3)	0.19	0.21		0.03	0.03	-0.06	-0.05	0.06	0.06
μROA_F3Y	(4)	0.11	0.11	0.03		0.95	-0.14	-0.13	0.26	0.24
μROA_F5Y	(5)	0.10	0.15	0.01	0.96		-0.14	-0.18	0.25	0.32
σROA_F3Y	(6)	0.00	-0.07	-0.03	-0.35	-0.34		0.87	-0.93	-0.73
σROA_F5Y	(7)	0.01	-0.09	-0.01	-0.30	-0.37	0.89		-0.80	-0.93
ZScore_F3Y	(8)	-0.07	0.19	0.01	0.36	0.34	-0.79	-0.69		0.82
ZScore_F5Y	(9)	-0.15	0.28	-0.03	0.26	0.36	-0.63	-0.81	0.82	
Listed BHCs										
DivNI	(1)		-0.02	0.23	-0.14	-0.17	0.06	0.09	-0.01	-0.08
DPS_%Chg	(2)	0.00		0.34	0.13	0.11	-0.05	-0.04	0.04	-0.01
DivNI_%Chg	(3)	0.09	0.66		0.03	0.03	-0.01	-0.02	-0.01	-0.01
μROA_F3Y	(4)	-0.08	0.12	0.06		0.94	-0.40	-0.34	0.45	0.38
μROA_F5Y	(5)	-0.09	0.11	0.06	0.97		-0.40	-0.44	0.44	0.51
σROA_F3Y	(6)	0.07	-0.06	-0.03	-0.51	-0.48		0.85	-0.96	-0.73
σROA_F5Y	(7)	0.09	-0.05	-0.03	-0.45	-0.52	0.87		-0.77	-0.96
ZScore_F3Y	(8)	-0.02	0.05	-0.01	0.51	0.49	-0.84	-0.71		0.76
ZScore_F5Y	(9)	-0.08	0.04	0.00	0.39	0.51	-0.65	-0.87	0.76	
Non-listed CBs										
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
DivNI	(1)		0.39	0.31	0.34	0.34	0.03	0.03	-0.01	-0.01
DPS_%Chg	(2)									
DivNI_%Chg	(3)	0.19	0.75		0.04	0.04	-0.08	-0.08	0.12	0.12
μROA_F3Y	(4)	0.21	0.22	-0.01		0.97	-0.15	-0.14	0.30	0.27
μROA_F5Y	(5)	0.20	0.14	-0.01	0.98		-0.15	-0.16	0.28	0.31
σROA_F3Y	(6)	-0.03	0.30	-0.05	-0.11	-0.08		0.94	-0.92	-0.79
σROA_F5Y	(7)	-0.03	0.26	-0.05	-0.10	-0.09	0.95		-0.82	-0.91
ZScore_F3Y	(8)	-0.01	-0.32	0.04	0.28	0.24	-0.74	-0.68		0.88
ZScore_F5Y	(9)	-0.02	-0.37	0.04	0.24	0.24	-0.66	-0.74	0.87	
Listed CBs										
DivNI	(1)		0.14	0.29	-0.07	-0.11	-0.09	-0.06	0.13	0.17
DPS_%Chg	(2)	0.09		0.48	0.09	0.06	-0.04	0.02	0.08	-0.09
DivNI_%Chg	(3)	0.05	0.84		-0.01	-0.04	-0.07	-0.08	0.12	0.07
μROA_F3Y	(4)	0.08	0.18	0.10		0.97	-0.28	-0.23	0.37	0.18
μROA_F5Y	(5)	0.03	0.15	0.08	0.96		-0.30	-0.27	0.41	0.30
σROA_F3Y	(6)	-0.01	-0.00	-0.01	-0.59	-0.62		0.93	-0.96	-0.81
σROA_F5Y	(7)	0.05	0.03	0.01	-0.49	-0.56	0.95		-0.78	-0.95
ZScore_F3Y	(8)	0.07	0.04	0.03	0.49	0.54	-0.83	-0.73		0.81
ZScore_F5Y	(9)	-0.00	-0.06	0.01	0.21	0.33	-0.79	-0.86	0.86	
CUs - Regular Shares										
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
DivNI	(1)		0.07	0.16	0.42	0.38	0.58	0.56	-0.54	-0.51
DPS_%Chg	(2)	0.11		0.65	0.05	0.04	-0.05	-0.04	-0.05	-0.19
DivNI_%Chg	(3)	0.17	0.52		0.00	-0.02	-0.09	-0.04	0.05	-0.10
μROA_F3Y	(4)	0.49	0.06	-0.07		0.96	0.44	0.44	-0.35	-0.33
μROA_F5Y	(5)	0.47	0.04	-0.08	0.97		0.42	0.39	-0.35	-0.28
σROA_F3Y	(6)	0.65	0.03	-0.05	0.57	0.56		0.94	-0.96	-0.84
σROA_F5Y	(7)	0.63	0.04	-0.03	0.56	0.54	0.96		-0.88	-0.94
ZScore_F3Y	(8)	-0.53	-0.06	0.06	-0.38	-0.39	-0.84	-0.79		0.88
ZScore_F5Y	(9)	-0.51	-0.17	-0.00	-0.38	-0.35	-0.78	-0.83	0.89	
CUs - Share Certificates										
DivNI	(1)		0.39	0.31	0.29	0.24	0.67	0.58	-0.68	-0.52
DPS_%Chg	(2)	0.28		0.77	0.33	0.24	0.41	0.36	-0.47	-0.49
DivNI_%Chg	(3)	0.24	0.75		0.19	0.10	0.24	0.21	-0.28	-0.35
μROA_F3Y	(4)	0.22	0.22	0.08		0.96	0.61	0.66	-0.50	-0.54
μROA_F5Y	(5)	0.17	0.14	0.01	0.96		0.54	0.61	-0.44	-0.47
σROA_F3Y	(6)	0.61	0.30	0.13	0.57	0.51		0.95	-0.95	-0.86
σROA_F5Y	(7)	0.51	0.26	0.12	0.63	0.58	0.94		-0.88	-0.92
ZScore_F3Y	(8)	-0.60	-0.32	-0.14	-0.47	-0.42	-0.89	-0.84		0.91
ZScore_F5Y	(9)	-0.46	-0.37	-0.21	-0.51	-0.45	-0.82	-0.89	0.92	

Table 2.4: Dividend Ratios and Future Profitability

VARIABLES	(1) μROA_F3Y	(2) μROA_F5Y	(3) μROA_F3Y	(4) μROA_F5Y
Bank Holding Companies	**Listed**		**Non-Listed**	
DivNI	-0.001**	-0.001***	-0.000**	-0.000***
	(-2.806)	(-4.441)	(-2.889)	(-3.303)
Constant	0.023**	0.017**	0.023***	0.019***
	(2.300)	(2.461)	(3.107)	(3.493)
R^2	0.389	0.333	0.354	0.290
Observations	5,287	5,287	11,426	11,426
Controls	Yes	Yes	Yes	Yes
Commercial Banks	**Listed**		**Non-Listed**	
DivNI	-0.001	-0.004***	-0.000**	-0.000***
	(-0.349)	(-4.231)	(-2.611)	(-3.017)
Constant	0.012*	0.003	0.014***	0.013***
	(2.067)	(0.793)	(4.204)	(5.018)
R^2	0.574	0.556	0.175	0.153
Observations	255	255	24,206	24,206
Controls	Yes	Yes	Yes	Yes
Credit Unions	**Regular Shares**		**Share Certificates**	
DivNI	0.003***	0.002***	0.001**	-0.000
	(9.435)	(11.207)	(2.344)	(-0.262)
Constant	0.017**	0.012**	0.032***	0.030***
	(2.659)	(2.731)	(3.240)	(4.133)
R^2	0.383	0.338	0.444	0.501
Observations	32,014	32,014	30,178	30,179
Controls	Yes	Yes	Yes	Yes

Notes: Table 2.4 reports the results for equation (2.1). The dependent variable is future profitability measured as the average return on assets over a three, and five year forward looking horizons (μROA_FXY). Standard errors are reported in parentheses. The independent variable is the dividend to net income ratio in each year (DivNI). Bank-specific controls include the variables Loans Growth, Size, Profitability (ROA), Loan Loss Provisions as a Proportion of Total Assets (LLPTA), Non-Performing Loans and Leases as a proportion of Total Loans (NPLLTL), Equity as a proportion of Total Assets (ETA), Short-Term Wholesale Funding as a proportion of Total Assets (STWSFTA), Marketable Securities as proportion of Total Assets (MSTA), Capital in excess or below regulatory minimums (TCBuffer), and whether a bank has been recapitalized (Recap). Macroeconomic controls include the unemployment rate (UnRate), the risk-free rate (TB3MS), Market Volatility (VIXCLS) and GDP Growth. Table 2.1 reports a detailed description and Table 2.2 report descriptive information of each variable in the regressions. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Table 2.5: Dividend Ratios and Future Risk-Taking

VARIABLES	(1) σROA_F3Y	(2) σROA_F5Y	(3) σROA_F3Y	(4) σROA_F5Y
Bank Holding Companies	**Listed**		**Non-Listed**	
DivNI	0.001***	0.001***	0.000**	0.000
	(4.472)	(3.291)	(2.171)	(0.995)
Constant	-0.016*	-0.008*	-0.014***	-0.010***
	(-2.076)	(-1.788)	(-2.970)	(-3.051)
R^2	0.270	0.269	0.198	0.150
Observations	5,214	5,214	11,331	11,332
Controls	Yes	Yes	Yes	Yes
Commercial Banks	**Listed**		**Non-Listed**	
DivNI	0.003**	0.004***	0.000	-0.000
	(2.538)	(5.905)	(1.056)	(-0.158)
Constant	-0.010***	-0.001	-0.004*	-0.000
	(-3.579)	(-0.278)	(-1.796)	(-0.247)
R^2	0.304	0.323	0.0658	0.0657
Observations	246	246	23,692	23,692
Controls	Yes	Yes	Yes	Yes
Credit Unions	**Regular Shares**		**Share Certificates**	
DivNI	0.002***	0.002***	0.003***	0.002***
	(9.110)	(13.923)	(4.517)	(3.659)
Constant	-0.003	0.004**	0.012	0.022***
	(-1.327)	(2.403)	(1.568)	(3.345)
R^2	0.355	0.314	0.608	0.569
Observations	31,944	31,945	30,093	30,095
Controls	Yes	Yes	Yes	Yes

Notes: Table 2.5 reports the results for equation (2.2). The dependent variable is future risk-taking measured as the volatility of return on asset over a three, and five year forward looking horizons. (σROA_FXY). Standard errors are reported in parentheses. The independent variable is the dividend to net income ratio in each year (DivNI). Bank-specific controls include the variables Loan Growth, Size, Profitability (ROA), Loan Loss Provisions as a Proportion of Total Assets (LLPTA), Non-Performing Loans and Leases as a proportion of Total Loans (NPLLTL), Equity as a proportion of Total Assets (ETA), Short-Term Wholesale Funding as a proportion of Total Assets (STWSFTA), Marketable Securities as proportion of Total Assets (MSTA), Capital in excess or below regulatory minimums (TCBuffer), and whether a bank has been recapitalized (Recap). Macroeconomic controls include the unemployment rate (UnRate), the risk-free rate (TB3MS), Market Volatility (VIXCLS) and GDP Growth. Table 2.1 reports a detailed description and Table 2.2 report descriptive information of each variable in the regressions. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Table 2.6: Dividend Ratios and Future Solvency

VARIABLES	(1) ZScore_F3Y	(2) ZScore_F5Y	(3) ZScore_F3Y	(4) ZScore_F5Y
Bank Holding Companies	**Listed**		**Non-Listed**	
DivNI	-0.687***	-0.076	-0.244**	-0.046
	(-3.612)	(-0.308)	(-2.585)	(-0.519)
Constant	11.640**	7.567***	12.289***	7.940***
	(2.837)	(3.097)	(3.742)	(3.372)
R^2	0.286	0.334	0.226	0.258
Observations	4,275	3,389	8,441	6,516
Controls	Yes	Yes	Yes	Yes
Commercial Banks	**Listed**		**Non-Listed**	
DivNI	-2.183***	-2.355***	-0.097***	-0.040***
	(-4.373)	(-6.771)	(-6.612)	(-5.508)
Constant	15.151**	12.122	8.967***	8.297***
	(2.567)	(1.636)	(7.390)	(8.523)
R^2	0.359	0.577	0.0750	0.116
Observations	121	84	16,455	12,944
Controls	Yes	Yes	Yes	Yes
Credit Unions	**Regular Shares**		**Share Certificates**	
DivNI	-0.728***	-0.852***	-1.253***	-0.816***
	(-7.346)	(-9.526)	(-6.731)	(-4.039)
Constant	6.929***	1.791	-0.491	-5.576**
	(3.897)	(1.362)	(-0.187)	(-2.843)
R^2	0.475	0.465	0.613	0.625
Observations	26,868	22,241	25,228	20,753
Controls	Yes	Yes	Yes	Yes

Notes: Table 2.6 reports the results for equation (2.3). The dependent variable is future solvency measured as the log of the Z-Score calculated over a one, three, and five year forward looking horizons. (ZScore_FXY). The independent variable is the dividend to net income ratio in each year (DivNI). Bank-specific controls include the variables Loan Growth, Size, Profitability (ROA), Loan Loss Provisions as a Proportion of Total Assets (LLPTA), Non-Performing Loans and Leases as a proportion of Total Loans (NPLLTL), Equity as a proportion of Total Assets (ETA), Short-Term Wholesale Funding as a proportion of Total Assets (STWSFTA), Marketable Securities as proportion of Total Assets (MSTA), Capital in excess or below regulatory minimums (TCBuffer), and whether a bank has been recapitalized (Recap). Macroeconomic controls include the unemployment rate (UnRate), the risk-free rate (TB3MS), Market Volatility (VIXCLS) and GDP Growth. Table 2.1 reports a detailed description and Table 2.2 report descriptive information of each variable in the regressions. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. Standard errors are reported in parentheses.

Table 2.7: Dividend Initiations and Future Solvency

VARIABLES	(1) ZScore_F3Y	(2) ZScore_F5Y	(3) ZScore_F3Y	(4) ZScore_F5Y
Bank Holding Companies	**Listed**		**Non-Listed**	
Div_Init	0.533***	0.498***	0.295***	0.314***
	(4.424)	(7.958)	(4.502)	(4.845)
Constant	9.025*	5.995**	10.176***	6.740**
	(2.055)	(2.682)	(2.996)	(2.743)
R^2	0.290	0.354	0.227	0.264
Observations	4,453	3,527	9,244	7,011
Controls	Yes	Yes	Yes	Yes
Commercial Banks	**Listed**		**Non-Listed**	
Div_Init	0.183	-0.272*	0.015	0.029
	(0.691)	(-2.141)	(0.394)	(1.290)
Constant	15.324**	11.490	8.466***	7.649***
	(2.446)	(1.639)	(7.133)	(7.742)
R^2	0.283	0.421	0.0724	0.110
Observations	123	86	16,961	13,311
Controls	Yes	Yes	Yes	Yes
Credit Unions	**Regular Shares**		**Share Certificates**	
Div_Init	0.126	0.110	-0.179	-0.063
	(1.220)	(1.616)	(-1.658)	(-0.873)
Constant	6.185***	1.292	0.772	-4.191*
	(3.492)	(0.961)	(0.253)	(-1.998)
R^2	0.464	0.444	0.552	0.592
Observations	27,733	23,045	26,070	21,539
Controls	Yes	Yes	Yes	Yes

Notes: Table 2.7 reports the results for equation (2.4). The dependent variable is future solvency measured as the log of the Z-Score calculated over a three, and five year forward looking horizons. (ZScore_FXY). The independent variable is a dummy equal to one if a bank initiates dividend payouts for the first time (Div_Init). Bank-specific controls include the variables Loan Growth, Size, Profitability (ROA), Loan Loss Provisions as a Proportion of Total Assets (LLPTA), Non-Performing Loans and Leases as a proportion of Total Loans (NPLLTL), Equity as a proportion of Total Assets (ETA), Short-Term Wholesale Funding as a proportion of Total Assets (STWSFTA), Marketable Securities as proportion of Total Assets (MSTA), Capital in excess or below regulatory minimums (TCBuffer), and whether a bank has been recapitalized (Recap). Macroeconomic controls include the unemployment rate (UnRate), the risk-free rate (TB3MS), Market Volatility (VIXCLS) and GDP Growth. Table 2.1 reports a detailed description and Table 2.2 report descriptive information of each variable in the regressions. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. Standard errors are reported in parentheses.

Table 2.8: Dividend-Per-Share Percentage Changes

(a) DPS Changes and Future Profitability

VARIABLES	(1) μROA_F3Y	(2) μROA_F5Y	(3) μROA_F3Y	(4) μROA_F5Y	(5) μROA_F3Y	(6) μROA_F5Y	(7) μROA_F3Y	(8) μROA_F5Y
	Listed BHCs		**Listed CBs**		**CUs - Reg. Shares**		**CUs - Share Cert.**	
DPS_%Chg	0.000	0.000	0.000	-0.000	0.000**	0.000***	0.000***	0.000***
	(1.157)	(1.195)	(0.224)	(-0.114)	(2.635)	(3.593)	(3.056)	(3.287)
Constant	0.036***	0.024***	0.016*	0.002	0.019**	0.014**	0.031***	0.030***
	(3.380)	(3.609)	(2.109)	(0.282)	(2.772)	(2.892)	(3.562)	(4.272)
R^2	0.447	0.335	0.760	0.703	0.362	0.327	0.458	0.508
Observations	3,232	3,232	142	142	32,340	32,340	30,490	30,490
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

(b) DPS Changes and Future Risk-Taking

VARIABLES	(1) σROA_F3Y	(2) σROA_F5Y	(3) σROA_F3Y	(4) σROA_F5Y	(5) σROA_F3Y	(6) σROA_F5Y	(7) σROA_F3Y	(8) σROA_F5Y
	Listed BHCs		**Listed CBs**		**CUs - Reg. Shares**		**CUs - Share Cert.**	
DPS_%Chg	-0.000*	-0.000**	0.000***	0.000*	0.000**	0.000	0.001***	0.000**
	(-2.109)	(-2.409)	(3.489)	(1.783)	(2.138)	(1.702)	(3.029)	(2.833)
Constant	-0.025***	-0.010**	-0.028***	-0.010***	-0.002	0.005**	0.008	0.020***
	(-3.765)	(-2.546)	(-5.204)	(-3.387)	(-0.750)	(2.637)	(1.229)	(3.803)
R^2	0.336	0.311	0.546	0.351	0.340	0.297	0.576	0.551
Observations	3,189	3,189	139	139	32,268	32,269	30,429	30,430
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

(c) DPS Changes and Future Solvency

VARIABLES	(1) ZScore_F3Y	(2) ZScore_F5Y	(3) ZScore_F3Y	(4) ZScore_F5Y	(5) ZScore_F3Y	(6) ZScore_F5Y	(7) ZScore_F3Y	(8) ZScore_F5Y
	Listed BHCs		**Listed CBs**		**CUs - Reg. Shares**		**CUs - Share Cert.**	
DPS_%Chg	0.055*	0.108***	-0.161*	-0.058**	-0.081**	-0.124***	-0.329***	-0.235***
	(1.792)	(9.232)	(-2.029)	(-2.938)	(-2.442)	(-3.270)	(-5.194)	(-3.236)
Constant	16.344***	8.111***	24.946***	3.782	6.204***	1.135	1.109	-3.820**
	(5.408)	(4.958)	(3.233)	(1.159)	(3.508)	(0.845)	(0.444)	(-2.341)
R^2	0.410	0.380	0.322	0.665	0.467	0.450	0.604	0.620
Observations	2,702	2,083	78	56	27,179	22,566	25,547	21,069
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

3

Cost Structure and Lending Quality

with Dr. María del Carmen Aranda León & Dr. Javier Arellano Gil

3.1 Introduction

This paper analyzes whether bank cost structure and lending growth dynamics influence lending quality.

First, we analyze the underlying reasons for the relationship between bank cost structures (cost rigidity) and bank lending quality. In line with previous literature, we define lending quality as the proportion of nonperforming loans and leases[1] to total loans. Lending quality has been a heavily analyzed topic in academic and policy circles in the last few decades. Given the global macro-economic repercussions stemming from poor lending practices in the past decade, which ultimately led to the crisis of 2007, it is, without a doubt, that lending quality exerts an immense influence in shaping financial markets and economies

Several studies have looked into the relation between lending growth and lending quality (Clair, 1992; Keeton, 1999; Ghosh, 2015). All conclude that lending quality generally decreases following long periods of credit expansions. Keeton (1999) suggests that this negative relation between lending growth and subsequent rises in nonperforming loans is primarily a result of bank competition, in which several institutions fight for the same customers by offering attractive lending terms to unattractive - in terms of credit score and other delinquency metrics, potential borrowers. This competition component in credit-granting decisions could be an especially intense practice in low-interest-rate environments, as bank profitability and net interest margins, in particular, have been directly affected by such monetary policies. Competitive credit-granting likely further exacerbates banks' profitability problems, and increases in lending to sub-optimal borrowers might be adapted to boost overall profitability. As profits suffer, riskier borrowers generally provide a faster,

[1] Nonperforming loans and leases are generally accepted to be those lines of credit on which the last scheduled payment is at least 90 days overdue or in non-accrual status. A non-accrual status is ascribed to a credit line that no longer generates its stated interest rate because borrowers have failed to meet their payment obligations.

albeit short-lived, remedy as such riskiness is often accounted for via higher lending rates. As a result, credit-granting becomes more risk-hungry, and lending standards become relatively relaxed. In fact, we observe that the increases in nonperforming loans, which started in 2006 and peaked in 2009, were preceded by a long credit expansion.[2] Also, the never before seen delinquency levels were at least partially due to deliberately relaxed lending standards at margin-hungry banks [3]. "Ultimately, too much money was lent to too many people who could either not afford - or were simply not willing - to pay it back" (Clare et al., 2016). However, while the average NPL increased, its standard deviation widened as well. The increase in variability among the banks in our sample points to a difference in the quality of banks' lending growth during this period. In other words, not all banks seem to have had the same capabilities (or perhaps even desire) in achieving healthy growth.

Another strand of the lending quality literature considers the causal relation between operational efficiency, which is generally measured in terms of profits and costs, and lending quality (Berger and DeYoung, 1997; Delis et al., 2017; Fiordelisi et al., 2011; Ghosh, 2015; Luo et al., 2016; Podpiera and Weill, 2008; Williams, 2004; Rossi et al., 2005). These studies are primarily empirical in nature and most employ Granger-causality methodologies to test along four dimensions which might be potential drivers in the relation between operational efficiency and lending quality; namely 'bad management', 'bad luck', 'skimping' and 'moral hazard' hypotheses, which were initially developed by Berger and DeYoung (1997).

While we believe that cost 'skimping'[4] to benefit short-term efficiency and profitability is likely to be

[2] In our sample, banks had an average growth of 10.1% (the average growth in the period 2004-2008 was 11.35%). The average NPL ratio before 2006 was 0.88%. This average rose to 4.05% in 2009.

[3] The burst in the housing bubble was another element in the delinquency equation. Borrowers had taken out loans that greatly exceeded the collateral values. Many relatively safe borrowers took a purely economic perspective that walking away from these loans is the most efficient option.

[4] 'Skimping' refers to the managerial practice to deliberately devote fewer efforts and resources in determining the creditworthiness of potential new borrowers as a means to boost profitability (and cost efficiency), those benefits will tend to be short-lived, however, and likely followed by increases in the proportion of bad loans for years to come.

followed by poor lending quality in the long-run, existing literature is largely silent on the impact of cost skimping on loans and lending practices. In fact, existing studies have persistently found the opposite relation between efficiency and lending quality. This literature predominantly suggests a negative association between current changes in cost efficiency and future changes in NPL (Berger and DeYoung, 1997; Delis et al., 2017; Fiordelisi et al., 2011; Ghosh, 2015; Luo et al., 2016; Podpiera and Weill, 2008; Williams, 2004), which has been justified by (i) the 'Bad management' argument that poor cost-performing banks would probably also have poor skills in credit screening and/or in ensuring that borrowers obey debt covenants (Berger and DeYoung, 1997; Delis et al., 2017; Fiordelisi et al., 2011; Ghosh, 2015; Podpiera and Weill, 2008; Williams, 2004) and by (ii) the 'Bad luck' argument that the lower cost efficiency of the banks with bad NPL ratios might be due to the extra cost associated with the need to monitor and complain an increased number of bad borrowers (caused by a precedent exogenous shock in the market) (Berger and DeYoung, 1997; Delis et al., 2017; Rossi et al., 2005). Despite the overall lack of support for the skimping hypothesis, Berger and DeYoung (1997) find that for a subset of consistently efficient banks across time, increases in measured cost efficiency generally precede increases in nonperforming loans, suggesting that these banks purposely trade short-run expense reductions for long-run reductions in loan quality. Thus, we believe that the causal relation between efficiency and lending quality should be revisited. Because information-gathering is a resource-intensive process, banks, and especially those with poor profitability and efficiency metrics, could (1) have a significant say in the allocation vs. skimping of such costs, without noticeable short-term implications that would spark investor inquiries.

While lending growth and efficiency as determinants or as a result of lending quality, and bank risk in general, we argue that lending quality (NPL) and efficiency are both affected by banks' cost structure selection. Specifically, we claim that, in periods of credit expansion, banks with higher cost rigidity (higher relative weight of fixed costs) tend to have lower NPL increases, at least for two reasons.

First, an important part of the information relevant to credit decisions (named 'soft information') (Petersen, 2004) is generated by fixed resources and cannot be increased in the short-run by adding new discrete amounts of resources as the volume of loans raises. 'Soft information' is collected over time through frequent and personal contacts with the borrower (Berger and Udell, 2002). It provides bank managers with a picture of the borrower that completes and complements the information available from public records. In periods of credit expansions, which have generally preceded spikes in NPLs, banks face greater credit demand. Banks that are able to rely on reliable inputs other than generic public records provide banks that nourish customer relations more intensively (in order to collect more qualitative information) will likely provide them with an informational advantage. This informational advantage, which banks derive from soft information, will, in turn, be better equipped in taking appropriate credit-granting decisions. In other words, the more complete the profile of the potential borrower, both in terms of public record and personal relation with the bank, the more precisely banks can manage delinquency probabilities. Thus in periods of credit expansion, which are known to generate an increase in the probability of loans' default (Clair, 1992; Keeton, 1999), access to soft information might significantly determine the quality of a bank's private information and, thus, its informational advantage. We argue that firms with a higher proportion of fixed costs are better able to generate and use soft information in lending decisions as such banks are likely to have more extensive branch networks and permanent staff[5].

Credit expansion makes soft information more valuable and useful. Banks that more extensively use soft information to complement 'hard information' would increase NPL to a lower extent. Yet, the extent of the change in screening methods over time (the change in the relative weight of hard and soft information) depends on the bank's organizational structure. In particular, D'Aurizio et al.

[5] Cost rigidity is the proportion of fixed expenses such as premises and staff in terms of total operational expenses.

(2015) argue that not only getting soft information is costly but sometimes difficult to do: "in the extreme case of a bank that had used only hard information, a sudden shift to soft-information-based screening would not be likely to be feasible" (D'Aurizio et al., 2015) p. 287.

Access to soft information is limited since soft information in credit markets is primarily local, and thus borrower proximity is required for its collection. In fact, bank–borrower distance greatly reduces the beneficial impact of a higher credit score on predicted delinquency. For instance, using an ex-post analysis of scores and real defaults of a single bank's borrowers during several months, Agarwal and Hauswald (2010) found that the further away a borrower was, the more likely the bank was to experience nonpayment because banks make more errors in granting credit the further away an applicant is. Access to soft information requires an extensive net of premises to capture the information and an extensive set of structures and processes to transmit, store, and use it. These resources are mainly fixed. Hence, the level of rigidity of a cost structure (the relative weight of fixed costs over total costs) reflects a bank's ability to generate soft information. Inasmuch as this ability cannot be changed in the short-run, we expect to find higher-quality growth among banks with bigger structures of fixed costs.

The second reason for the influential effect of bank cost structures on efficiency and NPL is that cost structures affect the collection and processing of hard information from additional costumers. In particular, more flexible short-run cost structures with higher variable and lower fixed costs suffer to a larger extent from congestion costs (Banker et al., 2014). The marginal productivity of variable inputs depends on the fixed input level. When volume increases and the fixed input stays constant while the variable input increases, there is "congestion" in the variable costs that reduce their marginal productivity. Moreover, due to the limited capacity of the fixed input, the congestion in the additional costs gets worse. The higher the increase in volume (i.e., the short-run cost function is convex in volume or, equivalently, the marginal cost is upward-sloping in volume). Conversely, an increase in the fixed input relieves the congestion for the variable input, making it more productive. Therefore, the congestion effect's severity will be more pronounced for cost structures with a lower ratio between variable and fixed costs. We then claim that banks with a higher capacity of fixed inputs that suffer to a lower extent from congestion costs are better prepared to maintain their lending quality when lending grows.

Second, we analyze whether when and how fast lending grows has an impact on changes in non-performing loans. To do so, we construct a measure to capture the distance of lending growth with respect to the complete lending growth cycle of each bank. To the best of our knowledge, we are the first to include lending growth dynamics as a determinant of lending quality.

Using US Bank Holding Company data[6] for the period spanning 1998-2010[7], we find that after controlling for macroeconomic as well as bank specifics, (i) there is a significant and positive inter-temporal association between lending growth and NPL (credit expansion leads to lower lending quality) but (ii) this association is lower the more fixed the cost structure of the bank is. In addition, compared to banks with lightweight cost structures, banks with more fixed cost structures have smaller short-run increases in costs in response to the same lending growth level (Banker et al., 2014) and yet our results show that (iii) these short-run cost increases reduce future NPL to a greater extent the more fixed the bank's cost structure was at the moment of increasing the volume of loans.

Our results are consistent with the arguments of both the 'Skimping' and the 'Bad Management' hypotheses. First, we study the effect of short-term cost decisions and, consistent with the 'bad Management' hypothesis, we find that banks having higher short-term costs increases (per dollar in-

[6]For comparative purposes, we rely on several distinct data sources. We collect Bank Holding Company regulatory data (in the form of FR Y 9C) from the Federal Reserve Bank of Chicago's Data Repository. We collect Commercial bank regulatory data (in the form of FFIEC 031/041 submissions), annual financial report data from Compustat, and Credit Union call reports data from National Credit Union Association (NCUA).

[7]While we have available data up to 2017, a large part of our analyses is designed to capture one complete lending growth cycle and so the data is trimmed to include observations prior to 2010.

creased in lending), and consequently larger efficiency reductions, are also the ones suffering higher increases in future NPL. We contribute by showing that this phenomenon is contingent on the banks' cost structure. Put differently, the amount of resources (per dollar lent) that each bank needs to add not to hurt its lending quality when growing is different for each bank and contingent on its own cost structure. Hence, the 'Bad Management' phenomenon that happens in the short-run seems to be the result of 'Skimping' in the long-run cost structure decisions. Avoiding long-term 'Skimping' by adopting a more fixed cost structure allows banks to achieve both higher short-term increases in cost efficiency and lower future NPL.

In addition, from a cost behavior literature perspective, while the existence of congestion costs (as well as its increase with more flexible cost structures) has been analytically proved (Banker et al., 2014), few empirical studies have been conducted to test this phenomenon empirically (Banker et al., 1988). Using NPL as a proxy for the productivity (effectiveness) of costs in generating useful information to screen borrowers, this paper contributes by showing that a short-term increase in costs improves screening and lending quality to a greater extent the more fixed the cost structure is.

Finally, from a regulatory point of view, our results are especially relevant in today's context. Credit is again growing, and there is an increasing number of internet-based banking platforms (online banks) with lightweight cost structures. While it is still too early to measure the differential impact that growth in lending might have on NPLs among online banks, a better understanding of the role of bank cost structures in periods of credit expansion might help to prevent harmful lending growths in the context of new business models.

In separate analyses, we find that lending growth dynamics, and in particular, when and how lending grows, significantly influence lending quality. Our results suggest that (i) more recent lending growth has a higher impact on lending quality. However, how fast lending grows in a given year with respect to the total growth of the lending growth cycle has a significant influence on the lending quality, and (ii) is more pronounced in periods of higher lending growth.

The rest of the paper is organized as follows: In the next section, we discuss the theoretical arguments for the influence of lending growth and banks' cost structure on efficiency and NPLs and develop our hypotheses. Section 3 describes our data set and variable measurement. Section 4 presents and discusses the results. Section 5 concludes.

3.2 Background

3.2.1 Institutional Setting

Our analysis is based on data characterized by a period of prolonged growth in commercial and industrial loans, which ultimately peaked in 2008 and subsequently declined until 2010. In the time horizon of our analysis, lending growth was at it's lowest point in 2004 at 879.85 Billion USD. By 2008 the value had nearly doubled to 1,509.84 Billion USD before dropping to 1,199.49 Billion USD in 2010.

This prolonged credit expansion period is also characterized by an unprecedented consecutive rise in the ratio of non-performing loans to total loans. In fact, as history points out, excessive risk-taking arising from the favorable macroeconomic environment, along with poor regulatory oversight, was one of the most dominant problems faced by most major banks at the time. The period leading up to the crisis is characterized by strong and stable GDP growth and relatively low inflation, unemployment, and interest rates. Expectations that house prices would continue to rise led to excessive and imprudent borrowing, many times at levels well above the value of the collateral assets. Oftentimes, such loans were made to borrowers with relatively high default risk. Risk-taking among banks, which seemed quite profitable at the time, arose from competition for ever-increasing loan levels among banks and the belief that the economy will keep a steady pace indefinitely, significantly reduced lending criteria. In addition, mortgage-backed securities (MBS), which banks sold to investors as highly-rated (safe) financial instruments, provided a layer of protection against potential losses. Investors in the US and globally increasingly flocked to US MBS in search of low-risk, high yield opportunities. They relied on loans to increase what undoubtedly was to be the upward potential of their investment.

While the catalyst was the downturn in the US housing market and the subsequently missed repayments on those assets, lending quality was a major reason for the problems that plagued most major banks at the time. Once housing prices began dropping, and borrowers stopped making payments, the value of MBS drastically declined as most investors tried to off-load such holdings. Loans made for the purchase of MBS securities put additional stress on the financial system.

In 2007, Ben Bernanke testified that 12 of the 13 most important U.S. financial institutions were faced with an imminent threat of failure. Ultimately, 13 of the 25 largest institutions either failed, required government assistance, merged or changed their business structure to avoid failure (Gorton, 2015). Financial distress peaked after the failure of Lehman Brothers and other financial institutions in 2008. Confidence in the banking system deteriorated sharply, and investor panic set in, as markets feared that more failures would follow. Everyone began pulling the plug on their investments at US financial institutions at the same time. This, in turn, led to firms' inability to obtain financing and the collapse in confidence to spend among households.

Despite the many government interventions that desperately tried to alleviate the stress on the financial system, the level of non-performing loans rose long after the onset of what has come to be known as the worst economic downturn since the Great Depression; the global financial crisis of 2007-2009 ignited in the U.S. and spread rapidly, due to high inter-connectedness, across most of the developed world' financial markets and banking systems.

In the end, one of every twenty loans was delinquent, and the associated collateral asset values were in free-fall. Non-performing loans increased seven-fold from 0.73 percent in 2006 to 5.30 percent in 2010, the highest level to have ever been recorded.

In October 2010, lending began another rapid expansion in the US commercial and industrial loan markets. It is the longest credit expansion since at least the 1980s. The slope of this expansion seems just as steep as the previous cycle. This will undoubtedly have significant implications for non-performing loans in the years to come. Therefore, analyzing this relation to its fullest extent is crucial, especially given the importance of non-performing loans for the viability of the financial system. This relationship is even more important today, when bank profitability is at a record low and when, given the low-interest-rate environment, large losses would be detrimental to their survival despite the overall improvements in solvency in the past decade.

3.2.2 Literature Review

Several previous studies have extensively examined the relation between efficiency and risk (Berger and DeYoung, 1997; Delis et al., 2017; Fiordelisi et al., 2011; Ghosh, 2015; Luo et al., 2016; Podpiera and Weill, 2008; Williams, 2004; Rossi et al., 2005). This efficiency-risk relation has primarily centered around four main hypotheses, developed by Berger and DeYoung (1997): (1)The 'Bad luck' Hypothesis suggests that bank failures are caused primarily by external events which are beyond the control of bank management. Such external events could influence the number of resources needed and expenses incurred in managing problem loans and could ultimately lead to lower-cost efficiency. (2) the 'Bad management' Hypothesis suggests that, contrary to the 'Bad luck' hypothesis, the major risks facing financial institutions are caused internally. Managers have poor capacities in overseeing both operational efficiency and lending procedures such that inefficient banks are also those with the largest proportions of problem loans (i.e., lowest lending quality).

(3) The 'Skimping' hypothesis also identifies an internal source for risk. Managers deliberately limit or restrict loan monitoring resources to improve cost-efficiency. However, this short-term increase in efficiency comes at the expense of an increase in non-performing loans in the long run. The hypothesis suggests a trade-off between short-term efficiency and long-term lending quality. (4) The 'Moral Hazard' hypothesis states that relatively less capitalized banks may respond to moral hazard incentives by increasing risks, generally related to lending quality.

Berger and DeYoung (1997) examine the intersection among problem loans (asset quality), cost efficiency, and financial capital using Granger-causality techniques to test the four hypotheses regarding the inter-temporal relationships among loan quality, cost efficiency, and bank capital. They find evidence for the bad luck hypothesis - increases in non-performing loans tend to be followed by decreases in measured cost efficiency. Their results suggest that high levels of problem loans lead to increases in spending on monitoring, working out, and/or selling off these loans. They also suggest that banks could possibly become more diligent in administering the portion of their existing loan portfolio that is currently performing. For the industry as a whole, they find support for the bad management hypothesis. which suggests that ecreases in measured cost efficiency are generally followed by increases in non-performing loans. The result indicate that bad management practices are manifested not only in excess expenditures but also in sub-par underwriting and monitoring practices that eventually lead to non-performing loans. However, for a subset of consistently efficient banks across time, the data favor the skimping hypothesis - increases in measured cost efficiency generally precede increases in non-performing loans, suggesting that these banks purposely trade short-run expense reductions for long-run reductions in loan quality. Finally, they find that decreases in bank capital ratios generally precede increases in non-performing loans for banks with low capital ratios, evidence that thinly capitalized banks may respond to moral hazard incentives by taking increased portfolio risks. Hence, cost efficiency could be an important indicator of not only future problem loans, but also problem banks. Fiordelisi et al. (2011) assess the inter-temporal relationship between bank efficiency and risk in the European Union using a Granger-causality methodology in a panel data framework. They also examine whether capital affects this relationship. They find that reductions in bank cost and revenue efficiencies Granger-causes higher future risk, thus supporting the 'bad management' hypothesis. They also find that bank efficiency improvements contribute to shore up bank capital levels, and those higher capital levels seem to have a positive impact on efficiency levels. The findings suggest that banks lagging in their efficiency levels might expect higher risk and subdued capital positions in the near future. Ghosh (2015) examines the state-level, industry-specific, and regional macro-economic determinants of non-performing loans and leases of US financial institutions between 1984 and 2013. They find that greater capitalization, liquidity risks, poor credit quality, greater cost inefficiency, and banking industry size significantly increase NPLs, while greater bank profitability leads to lower levels of NPLs. Higher state real GDP and real personal income growth rates, and changes in state housing price index reduce NPLs, while inflation, state unemployment rates, and US public debt significantly increase NPLs. Luo et al. (2016) assesses the interrelationship between financial openness and bank efficiency while accounting for the endogenous role of bank risk in a cross-country sample of 140 countries between 1999-2011. They find that (a) Financial openness reduces bank efficiency directly, not through changes in bank risk; (b) Bank risk reduces bank efficiency regardless of financial openness; (c) Financial openness increases bank risk indirectly through the decreased bank efficiency. The authors conclude that financial openness has a negative effect on bank risk and profit efficiency. Podpiera and Weill (2008) address the question of the causality between non-performing loans and cost efficiency and examine whether these factors are deep determinants of bank failures in emerging markets in a panel of Czech banks between 1994 and 2005. They find evidence of the 'bad management hypothesis' according to which reduced cost efficiency contributes to increasing non-performing loans. The authors conclude that banks' greater cost efficiency reduces the likelihood of bank failures and, therefore, contributes to financial stability. Williams (2004) examines managerial behavior for European savings banks in a sample spanning 1990 and 1998 by examining the inter-temporal relationships between loan loss provision, efficiency, and capitalization. This analysis provides a robustness test of the Berger and DeYoung (1997) results for US banks. Their results suggest that the most pressing management problem for European banks is bad management. These findings are inconsistent with previous results from the US. The former do not appear to engage in skimping behavior. The authors find that management behavior varies across countries, with management exhibiting more than one behavior type. The empirical evidence of this study suggests that some banks can produce information about customers and market conditions that allow management to assume greater portfolio risks without damaging the loan portfolio's quality or negatively affecting bank efficiency. Rossi et al. (2005) analyzes cost and profit efficiency level and the managerial behavior of banks in nine Central and Eastern European countries between 1995-2002. They find evidence of a generally low level of cost efficiency and an even lower level of profit efficiency. However, they caution of significant differences among countries and increasing tendency of profit and cost efficiency over time. They find the cost efficiency effects to be more pronounced. Furthermore, the authors test several hypotheses of managerial behavior and find evidence for the bad luck hypothesis, which suggest that the exogeneity of bad loans triggers inefficiency.

In short, these studies have persistently found a negative association between current changes in cost efficiency and future changes in NPL, which has been justified by (i) the 'Bad management' argument that poor cost-performing banks would probably also have poor skills in credit screening and/or in ensuring that borrowers obey debt covenants (Berger and DeYoung, 1997; Delis et al., 2017; Fiordelisi et al., 2011; Ghosh, 2015; Podpiera and Weill, 2008; Williams, 2004) and by (ii) the 'Bad luck' argument that the lower cost efficiency of the banks with bad NPL ratios might be a result of the extra cost associated with the need to monitor and complain an increased number of bad borrowers (caused by a precedent exogenous shock in the market) (Berger and DeYoung, 1997; Delis et al., 2017; Rossi et al., 2005).

We add to this strand of the literature by examining the lending quality and efficiency in the context of banks' cost structure selection.

3.2.3 Hypotheses

We believe that bank cost structure rigidity[8], or lack thereof, could influence both efficiency and lending quality. We argue that, in periods of credit expansion, banks with higher cost rigidity (higher proportion of fixed costs) tend to have lower increases in non-performing loans, at least for two reasons.

First, Despite banks' significantly increased geographic reach, the reliance on borrower-specific, 'Soft' information (see Petersen (2004)) has been an increasingly important component in credit-granting decisions. Since the crisis, banks have increased the relative weight in lending decisions that they attach to qualitative, 'soft' information and direct knowledge of the borrower.

Soft information refers to 'inside' information, which is transmitted through repeated interactions between the loan officer and the firm, its owner, and its local community on various dimensions (Berger and Udell, 2002; Petersen, 2004). It consists of information about the character and reliability of the firm's owner. It may be difficult to quantify, verify, and communicate through a banking organization's normal transmission channels. Such information relates to the lending officer's subjective evaluation of the firm's creditworthiness and is commonly used in decisions about the availability and terms of credit to the firm (Berger and Udell, 2002; Petersen, 2004). Soft information seems to be an important determinant of corporate lending, especially among small and 'informa-

[8] We measure cost rigidity as employee salaries and office expenses, which are relatively fixed throughout time, as a fraction of operating expenses.

tionally opaque' firms (Garcia-Appendini, 2011). Soft information provides bank managers with a picture of the borrower that completes and complements the information available from public records (Petersen, 2004).

However, the ability to incorporate 'Soft' Information as an invaluable component in screening methods largely depends on banks' organizational structures. Obtaining reliable 'Soft' information requires long-standing personal relations with potential borrowers. Therefore, it is costly both because of the time dimension necessary to establish and nurture such relations and because of the need for premises and personnel available for those ends. D'Aurizio et al. (2015) argues that not only getting soft information is costly but sometimes difficult to do: "in the extreme case of a bank that had used only hard information, a sudden shift to soft-information-based screening would not be likely to be feasible."

Access to soft information is limited since soft information in credit markets is primarily local and becomes less useful when separated from the environment in which it was collectedPetersen (2004). Thus borrower proximity is required for its collection. In fact, bank–borrower distance greatly reduces the beneficial impact of a higher credit score on predicted delinquency. For instance, using an ex-post analysis of scores and real defaults of a single bank's borrowers during several months, Agarwal and Hauswald (2010) finds that the further away a borrower was, the more likely the bank was to experience nonpayment because banks make more errors in granting credit the further away an applicant is. Access to soft information requires an extensive net of premises to capture the information and an extensive set of structures and processes to transmit, store, and use it. These resources are mainly fixed. Hence, the level of rigidity of a cost structure (the relative weight of fixed costs over total costs) reflects a bank's ability to generate soft information and take advantage of the 'information advantage' it generates. Inasmuch as this ability cannot be changed in the short-run, we expect to find higher-quality growth among banks with higher proportions of fixed costs in their structures. Banks with higher proportions of fixed costs can enjoy 'informational advantages' derived from high quality 'soft' information in their credit-granting decisions. As a result, lending growth will be primarily based on high-quality loans.

'Soft' Information is especially valuable and useful during periods of credit expansions. In times of credit expansions, the amount of fixed resources could not be easily increased to accommodate the increase in lending volume. As a result, the collection of 'Soft' information could not be increased in the short-run by adding new discrete amounts of resources. Banks with ex-ante relatively more rigid cost structures will be able to take advantage of the soft information collected over time, while banks with ex-ante relatively low fixed resources will likely not have ample resources and time to collect meaningful 'soft' information. Simultaneously, banks with relatively rigid cost structures will likely have 'more hands on deck' to properly screen potential borrowers, even if 'soft' information is not available. Thus in periods of credit expansions, banks with ex-ante more rigid cost structures will likely have an informational and performance advantage s over their counterparts with lower physical presence and staff base.

Previous studies have documented a strong negative relation between rapid lending growth and lending quality (Clair, 1992; Keeton, 1999). The authors find that Lending beyond normal levels at a given stage in the business cycle lowers lending quality after a three-year lag. The result is especially strong at banks with below-average capitalization (Clair, 1992). The authors claim that excessively accessible credit standards have been the main cause of unusually rapid growth in business loans at commercial banks. On one side, increased competition for loan customers has caused banks to reduce loan rates and ease credit standards to obtain new business. On the other side, continued economic expansion have generated an over-optimistc outlook at many as a result of which they have become more willing to take risks. However, This acceleration in lending growth could eventually lead to a surge in loan losses, and in the long-run, reduce bank profits, and cause a new round of bank failures (Keeton, 1999). We believe that banks with more rigid cost structures will better allocate the resources under their disposal in screening borrowers. Such banks will be better able to prioritize the most dependable and most transparent borrowers over opaque borrowers. In this context, access to soft information might significantly determine the quality of a bank's private information and, thus, its informational advantage.

H: We believe that banks who rely more heavily on soft information will experience healthier lending growth due to informational advantages. And since Banks with more rigid cost structures are better equipped to collect and process soft information, they will experience healthier lending growth due to informational advantages derived from 'soft' information. Consequently, banks that rely more extensively on 'Soft' Information to complement 'Hard' Information would likely increase the level of NPL to a lower extent than their counterparts that rely primarily on public records.

The second reason for the influential effect of bank cost structures on efficiency and NPL is that cost structures affect the collection and processing of hard information from additional costumers. In particular, more flexible short-run cost structures with higher variable and lower fixed costs suffer to a larger extent from congestion costs (Banker et al., 2014). The marginal productivity of variable inputs depends on the fixed input level. When volume increases and the fixed input stays constant while the variable input increases, there is 'congestion' in the variable costs that reduce their marginal productivity. Moreover, due to the limited capacity of the fixed input, the congestion in the additional costs gets worse with higher increases in volume (i.e., the short-run cost function is convex in volume or, equivalently, the marginal cost is upward-sloping in volume). Conversely, an increase in the fixed input relieves the congestion for the variable input, making it more productive. Therefore, the congestion effect's severity will be more pronounced for cost structures with lower ratios between variable and fixed costs. We then claim that banks with a higher capacity of fixed inputs that suffer to a lower extent from congestion costs are better prepared to maintain their lending quality when lending grows.

3.3 Data and Methodology

3.3.1 Data Sources

3.3.1.1 Bank Holding Company and Commercial Banks Data

Our empirical analysis on banks is based on data obtained from The Federal Reserve Bank of Chicago's Commercial Bank and Bank Holding Company Regulatory Database. The data consists of annualized accounting information submitted by regulated depository financial institutions for supervisory purposes to the respective regulatory supervisors (in the form of financial statements and regulatory reports)[9]. The filings provide balance sheet, income statement, and regulatory capital data. This analysis focuses on listed and non-listed Bank-Holding Company (BHC) top-holders for the period spanning 1994 to 2017. After calculating all relevant variables and dropping observations where loans, total non-interest expense, staff expenses, non-performing loans, total income, or equity are negative, our initial sample of BHCs comprises an initial sample of 29,225 bank-year observations corresponding to 3,456 unique entities. 8,819 of the observations correspond to 1,061 unique BHCs listed on a stock exchange, and the remaining 20,406 observations correspond to 2,818 unique, private, non-listed BHCs. Because we are interested in examining the credit expansion in the period leading up to the crisis and the subsequent lending quality implications associated with this specific period, in most of the analyses, we truncate our sample between 1998 and 2010. In addition, and since some of our analyses require a complete set of data for each bank, in a subset of data, we include only BHCs for which we have information for all years (balanced sample). Af-

[9]Information on BHCs is obtained from the FR Y-9C reports and information on Commercial Banks is obtained from the FFIEC 031/041 reports.

ter dropping extreme values in our main variables of interest (we truncate the tales of $\Delta Loans$ and ΔNPL by 3%), the sample for which we have a complete set of data points drops to 14,872 observations corresponding to 2,179 BHCs for the sample of 1998 to 2010. For the balanced sample, we have a complete set of information on 3,571 observations for 347 BHCs spanning 1998 - 2010. In some analysis, we truncate our sample even further to include only the years between 2005 and 2010.

Macroeconomic data, namely unemployment, inflation, and interest rates, are obtained from the World Bank's Open Data repository. While our focus is on bank holding companies, where possible, we run a parallel analysis for commercial banks and credit unions to complement the BHC analysis discussed above.

3.3.1.2 Credit Union Data and Compustat Data

Annualized Credit Union data is obtained from the call reports collected by the National Credit Unions Administration (NCUA). As in banks, the data contains balance-sheet and income statement information and spans from 1994 to 2017. Our sample excludes CUs with assets below $50 million since the reporting frequency of such entities is inconsistent across our sample period[10]. Given the sample horizon and available data, not all analyses could be replicated for across the different institutions. Nonetheless, we try to provide consistent insight into all institutions.

[10] Prior to 2002Q3 only CUs with assets in excess of $50 million reported financial statement information on a quarterly basis, while their smaller counterparts reported on a semiannual basis.

3.3.2 Variables Used and Derived from Accounting Data

3.3.2.1 Dependent Variables

Lending Quality (Δ NPL): Calculated as the year-over-year log change in non-performing loans and leases as a proportion of total loans ($NPL = NPLL \div TL$), the variable is a proxy for changes in the quality of banks' borrower screening and lending activities. The annual change is calculated as: $\Delta NPL_{it} = log(NPL_{it}) - log(NPL_{it-1})$

3.3.2.2 Independent Variables

Our main independent variables are:

1. Lending Growth (ΔLoans): Calculated as the year-over-year log change in total loans and leases (TL), such that: $\Delta Loans_{it} = log(TL_{it}) - log(TL_{it-1})$. The variable captures credit expansions or contractions at the firm-level and is a significant predictor of lending quality.

2. Cost Structure: We believe that 'soft' information, an increasingly integral part of the information-gathering in credit-granting decisions, is primarily generated by fixed resources and cannot be sporadically adjusted to meet increases in lending demand. Access to soft information, however, might significantly influence the quality of a bank's informational advantage. As a result, lending quality will depend on the flexibility of banks' fixed expenses. Cost structures also affect the collection and processing of hard information from additional customers. Banks with relatively higher variable costs and lower fixed costs may suffer relatively larger variable "congestion" costs arising from increases in volume in periods of credit expansions. The congestion in variable costs ultimately reduces marginal productivity. The congestion worsens due to fixed resources' limited capacity to absorb the volume increases. To increase marginal productivity, fixed resources must increase to alleviate some of the variable cost

congestion. We believe banks with higher fixed input capacity, which suffer to a lower extent from congestion costs, are better prepared to maintain lending quality when lending demand increases. We rely on three different methodologies to obtain a measure for cost-structure. For all analyses, we use data prior to 2004 to obtain the cost structure variables so that they reflect pre-expansion conditions. Furthermore, to ensure that the variables are consistent for each bank, we only include banks for which we have a full set of observations between 1998 and 2004. Balancing the sample allows us to use an equal number of observations for each bank and also to consider the same sample for each cost structure measure.

(a) Prem: Calculated as fixed expenses / total non-interest expenses, the variable captures the rigidity in banks' fixed costs. In banks, fixed expenses are occupancy and equipment expenses. Total non-interest expenses are calculated as the sum of Staff + Occupancy and Equipment + Aggregate Other Current Operating Expenses[11]. In credit unions, fixed expenses are calculated as the sum of Office Occupancy Expenses + Office Operations Expenses. Total non-interest expenses are calculated as the sum of Total Employee Compensation and Benefits + Office Occupancy + Office Operations + Aggregate Other Current Operating Expenses[12].

(b) Banker Slope: For each bank, we estimate the slope between changes in total costs and lending growth prior to 2004. The betas derived from the simple estimation allow us to capture whether and how rapidly banks adjusted their total costs in response

[11] Data processing expenses; Advertising and marketing expenses; Directors' fees; Printing, stationery, and supplies; Postage; Legal fees and expenses; FDIC deposit insurance assessments; Accounting and auditing expenses; Consulting and advisory expenses; Automated teller machine (ATM) and interchange expenses; Telecommunications expenses; Other real estate owned expenses; Insurance expense (not included in employee expenses, premises and fixed assets expenses, and other real estate owned expenses

[12] Travel and Conference Expense; Educational and Promotional Expenses; Loan Servicing Expense; Professional and Outside Services; Member Insurance (NCUSIF Premium Expense, Temp. Corporate Stabilization Fund Assessment, Other Member Insurance Expense); Operating Fees (Examination and/or supervision fees); Miscellaneous Operating Expenses

to lending growth. This allows us to capture cost structure flexibility, or lack thereof (rigidity). Higher values indicate more flexible cost structures, while lower values indicate more rigidity. We choose the period prior to 2004, as we are interested in capturing these dynamics prior to a period characterized by very high lending growth. Once estimated, the slopes are used as one of our main variables of interest for regressions based on the period between 2005 and 2010.

(c) σ Costs-to-Loans: Our third cost structure measure relies on the standard deviations of cost-to-asset ratios for each bank. The measure allows us to capture the variation in the proportion of fixed costs relative to total assets. The higher the standard deviation, the more flexible the cost structure is. Again, we calculate this variable based on data prior to 2004.

3. Short-run Cost Changes ($\Delta Cost$):

The variable measures short-run cost efficiency, or the proportion/weight of resources allocated to screening and scoring new customers, appraising collateral, monitoring and controlling borrowers, etc. We use the following calculations to proxy for short-run cost changes:

$\Delta Cost$: calculated as the change in total non-interest expense ($XNITB$) scaled by change in net loans and leases ($LNTAL$) such that:

$$\Delta Cost_t = (XNITB_t - XNITB_{t-1}) \div (LNTAL_t - LNTAL_{t-1})$$

We believe that banks that allocate minimal effort in vetting prospective borrowers and other credit-granting and credit-management decisions are very cost-efficient in the short-run since they allocate less effort and resources in the initial stages of their relationship with borrowers. However, this short-run cost 'skimping' will come at the expense of increasing the number of NPLs in the long-run.

4. Distance:

The variable is meant to capture the relative distance of lending growth with respect to the Lending Growth Horizon. It measures how far each observation is from the final year of lending growth. The variable takes a value between 0 and 1. Each bank has a distinct lending growth horizon. First, we extract the first and last year of the lending growth horizon of each bank. Because we are interested in capturing one complete cycle of lending growth and the associated cycle of NPL growth, we restrict our sample to years before 2010. To construct the lending growth horizon, we also restrict our sample to those banks whose NPL growth had not yet peaked. We take the maximum value of lending under the restriction that it precedes the maximum value of NPL. We then take the minimum value of lending, under the restriction that it precedes the maximum value of lending. We then take into account the number of years in the lending growth horizon. Once we have the initial and final years of the lending horizon and the number of years associated with this lending horizon, for each observation within this horizon, we calculate the distance between the maximum year of the lending growth horizon and the year of each observation within the lending growth horizon. We then scale this difference by the number of years within the lending growth horizon. Scaling by the number of years allows us to normalize the distance so that banks with a large lending growth horizon are relatively aligned with the distance of banks with a small lending growth horizon. For each observation within the lending growth horizon and for each bank, we obtain a ratio between 1 and 0. At the beginning of the lending horizon, the ratio is equal to 1 and reaches 0 in the final year of lending growth. The variable allows us to capture whether the timing of lending growth influences lending quality. In an alternative analysis, we restrict the distance variable to only capture the distance for the year in which lending growth increased the most within our lending growth horizon. This measure's caveats include that we are not capturing years in which lending growth decreases within the lending growth horizon. Furthermore, because we restrict the sample to the years before 2010 and because we only have available data from the late 90s, it could be that for some banks, we are not capturing the entire growth period. In addition, the restriction that lending quality should precede the peak of NPL growth could be skipping some observations. Despite the caveats, the measure consistently points to the significance of timing.

5. The relative pace of lending growth with respect to the Lending Growth Horizon (Lending_Growth (Normalized)): The lending growth variable in the previous analysis is based on the year over year change and thus captures how much lending has increased with respect to only the prior period. We implement an alternative measure, which captures how much of the total growth within the beginning and the end of the lending growth horizon is attributed to each year. The measure allows us to capture the relative speed with respect to each other observation within the lending growth horizon. First, we calculate the total change in the level of lending between the first and last year of the lending growth horizon. Then we calculate the annual changes in the level of lending for each year of the lending growth horizon. In the final step, we scale each annual change by the total change. This normalized variable represents the percentage of lending growth attributed to each year as a proportion of the total lending growth. The sum of this variable across all years within the lending growth horizon is equal to 1.

6. Log Growth Horizon and Average Percent Growth per year within the lending growth horizon: In additional analyses we consider the log length of the lending growth horizon. A relatively long lending growth time span may indicate slower average lending growth, which in turn is expected to have a negative effect on the amount of non-performing loans as banks are better able to assess the riskiness of those loans. Average percent growth in lending over the lending growth horizon captures similar dynamics, it allows us to capture the effect of banks

which grew their loan portfolios rapidly, even within a relatively long growth horizon. We expect a positive relation as banks that experience rapid lending growth may have difficulties in granting each loan application the necessary vetting.

7. Interaction Effects: First, we interact (1) $LendingGrowth \times CostStructure$ and (2) $Short-runCostChanges \times CostSturtures$ to evaluate how the cost structure selection of a given bank influences the effects of lending growth and short-run cost efficiency on lending quality. Second, to analyze whether lending growth dynamics influence lending growth, we interact (3) $Distance \times LendingGrowth(Normalized)$.

3.3.2.3 Macroeconomic and Bank-Specific Control Variables

In addition, we control for a wide array of macroeconomic and entity-specific variables that previous studies have pointed out as potential drivers of our dependent variables. At the firm level, indicators related to the size, specialization, and solvency of each BHC, CB, or CU are included to allow for the impact of standard entity characteristics. At the macro-economic level, we consider inflation and changes in unemployment rates and the real interest rate.

Graph 3.2 provides the evolution of lending growth and non-performing loans for our data, while largely in line with Graph 3.1, on the aggregate level, our data suggests large variations in the timing of lending growth across the bank holding companies in our sample. Because of this, rather then relying on a static time period in capturing the lending growth horizon, we implement each analyses on per-bank lending growth time-frame.

Table 3.1 provides a summary of the variables used in our analysis. Table 3.2 provides descriptive statistics of the aforementioned variables for the different types of entities covered in our analyses.

3.3.2.4 Summary Statistics

Table 3.2 provides descriptive statistics for the variables used throughout our analysis. We rely on an unbalanced sample of BHCs spanning 1998 to 2010.

We observe that ΔNPL, our dependent variable, increased significantly after 2004. The observation is consistent with Figure 3.1. Prior to 2004, changes in non-performing loans were actually negative, at an average of -0.041 percent with respect to the previous year. After 2004, however, changes in non-performing loans had increased tenfold to an average of 0.314 percent. The statistics for Lending Growth, one of our main variables of interest, indicate that lending growth was higher at 0.103 prior to 2004 and lower at 0.073 after. The observation is consistent with Figure 3.1, which suggests that while average lending grew well into 2008, the sharp decline between 2008 and 2010 are reflected in our statistics for the period between 2004 and 2010.

The statistic of our second variable of interest short-run cost changes, $\Delta Cost$, indicates a large increase after 2004. Furthermore, the standard deviation of this variable is substantial and points to significant differences among banks. The variable suggests that while bank management did not rely as heavily on such tactics prior to 2004, short-run cost changes had become an important component of the operational toolkit in the years that followed. The ratio more than doubles after 2004, to 0.493 from 0.212

Next, we turn our attention to our three cost structure variables, Premises, Banker/'s Slope, and the standard deviation of the cost-to-loans ratio. Ratio premises or the proportion of fixed to total costs exhibits a tiny decline from 0.143 before 2004 to 0.139 after 2004. The ratio suggests that, on average, the proportion of fixed costs relative to total costs has declined slightly. Perhaps the observation is driven by technological advances (related to customer engagement), which have reduced the need for large branches and customer-service staff. Consolidation could be another reason. Because we estimate Banker's Slope and the standard deviation of the cost-to-loans ratio for the period before 2004, we cannot determine precise time dynamics for these variables. However, we do observe that Banker's slope exhibits significantly higher variance across banks in comparison to the Ratio Premises. While Ratio premises is our main variable of interest, the two additional metrics would be implemented for robustness purposes.

In terms of bank characteristics, we observe that bank size, as proxied by the log of total assets, is significantly larger in more recent years. This observation is consistent with the rapid growth of financial institutions via merger and acquisition activity. In terms of solvency, we observe a slight decrease in the sub-sample after 2004. The decrease in solvency likely suggests that some banks with relatively high solvency proportions ceased to be part of our (likely as a result of mergers & acquisitions), or banks with relatively lower solvency appear in our data in later years. We observed a higher ratio of loans to assets in the period spanning 2004 and 2010. This is consistent with the increase in lending growth, which characterizes this time horizon.

In terms of macroeconomic conditions, we observe greater changes in unemployment, real interest rates, and inflation after 2004. The observations are consistent with our previous comments regarding the state of the macro economy at the time. The greater changes in real interest rates and unemployment are likely reflections of the recessionary period, which began in 2007. The period before 2007 is characterized by steady growth and healthy inflation. And while inflation dropped significantly in the period of the crisis, by 2010, it had recuperated significantly. The period between 1998 and 2002 is characterized by a sharp rise and subsequent fall of inflation and so the average for this period is small.

Table 3.3 reports sample correlations of the main variables of our analysis.

3.3.3 Methodology

3.3.3.1 Do Cost Structures Influence Lending Quality?

In our first set of regressions, we examine the inter-temporal relationships among lending quality and (1) Lending Growth; (2) Short-run cost changes; and (3) how cost structures influence the results of (1) and (2) for the period 1998-2010. We rely on a dynamic panel model with bank and year dummy fixed effects and robust variance estimator standard errors. Our baseline regression can be represented as follows:

$$\begin{aligned}\Delta NPL_{it} = {} & \sum_{j=0}^{2}\beta_{1j}\Delta Loans_{it-j} + \sum_{j=1}^{2}\beta_{2j}\Delta Loans_{it-j}\times Prem_{it-j} + \sum_{j=1}^{2}\beta_{3j}\Delta Cost_{it-j}\times Prem_{it-j} \\ & + \sum_{j=1}^{2}\beta_{4}Prem_{it-j} + \beta_{5j}Cost_{it-j} + \beta_{6}Size_{it} + \beta_{7}Solv_{it} + \beta_{8}LTA_{it} \\ & + \beta_{9}Unemp_{it} + \beta_{10}Inf_{it} + \beta_{11}Int_{it} + \mu_{i} + \lambda_{t} + \varepsilon_{it}\end{aligned} \tag{3.1}$$

where, for all analysis, i=1, 2, ..., N labels panel units (banks) and t= 1, 2, ..., T labels time periods (years). Expected coefficient signs: Result (1): $\beta_{1j} > 0$; Result (2): $\beta_{2j} < 0$; Result (3): $\beta_{3j} < 0$. Table 3.4(a) provides the results for this analysis.

For robustness purposes, we implement the Arellano and Bond's Two-step "system" GMM dynamic panel data estimator for the period 1998-2010.

$$\begin{aligned}\Delta NPL_{it} = {} & \Delta NPL_{it-1} + \sum_{j=0}^{2}\beta_{1j}\Delta Loans_{it-j} + \sum_{j=1}^{2}\beta_{2j}\Delta Loans_{it-j}\times Prem_{it-j} \\ & + \sum_{j=1}^{2}\beta_{3j}\Delta Cost_{it-j}\times Prem_{it-j} + \sum_{j=1}^{2}\beta_{4}Prem_{it-j} + \beta_{5j}Cost_{it-j} + \beta_{6}Size_{it} \\ & + \beta_{7}Solv_{it} + \beta_{8}LTA_{it} + \beta_{9}Unemp_{it} + \beta_{10}Inf_{it} + \beta_{11}Int_{it} + \mu_{i} + \lambda_{t} + \varepsilon_{it}\end{aligned} \tag{3.2}$$

where, again, for all analysis, i=1, 2, ..., N labels panel units (banks) and t= 1, 2, ..., T labels time periods (years). Table 3.4(b) provides the results for this analysis.

We also implement a linear regression model for the period 2005-2010 which takes into account alternative measures of cost structure, namely Banker Slope and σ Cost-to-Loans. Because these variables provide a single observation per bank, we are unable to apply a panel framework methodology. We consider average values over the lending growth horizon for all variables considered in equation 3.1 above. Furthermore, we restrict this sample to banks for which we have full financial information for the entire period between 1998 and 2010. This avoids the inclusion of any potential effects of merger and acquisition activity.

Tables 3.7(a) and Table 3.7(b) provide the results for these alternative analyses.

3.3.3.2 Do Lending Growth Dynamics Influence Lending Quality?

We examine the relationships among lending quality and (4) Relative Distance of Lending Growth; (5) Relative Change of Lending Growth; and the interaction of (4) and (5). We rely on a methodology which considers a full cycle of lending growth and it's consecutive effects on lending quality, our data focuses on the most recent complete credit expansion cycle. The data used for this analysis focuses on lending growth prior to 2010. We Implement this analyses by incorporating our variables of interest, into equation 3.1 above. Such that:

$$\begin{aligned}\Delta NPL_{it} = &\sum_{j=0}^{2}\beta_{1j}\Delta Loans_{it-j} + \sum_{j=1}^{2}\beta_{2j}\Delta Loans_{it-j}\times Prem_{it-j} + \sum_{j=1}^{2}\beta_{3j}\Delta Cost_{it-j}\times Prem_{it-j}\\ &+\sum_{j=1}^{2}\beta_{4}Prem_{it-j} + \beta_{5j}Cost_{it-j} + \beta_{6}Size_{it} + \beta_{7}Solv_{it} + \beta_{8}LTA_{it} + \beta_{9}Unemp_{it} + \beta_{10}Inf_{it} + \beta_{11}Int_{it}\\ &+\beta_{12}Distance_{it-1} + \beta_{13}\Delta Loans\_Normalized_{it-1} + \beta_{14}Distance_{it-1}\times\Delta Loans\_Normalized_{it-1}\\ &+\mu_{i} + \lambda_{t} + \varepsilon_{it}\end{aligned} \tag{3.3}$$

where, for all analysis, i=1, 2, ..., N labels panel units (banks) and t= 1, 2, ..., T labels time periods (years). Expected coefficient signs: Result (1): $\beta_{12} < 0$; Result (2): $\beta_{13} > 0$; Result (3): $\beta_{14} < 0$. Table 3.5(a) provides the results for this analysis. In alternative analyses, we append the two-step

GMM methodology of equation 3.2 to include the lending growth dynamics. Table 3.5(b) provides the results for this analysis. For comparative purposes, we also implement a linear model with clustered fixed effects which considers a balanced version of our sample of interest. Tables 3.8(a) and Table 3.8(b) provide the results for these alternative specifications. For all analyses, i=1, 2, ..., N labels panel units (banks). Distance takes into account (1) the distance of each year in the lending growth period from the final year of lending growth scaled by the number of years from the beginning to the end of the lending growth horizon; or (2) the distance between the period of the highest lending growth.

3.3.3.3 Determinants of Efficiency

In our final set of analyses, we analyze whether standard bank characteristics determine bank operational efficiency. To do so, we estimate:

$$\begin{aligned} \Delta NPL_{it} &= \beta_1 Cost_{it} + \beta_2 Diversification_{it} + \beta_3 LTA_{it} + \beta_4 TDTL_{it} \\ &+ \beta_5 Size_{it} + \beta_6 Solv_{it} + \beta_7 LTA_{it} + \beta_8 Unemp_{it} + \beta_9 Inf_{it} + \beta_{10} Int_{it} + \mu_i + \lambda_t + \varepsilon_{it} \end{aligned} \tag{3.4}$$

For all analyses, i=1, 2, ..., N labels panel units (banks) and t= 1, 2, ..., T labels time periods (years). We use levels of NPL_{it} rather than the annual change in an alternative specification. Table 3.6 provides the results for this analysis.

3.4 Results

3.4.1 Do Cost Structures Influence Lending Quality?

Table 3.4(a) provides the results for our Fixed-Effect Panel Data Model (equation 3.1). While table 3.4(b) is a Two-step GMM Specification (equation 3.2). Table 3.7 provides a linear regression model specification with clustered fixed effects over a defined time horizon that captures one full cycle of lending growth and consecutive changes in lending quality.

When analyzing the relation between lending growth and the proportion of NPLs in banks' lending portfolios, we observe a statistically strong negative relation between current period lending growth and changes in the proportion of non-performing loans. This could be a sign of managerial decisions to restrict lending growth in periods of high non-performing loans. However, when we consider lagged values of lending growth, the relation becomes statistically strong and positive. In other words, ex-ante high lending growth results in high proportions of non-performing loans in the long run. This finding is consistent with the previous literature, which documents that decreased lending quality is generally preceded by a period of increased lending (Clair, 1992; Keeton, 1999; Ghosh, 2015).

Next, and while most existing literature finds no support for Berger and DeYoung (1997)'s skimping hypothesis, we revisit the idea that deliberate managerial decisions to reduce the costs of credit-granting will generally result in significant worsening in credit appraisal processes, and as a result, lead to poor lending quality in the future. Contrary to prior literature, we find that short-run cost changes are, in fact, a significant determinant of lending quality.

In virtually all specifications, our results suggest a positive relation between lagged short-run cost changes and changes in non-performing loans and leases. The result indicates that an increase in short-run costs will lead to increases in non-performing loans, and by proxy, a decrease in lending quality. Conversely, a decrease in short-run costs will be followed by a decrease in non-performing, and thus an increase in lending quality. This is consistent with the 'bad management' hypothesis, which has been extensively documented in prior studies. "*Under the 'bad management' hypothesis, low measured cost efficiency is a signal of poor senior management practices, which apply to both day-to-day operations and to manage the loan portfolio. Sub-par managers do not sufficiently monitor and control their operating expenses, reflected in low measured cost efficiency almost immediately. Managers in these banks also do not practice adequate loan underwriting, monitoring, and control.*

As 'bad' managers, they may a) have poor skills in credit scoring and therefore choose a relatively high proportion of loans with low or negative net present values, b) be less than fully competent in appraising the value of collateral pledged against the loans, and c) have difficulty monitoring and controlling the borrowers after loans are issued to assure that covenants are obeyed. In contrast to the almost immediate reduction in measured cost efficiency, poor underwriting and monitoring practices lead to high numbers of non-performing loans only after some time passes. The loan portfolio becomes seasoned, and delinquencies begin to mount. Thus, under the bad management hypothesis, low-cost efficiency is expected to occur before or Granger-cause higher non-performing loans. Note that this hypothesis has the opposite temporal ordering from that predicted by the bad luck hypothesis, but both hypotheses predict that non-performing loans will be negatively associated with cost efficiency."–Berger and DeYoung (1997)

Tables 3.4(a), and 3.4(b), supports this positive relation between short-run cost changes and non-performing loans.

While these results have been explored in past studies, the literature does not consider their effects under alternative cost structures. We introduce cost rigidity, which, in this first specification, is measured as the proportion of fixed costs to total costs and suggests that the number of fixed resources will influence both lending growth and short-run cost changes. In alternative analyses discussed below, we introduce two alternative cost structure measures within a more confined set of analyses designed to capture one full lending growth cycle.

We begin by first analyzing the interaction between lending growth and cost rigidity. And while we previously observed an overall positive relation between lending growth and non-performing loans, the introduction of the interaction term suggests that cost structures matter. We observe e negative relation for the interaction between lending growth and cost rigidity with future NPLs. The interaction suggests that following a period of lending growth, NPLs increase by more among banks with lower cost-rigidity (i.e., firms where fixed costs comprise a small proportion in terms of total costs). Conversely, following periods of credit expansion, banks with more rigid cost structures (e.g., with more fixed resources) exhibit smaller increases in NPLs. This result is in line with our hypothesis that banks with substantial premises and employee bases are better equipped to cope with increased lending demand. On one side, we argue that such banks are better at retaining and taking advantage of 'soft' information. This provides them with an informational advantage over banks with lower fixed-to-total cost ratios. The second reason we observe this relation arises from banks whose more rigid cost structures allows higher capabilities in dealing with congestion costs (Banker et al., 2014).

We also consider how cost structure rigidity affects short-run cost changes, and we find that cost rigidity influences the short-run cost changes - lending quality relationship. First, we find that banks with more fixed cost structures are able to achieve higher short-term cost efficiency while maintaining changes in future NPLs to relatively low proportions.

Table 3.7 takes into account two alternative cost structure definitions; the slope between lending growth and fixed costs and the standard deviation of the cost to loans ratio, respectively. Given that each of these alternative cost specifications restricts our sample to only one observation per bank, we rely on a linear model to implement this analysis. We transform our baseline variables to represent one observation for each bank by either (1) taking the average value over the lending growth horizon of each variable from equation 3.1; or (2) taking into account total growth rates over the lending growth horizon. The baseline results, discussed thus far, are confirmed under these alternative model specifications and cost structure measures in Table 3.7(a) and, partially, in Table 3.7(b).

3.4.2 Do Lending Growth Dynamics Influence Lending Quality?

Next, we consider an alternative determinant of non-performing loans. Under this specification, we consider when and how lending grows and whether these dynamics influence lending quality. To test the former, we construct a variable "Distance", which measures how far the observed change in lending growth is with respect to the lending growth horizon in terms of time. The variable takes a numeric value between 0 and 1, with 0 being the final year of the lending growth horizon and 1 being the first year of the lending horizon. We define the lending horizon as those years that fall between the minimum and maximum lending values after 2000 and prior to 2010. We then subtract the current year from the maximum year of the lending horizon, and that gives us the distance in years between the lending growth observation in question and the final year of lending growth horizon. However, because the lending horizon is different for each institution, we normalize this distance in years by dividing the value by the total number of years within each lending horizon and hence get a proportion in terms of total lending growth years. A value close to zero indicates the observation is near the very end of the lending growth horizon. In contrast, a value close to 1 indicates that the observation in question refers to the very beginning of our pre-defined horizon. Table 3.5 shows that the timing of lending growth is a significant determinant of lending quality. We observe a strong negative relation between Distance in t-1 and Changes in Non-Performing Loans and Leases in t. The result strongly indicates that observations closer to the lending growth horizon's end lead to decreases in Lending Quality. The result is not surprising as loans made further down the line have already likely exhibited influence in non-performing loans in periods prior. It could also suggest that non-performing loans generally peak only a short period after lending growth and do not take a long time to materialize.

We then normalize lending growth to be reflect as a proportion of the growth accumulated over the lending horizon. This measures how fast lending has grown in a given year, in relative terms to the rest of the observations in the lending growth horizon. A large value (close to 1) indicates a year of relatively high lending volume, while a small value (close to 0) indicates a year of slow growth. We find a positive relation between the pace of lending growth and changes in non-performing loans and leases. The results suggest that more rapid growth is associated with increases in non-performing loans. The finding is consistent with our hypothesis that rapid lending increases significantly strain credit-granting institutions' ability to process credit-granting properly (i.e., congestion costs). We hypothesize that this inability to cope with the increase is reflected in increases in Non-performing Loans down the line. Alternatively, rapid lending growth could be a deliberate decision by bank managers to boost their lending portfolio. Our results suggest that the increase in lending supply might have been accompanied by relaxed lending standards to creditors with relatively high-risk scores. Given that we consider the period prior to 2010, both are likely to have driven the positive relation between lending growth and non-performing loans. Finally, we create an interaction that captures when and by how much lending grows. We expect that while rapid growth would positively influence non-performing loans, rapid growth in years further in the past would have a smaller impact on this relation. In other words, rapid lending growth very close to the end of the lending horizon has the largest impact on non-performing loans. Table 3.5 provides support for the hypotheses above.

For robustness purposes, in Table 3.8 we consider alternative growth dynamics specifications. First, we take the log of the number of years in the lending growth horizon, this gives us an alternative measure of how fast lending has reached its' maximum value for each bank. We then take total lending growth over the lending growth horizon and scale it by the number of years from trough to peak in lending. The measures gives us an indicator of how fast lending has grown in relative terms. Again, the construction of these terms provides us with one observation per bank, and thus, we implement a linear regression model for the execution of this analysis. The results in table 3.8(a) suggest that banks with higher levels of normalized annual lending growth have higher levels of non-performing loans in the future. But the association is lower for banks that grew more slowly (i.e., banks with longer growth horizons). The results supports our previous finding and congestion costs hypothesis. For comparative purposes, we consider average distance and average normalized lending growth. Panel (b) of table 3.8, provides the results for these analyses.

3.4.3 Determinants of Efficiency

Finally, and because we have used short-run cost changes and cost efficiency interchangeably, we provide evidence that short-run cost changes are a significant determinant of cost-efficiency. In table 3.6, we analyze potential drivers of cost efficiency and changes in cost efficiency. As previously discussed, we find that Short-run cost changes are significantly and negatively associated with both efficiency and its annual changes. We also find inflation, size, and loan portfolio size are positively associated with both the level and changes in efficiency. We find that Diversification, Deposits to Liabilities, and Solvency affect the level of efficiency differently from efficiency changes.

3.5 Conclusions

Motivated by lending quality's importance for financial stability, the extensive media coverage around banks' need to reduce costs as a necessary ailment for poor profitability as a consequence of globally prevalent low-interest rate monetary policy stances, and the steady growth of online banking, this paper analyzes the underlying reasons for the relationship between bank cost structures (cost rigidity) and bank lending quality. While previous studies have extensively analyzed the determinants of lending quality and, more precisely, the relation between lending quality and efficiency, whether and how bank cost structures or cost rigidity ties into this relation has not been previously considered. And thus, using US data spanning 1994 to 2017, we reexamine the relation between lending growth and efficiency with lending quality in the context of bank cost rigidity. Given the vast operational differences in US financial organizations, we extend this study to include Bank Holding Companies, Commercial Banks, and Credit Unions. Our results confirm the findings of previous studies that (i) there is a significant and positive inter-temporal association between lending growth and NPL (credit expansions lead to lower lending quality). However, bank cost rigidity plays an important role in this relation. Our results suggest that (ii) the association is lower, the more fixed the bank's cost structure is. In addition, we find that, compared to banks with lightweight cost structures, banks with more fixed cost structures have smaller short-run increases in costs in response to the same lending growth level (Banker et al., 2014) and yet our results show that (iii) these short-run cost increases reduce future NPL to a greater extent the more fixed the bank's cost structure was at the moment of increasing the volume of loans.

Our results are consistent with the arguments of both the 'Skimping' and the 'Bad Management' hypotheses. First, we study the effect of short-term cost decisions and, consistent with the 'bad Management' hypothesis, we find that banks having higher short-term costs increases (per dollar increased in lending), and consequently larger efficiency reductions, are also the ones suffering higher increases in future NPL. We contribute by showing that this phenomenon is contingent on the banks' cost structure. Put it differently, the amount of resources (per dollar lent) that each bank needs to add not to hurt its lending quality when growing is different for each bank and contingent on its own cost structure. Hence, the 'Bad Management' phenomenon that happens in the short-run seems to be the result of 'Skimping' in the long-run cost structure decisions. Avoiding long-term 'Skimping' by adopting a more fixed cost structure allows banks to achieve both higher short-term increases in cost efficiency and lower future NPL.

In addition, from a cost behavior literature perspective, while the existence of congestion costs (as well as its increase with more flexible cost structures) has been analytically proven (Banker et al., 2014), few empirical studies have been conducted to test this phenomenon empirically (Banker et al., 1988). Using NPL as a proxy for the productivity (effectiveness) of costs in generating useful information to screen borrowers, this paper contributes by showing that a short-term increase in costs improves screening and lending quality to a greater extent the more fixed the cost structure is.

We also examine whether when and how lending grows influences lending quality. We find that more recent lending growth has a higher impact on lending quality, particularly in periods of higher lending growth. To the best of our knowledge, we are the first to include lending growth dynamics into the relationship between lending and non-performing loans.

Our paper provides an important dimension of the determinants of lending quality. The results are especially important in today's context of yet another credit expansion. Furthermore, the online banking market, which relies on a much lower proportion of fixed cost than their traditional counterparts, has been steadily gaining traction in the last several years. While analyzing lending quality implications of traditional versus online banks would be ideal, the lack of sufficient data would put the reliability of these results under question. However, a better understanding of the role of banks' cost structure in periods of credit expansion might help shed light on lending quality in the context of new business models in times of credit expansions.

Our findings, along with the rise in online banking and, the simultaneous steady decline[13] in the number of banks, paints a dire picture for financial stability. As the proportion of online banks in the financial system catches up to or surpasses the proportion of traditional banks, their effect on the financial system would naturally have a tremendous impact on the financial system. Sub-par lending practices in such institutions will have tremendous effects on financial stability and could likely lead to a larger and more frequent banking crisis.

[13] The last decade has been characterized by an unprecedented amount of mergers

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Figure 3.1: Motivational Graph – The Evolution of Lending and Non-Performing Loans

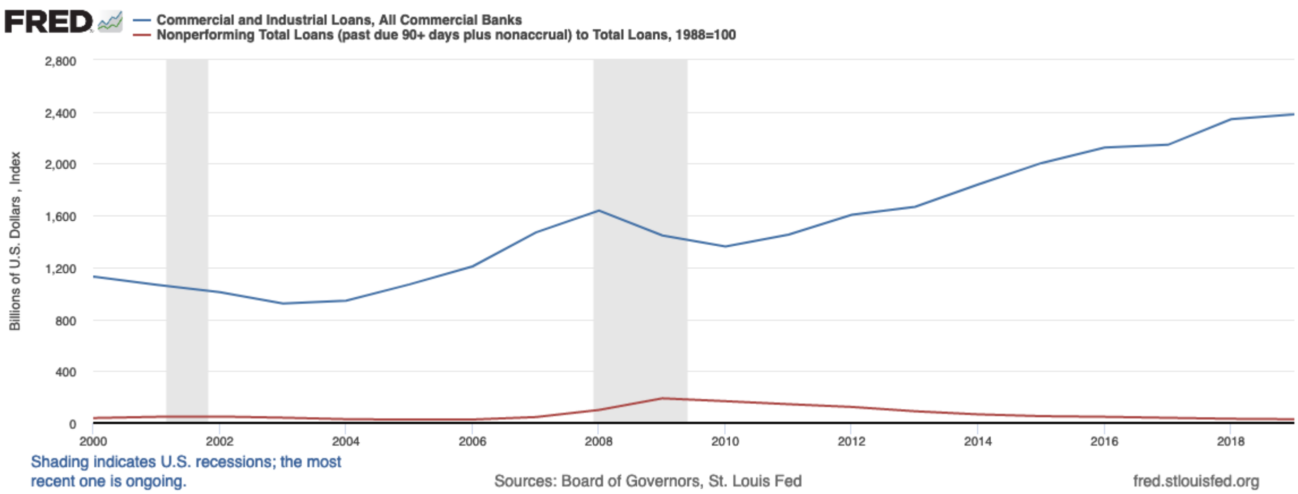


Figure 3.2: In Our Data – The Evolution of Lending and Non-Performing Loans

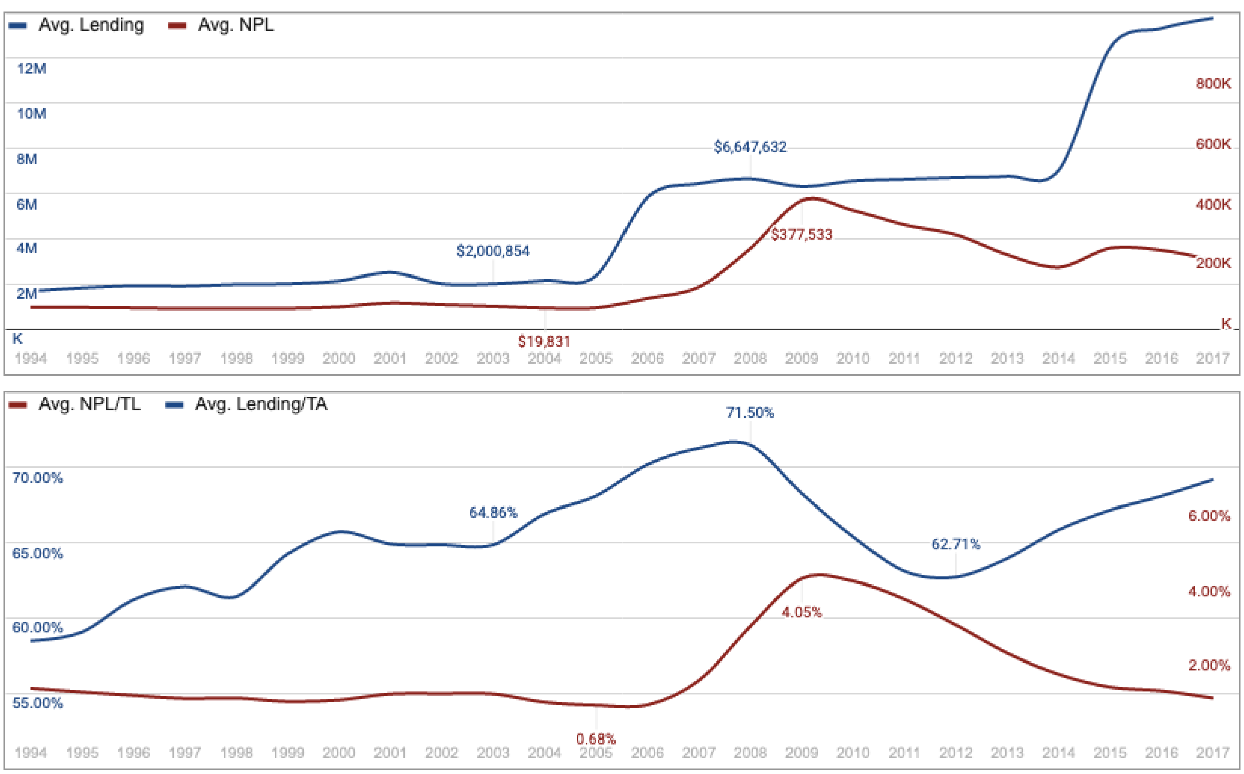


Table 3.1: Variable Definitions

Dependent Variables			
Change in NPL	Change in Lending Quality Proxy	ΔNPL_t	$= log(\frac{NPLL_t}{TL_t}) - log(\frac{NPLL_{it-1}}{TL_{it-1}})$
Explanatory Variables:	Cost Structure Analysis		
Lending Growth	Annual log change in Total Loans	$\Delta Loans_t$	$= log(TL_t) - log(TL_{it-1})$
Ratio Premises	Cost Structures Proxy	$Prem_t$	$= \frac{XLR_t}{XNITB_t}$
Banker Slope	Cost Structures Proxy 2: β from Lending Growth = $\alpha + \beta\ \Delta$ Total Costs	$BankerSlope$	$= \frac{n(\sum XY)-(\sum X)-(\sum Y)}{n(\sum X^2)-(\sum X)2}$
Cost-to-Loans Variance	Cost Structures Proxy 3	$\sigma Cost - to - Loans$	$= \sigma(\frac{XNITB_t}{LNTAL_t})$
Short-run Cost Changes	Skimping Hypothesis Proxy	$\Delta Cost_t$	$= \frac{(XNITB_t - XNITB_{it-1})}{(LNTAL_t - LNTAL_{it-1})}$
Explanatory Variables:	Lending Growth Dynamics Analysis		
Distance	Haw far the observation is from the end of the lending growth horizon	$Distance$	Max Year of Lending Growth Horizon - Current Year scaled by Number of Years in Lending Growth Horizon
Max Distance	How far the highest lending growth is from the end of the lending growth horizon	$MaxDistance$	Max Year of Lending Growth Horizon - Year of Highest Growth scaled by Number of Years in Lending Growth Horizon
Lending Growth (Normalized)	Proportion of Annual Lending Growth in terms of Total Growth	$LendingGrowth$ $(Normalized)$	Change in Lending from t to t-1 scaled by change in growth from t to t-x
Length of Lending Growth	Log length of Lending Growth	$LogGrowthHorizon$	= Log (Max Year - Min Year of Lending Horizon)
Average Annual % Growth	Captures relative speed of growth	$AveragePercentGrowth$	Percentage Change in Lending from first to last year in growth horizon scaled by number of years in growth horizon
Bank-Specific Controls			
Specialization	Loans-to-Assets Ratio	LTA_t	$= \frac{TL_t}{TA_t}$
Solvency	Common Equity-to-Assets Ratio	$Solv_t$	$= \frac{Equity_t}{TA_t}$
Size	Natural Logarithm of Total Assets	$Size_t$	$= ln(TA_t)$
Macroeconomic Controls			
Inflation	Percentage Change in Consumer Price Index	Inf_t	From Source
Change in Unemployment	Log Change in Unemployment Rate	$\Delta Unemp_t$	$= log(Unemp_t) - log(Unemp_{it-1})$
Change in Real Interest Rates	Log Change in Real Interest Rates	ΔInt_t	$= log(Int_t) - log(Int_{it-1})$

Table 3.2: Descriptive Statistics

	1998-2010			1998-2004			2005-2010		
VARIABLES	N	mean	sd	N	mean	sd	N	mean	sd
Δ NPL	14,751	0.099	0.957	8,938	-0.041	0.893	5,813	0.314	1.010
Lending Growth	14,751	0.092	0.140	8,938	0.103	0.135	5,813	0.073	0.147
Δ Cost	14,751	0.212	15.708	8,938	0.029	4.374	5,813	0.493	24.426
Prem	14,751	0.143	0.034	8,938	0.146	0.034	5,813	0.139	0.033
σCost-to-Loans	4,802	0.006	0.004	2,744	0.006	0.004	2,058	0.006	0.004
Banker Slope	4,858	0.361	0.615	2,776	0.361	0.616	2,082	0.361	0.616
Size	14,751	13.547	1.299	8,938	13.334	1.277	5,813	13.875	1.265
Solv	14,751	0.091	0.034	8,938	0.092	0.031	5,813	0.089	0.037
LTA	14,751	0.659	0.125	8,938	0.639	0.123	5,813	0.688	0.122
Δ Unemp	14,751	0.035	0.161	8,938	0.011	0.121	5,813	0.073	0.203
Δ Int	14,751	-0.009	0.393	8,938	-0.167	0.175	5,813	0.234	0.496
Inf	14,751	2.439	0.966	8,938	2.360	0.566	5,813	2.562	1.361

Notes: Table 3.1 reports detailed descriptions of the variables employed.

Table 3.3: Correlations (1998 - 2010)

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1)	Δ NPL		-0.07	-0.01	-0.01	0.02	-0.01	0.11	-0.04	0.10	0.04	-0.06	0.21
(2)	Lending Growth	-0.01		0.13	0.05	0.06	0.03	0.06	-0.14	0.17	0.15	0.11	-0.23
(3)	Δ Cost	-0.00	-0.01		-0.02	-0.01	-0.04	-0.00	-0.01	-0.04	-0.01	0.03	-0.07
(4)	Prem	-0.01	0.03	-0.02		0.03	0.00	-0.03	-0.05	-0.06	0.03	-0.00	-0.05
(5)	Banker Slope	0.01	0.07	0.03	0.10		-0.20	0.25	-0.10	0.08	0.00	0.00	0.00
(6)	σCost-to-Loans	-0.01	0.01	-0.01	-0.02	-0.12		0.09	-0.07	-0.06	0.00	0.00	-0.00
(7)	Size	0.07	0.06	0.03	-0.03	0.29	0.09		-0.14	0.12	0.02	0.02	0.12
(8)	Solv	-0.03	-0.09	0.15	-0.11	-0.12	0.00	-0.06		-0.21	-0.02	-0.00	-0.04
(9)	LTA	0.09	0.15	-0.04	-0.05	0.03	-0.06	-0.00	-0.22		0.15	0.04	0.06
(10)	Inf	-0.02	0.16	-0.03	0.06	0.00	-0.00	-0.04	0.01	0.08		0.29	-0.22
(11)	Δ Int	-0.06	0.10	-0.00	-0.01	0.00	0.00	-0.01	0.00	0.06	0.38		-0.72
(12)	Δ Unemp	0.21	-0.16	0.02	-0.06	0.00	-0.00	0.10	-0.04	0.05	-0.55	-0.52	

Table 3.4: Lending Quality & Cost Rigidity

(a) Fixed Effects Panel Model

VARIABLES	(1) Δ NPL$_t$	(2) Δ NPL$_t$	(3) Δ NPL$_t$	(4) Δ NPL$_t$	(5) Δ NPL$_t$
Lending Growth$_t$	-0.057	-0.057	-0.057	-0.058	-0.058
	(-0.800)	(-0.800)	(-0.797)	(-0.808)	(-0.810)
Lending Growth$_{t-1}$	0.332***	0.332***	0.318	0.329***	0.258
	(5.162)	(5.162)	(1.212)	(5.103)	(0.974)
Lending Growth$_{t-2}$	0.360***	0.360***	0.863***	0.357***	0.910***
	(5.473)	(5.473)	(2.860)	(5.403)	(3.098)
Prem$_{t-1}$			0.801	0.821	0.755
			(1.369)	(1.489)	(1.289)
Prem$_{t-2}$			-0.804	-1.295**	-0.753
			(-1.289)	(-2.322)	(-1.212)
Lending Growth$_{t-1}$ $\times$ Prem$_{t-1}$			0.121		0.516
			(0.065)		(0.275)
Lending Growth$_{t-2}$ $\times$ Prem$_{t-2}$			-3.690*		-4.003*
			(-1.676)		(-1.855)
Δ Cost$_{t-1}$				0.002**	0.002**
				(2.336)	(2.547)
Δ Cost$_{t-2}$				0.020***	0.019***
				(3.250)	(3.075)
Δ Cost$_{t-1}$ $\times$ Prem$_{t-1}$				-0.015	-0.016
				(-0.989)	(-1.086)
Δ Cost$_{t-2}$ $\times$ Prem$_{t-2}$				-0.130**	-0.127**
				(-2.386)	(-2.285)
Size	0.270***	0.270***	0.271***	0.270***	0.269***
	(11.971)	(11.971)	(12.052)	(12.011)	(11.973)
Solv	0.142	0.142	0.198	0.177	0.225
	(0.286)	(0.286)	(0.393)	(0.356)	(0.450)
LTA	0.627***	0.627***	0.626***	0.630***	0.631***
	(4.178)	(4.178)	(4.180)	(4.203)	(4.216)
Inf	0.103***	0.103***	0.102***	0.102***	0.103***
	(10.302)	(10.302)	(10.192)	(10.175)	(10.225)
Δ Int	0.031	0.031	0.028	0.028	0.029
	(1.092)	(1.092)	(0.979)	(0.975)	(1.012)
Δ Unemp	1.389***	1.389***	1.382***	1.381***	1.386***
	(18.758)	(18.758)	(18.518)	(18.517)	(18.571)
Constant	-4.362***	-4.362***	-4.367***	-4.296***	-4.351***
	(-14.311)	(-14.311)	(-14.099)	(-13.904)	(-14.022)
R^2	0.0665	0.0665	0.0672	0.0678	0.0681
Observations	14,751	14,751	14,751	14,751	14,751
Number of gvkey	2,253	2,253	2,253	2,253	2,253

(b) Two-Step GMM Model

VARIABLES	(1) Δ NPL$_t$	(2) Δ NPL$_t$	(3) Δ NPL$_t$
Δ NPL$_{t-1}$	-0.229***	-0.242***	-0.243***
	(-16.180)	(-17.013)	(-17.469)
Lending Growth$_{t-1}$	-0.235	0.157	-0.903
	(-0.316)	(1.313)	(-1.166)
Lending Growth$_{t-2}$	1.016**	0.150*	1.204***
	(2.486)	(1.703)	(3.142)
Prem$_{t-1}$	-2.141	-2.053	-3.384
	(-0.828)	(-0.959)	(-1.402)
Prem$_{t-2}$	-0.648	-1.202	0.021
	(-0.343)	(-0.697)	(0.011)
Lending Growth$_{t-1}$ $\times$ Prem$_{t-1}$	2.602		6.997
	(0.478)		(1.253)
Lending Growth$_{t-2}$ $\times$ Prem$_{t-2}$	-6.281**		-7.698***
	(-2.094)		(-2.701)
Δ Cost$_{t-1}$		0.010	0.012
		(1.054)	(1.439)
Δ Cost$_{t-2}$		0.027***	0.027***
		(3.250)	(3.656)
Δ Cost$_{t-1}$ $\times$ Prem$_{t-1}$		-0.139	-0.161
		(-0.892)	(-1.214)
Δ Cost$_{t-2}$ $\times$ Prem$_{t-2}$		-0.192***	-0.191***
		(-2.600)	(-2.732)
Size	-0.077	-0.022	-0.051
	(-1.158)	(-0.339)	(-0.791)
Solv	3.771	4.265**	3.301*
	(1.611)	(2.207)	(1.754)
LTA	2.418***	2.326***	2.131***
	(3.859)	(3.853)	(3.433)
Inf	0.068***	0.071***	0.077***
	(5.046)	(5.193)	(5.711)
Δ Int	-0.089***	-0.081***	-0.078**
	(-2.860)	(-2.630)	(-2.400)
Δ Unemp	1.373***	1.384***	1.428***
	(13.737)	(13.554)	(14.052)
Observations	12,234	12,234	12,234
Number of gvkey	1,894	1,894	1,894

Notes: Table 3.1 reports detailed descriptions of the variables employed and Table 3.2 reports descriptive information on each variable. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. Standard errors are reported in parentheses.

Table 3.5: Lending Quality, Lending Growth Dynamics & Cost Rigidity

(a) Fixed Effects Panel Model

VARIABLES	(1) Δ NPL$_t$	(2) Δ NPL$_t$	(3) Δ NPL$_t$	(4) Δ NPL$_t$
Lending Growth$_t$	-0.058	-0.408***	-0.372**	-0.506***
	(-0.810)	(-2.730)	(-2.526)	(-3.104)
Lending Growth$_{t-1}$	0.258	-0.273	-0.095	-0.537
	(0.974)	(-0.527)	(-0.171)	(-0.810)
Lending Growth$_{t-2}$	0.910***	1.058**	1.057**	1.103**
	(3.098)	(2.154)	(2.150)	(2.056)
Prem$_{t-1}$	0.755	-0.014	-0.052	0.061
	(1.289)	(-0.013)	(-0.049)	(0.051)
Prem$_{t-2}$	-0.753	0.777	0.780	1.421
	(-1.212)	(0.753)	(0.757)	(1.269)
Lending Growth$_{t-1}$ $\times$ Prem$_{t-1}$	0.516	2.175	2.294	1.726
	(0.275)	(0.610)	(0.644)	(0.407)
Lending Growth$_{t-2}$ $\times$ Prem$_{t-2}$	-4.003*	-6.123*	-6.079*	-6.554
	(-1.855)	(-1.667)	(-1.653)	(-1.622)
Δ Cost$_{t-1}$	0.002**	0.010***	0.010***	-0.000
	(2.547)	(3.219)	(3.167)	(-0.008)
Δ Cost$_{t-2}$	0.019***	0.034***	0.034***	0.034***
	(3.075)	(7.124)	(6.973)	(6.383)
Δ Cost$_{t-1}$ $\times$ Prem$_{t-1}$	-0.016	-0.077**	-0.075**	0.066
	(-1.086)	(-2.252)	(-2.182)	(0.471)
Δ Cost$_{t-2}$ $\times$ Prem$_{t-2}$	-0.127**	-0.274***	-0.270***	-0.255***
	(-2.285)	(-4.650)	(-4.542)	(-4.009)
Distance$_{t-1}$		-0.140*	-0.132*	-0.029
		(-1.956)	(-1.831)	(-0.320)
Lending Growth$_{t-1}$ (Normalized)				0.704***
				(2.896)
Lending Growth$_{t-1}$ (Normalized) $\times$ Distance$_{t-1}$				-0.806***
				(-3.218)
Size	0.269***	0.621***	0.580***	0.676***
	(11.973)	(6.312)	(5.683)	(6.415)
Solv	0.225	0.687	0.678	1.246
	(0.450)	(0.674)	(0.662)	(1.059)
LTA	0.631***	1.564***	1.521***	1.697***
	(4.216)	(5.376)	(5.180)	(4.810)
Inf	0.103***	0.141***	0.141***	0.102***
	(10.225)	(9.340)	(9.330)	(5.668)
Δ Int	0.029	-0.057*	-0.057*	-0.064*
	(1.012)	(-1.830)	(-1.827)	(-1.889)
Δ Unemp	1.386***	1.426***	1.429***	1.252***
	(18.571)	(12.601)	(12.644)	(9.906)
Lending Growth$_{t-1}$ $\times$ Distance$_{t-1}$			-0.333	
			(-1.089)	
Constant	-4.351***	-9.869***	-9.285***	-10.807***
	(-14.022)	(-6.704)	(-6.111)	(-6.918)
R^2	0.068	0.102	0.102	0.097
Observations	14,751	7,950	7,950	6,969
Number of gvkey	2,253	1,747	1,747	1,677

(b) Two-Step GMM Model

VARIABLES	(1) Δ NPL$_t$	(2) Δ NPL$_t$	(3) Δ NPL$_t$
Δ NPL$_{t-1}$	-0.243***	-0.261***	-0.282***
	(-17.469)	(-13.928)	(-12.843)
Lending Growth$_{t-1}$	-0.903	0.173	-1.779
	(-1.166)	(0.124)	(-1.069)
Lending Growth$_{t-2}$	1.204***	1.379***	1.339***
	(3.142)	(3.759)	(3.004)
Prem$_{t-1}$	-3.384	-1.058	1.737
	(-1.402)	(-0.365)	(0.645)
Prem$_{t-2}$	0.021	0.576	-1.368
	(0.011)	(0.294)	(-0.576)
Lending Growth$_{t-1}$ x Prem$_{t-1}$	6.997	3.784	9.099
	(1.253)	(0.411)	(0.830)
Lending Growth$_{t-2}$ x Prem$_{t-2}$	-7.698***	-7.920***	-7.815**
	(-2.701)	(-2.715)	(-2.146)
Δ Cost$_{t-1}$	0.012	0.089	-0.043
	(1.439)	(1.008)	(-0.453)
Δ Cost$_{t-2}$	0.027***	0.039***	0.047***
	(3.656)	(5.085)	(6.417)
Δ Cost$_{t-1}$ x Prem$_{t-1}$	-0.161	-0.818	0.609
	(-1.214)	(-1.055)	(0.646)
Δ Cost$_{t-2}$ x Prem$_{t-2}$	-0.191***	-0.307***	-0.406***
	(-2.732)	(-3.064)	(-4.289)
Distance$_{t-1}$		-0.088	-0.091
		(-0.591)	(-0.533)
Lending Growth$_{t-1}$ (Normalized)			1.290**
			(2.494)
Lending Growth$_{t-1}$ (Normalized) $\times$ Distance$_{t-1}$			-1.420***
			(-2.715)
Size	-0.051	0.734**	0.508**
	(-0.791)	(2.535)	(2.094)
Solv	3.301*	7.848**	11.593***
	(1.754)	(2.576)	(3.487)
LTA	2.131***	1.714**	2.012**
	(3.433)	(2.392)	(2.030)
Inf	0.077***	0.104***	0.082***
	(5.711)	(6.406)	(4.077)
Δ Int	-0.078**	-0.165***	-0.175***
	(-2.400)	(-4.880)	(-4.876)
Δ Unemp	1.428***	1.548***	1.439***
	(14.052)	(11.255)	(9.994)
Lending Growth$_{t-1}$ $\times$ Distance$_{t-1}$		-0.960	
		(-1.545)	
Observations	12,234	6,115	5,263
Number of gvkey	1,894	1,494	1,406

Notes: Table 3.1 reports detailed descriptions of the variables employed and Table 3.2 reports descriptive information on each variable. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. Standard errors are reported in parentheses.

Table 3.6: Determinants of Efficiency

VARIABLES	(1) Efficiency	(2) Δ Efficiency	(3) Efficiency	(4) Δ Efficiency
Δ $Cost_t$	-0.145***	-0.183***	-0.099***	-0.181***
	(-8.507)	(-13.109)	(-5.485)	(-12.772)
Diversif	-0.161**	0.273***	-0.312***	0.219***
	(-2.326)	(8.444)	(-5.847)	(8.721)
LTA	0.229***	0.126***	0.126***	0.083***
	(6.261)	(7.737)	(3.392)	(5.225)
DTL	-0.053	-0.046*	-0.116**	-0.000
	(-1.211)	(-1.709)	(-2.557)	(-0.005)
Size	0.119***	-0.016***	-0.017***	-0.042***
	(10.446)	(-3.600)	(-2.691)	(-13.995)
Solv	2.128***	-0.120	1.891***	-0.171
	(12.058)	(-0.985)	(10.006)	(-1.391)
Δ Int	0.015	-0.019	-0.007**	0.016***
	(0.636)	(-0.830)	(-1.991)	(6.439)
Inf	0.090***	0.014**	-0.000	0.004***
	(10.316)	(2.268)	(-0.245)	(3.617)
Δ Unemp	0.025	-0.069*	-0.092***	0.035***
	(0.693)	(-1.854)	(-8.657)	(4.296)
Constant	-0.429**	0.141**	1.711***	0.481***
	(-2.429)	(2.057)	(16.825)	(9.914)
R^2	0.144	0.0790	0.0555	0.0487
Observations	17,881	17,881	17,881	17,881
Number of gvkey	2,802	2,802	2,802	2,802
Time FE	Yes	Yes	-	-

Notes: Table 3.1 reports detailed descriptions of the variables employed and Table 3.2 reports descriptive information on each variable. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. Standard errors are reported in parentheses.

Table 3.7: Robustness: Lending Quality & Cost Rigidity

(a) Banker Slope

VARIABLES	(1) Avg. Δ NPL	(2) Avg. Δ NPL	(3) Avg. Δ NPL
Avg. Lending Growth	1.013**	0.608*	0.970**
	(2.464)	(1.708)	(2.354)
Avg. Size	0.026**	0.023**	0.024**
	(2.432)	(2.244)	(2.281)
Avg. Solvency	-0.035	0.002	-0.088
	(-0.050)	(0.003)	(-0.124)
Avg. Loan-to-Assets	0.110	0.055	0.083
	(0.862)	(0.438)	(0.652)
Avg. Δ Int	0.312*	0.259	0.270
	(1.739)	(1.415)	(1.496)
Avg. Δ Unemp	1.279**	1.295**	1.297**
	(2.406)	(2.413)	(2.441)
Avg. Inflation	0.113*	0.117**	0.124**
	(1.948)	(1.983)	(2.126)
Banker Slope	0.034	-0.054***	0.040
	(0.750)	(-2.883)	(0.845)
Avg. Δ Cost		0.007***	0.008***
		(4.060)	(4.299)
Avg. Δ Cost × Banker Slope		-0.073	-0.090*
		(-1.459)	(-1.862)
Avg. Δ Lending × Banker Slope	-1.131**		-1.153**
	(-1.980)		(-1.992)
Constant	-0.574**	-0.488**	-0.551**
	(-2.278)	(-1.985)	(-2.209)
R^2	0.103	0.099	0.114
Observations	789	789	789

(b) σCost-to-Loans

VARIABLES	(1) Avg. Δ NPL	(2) Avg. Δ NPL	(3) Avg. Δ NPL
Avg. Lending Growth	-0.248	0.373	-0.210
	(-0.293)	(0.963)	(-0.252)
Avg. Size	0.018*	0.018*	0.017*
	(1.806)	(1.688)	(1.697)
Avg. Solvency	-0.172	-0.122	-0.122
	(-0.228)	(-0.162)	(-0.161)
Avg. Loan-to-Assets	0.090	0.053	0.060
	(0.649)	(0.379)	(0.429)
Avg. Δ Int	0.260	0.272	0.265
	(1.363)	(1.442)	(1.391)
Avg. Δ Unemp	1.492***	1.469***	1.480***
	(2.667)	(2.632)	(2.659)
Avg. Inflation	0.154*	0.147*	0.147*
	(1.918)	(1.828)	(1.833)
σ Cost-to-Loans	-10.232	-1.334	-9.562
	(-0.817)	(-0.369)	(-0.793)
Avg. Δ Cost		-0.097**	-0.096**
		(-2.094)	(-2.061)
Avg. Δ Cost × σ Cost-to-Loans		13.245***	12.948***
		(2.744)	(2.782)
Avg. Δ Lending × σ Cost-to-Loans	99.428		91.371
	(0.794)		(0.745)
Constant	-0.470*	-0.472	-0.425
	(-1.673)	(-1.642)	(-1.492)
R^2	0.067	0.072	0.075
Observations	790	790	790

Notes: Table 3.1 reports detailed descriptions of the variables employed and Table 3.2 reports descriptive information on each variable. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. Standard errors are reported in parentheses.

Table 3.8: Robustness: Lending Quality, Lending Growth Dynamics & Cost Rigidity

(a)

VARIABLES	(1) Avg. Δ NPL	(2) Avg. Δ NPL	(3) Avg. Δ NPL
Avg. Lending Growth	4.381**	4.935*	3.396*
	(2.430)	(1.858)	(1.912)
Avg. Size	0.005	0.003	-0.009
	(0.437)	(0.220)	(-0.753)
Avg. Solvency	-1.226*	-1.258**	-0.321
	(-1.954)	(-2.005)	(-0.513)
Avg. Loan-to-Assets	-0.040	-0.041	0.012
	(-0.285)	(-0.284)	(0.080)
Avg. Δ Int	0.330*	0.268	-0.335*
	(1.916)	(1.460)	(-1.668)
Avg. Δ Unemp	1.867***	2.082***	2.287***
	(3.657)	(3.458)	(4.864)
Avg. Inflation	0.191**	0.205**	0.165**
	(2.338)	(2.415)	(2.058)
Ratio Premises (Pre-Growth)	2.374*	2.368	2.381*
	(1.872)	(1.592)	(1.915)
Avg. Lending Growth × Prem (Pre-Growth)	-25.888**	-25.611*	-23.116*
	(-2.039)	(-1.654)	(-1.899)
Avg. Δ Cost	0.017***	0.019***	0.025***
	(5.866)	(5.041)	(7.704)
Avg. Δ Cost × Prem (Pre-Growth)	-0.112***	-0.120***	-0.160***
	(-6.251)	(-5.267)	(-7.782)
Avg. Percent Growth Per Year			2.023**
			(2.193)
Log Growth Horizon		-0.037	-0.220**
		(-0.374)	(-2.202)
Log Growth Horizon × Avg. Percent Growth Per Year			-0.897*
			(-1.948)
Avg. Lending Growth × Log Growth Horizon		-0.354	
		(-0.399)	
Constant	-0.672*	-0.621	-0.112
	(-1.739)	(-1.364)	(-0.248)
R^2	0.106	0.110	0.204
Observations	412	407	345

(b)

VARIABLES	(1) Avg. Δ NPL	(2) Avg. Δ NPL	(3) Avg. Δ NPL
Avg. Lending Growth	4.381**	4.953	3.949**
	(2.430)	(1.063)	(2.517)
Avg. Size	0.005	-0.004	0.001
	(0.437)	(-0.285)	(0.122)
Avg. Solvency	-1.226*	-1.241**	-1.208**
	(-1.954)	(-2.007)	(-2.114)
Avg. Loan-to-Assets	-0.040	-0.056	0.041
	(-0.285)	(-0.395)	(0.301)
Avg. Δ Int	0.330*	0.281	0.136
	(1.916)	(1.480)	(0.639)
Avg. Δ Unemp	1.867***	1.778***	2.111***
	(3.657)	(3.392)	(3.840)
Avg. Inflation	0.191**	0.181**	0.105
	(2.338)	(2.083)	(1.428)
Ratio Premises (Pre-Growth)	2.374*	2.430	2.034*
	(1.872)	(1.603)	(1.920)
Avg. Lending Growth × Prem (Pre-Growth)	-25.888**	-26.931*	-22.316**
	(-2.039)	(-1.700)	(-2.035)
Avg. Δ Cost	0.017***	0.017***	0.019***
	(5.866)	(5.627)	(7.415)
Avg. Δ Cost × Prem (Pre-Growth)	-0.112***	-0.112***	-0.124***
	(-6.251)	(-5.860)	(-7.630)
Avg. Lending Growth (Normalized)			-2.692
			(-1.429)
Avg. Distance		-0.275	-1.164*
		(-0.333)	(-1.856)
Avg. Distace × Avg. Lending Growth (Normalized)			5.790
			(1.542)
Avg. Lending Growth × Avg. Distace		-0.729	
		(-0.109)	
Constant	-0.672*	-0.380	0.127
	(-1.739)	(-0.557)	(0.257)
R^2	0.106	0.109	0.158
Observations	412	407	378

Notes: Table 3.1 reports detailed descriptions of the variables employed and Table 3.2 reports descriptive information on each variable. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. Standard errors are reported in parentheses.

A

Chapter 1: Supervisory Stress Tests and Bank Risk-Taking

A.1 Fundamentals of US Stress Tests

A.1.1 Scenarios

The macroeconomic stress scenarios implemented in the DFAST and CCAR exercises are divided into two groups based on their source.

The first set of stress tests (required of all participating institutions) contain the regulator-prescribed scenarios designed by the Federal Reserve and the OCC. These forecasts are quarterly and cover an extensive range of macroeconomic variables, such as real GDP growth, inflation, and unemployment, among others. The scenarios are provided for both the domestic U.S. economy and overseas areas, including Europe and Developing Asia. The three regulator-developed scenarios are: (1) The "baseline" stress scenario, which reflects industry and regulatory consensus expectations for the economy's evolution over the stress horizon. This scenario serves as the beginning benchmark of a bank's performance against the remaining stress scenarios. (2) The "severely adverse" scenario, which is designed to incorporate a significant recession, including a meaningful increase in the unemployment rate as well as severe deterioration in a particular sector or extreme stress in a given geographic region, is designed to convey a what-if analysis of institutions' balance sheet given an economy characterized by a recession that is similar or worse than the 2007-2009 crisis. This scenario's design was heavily influenced by the crisis, where capital markets nearly collapsed, leaving institutions with little held capital vulnerable to potential liquidity and solvency issues. (3) The "adverse" scenarios, which is generally perceived to be less acute than the "severely adverse" scenario, [1] is designed to uncover vulnerabilities and/or risks of particular interest given prevailing economic conditions. The Federal Reserve's set of stress tests is intended to facilitate the consistency of projections across firms (same scenarios, industry level models, consistent assets, and risk-weighted assets

[1] While the severely adverse scenario does generally have a more severe impact on a bank's capital, in some cases, the adverse could have a much more severe impact.

assumptions) and to provide industry-level insights (i.e., macro-prudential supervision).

The second group contains the internally-developed macroeconomic stress scenarios.[2] This set of internal scenarios, in contrast to the Federal Reserve-generated scenarios, allows for a micro-prudential assessment and intends to exploit unique firm-specific vulnerabilities based on each firm's portfolio, business focus, and geographic region (same scenario, different models and growth assumptions). It consists of: (1) a bank-generated "baseline" scenario based on consensus expectations about the path of the economy and (2) a "BHC" scenario, which stresses key sources of revenue and most vulnerable sources of losses. The Federal Reserve uses these company-run stress tests to evaluate each firm's ability to maintain post-stress capital ratios above the applicable minimum regulatory capital ratios after considering the capital actions described in each BHC's own baseline scenario. The CCAR quantitative assessment is based on (a) the results of the firm's internal stress tests and (b) post-stress capital ratios estimated by the Federal Reserve under the supervisory scenarios (CCAR supervisory post-stress capital analysis).

While the CCAR and DFAST exercises both rely on the same scenarios, pre-tax net income, balance sheet, and risk-weighted asset projections [3], there is an important distinction between DFAST and CCAR stemming from the differences in assumed capital actions. DFAST uses a standardized set of capital action assumptions specified in the Doff-Frank Act Stress Test rules, where dividend payments follow a four-quarter historical trend and capital issuance and redemptions are assumed to be zero. In contrast, for the CCAR post-stress capital analysis, the Federal Reserve uses BHCs' planned capital actions as indicated in each BHC's capital plan submission. It assesses whether BHCs would be capable of meeting supervisory expectations and the minimum capital ratios in the case where banks continue to distribute capital despite financial distress (as was the case in the crisis of 2007-

[2] Before DFAST 2016, only institutions with total assets exceeding $50 billion were required to produce their own scenarios. This distinction, however, was removed for DFAST 2016 and going forward.

[3] The DFAST projections are direct inputs to the CCAR capital analysis

2009). As a result of this difference, projected post-stress capital levels and ratio estimates between the two may vary significantly.

A.1.2 Stress Testing Framework and Processes

Stage 1 - Stress Test Guidelines: The Federal Reserve provides guidelines along with information related to the macroeconomic conditions reflected in each stress test scenario. The scenarios are defined through several variables related to drops in the gross domestic product (GDP), unemployment, and stock or housing market crashes. They are expected to impact capital, consolidated earnings, and losses.

Stage 2 - Firm-level Projections: Stress Test-compliant institutions are required to estimate bank fundamentals and determine capital levels under adverse hypothetical scenarios. They must submit a set of revenue and loss rate projections for the different loan categories in their portfolios based on (1) pre-subscribed macroeconomic scenarios provided by the Office of the Comptroller of the Currency (OCC) and Federal Reserve and (2) internally created scenarios in the case of large institutions. While the common to all BHCs, Federal Reserve-generated set of scenarios, models and assumptions allow for comparability across firms; the internal bank-generated scenarios allow supervisors to grasp the specific, idiosyncratic vulnerabilities facing each BHC or a given geographic segment.

Stage 3 - Post-Stress Federal Reserve Projections: The Federal Reserve run their own estimates of post-stress capital levels and regulatory capital ratios based on input data (projected post-stress revenues, expenses, and losses) provided by each BHC. [4] In this stage, projected net income along

[4] In DFAST 2013, firm balance sheet and risk-weighted assets projections were used in the calculation. Starting with DFAST 2014, results are based on Federal Reserve's own independent projections, an important assumption which mandates that credit supply does not contract even in the adverse and severely adverse scenarios. This is consistent with the macro-prudential view of the DFAST stress tests. The results measure capital strength relative to the benchmark that banks should be able to continue lending even in the bleakest

with assumptions about capital actions[5] are key determinants of projected changes in regulatory capital.[6] In addition to the quantitative required submissions, BHCs with total assets exceeding $250 billion that are subject to CCAR are required to submit a detailed capital plan.

Stage 4 - Disclosure of Stress Test Results: Stress test results are publicly disclosed, both in the aggregate and for individual BHCs. The disclosures include information about the nine-quarter cumulative projected pre-provision net revenue, loan loss amounts and rates by loan category, losses on securities, losses on trading and counterparty positions, overall pre-tax net income, and starting, ending and minimum values of projected regulatory capital ratios[7] under each scenario. For large banks (those with assets above $50 billion), the Federal Reserve evaluates reported stress tests with greater scrutiny. It publishes the results of both the ”adverse” and ”severely adverse” internal scenarios in a consolidated report.[8] Mid-size institutions are required to self-disclose the results. These results are not ”graded” by the regulatory agencies; however, they are taken into account when the Federal Reserve evaluates potential mergers and acquisitions, dividend payments, and redemptions of capital instruments. Starting in 2013, in addition to the post-stress capital analysis results, the Federal Reserve discloses a brief description of CCAR's capital plan objections.

Stage 5 - Supervisory Actions: The primary purpose of the DFAST stress tests and subsequent disclosures is to **assess** the capital positions of each participating institution and relay the informa-

economic conditions. and a set of models developed by the Federal Reserve.

[5]In the DFAST exercises, each firm's own historical behavior is reflected in the projections. Dividends are assumed to equal the average dollar amount of the preceding four quarters, while stock issuance and redemptions are assumed to be zero. In the CCAR exercises, each BHCs proposed capital actions under the internally-run scenarios taken into account.

[6]Regulatory capital is calculated for each quarter in the stress test horizon under the regulatory capital rules that apply in any given quarter of the stress horizon. The transition to the new Basel Capital Rules is reflected in both CCAR and DFAST.

[7]Common Equity Tier 1 Ratio: common equity tier 1 capital to risk-weighted assets; Tier 1 Risk-Based Capital Ratio: Tier 1 Capital to Risk-Weighted Assets; Total Risk-Based Capital Ratio: Total Risk-Based Capital to Risk-Weighted Assets; Tier 1 Leverage Ratio: Tier 1 capital to average assets

[8]In the first disclosure of the DFAST results in March 2013, the Federal Reserve was required to include firm-level results for the ”severely adverse scenario”.

tion to market participants. As a result, the DFAST stress tests' particular pitfall is that no specific supervisory actions follow the DFAST results beyond a requirement for the participating companies to take the results into account in upcoming capital planning, assessment of capital adequacy, and risk management practices.

Conversely, CCAR stress-tests designed to **ensure** sufficient capital levels, carry direct and meaningful supervisory actions following the stress-test results. An inability to maintain capital above minimum regulatory capital throughout the planning horizon in the quantitative component of the exercise (i.e., the post-stress analysis) or having significant qualitative deficiencies related to internal capital planning processes and governance indicates the failure of the particular stress test exercise. Failure can result in an objection to the proposed capital plans or processes and a ban on the bank's capital distributions without prior regulatory permission. In non-US banks with a US subsidiary, failing the stress test prevents those US entities from distributing capital to their parent companies. Following an objection, firms must revise and resubmit capital plans reflecting only those (if any) payouts deemed appropriate by the Federal Reserves.

Table A.1: Prudential Regulation in the US

	Purpose/Requirements	N.Banks	N.Failed	Risk Asmt.	Capital Thresholds	Economic Cycle
SCAP 2009	Reduce uncertainty; Restore market confidence; Identify banks with capital shortfalls due to economic conditions.	19	10	C. M.	6% Tier 1 capital; 4% Tier 1 common equity ratio.	Contraction
CCAR 2011	Quantitative and qualitative assessment of capital levels and internal capital planning processes for managing and allocating capital resources. Banks must submit Capital Plans; Largest 6 banks submit trading P&L statements.	19	Private	C. M.	Not Disclosed	Expansion
CCAR 2012	Quantitative and qualitative assessment of capital levels and internal capital planning processes for managing and allocating capital resources.	19	4	C. M. O.	4% (8%) Tier 1 (total capital) ratio; 5% (3-4%) Tier 1 common (leverage) ratio	Expansion
DFAST 2013	Quantitative assessment of bank capital adequacy in case of adverse economic conditions. Must submit internal stress test estimates for BHCs with TA of $10 to $50 billion.	18	1 [9]	C. M. O.	4% (8%) Tier 1 (total capital) ratio; 5% (3-4%) Tier 1 common (leverage) ratio	Expansion
CCAR 2013	Quantitative and qualitative assessment of capital levels and internal capital planning processes for managing and allocating capital resources. Must submit internal stress test estimates; The Fed discloses objections to capital plans.	18	2 [10]	C. M. O.	4% (8%) Tier 1 (total capital) ratio; 5% (3-4%) Tier 1 common (leverage) ratio	Expansion
DFAST 2014	Quantitative assessment of bank capital adequacy in case of adverse economic conditions. Includes Assessment of additional banks with TA $50 billion or more. Independent Balance Sheet and RWAs projections by the Fed. Basel III framework is incorporated going forward.	30	1	C. M. O.	4.5% CET 1 Ratio; 5% (4%) Tier 1 common (leverage) ratio; 8% Total risk-based capital; 6% Tier 1 risk-based ratio.	Expansion
CCAR 2014	Quantitative and qualitative assessment of capital levels and internal capital planning processes for managing and allocating capital resources. Banks with significant trading activities are required to apply a hypothetical Global Market Shock to trading and counter-party exposures. New counter-party default scenario requirement; Losses from the default of largest stressed counter-party to be included.	30	5	C. M. O.	4.5% CET 1 Ratio; 5% (4%) Tier 1 common (leverage) ratio; 8% Total risk-based capital; 6% Tier 1 risk-based ratio.	Expansion
DFAST 2015/2016	Quantitative assessment of bank capital adequacy in case of adverse economic conditions.	31 / 33	0	C. M. O.	4.5% CET 1 Ratio; 5% (4%) Tier 1 common (leverage) ratio; 8% Total risk-based capital; 6% Tier 1 risk-based ratio.	Expansion
CCAR 2015/2016	Quantitative and qualitative assessment of capital levels and internal capital planning processes for managing and allocating capital resources. Banks are required to reflect the transition arrangements and minimum capital requirements of the revised regulatory capital framework in their estimates of pro-forma capital levels and capital ratios.	31 / 33	2 / 3	C. M. O.	4.5% CET 1 Ratio; 5% (4%) Tier 1 common (leverage) ratio; 8% Total risk-based capital; 6% Tier 1 risk-based ratio.	Expansion

Note: The table provides an overview of all stress tests conducted in the US. It includes information on the specific goals and requirements inherent in each stress test exercise, along with the number of participating banks; number of banks with capital shortfalls (those who failed to meet the required minimum regulatory capital levels); the specific risks assessed (C - Credit Risk; M - Market Risk; O - Operational Risk); and the economic environment during which the exercises have been conducted.
Sources: Hirtle and Lehnert (2015); Neretina et al. (2015); Federal Reserve (2009a,b, 2011b,a, 2012, 2013a,b, 2014a,b, 2015b,a)

Table A.2: Stress Test Requirements by Type and Total Asset Size

	DFAST	CCAR
Total Assets		
Below $10 Billion	Not Required	Not Required
$10 Billion to $50 Billion	Full*	Not Required
Above $50 Billion	Full	Full - Quantitative Only
Above $250 Billion	Full	Full - Qualitative and Quantitative
Other		
Globally Systematically Important	Yes - Full	Yes - Full
Non-bank assets above $75 Billion	Yes - Full	Yes - Full

Notes: Full Set of stress test submissions include both internally and Federal Reserve-generated Stress Tests.
*Previously, institutions within this range were not required to run internally generated macroeconomic scenarios. This distinction will be removed starting with DFAST 2017.

Table A.3: Stress Test Related Events

Stress Test	Event	Date
SCAP 2009	Announcement	February 2, 2009
	Clarification	February 20, 2009
	Methodology	April 24, 2009
	Results	May 7, 2009
	Planning Horizon	2009:Q1 - 2010:Q4
CCAR 2011	Announcement	October 17, 2010
	Methodology	March 18, 2011
	Planning Horizon	2010:Q4 - 2012:Q4
CCAR 2012	Announcement	November 22, 2011
	Methodology	March 12, 2012
	Results	March 13, 2012
	Planning Horizon	2011:Q4 - 2013:Q4
DFAST 2013	Announcement	October 9, 2012
	Results	March 7, 2013
	Planning Horizon	2012:Q4 - 2014:Q4
CCAR 2013	Announcement	November 9, 2012
	Results	March 14, 2013
	Planning Horizon	2012:Q4 - 2014:Q4
DFAST 2014	Announcement	November 1, 2013
	Results	March 18, 2014
	Planning Horizon	2013:Q4 - 2015:Q4
CCAR 2014	Announcement	November 1, 2013
	Results	March 26, 2014
	Planning Horizon	2013:Q4 - 2015:Q4
DFAST 2015	Announcement	October 17, 2014
	Results	March 5, 2015
	Planning Horizon	2014:Q4 - 2016:Q4
CCAR 2015	Announcement	October 17, 2014
	Results	March 11, 2015
	Planning Horizon	2014:Q4 - 2016:Q4
DFAST 2016	Announcement	January 28, 2016
	Results	June 23, 2016
	Planning Horizon	2016:Q1 - 2018:Q1
CCAR 2016	Announcement	January 28, 2016
	Results	June 29, 2016
	Planning Horizon	2016:Q1 - 2018:Q1

Note: The table provides information on revevant stress test events.

Table A.4: Microprudential vs. Macroprudential Supervision

	Microprudential	Macroprudential
Proximate Objective	Limit distress of individual institutions	Limit financial system-wide distress
Ultimate Objective	Investor / Depositor Protection	Avoid macroeconomic costs linked to financial instability
Characterization of Risk	”Exogenous” - Independent of individual agents’ behavior	Endogenous - Dependent on collective behavior
Correlations and Common Exposures Across Institutions	Risk of individual institutions	System-wide risk

Note: The table summarizes the main differences between macro-prudential and micro-prudential supervision.
Source: Borio (2003)

Table A.5: List of US Banks and BHCs Subject to Federal Reserve Stress Tests from 2009 to 2016.

	RSSD ID	US Owned	Initial Stress Test	Listed	Data
Domestic SIFIs					
Ally Financial Inc.*	1562859	Yes	2009	-	Yes
American Express Company	1275216	Yes	2009	Yes	Yes
Bancwest Corporation	5005998	Yes	2016	Yes	-
BB&T Corporation	1074156	Yes	2009	Yes	Yes
BMO Financial Corp.	1245415	-	2014	Yes	-
Capital One Financial Corporation	2277860	Yes	2009	Yes	Yes
Comerica Incorporated	1199844	Yes	2014	Yes	Yes
Discover Financial Services	3846375	Yes	2014	Yes	Yes
Fifth Third Bancorp	1070345	Yes	2009	Yes	Yes
Huntington Bancshares Incorporated	1068191	Yes	2014	Yes	Yes
KeyCorp	1068025	Yes	2009	-	Yes
M&T Bank Corporation	1037003	Yes	2014	Yes	Yes
MetLife, Inc.	2945824	-	2009	Yes	Yes**
Northern Trust Corporation	1199611	Yes	2014	Yes	Yes
The PNC Financial Services Group, Inc.	1069778	Yes	2009	Yes	Yes
RBS Citizens Financial Group, Inc.	1132449	-	2014	Yes	Yes****
Regions Financial Corporation	3242838	Yes	2009	Yes	Yes
SunTrust Banks, Inc.	1131787	Yes	2009	Yes	Yes
TD Group US Holdings LLC	3606542	-	2016	Yes	-
U.S. Bancorp	1119794	Yes	2009	Yes	Yes
Zions Bancorporation	1027004	Yes	2014	Yes	Yes
Global SIFIs					
Bank of America Corporation	1073757	Yes	2009	Yes	Yes
The Bank of New York Mellon Corporation	3587146	Yes	2009	Yes	Yes
BBVA Compass Bancshares, Inc.	1078529	-	2014	Yes	-
Citigroup Inc.	1951350	Yes	2009	-	Yes
Deutche Bank	1032473	-	2015	Yes	-
The Goldman Sachs Group, Inc.	2380443	Yes	2009	Yes	Yes
HSBC North America Holdings Inc.	3232316	-	2014	Yes	-
JPMorgan Chase & Co.	1039502	Yes	2009	Yes	Yes
Morgan Stanley	2162966	Yes	2009	Yes	Yes
MUFG Americas Holdings Corporation***	1378434	-	2014	Yes	-
Santander Holdings USA, Inc.	3981856	-	2014	Yes	-
State Street Corporation	1111435	Yes	2009	Yes	Yes
Wells Fargo & Co.	1120754	Yes	2009	Yes	Yes

Note: Starting in 2012, additional BHCs with assets in excess of $50 billion and which did not participate in the original SCAP program submitted their capital plans to the Federal Reserve. The capital plans of these banks were reviewed in a separate, parallel exercise to the CCAR. While the capital plans for these firms contained BHC-generated stress test results, the Federal Reserve did not calculate supervisory stress test results for these firms until the 2014 CCAR (Federal Reserve (2013a, 2014a)). The SIFI classifications are obtained from the Financial Stability FSB (2016).
We do not have financial information on the following foreign-owned BHCs: BMO Financial Corp., TD Group, BBVA Compass Bankshares Inc., Deutche Bank, HSBC North America Holdings Inc., MUFG Americas Holdings Corporation, and Santander Holdings USA Inc.
*Formely known as GMAC Inc.
**MetLife Bank failed the stress test in 2012, and as a consequence it ceased to be a BHC in 2013 after selling its commercial banking unit to GE Capital and its mortgage servicing business to JPMorgan Chase. The available financial data spans the SCAP exercise of 2009 and the subsequent 2012 CCAR stress test.
***Formerly known as Union Bank of California.
**** Financial data is only available as of 2015 Q4.

Table A.6: Stress Test Results

	2009	2012	2013		2014		2015		2016	
	SCAP	CCAR	DFAST	CCAR	DFAST	CCAR	DFAST	CCAR	DFAST	CCAR
Domestic SIFIs										
Ally Financial Inc.*	-	-	-	-	+	+	+	+	+	+
American Express Company	+	+	+	-	+	+	+	+	+	+
Bancwest Corporation									+	+
BB&T Corporation	+	+	+	-	+	+	+	+	+	+
BMO Financial Corp.***					+	+	+	+	+	+
Capital One Financial Corporation	+	+	+	+	+	+	+	+	+	+
Comerica Incorporated					+	+	+	+	+	+
Discover Financial Services					+	+	+	+	+	+
Fifth Third Bancorp	-	+	+	+	+	+	+	+	+	+
Huntington Bancshares Incorporated					+	+	+	+	+	+
KeyCorp	-	+	+	+	+	+	+	+	+	+
M&T Bank Corporation					+	+	+	+	+	+
MetLife, Inc. **	+	-								
Northern Trust Corporation					+	+	+	+	+	+
The PNC Financial Services Group, Inc.	-	+	+	+	+	+	+	+	+	+
RBS Citizens Financial Group, Inc.					+	-	+	+	+	+
Regions Financial Corporation	-	+	+	+	+	+	+	+	+	+
SunTrust Banks, Inc.	-	-	+	+	+	+	+	+	+	+
TD Group US Holdings LLC***									+	+
U.S. Bancorp	+	+	+	+	+	+	+	+	+	+
Zions Bancorporation					-	-	+	+	+	+
Global SIFIs										
Bank of America Corporation	-	+	+	+	+	+	+	+	+	+
The Bank of New York Mellon Corporation	+	+	+	+	+	+	+	+	+	+
BBVA Compass Bancshares*** Inc.					+	+	+	+	+	+
Citigroup Inc.	-	-	+	+	+	-	+	+	+	+
Deutche Bank***							+	-	+	-
The Goldman Sachs Group, Inc.	+	+	+	-	+	+	+	+	+	+
HSBC NA Holdings Inc.****					+	-	+	+	+	+
JPMorgan Chase & Co.	+	+	+	-	+	+	+	+	+	+
Morgan Stanley	-	+	+	+	+	+	+	+	+	+
MUFG Americas Holdings Corporation***					+	+	+	+	+	+
Santander USA, Inc.****					+	-	+	-	+	-
State Street Corporation	+	+	+	+	+	+	+	+	+	+
Wells Fargo & Co.	-	+	+	+	+	+	+	+	+	+

Note: This table presents the stress test outcome for each banking for the period 2009-2016. Plus signs (+) indicate successful performance in a given exercise, while minus signs (-) indicate failure to meet either the minimum post-stress capital ratio requirements or deficient capital planning processes that may undermine its overall reliability. Where pass/fail results are not posted, it is due to those particular banks' incorporation at a later date. The SIFI classifications come from the Financial Stability FSB (2016).
*Formely known as GMAC Inc.
**In 2013, Metlife, Inc. dropped out of the program after it sold its commercial bank and ceased to be a bank holding company.
***Formerly known as UnionBanCal.
**** Excluded from our analysis due to lack of balance sheet and income information.
Sources: Neretina et al. (2015); Federal Reserve (2009a,b, 2011b,a, 2012, 2013a,b, 2014a,b, 2015b,a)

A.2 Do banks meet regulatory requirements through deleveraging or equity increases?

Graph A.1 offers evidence of a significant rise in banks' capital ratios in the years following the global financial crisis, especially among BHCs subject to supervisory stress tests. The average Equity to Risk-weighted Assets Ratio (ERWA) increased from 11.89% to 15.02% (A change of 3.13 percentage points) from 2009 to 2012, while for BHCs under the stress-testing framework, the ratio increased from 14.63% to 16.56% (a change of 1.93 percentage points) during the same three-year time frame. Among BHCs that failed the 2009 stress testing exercise, ERWA increased from 14.06% to 15.95% (a change of 1.88 percentage points), while those that passed the 2009 exercise increased ERWA from 15.04% to 16.99% (a change of 1.96 percentage points). Although we observe positive increases since the implementation of the stress-testing framework, it is worth noting that the divergence in capital ratios between banks subject to stress tests became apparent in 2007, when the average ERWA of banks that would eventually pass the stress test exercise of 2009 was 13.46% on average, compared to 10.88% among banks that would eventually fail the 2009 exercise. We see significantly larger increases in ERWA among banks that fail the exercise, especially between 2007 and 2009.

Graph A.2 provides a breakdown of the core capital ratio components, in particular, Equity and Risk-weighted Assets as percentages of Total Assets (denoted ETA and RWATA, respectively). We observe that while ETA decreases in the banking sector from 2007 until 2009, it is not the case among banks subject to stress tests, where we observe an increase of 0.9 percentage points. The largest increase is among banks that Fail the 2009 exercise. We observe similar trends when considering RWATA; while we see a general decline in the amount of Risk-weighted Assets to Total Assets between 2007 and 2009, the reduction is largest among the banks that fail the 2009 stress test.

It is also worth noting that banks subject to stress tests had significantly lower ERWA ratios than banks that would not be considered in the stress-testing framework prior to 2007, but the trend has begun to reverse since 2007. ETA ratios follow a similar trend as ERWA ratios. Banks subject to Stress tests have traditionally held a much larger proportion to risk-weighted assets up until 2007. While banks that passed the 2009 exercise have RWATA ratios close to the industry average, those banks that failed the 2009 exercise continue to exhibit higher than average RWATA ratios, despite the large reductions between 2007 and 2009. In fact, we observe that movements across all three ratios are most volatile among those banks that have failed the 2009 exercise.

We implement a number of descriptive analysis that decompose the various components of the core capital ratio to determine the aforementioned increases' primary drivers.

The analysis follows Cohen (2013) and is based on several adjustment channels through which banks seek to increase their risk-based capital ratios. One set of adjustment strategies focuses on increasing retained earnings, either through reductions in dividend payouts, increases in profit (through increases in interest spreads[11], increases in profits from other business lines, decreases in operating expenses), or both. Alternatively, banks could issue new equity[12]. The third set of adjustment strategies involves changes to the assets side of the bank's balance sheet. The bank can reduce its loan portfolio, sell assets, or slow down lending growth. Finally, a bank can seek to reduce its risk-weighted assets by replacing riskier (higher-weighted) loans with safer ones or with government securities(Cohen, 2013).

First, we look at the average changes in the various components comprising the ERWA ratio. Graph A.7, provides aggregate changes in ERWA components calculated as the differences between 2012q4

[11] While competitive pressures may limit how much an individual bank can widen these spreads, lending spreads could rise across the system if all banks followed a similar strategy and alternative funding channels (such as capital markets) did not offer more attractive rates (Cohen, 2013).

[12] However, given that a new share issue tends to reduce the market value of the existing shares (Cohen, 2013), this is likely to be the least attractive option.

and 2009q4. We first look at Changes in Equity and Risk-weighted assets scaled by Total Assets. We observe that ERWA changed by an average of 1.83 percentage points across the entire sample. The figure is slightly higher among stress-tested BHCs who exhibit an average change of 1.88 percentage points. There is no significant variation in the sub-samples of banks that meet projected capital levels under the stress scenarios (hereafter denoted as banks that pass a given stress test) and those who fail to do so. However, significant differences among the sub-samples arise when analyzing the Equity to Total Assets (ETA) and Risk-weighted Assets to Total Assets ratios (RWATA). While BHCs, in general, increased ETA by 3.57 percentage points, banks subject to stress tests increased their equity holdings by 6.91 percentage points. A large and significant difference can be observed among the two sub-samples of banks which passed and failed the 2009 exercise. Banks that had projected capital levels in excess of regulatory minimums increased ETA ratios by an average of 14.39 percentage points. In comparison, their counterparts with projected capital shortfalls decreased ETA by an average of 2.82 percentage points. In terms of RWATA, we observe similar dynamics. Stress tested BHCs increased their Risk-Weighted Assets by an average of 15.65 percentage points, while BHCs increased RWATA by 10.95 percentage points. Pass banks increased RWATA at a much higher rate (25.95 percentage points) than their Fail counterparts (2.26 percentage points). The magnitude of these increases provides support for the non-significant difference in ERWA ratios among the Stress-Tested BHCs sub-samples. In both cases, the change in ETA is smaller than the change in ERWA.

A further look into the growth rates of these components indicates significant differences among the sub-samples. Banks subject to stress tests increase equity by 19.08% between 2009 and 2012, with banks that have passed the exercise exhibiting an increase of 25.79% and BHCs that failed increased equity by only 10.36%. In terms of risk-weighted assets, stress-tested banks exhibit a decrease of 4.49%, with -5.20% and -3.58% for passing and non-passing entities, respectively. Asset growth is 19.08% among ST BHCs, with 25.79% for passing and 10.36% for failing entities.

To better grasp these effects, we implement the methodology of Cohen (2013), which allows for visual analysis of how banks have adjusted to higher capital requirements. We decompose the change in risk-weighted capital requirements as follows:

$$\frac{K_1/RWA_1}{K_0/RWA_0} = \frac{(1 + \frac{Inc_1}{K_0} - \frac{Div_1}{K_0} + \frac{Oth_1}{K_0})}{(\frac{RWA_1/TA_1}{RWA_0/TA_0})(\frac{TA_1}{TA_0})} \tag{A.1}$$

where K_i is capital, RWA_i is risk-weighted assets, and TA_i is total assets, at time i; while Inc_1 is net income, Div_1, is dividends, and Oth_1 is other changes in capital (calculated as a residual) between time 0 and time 1. This decomposition allows us to isolate the three factors that influence a risk-weighted capital ratio: changes to capital, changes to the ratio of risk-weighted assets to total assets, and changes to total assets (Cohen, 2013).

In order to better understand the impact of different factors, it is helpful to transform equation (1) so that the different quantities can be expressed as additive components of the percentage point change in the risk-weighted capital ratio. To do this we can take logarithms of both sides of equation (1) and then multiply both sides by a common factor (Cohen, 2013). The resulting decomposition is as follows:

$$\frac{K_1}{RWA_1} - \frac{K_0}{RWA_0} = Fln(1 + \frac{Inc_1}{K_0} - \frac{Div_1}{K_0} + \frac{Oth_1}{K_0}) - F(ln(\frac{RWA_1}{TA_1}) - ln(\frac{RWA_0}{TA_0})) - Fln(\frac{TA_1}{TA_0}) \tag{A.2}$$

where F, the normalisation factor, equals:

$$\frac{\frac{K_1}{RWA_1} - \frac{K_0}{RWA_0}}{ln(\frac{K_1}{RWA_1}) - ln(\frac{K_0}{RWA_0})}$$

Graph A.4, shows the annual breakdowns for each of the sub-samples previously considered where Panel A provides the evolution of changes in the core capital ratio components, while Panel B provides the evolution of changes in Equity. Graph A.8, provides a numerical representation of the underlying components.

However, and for the sake of a cleaner means of comparison among the different sub-samples, we take the average of the annual components between 2009 and 2012 for each sub-sample. Graph A.3, panel A shows changes in Core Capital Ratio Components as an average between 2009 and 2012. It confirms that increases in equity drove increases in the overall ratio across all sub-samples.

The charts support the descriptive statistics previously discussed. We can see a clear distinction between banks that have passed and failed the 2009 stress testing exercise. Once again, we see higher decreases in RWA as a proportion of TA among passing banks, but large increases in Total Assets counteract the positive effects. Among passing banks, equity increases seem to be the primary contributor to increases in core capital ratios. Among banks that have failed the 2009 stress test, we observe a much lower contribution of Equity, but significant reductions in both RWA as well as Total Assets have a positive effect on their capital ratios. The results are in line with the descriptive statistics previously discussed and suggest that banks that have passed the 2009 exercise continued to increase their balance sheet while shifting towards a safer asset composition as the amount of risk-weighted assets decreases. Among banks that did not pass the exercise, we observe low equity growth and total asset declines despite reductions in RWA.

Panel B provides a visual representation of the components that contribute to increases in Equity. Among all sub-samples, we observe that Equity growth was primarily driven by Retained Earnings (Income less Dividends), while other sources of equity growth are most pronounced among BHCs not subject to stress tests.

Our analysis indicates that between 2009 and 2012, BHCs increased their core capital ratios primarily through increases in equity. Although roughly one-fourth of the increase in equity was due to decreases in risk-weighted assets, the positive effect was counteracted by increases in total assets, whose negative effect is generally larger than the positive contribution of risk-weighted assets. We see a clear distinction among stress-tested banks which failed versus those that passed the 2009 stress exercise. We observe a significant increase in total assets for those banks that had sufficient capital buffers during the stress exercise. For those banks, The reduction in Risk-weighted assets is not enough to offset the increase in Total Assets, meaning there is a net negative effect on Core Capital Ratios stemming from the Asset Side. Despite this negative effect, they achieve increases in core capital ratios through increases in equity. On the other side, the average change in total assets between 2009 and 2012 is exceptionally small and negative among those BHCs that did not meet the stress exercise's capital requirements. The slight reduction in total assets, coupled with relatively strong reductions in risk-weighted assets, results in positive effects on core capital ratios in addition to increasing equity.

To summarize, while well-capitalized banks reduced their risk exposure, their counterparts with poor stress test results seem to have also implemented balance sheet contractions.

Graph A.5, shows differences among Banks that failed the stress tests once in 2009 versus those that failed the exercise both in 2009 and again in 2012. We observe that a combination of increases in equity and decreases in total assets and risk-weighted assets helped those banks achieve the required regulatory minimums for successful passing of the subsequent stress exercise.

Figure A.1: The Evolution of Core Capital Ratio

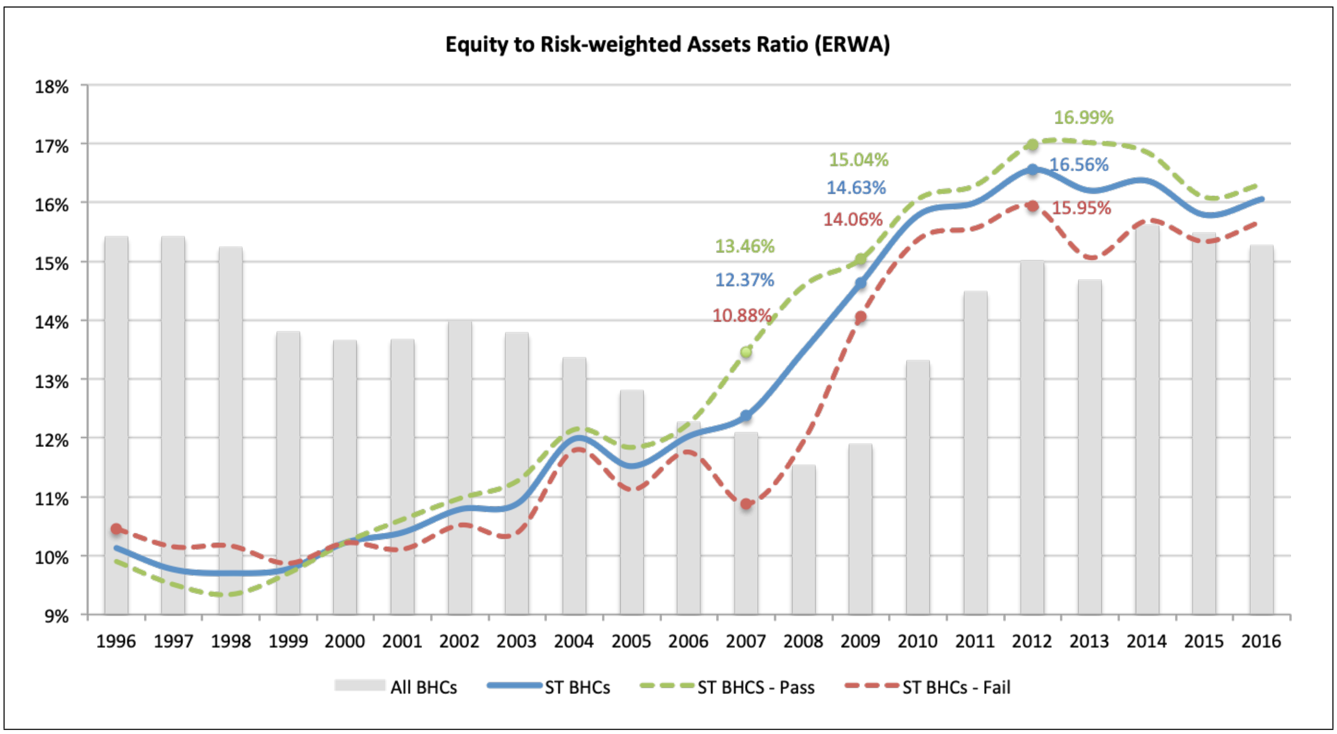


Figure A.2: The Evolution of Core Capital Ratio Components

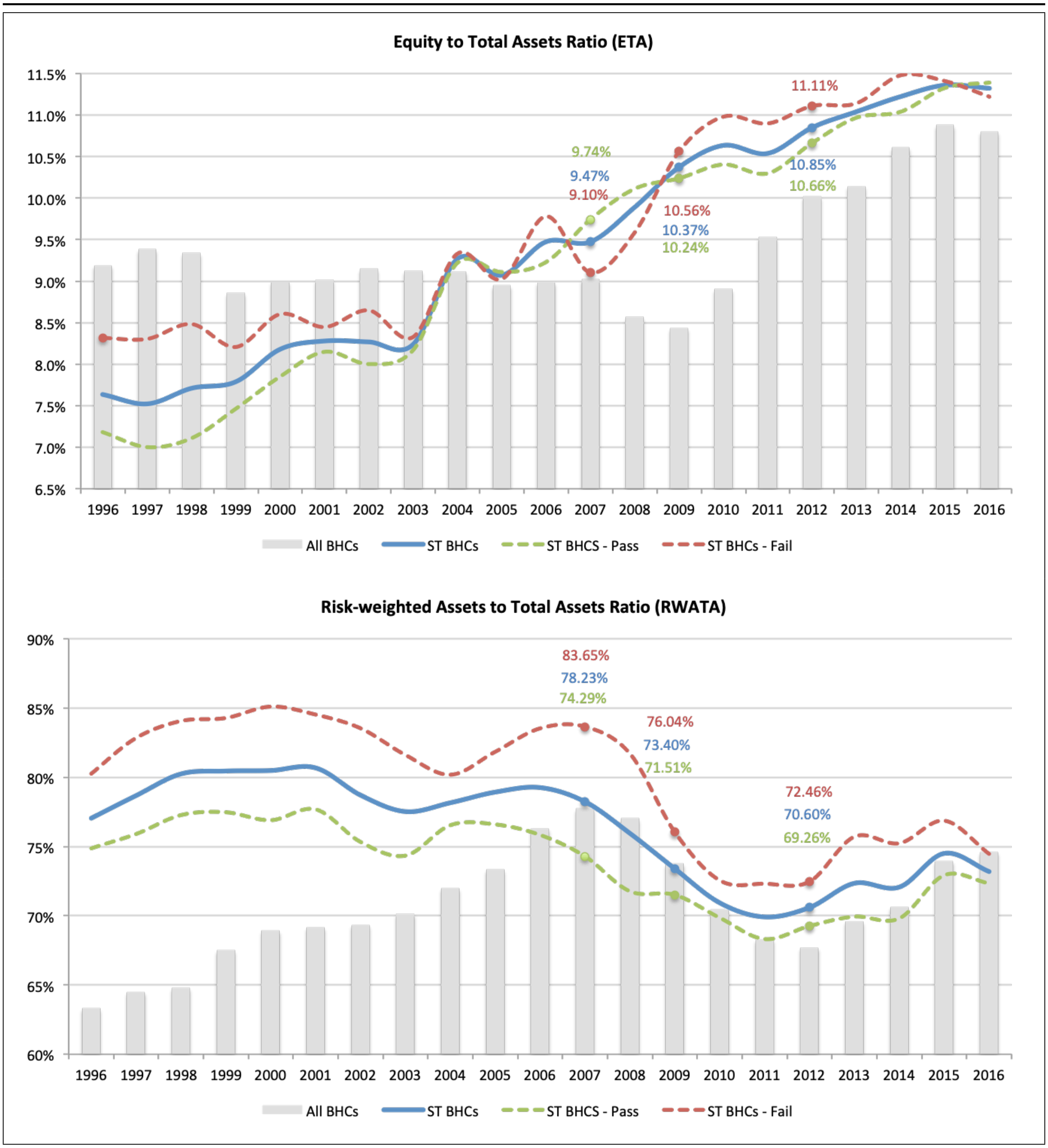


Table A.7: Summary Statistics of Core Capital Ratio Components

ERWA Change (2009 - 2012)	N	mean	sd	min	max
All BHCs	782	1.83	4.19	-14.93	23.77
ST BHCs	23	1.88	2.76	-4.74	7.61
ST BHCs - Pass 2009	*13*	*1.87*	*3.01*	*-4.74*	*7.61*
ST BHCs - Fail 2009	*10*	*1.88*	*2.56*	*-0.88*	*5.44*

ETA Change (2009 - 2012)	N	mean	sd	min	max
All BHCs	782	3.57	29.15	-68.00	136.92
ST BHCs	23	6.91	21.91	-21.77	92.14
ST BHCs - Pass 2009	*13*	*14.39*	*25.71*	*-14.39*	*92.14*
ST BHCs - Fail 2009	*10*	*-2.82*	*10.29*	*-21.77*	*12.31*

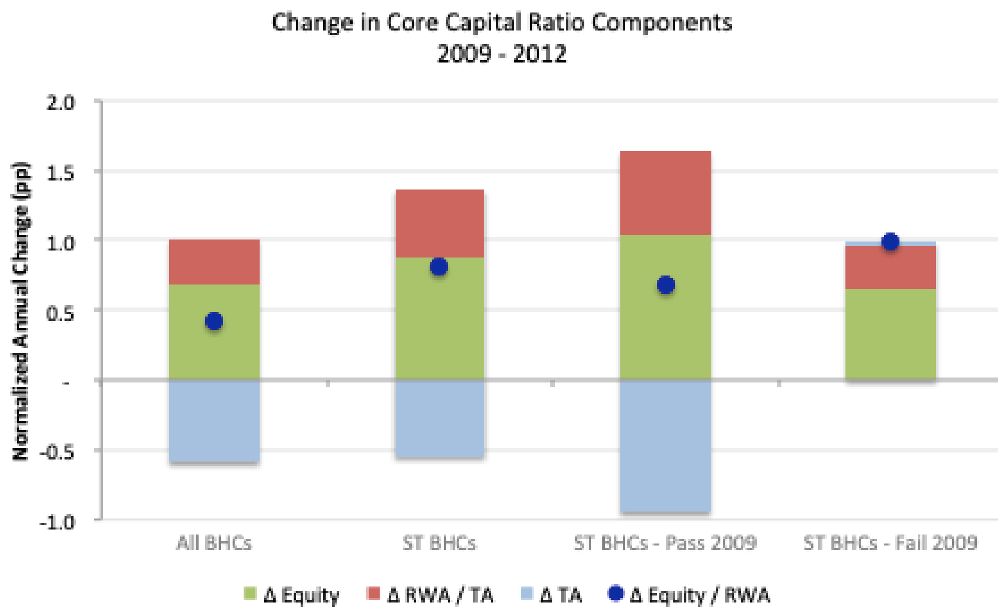
RWATA Change (2009 - 2012)	N	mean	sd	min	max
All BHCs	782	10.95	26.51	-46.81	124.02
ST BHCs	23	15.65	22.59	-14.76	84.79
ST BHCs - Pass 2009	*13*	*25.95*	*24.83*	*7.18*	*84.79*
ST BHCs - Fail 2009	*10*	*2.26*	*8.54*	*-14.76*	*14.42*

Equity Growth (2009 - 2012)	N	mean	sd	min	max
All BHCs	782	0.52%	2.51%	-11.42%	10.12%
ST BHCs	23	0.23%	1.56%	-3.51%	2.99%
ST BHCs - Pass 2009	*13*	*-0.02%*	*1.76%*	*-3.51%*	*2.99%*
ST BHCs - Fail 2009	*10*	*0.55%*	*1.25%*	*-1.18%*	*2.08%*

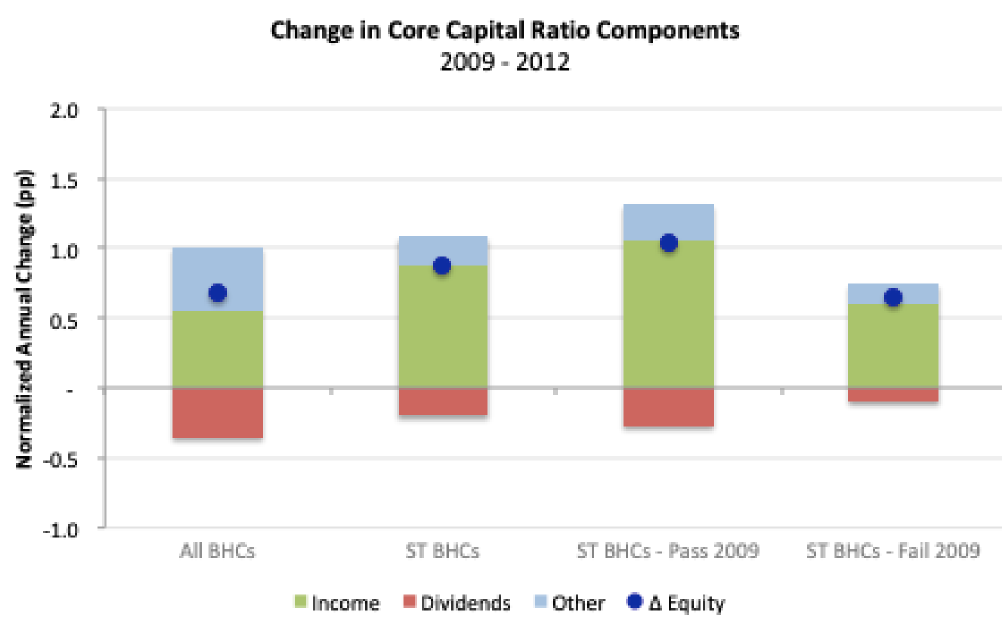
RWA Growth (2009 - 2012)	N	mean	sd	min	max
All BHCs	782	-5.24%	7.53%	-28.87%	19.81%
ST BHCs	23	-4.49%	7.68%	-21.21%	12.67%
ST BHCs - Pass 2009	*13*	*-5.20%*	*9.26%*	*-21.21%*	*12.67%*
ST BHCs - Fail 2009	*10*	*-3.58%*	*5.30%*	*-14.78%*	*3.90%*

TA Growth (2009 - 2012)	N	mean	sd	min	max
All BHCs	782	21.31%	49.93%	-194.43%	326.82%
ST BHCs	23	19.08%	19.57%	-13.32%	52.31%
ST BHCs - Pass 2009	*13*	*25.79%*	*17.40%*	*-1.20%*	*52.31%*
ST BHCs - Fail 2009	*10*	*10.36%*	*19.56%*	*-13.32%*	*40.94%*

Figure A.3: Normalized Change in Core Capital Ratio Components between 2009 and 2012



	Δ Equity / RWA	Δ Equity	Δ RWA / TA	Δ TA
All BHCs	0.42	0.67	0.34	-0.59
ST BHCs	0.82	0.88	0.48	-0.55
Pass	*0.69*	*1.04*	*0.60*	*-0.95*
Fail	*0.99*	*0.65*	*0.31*	*0.04*



	Δ Equity	Income	Dividends	Others
All BHCs	0.67	0.55	-0.35	0.46
ST BHCs	0.88	0.88	-0.20	0.20
Pass	*1.04*	*1.06*	*-0.27*	*0.25*
Fail	*0.65*	*0.61*	*-0.10*	*0.13*

Figure A.4: Changes in Core Capital and Equity Components by Bank Type

Table A.8: Normalized Component Effects on the Equity to Risk-Weighted Assets Ratio

Panel A: Changes in Core Capital Ratio Components

Δ Equity	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
All BHCs	0.92	0.39	0.16	0.46	1.11	0.96	0.47	1.73	1.26	1.19
ST BHCs	1.21	2.30	0.55	0.97	0.85	1.16	0.50	0.96	0.57	0.70
Pass	*1.82*	*1.87*	*-0.00*	*1.24*	*1.38*	*1.54*	*0.71*	*0.96*	*0.82*	*0.73*
Fail	*0.45*	*2.89*	*1.31*	*0.59*	*0.05*	*0.63*	*0.20*	*0.97*	*0.22*	*0.65*

Δ RWA / TA	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
All BHCs	-0.27	0.06	0.51	0.49	0.31	0.03	-0.53	-0.26	-0.71	-0.16
ST BHCs	-0.02	0.78	0.25	0.88	0.59	0.21	-0.56	-0.10	-0.79	0.22
Pass	*0.00*	*1.04*	*0.13*	*1.04*	*0.95*	*0.27*	*-0.25*	*-0.22*	*-1.09*	*-0.03*
Fail	*-0.04*	*0.42*	*0.41*	*0.66*	*0.04*	*0.12*	*-0.99*	*0.06*	*-0.38*	*0.60*

Δ TA	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
All BHCs	-0.86	-0.89	-0.58	-0.34	-0.61	-0.83	-0.52	-1.09	-1.32	-1.26
ST BHCs	-1.52	-1.98	0.48	-0.59	-1.22	-0.86	-0.29	-0.69	-0.42	-0.65
Pass	*-1.69*	*-1.79*	*0.57*	*-1.05*	*-2.09*	*-1.22*	*-0.43*	*-0.90*	*-0.58*	*-0.48*
Fail	*-1.29*	*-2.24*	*0.35*	*0.06*	*0.10*	*-0.37*	*-0.10*	*-0.40*	*-0.20*	*-0.91*

Δ Equity / RWA	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
All BHCs	-0.21	-0.43	0.10	0.61	0.82	0.17	-0.58	0.38	-0.77	-0.22
ST BHCs	-0.32	1.10	1.28	1.26	0.22	0.50	-0.35	0.17	-0.64	0.27
Pass	*0.13*	*1.12*	*0.70*	*1.23*	*0.23*	*0.59*	*0.02*	*-0.17*	*-0.84*	*0.22*
Fail	*-0.88*	*1.07*	*2.07*	*1.31*	*0.19*	*0.38*	*-0.88*	*0.63*	*-0.35*	*0.34*

Panel B: Changes in Equity Components

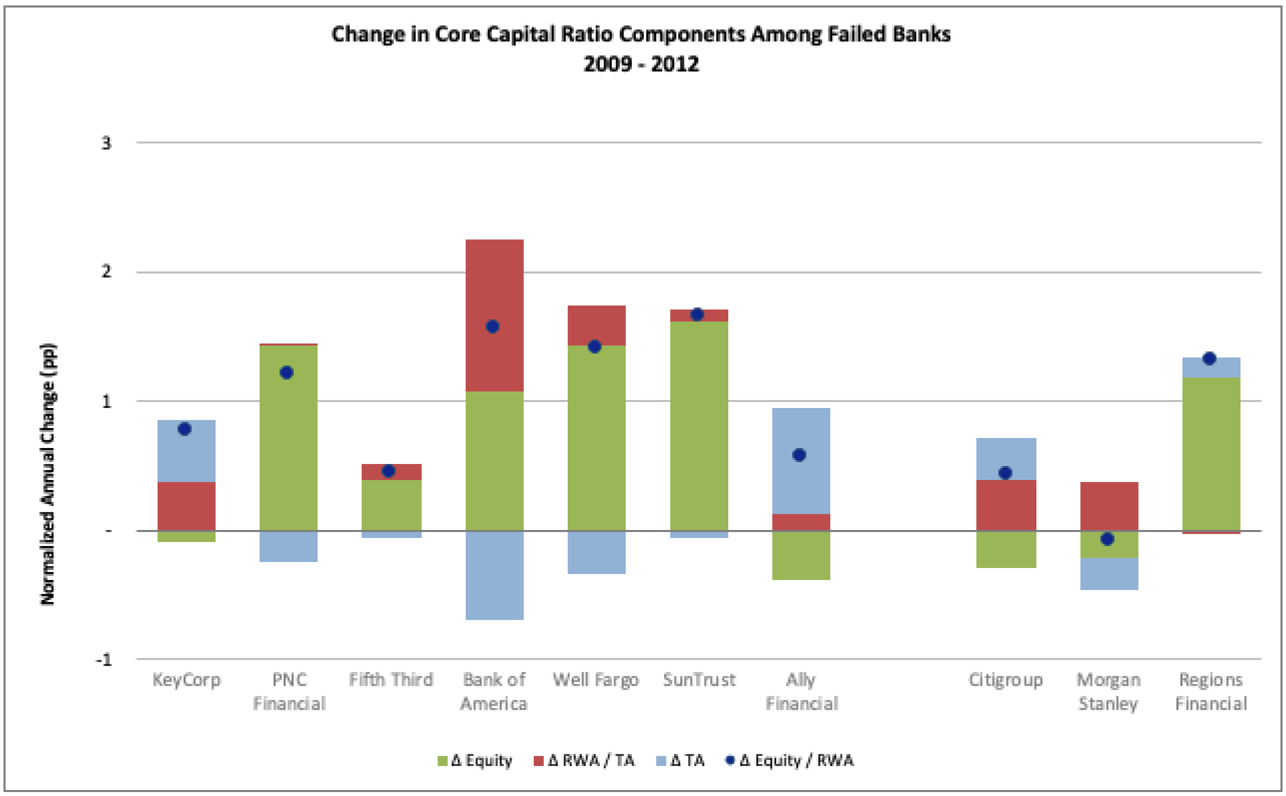
Income	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
All BHCs	1.20	0.27	-0.40	0.43	0.89	1.27	1.33	1.36	1.43	1.40
ST BHCs	1.28	-0.07	-0.54	1.11	1.41	1.52	1.53	1.55	1.51	1.46
Pass	*1.43*	*0.85*	*-0.90*	*1.41*	*1.82*	*1.90*	*1.81*	*1.84*	*1.67*	*1.64*
Fail	*1.08*	*-1.32*	*-0.04*	*0.69*	*0.79*	*1.00*	*1.15*	*1.15*	*1.28*	*1.21*

Dividends	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
All BHCs	-0.55	-0.46	-0.33	-0.29	-0.33	-0.46	-0.38	-0.42	-0.44	-0.44
ST BHCs	-0.69	-0.67	-0.16	-0.14	-0.23	-0.27	-0.30	-0.33	-0.34	-0.35
Pass	*-0.61*	*-0.65*	*-0.21*	*-0.20*	*-0.31*	*-0.36*	*-0.39*	*-0.41*	*-0.41*	*-0.40*
Fail	*-0.79*	*-0.70*	*-0.08*	*-0.04*	*-0.11*	*-0.15*	*-0.18*	*-0.22*	*-0.25*	*-0.28*

Others	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
All BHCs	0.27	0.58	0.90	0.24	0.54	0.16	-0.47	0.78	0.27	0.23
ST BHCs	0.63	3.04	1.25	-0.01	-0.33	-0.09	-0.73	-0.26	-0.59	-0.42
Pass	*1.00*	*1.68*	*1.11*	*0.03*	*-0.14*	*0.00*	*-0.71*	*-0.47*	*-0.43*	*-0.51*
Fail	*0.16*	*4.91*	*1.43*	*-0.05*	*-0.63*	*-0.22*	*-0.77*	*0.04*	*-0.81*	*-0.28*

Δ Equity	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
All BHCs	0.92	0.39	0.16	0.46	1.11	0.96	0.47	1.73	1.26	1.19
ST BHCs	1.21	2.30	0.55	0.97	0.85	1.16	0.50	0.96	0.57	0.70
Pass	*1.82*	*1.87*	*-0.00*	*1.24*	*1.38*	*1.54*	*0.71*	*0.96*	*0.82*	*0.73*
Fail	*0.45*	*2.89*	*1.31*	*0.59*	*0.05*	*0.63*	*0.20*	*0.97*	*0.22*	*0.65*

Figure A.5: Changes in Core Capital Ratio Components among Failed Banks



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B

Chapter 2: The Puzzle of Dividend Payouts: BHCs and Credit Unions

B.1 Dividends-to-Net Income Ratio Annual Percentage Changes

Table B.1: Dividend-to-Net-Income Ratio Changes

(a) DivNI Changes and Future Profitability

VARIABLES	(1) μROA_F3Y	(2) μROA_F5Y	(3) μROA_F3Y	(4) μROA_F5Y
Bank Holding Companies	**Listed**		**Non-Listed**	
DivNI_%Chg	0.000	0.000	0.000	-0.000
	(0.325)	(0.067)	(1.060)	(-0.747)
Constant	0.039***	0.026***	0.026***	0.019***
	(3.517)	(3.718)	(3.636)	(4.839)
R^2	0.445	0.332	0.406	0.279
Observations	3,035	3,035	5,281	5,281
Commercial Banks	**Listed**		**Non-Listed**	
DivNI_%Chg	0.000	0.000	0.000**	0.000***
	(0.565)	(1.330)	(2.235)	(3.637)
Constant	0.016	0.002	0.015***	0.016***
	(1.707)	(0.253)	(4.006)	(5.018)
R^2	0.728	0.677	0.201	0.183
Observations	150	150	13,027	13,027
Credit Unions	**Regular Shares**		**Share Certificates**	
DivNI_%Chg	0.000	0.000	0.000**	0.000**
	(1.094)	(0.787)	(2.422)	(2.792)
Constant	0.019**	0.014**	0.031***	0.030***
	(2.738)	(2.832)	(3.409)	(4.155)
R^2	0.357	0.320	0.450	0.504
Observations	30,095	30,095	28,404	28,404

(b) DivNI Changes and Future Risk-Taking

VARIABLES	(1) σROA_F3Y	(2) σROA_F5Y	(3) σROA_F3Y	(4) σROA_F5Y
Bank Holding Companies	**Listed**		**Non-Listed**	
DivNI_%Chg	-0.000*	-0.000**	0.000	0.000***
	(-1.849)	(-2.513)	(0.211)	(5.831)
Constant	-0.026***	-0.010**	-0.019***	-0.008***
	(-3.765)	(-2.344)	(-4.596)	(-3.680)
R^2	0.325	0.285	0.237	0.130
Observations	3,001	3,001	5,249	5,249
Commercial Banks	**Listed**		**Non-Listed**	
DivNI_%Chg	0.000***	0.000*	-0.000	-0.000**
	(5.488)	(1.883)	(-0.037)	(-2.293)
Constant	-0.028***	-0.010**	-0.006**	-0.002
	(-5.945)	(-2.466)	(-2.548)	(-1.259)
R^2	0.554	0.320	0.0582	0.0656
Observations	147	147	12,777	12,777
Credit Unions	**Regular Shares**		**Share Certificates**	
DivNI_%Chg	0.000	0.000	0.000**	0.000**
	(0.735)	(1.138)	(2.339)	(2.244)
Constant	-0.002	0.005**	0.008	0.018***
	(-0.870)	(2.523)	(1.093)	(3.471)
R^2	0.346	0.304	0.568	0.556
Observations	30,039	30,039	28,354	28,354

(c) DivNI Changes and Future Solvency

	(1)	(2)	(3)	(4)
VARIABLES	ZScore_F3Y	ZScore_F5Y	ZScore_F3Y	ZScore_F5Y
Bank Holding Companies	**Listed**		**Non-Listed**	
DivNI_%Chg	0.012	0.018***	-0.009	-0.023***
	(1.355)	(4.581)	(-0.469)	(-4.658)
Constant	16.628***	7.952***	15.708***	9.108***
	(5.322)	(3.975)	(6.097)	(5.378)
R^2	0.396	0.327	0.333	0.267
Observations	2,565	1,975	3,697	2,781
Commercial Banks	**Listed**		**Non-Listed**	
DivNI_%Chg	-0.094**	-0.010	-0.001	0.000
	(-2.948)	(-0.326)	(-0.248)	(0.066)
Constant	29.205***	16.322***	10.433***	10.447***
	(4.399)	(3.401)	(8.929)	(8.895)
R^2	0.347	0.602	0.0727	0.112
Observations	84	60	9,328	7,401
Credit Unions	**Regular Shares**		**Share Certificates**	
DivNI_%Chg	-0.015**	-0.035**	-0.142***	-0.112***
	(-2.299)	(-2.481)	(-3.884)	(-3.925)
Constant	6.380***	0.866	1.270	-3.882*
	(3.716)	(0.567)	(0.448)	(-2.056)
R^2	0.473	0.451	0.592	0.611
Observations	25,258	20,877	23,744	19,480

C

Chapter 3: Cost Structure and Lending Quality

C.1 Analyses of Commercial Banks, Credit Unions and Bankscope Annual Financial Statements

To analyze whether other financial institutions, such as commercial banks and credit unions, exhibit different behavior from bank holding companies, we implement a set of comparative analyses which runs in parallel to the bank holding company analyses discussed in Chapter 3. Tables C.1 through C.3 report the results for this comparative set of analysis. Because of data restrictions relating to the time horizon and variable availability, we cannot implement all analyses for all types of institutions. Nonetheless, we manage to provide a relatively comprehensive view among both credit unions and commercial banks. The comparative analysis includes the results for an alternative set of financial data obtained from banks' annual financial statements, rather than regulatory reports. It is important to note that the analysis is restricted to available data. Thus far, we have matched the analysis neither on the time horizon nor on the set of BHCs represented under the regulatory data and annual financial statement data analyses. While the results are meant to provide a general picture, a more balanced set of analyses would be an important next step.

While the results suggest that cost rigidity is an important component in lending quality among bank-holding companies, we find scant evidence of this relation in other institutions.

Table C.1: Lending Quality & Cost Rigidity

(a) Fixed Effects Panel Model

	BHCs	CBs	CUs
VARIABLES	(1) Δ NPL$_t$	(2) Δ NPL$_t$	(3) Δ NPL$_t$
Lending Growth$_t$	-0.058	-0.863***	-0.315***
	(-0.810)	(-2.941)	(-5.227)
Lending Growth$_{t-1}$	0.258	0.649	0.401*
	(0.974)	(1.470)	(1.714)
Lending Growth$_{t-2}$	0.910***	-0.395	-0.199
	(3.098)	(-1.206)	(-0.880)
Prem$_{t-1}$	0.755	2.537*	-0.088
	(1.289)	(1.888)	(-0.391)
Prem$_{t-2}$	-0.753	-3.355*	-0.196
	(-1.212)	(-1.954)	(-0.913)
Lending Growth$_{t-1}$ $\times$ Prem$_{t-1}$	0.516	-1.502	0.293
	(0.275)	(-0.472)	(0.371)
Lending Growth$_{t-2}$ $\times$ Prem$_{t-2}$	-4.003*	4.581	0.981
	(-1.855)	(1.243)	(1.248)
Δ Cost$_{t-1}$	0.002**	-0.110	-0.009
	(2.547)	(-1.580)	(-1.157)
Δ Cost$_{t-2}$	0.019***	-0.060	-0.007
	(3.075)	(-0.792)	(-1.391)
Δ Cost$_{t-1}$ $\times$ Prem$_{t-1}$	-0.016	0.646	0.028
	(-1.086)	(0.972)	(1.145)
Δ Cost$_{t-2}$ $\times$ Prem$_{t-2}$	-0.127**	0.401	0.023
	(-2.285)	(0.766)	(1.396)
Size	0.269***	0.538**	0.353***
	(11.973)	(2.002)	(13.791)
Solv	0.225	1.058	2.224***
	(0.450)	(0.672)	(5.502)
LTA	0.631***	1.649**	1.002***
	(4.216)	(2.414)	(10.919)
Inf	0.103***	0.063*	0.083***
	(10.225)	(1.748)	(13.595)
Δ Int	0.029	0.118	-0.065***
	(1.012)	(1.509)	(-4.473)
Δ Unemp	1.386***	0.403	0.844***
	(18.571)	(1.554)	(19.194)
Constant	-4.351***	-7.413**	-5.327***
	(-14.022)	(-2.330)	(-15.707)
R^2	0.0681	0.0124	0.0781
Observations	14,751	4,051	17,306
Number of gvkey	2,253	999	2,105

(b) Two-Step GMM Model

	BHCs	CBs	CUs
VARIABLES	(1) Δ NPL$_t$	(2) Δ NPL$_t$	(3) Δ NPL$_t$
Δ NPL$_{t-1}$	-0.243***	-0.316***	-0.180***
	(-17.469)	(-14.164)	(-12.053)
Lending Growth$_{t-1}$	-0.903	0.813*	1.133
	(-1.166)	(1.796)	(1.381)
Lending Growth$_{t-2}$	1.204***	-0.369	-0.301
	(3.142)	(-1.322)	(-0.787)
Prem$_{t-1}$	-3.384	3.146	1.890
	(-1.402)	(1.505)	(0.911)
Prem$_{t-2}$	0.021	-1.222	-1.004
	(0.011)	(-0.482)	(-0.658)
Lending Growth$_{t-1}$ $\times$ Prem$_{t-1}$	6.997	-8.860***	-2.435
	(1.253)	(-3.000)	(-0.810)
Lending Growth$_{t-2}$ $\times$ Prem$_{t-2}$	-7.698***	7.264*	1.820
	(-2.701)	(1.869)	(1.301)
Δ Cost$_{t-1}$	0.012	0.052	0.034
	(1.439)	(0.702)	(0.535)
Δ Cost$_{t-2}$	0.027***	0.021	0.014
	(3.656)	(0.625)	(1.197)
Δ Cost$_{t-1}$ $\times$ Prem$_{t-1}$	-0.161	-0.932	-0.096
	(-1.214)	(-0.701)	(-0.464)
Δ Cost$_{t-2}$ $\times$ Prem$_{t-2}$	-0.191***	-0.139	-0.053
	(-2.732)	(-0.539)	(-1.170)
Size	-0.051	-0.933*	0.510***
	(-0.791)	(-1.847)	(10.779)
Solv	3.301*	-6.139	4.377***
	(1.754)	(-1.502)	(2.934)
LTA	2.131***	0.404	1.535***
	(3.433)	(0.315)	(4.308)
Inf	0.077***	0.087**	0.060***
	(5.711)	(2.368)	(7.457)
Δ Int	-0.078**	0.055	-0.109***
	(-2.400)	(0.768)	(-6.490)
Δ Unemp	1.428***	0.812***	0.854***
	(14.052)	(3.110)	(14.943)
Observations	12,234	2,824	15,181
Number of gvkey	1,894	775	2,023

Notes: The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. Standard errors are reported in parentheses.

Table C.2: Lending Quality, Lending Growth Dynamics & Cost Rigidity

(a) Fixed Effects Panel Model

	BHCs		CBs		CUs	
VARIABLES	(1) Δ NPL$_t$	(2) Δ NPL$_t$	(3) Δ NPL$_t$	(4) Δ NPL$_t$	(5) Δ NPL$_t$	(6) Δ NPL$_t$
Lending Growth$_t$	-0.372**	-0.506***	-1.196**	-1.582***	-1.555***	-1.376***
	(-2.526)	(-3.104)	(-2.554)	(-2.804)	(-3.158)	(-3.408)
Lending Growth$_{t-1}$	-0.095	-0.537	0.673	0.622	0.630	1.184
	(-0.171)	(-0.810)	(0.685)	(0.908)	(0.539)	(1.088)
Lending Growth$_{t-2}$	1.057**	1.103**	-0.162	-0.502	0.751	-0.310
	(2.150)	(2.056)	(-0.360)	(-1.270)	(0.790)	(-0.347)
Prem$_{t-1}$	-0.052	0.061	1.864	-2.212	-0.619	-1.405
	(-0.049)	(0.051)	(1.339)	(-1.126)	(-0.351)	(-0.870)
Prem$_{t-2}$	0.780	1.421	-2.048	-0.573	1.416	2.648*
	(0.757)	(1.269)	(-1.209)	(-0.275)	(0.864)	(1.696)
Lending Growth$_{t-1}$ $\times$ Prem$_{t-1}$	2.294	1.726	-1.361	3.303	-3.847	-3.782
	(0.644)	(0.407)	(-0.344)	(0.783)	(-1.397)	(-1.053)
Lending Growth$_{t-2}$ $\times$ Prem$_{t-2}$	-6.079*	-6.554	3.118	4.478	-3.040	2.295
	(-1.653)	(-1.622)	(0.664)	(0.921)	(-0.804)	(0.668)
Δ Cost$_{t-1}$	0.010***	-0.000	-0.171	-0.026	0.035	0.034
	(3.167)	(-0.008)	(-1.250)	(-0.297)	(0.625)	(0.600)
Δ Cost$_{t-2}$	0.034***	0.034***	0.041	0.092	0.261**	0.196***
	(6.973)	(6.383)	(0.353)	(0.750)	(2.440)	(2.978)
Δ Cost$_{t-1}$ $\times$ Prem$_{t-1}$	-0.075**	0.066	1.026	-0.095	-0.105	-0.102
	(-2.182)	(0.471)	(0.825)	(-0.130)	(-0.583)	(-0.563)
Δ Cost$_{t-2}$ $\times$ Prem$_{t-2}$	-0.270***	-0.255***	0.572	0.169	-1.127**	-0.838**
	(-4.542)	(-4.009)	(0.575)	(0.165)	(-2.127)	(-2.420)
Distance$_{t-1}$	-0.132*	-0.029	0.251	0.371	0.195	0.071
	(-1.831)	(-0.320)	(1.199)	(1.286)	(1.117)	(0.362)
Lending Growth$_{t-1}$ (Normalized)		0.704***		0.843		-0.116
		(2.896)		(1.135)		(-0.226)
Lending Growth$_{t-1}$ (Normalized) $\times$ Distance$_{t-1}$		-0.806***		-1.169		0.420
		(-3.218)		(-1.317)		(0.607)
Size	0.580***	0.676***	0.364	0.439	0.595	0.228
	(5.683)	(6.415)	(0.831)	(1.041)	(1.597)	(0.563)
Solv	0.678	1.246	-0.454	-1.783	1.635	2.159
	(0.662)	(1.059)	(-0.163)	(-0.700)	(0.618)	(0.745)
LTA	1.521***	1.697***	1.622*	1.505	2.056***	1.946***
	(5.180)	(4.810)	(1.735)	(1.445)	(2.680)	(2.827)
Inf	0.141***	0.102***	0.055	-0.014	0.101**	0.103***
	(9.330)	(5.668)	(1.376)	(-0.303)	(2.301)	(2.642)
Δ Int	-0.057*	-0.064*	0.032	0.085	-0.109	-0.055
	(-1.827)	(-1.889)	(0.357)	(0.910)	(-1.386)	(-0.692)
Δ Unemp	1.429***	1.252***	0.496	0.064	0.727**	1.120***
	(12.644)	(9.906)	(1.486)	(0.156)	(2.222)	(4.070)
Lending Growth$_{t-1}$ $\times$ Distance$_{t-1}$	-0.333		0.467		1.336	
	(-1.089)		(0.344)		(1.054)	
Constant	-9.285***	-10.807***	-5.463	-5.671	-8.698*	-4.640
	(-6.111)	(-6.918)	(-1.020)	(-1.061)	(-1.906)	(-0.910)
R^2	0.102	0.097	0.016	0.026	0.137	0.196
Observations	7,950	6,969	2,926	2,402	421	371
Number of gvkey	1,747	1,677	817	697	86	79

(b) Two-Step GMM Model

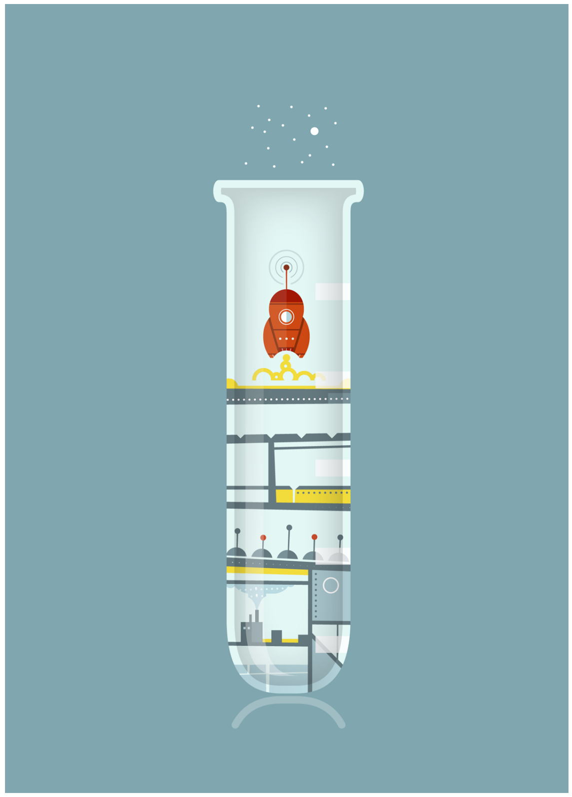
	BHCs	CBs	CUs
VARIABLES	(1) Δ NPL$_t$	(2) Δ NPL$_t$	(3) Δ NPL$_t$
Δ NPL$_{t-1}$	-0.282***	-0.333***	-0.362***
	(-12.843)	(-11.004)	(-5.638)
Lending Growth$_{t-1}$	-1.779	0.270	1.093
	(-1.069)	(0.355)	(0.486)
Lending Growth$_{t-2}$	1.339***	0.063	-0.486
	(3.004)	(0.191)	(-0.210)
Prem$_{t-1}$	1.737	-2.915	-2.545
	(0.645)	(-0.819)	(-0.610)
Prem$_{t-2}$	-1.368	2.756	3.687
	(-0.576)	(0.766)	(1.135)
Lending Growth$_{t-1}$ $\times$ Prem$_{t-1}$	9.099	-3.170	-3.217
	(0.830)	(-0.775)	(-0.530)
Lending Growth$_{t-2}$ $\times$ Prem$_{t-2}$	-7.815**	2.233	4.602
	(-2.146)	(0.405)	(0.490)
Δ Cost$_{t-1}$	-0.043	0.062	0.029
	(-0.453)	(0.225)	(0.251)
Δ Cost$_{t-2}$	0.047***	0.110	0.354
	(6.417)	(0.704)	(1.354)
Δ Cost$_{t-1}$ $\times$ Prem$_{t-1}$	0.609	-0.992	-0.081
	(0.646)	(-0.349)	(-0.202)
Δ Cost$_{t-2}$ $\times$ Prem$_{t-2}$	-0.406***	-0.108	-1.747
	(-4.289)	(-0.070)	(-1.569)
Distance$_{t-1}$	-0.091	0.074	-0.572
	(-0.533)	(0.169)	(-1.086)
Lending Growth$_{t-1}$ (Normalized)	1.290**	2.096**	-0.312
	(2.494)	(2.115)	(-0.340)
Lending Growth$_{t-1}$ (Normalized) $\times$ Distance$_{t-1}$	-1.420***	-2.537**	0.287
	(-2.715)	(-2.027)	(0.262)
Size	0.508**	-0.952	-0.835
	(2.094)	(-0.965)	(-0.695)
Solv	11.593***	-2.109	1.106
	(3.487)	(-0.409)	(0.150)
LTA	2.012**	0.639	0.779
	(2.030)	(0.548)	(0.388)
Inf	0.082***	-0.007	0.120**
	(4.077)	(-0.164)	(2.280)
Δ Int	-0.175***	0.032	0.009
	(-4.876)	(0.351)	(0.079)
Δ Unemp	1.439***	0.064	1.329***
	(9.994)	(0.161)	(4.073)
Observations	5,263	1,680	292
Number of gvkey	1,406	531	69

Notes: The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. Standard errors are reported in parentheses.

Table C.3: Determinants of Efficiency

	BHCs		CBs		CUs	
VARIABLES	(1) Efficiency	(2) Δ Efficiency	(3) Efficiency	(4) Δ Efficiency	(5) Efficiency	(6) Δ Efficiency
Δ $Cost_t$	-0.099***	-0.181***	-0.019	-0.048***	-0.047**	-0.072***
	(-5.485)	(-12.772)	(-0.783)	(-2.724)	(-2.266)	(-4.047)
Diversif	-0.312***	0.219***	0.061	0.472***	0.429***	0.503***
	(-5.847)	(8.721)	(0.331)	(3.367)	(6.221)	(9.365)
LTA	0.126***	0.083***	0.102	0.117***	0.060	0.204***
	(3.392)	(5.225)	(1.414)	(2.680)	(1.324)	(6.833)
DTL	-0.116**	-0.000	0.069	-0.084	0.000	0.000
	(-2.557)	(-0.005)	(0.525)	(-0.836)	(1.468)	(1.539)
Size	-0.017***	-0.042***	0.001	-0.034*	-0.050***	-0.089***
	(-2.691)	(-13.995)	(0.018)	(-1.664)	(-2.941)	(-6.863)
Solv	1.891***	-0.171	-0.137	-0.646***	1.010***	-0.405*
	(10.006)	(-1.391)	(-0.435)	(-3.811)	(3.882)	(-1.805)
Δ Int	-0.007**	0.016***	-0.034***	-0.013***	-0.006	0.025***
	(-1.991)	(6.439)	(-5.975)	(-2.916)	(-1.270)	(6.559)
Inf	-0.000	0.004***	-0.005	-0.002	-0.030***	0.000
	(-0.245)	(3.617)	(-1.526)	(-0.756)	(-15.168)	(0.161)
Δ Unemp	-0.092***	0.035***	-0.209***	-0.053***	0.018	0.259***
	(-8.657)	(4.296)	(-9.936)	(-2.959)	(1.198)	(19.372)
Constant	1.711***	0.481***	1.391***	0.432	1.812***	0.880***
	(16.825)	(9.914)	(3.365)	(1.417)	(8.643)	(5.641)
R^2	0.0555	0.0487	0.0363	0.0306	0.163	0.243
Observations	17,881	17,881	5,698	5,698	5,190	5,190
Number of gvkey	2,802	2,802	1,383	1,383	1,323	1,323

Notes: The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. Standard errors are reported in parentheses.



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