

Essays on Banking

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Dedication

To my childhood family.

Declaration

The following article is drawn directly from one of the chapters of this thesis: Nguyen, T. V. H., Ahmed, S., Chevapatrakul, T., & Onali, E. (2020). Do stress tests affect bank liquidity creation?. *Journal of Corporate Finance*, 101622.

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Abstract

The first chapter examines the impact of Federal Reserve stress tests from 2009 to 2016 on U.S. bank liquidity creation. Empirical results show that regulatory stress tests have a negative effect on both on- and off-balance sheet bank liquidity creation and asset-side liquidity creation. As banks enter the stress tests, they reduce their liquidity creation to avoid failing the stress tests. These results are consistent with the hypothesis that banks manage their risk exposures to meet higher capital requirements. The negative effect of stress testing on liquidity creation continues to persist in the quarters after the stress tests. Finally, stress test banks appear to increase liability-side liquidity creation. These findings highlight that the enhanced financial stability from greater regulatory scrutiny may be achieved at the expense of financial intermediation.

The second chapter empirically examines the effects of different measures of liquidity on interest margins of a sample of U.S. commercial banks from 2001 to 2018. Overall, the results reveal that liquidity ratios exert a positive influence on bank margins. Furthermore, the study investigates the role of market power in the relationship between liquidity and interest margins. It is documented that dominant banks incorporate the costs associated with investing in liquidity into the bank margins to a lesser extent than banks with less market power, suggesting that the cost of complying with regulatory liquidity standards is reduced when the competition in the banking sector is less intense. The study highlights that market competition might be important in the design and implementation of liquidity regulations.

The third chapter revisits the signalling effects of dividend announcements for a sample of U.S. firms from 2000 to 2018. The study finds that increasing (decreasing) dividend announcements are associated with positive (negative) cumulative

abnormal stock returns around the announcement day. On average, financial firms and banks appear to have lower abnormal stock returns around increasing dividend announcements than non-financial firms. Nevertheless, banks have higher abnormal returns around unchanged payout announcements than non-financial firms, especially during the Financial Crisis period. Such differences in stock returns between firm types are not observed for dividend reduction announcements. The panel regressions reveal that the reactions of stock prices to dividend changes are found to be stronger for financial and banking firms than for non-financial firms only when the payout changes are positive. Furthermore, the effects of dividend changes on cumulative abnormal stock returns are amplified in the Financial Crisis period, stressing the importance of such signalling motive in times of high uncertainty and severe informational asymmetry than in normal times. Finally, the study documents that the market's reactions to banks' dividend announcements tend to be weaker/stronger when banks understate/overstate their earnings.

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Chapter 1

Introduction

Credit risk and liquidity risk have been identified as major causes of commercial bank failures during the 2008 Financial Crisis (Imbierowicz & Rauch 2014). The Federal Reserve, concerned with bank capital levels and their ability to absorb losses, started conducting annual regulatory stress testing exercises to restore and promote the resilience of the banking system without resorting to costly bailouts and other forms of interventions. Furthermore, a new set of regulatory standards including the Net Stable Funding Ratio (NSFR) and the Liquidity Coverage Ratio (LCR) was introduced by the Basel Committee on Banking Supervision (BCBS) in the Basel III accord to address bank liquidity risks.

The payout policies of the banking sector also received considerable attention during the Crisis when many banks maintained large dividend payouts as their financial situation worsened (e.g., Acharya, Gujral, Kulkarni & Shin 2011, Acharya, Le & Shin 2016). While Juelsrud & Nenov (2019) demonstrate that banks use dividends as a tool to signal their liquidity availability in the presence of an increased risk of a rollover crisis, Floyd et al. (2015) maintain that banks pay dividends as a means to convey information about their financial strength. This poses important questions. Are dividends more important for banks than for industrials? Should the authorities suspend or restrict bank dividends during the crisis period?

This thesis discusses three topics concerning bank capital regulations, liquidity regulations and dividends. While the first two empirical chapters of the thesis offer new insights on the effects of banking supervisory and regulatory actions, the

third chapter takes a distinct direction and contributes to the justifications for such regulations.

Considerable progress in strengthening the resilience and solvency of financial institutions has been made since the 2008 Global Financial Crisis. Supervisory stress testing aiming at making sure that banks maintain a sufficient amount of capital to continue their credit lending even in adverse economic conditions has emerged as the primary tool of macro-prudential policy to preserve the stability of the financial system. There are, however, growing concerns that stress testing exercises alter managerial decisions as bank managers try to pass the stress tests and those additional capital requirements might be achieved at the expense of financial intermediation. As the consequence of failing stress tests can be severe, stress tests are likely to influence the behaviour of participating banks. An emerging strand of literature attempts to quantify the effects of stress tests on bank credit provision and loan pricing (Acharya et al. 2018, Berrospide & Edge 2019, Calem et al. 2019, Connolly 2018, Cortés et al. 2020, Lambertini & Mukherjee 2016), capital ratios (Cornett et al. 2020), loan loss provisions and non-performing loans (Shahhosseini 2015), risk taking (Pierret & Steri 2018), and entrepreneurship and innovation (Doerr 2019). The existing literature also suggests that capital support and government interventions affect bank liquidity creation (Berger et al. 2016). Leveraging the Federal Reserve stress tests from 2009 to 2016, the first chapter of this thesis investigates their impact on U.S. bank liquidity creation. Empirical results from the Regression Discontinuity Design (RDD) show that regulatory stress tests have a negative effect on both on- and off-balance sheet bank liquidity creation and asset-side liquidity creation as banks manage their risk exposures to meet higher capital standards. Furthermore, the study documents an increase in liability-side liquidity creation, indicating that stress tests encourage banks to adopt a more stable funding structure. Additional analyses find that those banks that are subject to the stress tests reduce their liquidity creation as they enter the stress tests for the first time, and in the quarters when the stress tests start, to avoid failing the tests.

Liquidity shocks are often deemed to be primarily responsible for the 2008 Global Financial Crisis which revealed the weaknesses in bank risk management.

Against this backdrop, the Basel III, which is a new set of regulatory standards, was introduced by the Basel Committee on Banking Supervision (BCBS) to address both short-run and long-run liquidity risks, highlighting the importance of liquidity regulation in the banking system. Despite the fact that there is no general consensus regarding the accurate measurement of liquidity that is able to capture all dimensions of liquidity risk, the objective of liquidity standards is to minimise the likelihood and intensity of banks' liquidity dry-ups, to enhance the resilience of banks during downturn periods. The literature on the new liquidity standards and their possible effects on the resilience and efficiency of the banking system once these new liquidity requirements are implemented is growing (e.g., Hong et al. 2014, Dietrich et al. 2014, Vazquez & Federico 2015, Du 2017, Chiaramonte & Casu 2017, Sclip et al. 2019). However, these studies do not investigate how liquidity is priced into bank spread under imperfect competitive environments. Acharya & Viswanathan (2011) highlight that in competitive banking markets, the higher opportunity costs associated with holding low-yielding liquid assets adversely affect bank wealth creation. This suggests that although investment in liquidity reduces the likelihood of bank failure due to sudden liquidity shortage, it comes with a cost that should be incorporated into bank interest margins. The second empirical chapter in this thesis empirically examines the effects of liquidity measures on bank net interest margins and the role of market power in the relationship between bank liquidity and net interest margins for a sample of U.S. commercial banks from 2001 to 2018. Besides the traditional liquidity measure, the study adopts the Liquidity Coverage Ratio (LCR) and the Net Stable Funding Ratio (NSFR) established under Basel III so as to provide more comprehensive estimates of bank liquidity. The study documents that bank liquidity ratios exert a positive influence on net interest margins, indicating that there is a cost associated with complying with liquidity rules. Moreover, using the Lerner index as a non-structural proxy for market power, the chapter presents evidence that banks with greater market power incorporate the costs of liquidity into the interest margins to a lesser extent relatively to those banks with less market power. Further investigation reveals that the role of market power in the valuation of banks' liquidity appears to be more important for small banks than for large banks. The finding is robust to a battery of robustness checks

including taking into account additional macroeconomic factors, using alternative measures of the main variables and different econometric estimation techniques.

The last decades are characterised with improved information technology, significant economic changes and increased scrutiny of financial supervisions and regulations that shape the transformations of the financial system. The literature suggests that dividends might be more important for banks as the signalling content of dividends might be stronger for banks than for non-financials (Floyd et al. 2015), especially in a financial crisis period (Forti & Schiozer 2015). This is because a large part of banks' assets is intangible (e.g. loans) and hard to value, making banks inherently opaque (Floyd et al. 2015). Motivated by this view, the third chapter of this thesis examines the signalling effects of dividend announcements for a sample of U.S. firms during the recent period from 2000 to 2018. Using the event-study methodology, the chapter documents that increasing (decreasing) dividend announcements are associated with positive (negative) cumulative abnormal stock returns around the announcement day. Banks are reported to have higher abnormal returns around unchanged payout announcements than non-financial firms, especially during the 2008 Financial Crisis period. Furthermore, the empirical results reveal that the effects of dividend changes on stock price reactions appear to be stronger for financials and banking firms than for non-financials only when the change in dividend is positive, indicating that the signalling motive might be more important for banks than for non-financial firms due to the opacity of banks' assets. The study also shows that the effects of dividend changes on cumulative abnormal stock returns are amplified in the Financial Crisis period, stressing the importance of such signalling motive in times of high uncertainty and severe informational asymmetry than in normal times. Finally, as bank earnings opacity exacerbates the information asymmetries in the market by hindering the ability of outsiders to accurately assess the risks and value of banks, this study shows that the market tends to respond to banks' dividend announcements to a lesser extent as banks become more opaque and understate their earnings and react more when banks overstate their earnings.

Chapter 2

Do stress tests affect bank liquidity creation?

Abstract

We examine the impact of Federal Reserve stress tests from 2009 to 2016 on U.S. bank liquidity creation. Empirical results show that regulatory stress tests have a negative effect on both on- and off-balance sheet bank liquidity creation and asset-side liquidity creation. As banks enter the stress tests, they reduce their liquidity creation to avoid failing the stress tests. These results are consistent with the hypothesis that banks manage their risk exposures to meet higher capital requirements. The negative effect of stress testing on liquidity creation continues to persist in the quarters after the stress tests. Finally, stress test banks appear to increase liability-side liquidity creation. These findings highlight that the enhanced financial stability from greater regulatory scrutiny may be achieved at the expense of financial intermediation.

2.1 Introduction

Bank capital acts as a buffer to absorb losses and is particularly important for financial stability in periods of adverse economic conditions. Insufficient bank capital levels in the banking system hinder its ability to create liquidity and support economic growth. For this reason, stress tests aiming at evaluating the resilience of the banking system under adverse economic shocks are a very important component of the regulatory framework in the banking systems worldwide. The objective of stress tests is therefore to ensure that banks hold – at all times – an adequate amount of capital to withstand such shocks and sustain their credit supply. This is important because recent contributions have shown that the costs of bank bailouts are very large.[1]

In late February 2009, the Supervisory Capital Assessment Program (SCAP) was launched to measure the ability of the 19 largest U.S. financial institutions to withstand future economic crises. These were domestic bank holding companies (BHCs) with year-end 2008 assets exceeding $100 billion. Since 2011, the Federal Reserve has conducted the Comprehensive Capital Analysis and Review (CCAR). From 2014, the stress testing exercise has been expanded to include all BHCs with total assets exceeding $50 billion.

Annual stress tests have been shown to lead to changes in the risk management practices of BHCs (Acharya et al. 2018, Cornett et al. 2020). Participating banks tend to avoid investments that require high capital buffer according to the stress tests. To maximize the probability of passing the tests, these banks have the incentive to align their internal risk evaluation processes with the stress tests' criteria. Since stress tests take a more forward-looking perspective when evaluating bank risk, the annual implementation of stress tests should improve the supervision of bank capital. Nevertheless, there are concerns that stress tests might lead to constraints on the ability of banks to create liquidity – an essential function of banks (Diamond & Dybvig 1983).

In this chapter, we are the first to provide empirical evidence on the impact

[1]For example, Veronesi & Zingales (2010) estimate that the cost for taxpayers of the Treasury-Federal Deposit Insurance Corporation joint plan in 2008 was between $21 billion and $44 billion, and Cardillo et al. (2020) report that from 2008 to 2017 the governments of EU-15 countries spent 793 billion euros for recapitalizations of distressed banks.

of stress tests (SCAP and CCAR) on the liquidity creation of U.S. banks. We focus on liquidity creation because, alongside risk transformation (Bhattacharya & Thakor 1993, Diamond & Rajan 2001), it is one of the key functions of banks, which supports the economy (Berger et al. 2016, Huang et al. 2018). Liquidity is created when banks transform relatively liquid liabilities (e.g., demand deposits) into relatively illiquid assets (e.g., corporate loans). Liquidity can also be created off the balance sheet, as is the case when banks extend loan commitments or lines of credits to businesses. Liquidity creation is a better measure of bank output than bank loans because it considers not only bank assets (in particular, loans), but also off-balance sheet activities, demand deposits, equity, and other bank liabilities (Berger & Sedunov 2017). By creating liquidity, banks promote economic growth and improve capital allocation in the financial system.

Existing literature suggests that capital support and government interventions affect bank liquidity creation (Berger et al. 2016), while stress tests lead to a reduction in credit supply of U.S. banks (Acharya et al. 2018). These studies suggest that government intervention and stress tests may reduce liquidity creation by banks. However, at present, there is no empirical work on the effect of stress tests on bank liquidity creation. This is the question that this chapter aims to answer empirically. We employ a regression discontinuity approach that relies on the Federal Reserve's selection criterion to include banks in the stress tests as an exogenous source of variation and provide evidence that regulatory stress tests reduce banks' liquidity creation both on- and off-balance sheets. A test for the continuity of the density of the distance between the bank size and the threshold, which is the running variable in our regression discontinuity method, suggests that banks do not manipulate their balance sheets to avoid being included in the stress tests. We acknowledge that it is difficult to precisely gauge the impact of Federal Reserve stress tests on U.S. bank liquidity creation because so many government intervention programs, regulatory/policy actions, and financial market events occurred around the same time. Even so, we argue that our empirical design and additional robustness tests help mitigate some of the concerns.

Our main findings are as follows. First, consistent with the risk-management hypothesis discussed in Acharya et al. (2018), our results show that banks manage

their risk exposures by cutting down the asset-side component of liquidity creation, particularly to risky borrowers, in order to meet the higher capital standards of the stress tests. Second, we document an increase in the liability-side liquidity creation. However, the result does not suggest that banks become riskier following the stress tests as customer savings deposits make up around 70–80% of the total liquid liabilities of stress test banks. Therefore, this result indicates that stress tests encourage banks to adopt a more stable funding structure. This happens plausibly because banks have an incentive to rely on more liquid and relatively cheaper funding sources to increase their profits as a consequence of the decrease in asset-side liquidity creation. Third, stress test banks are found to reduce liquidity creation as they enter the stress tests for the first time, and in the quarters when the stress tests start, to avoid failing the tests. For some components of liquidity creation, such behavior becomes even more pronounced in subsequent quarters.

We perform a number of robustness checks. First, we conduct the parallel trends test for the differences in the liquidity creation growth rate of stress test banks vis-à-vis non-stress test banks in the quarters prior to the stress tests. Second, we present the estimates of regression discontinuity under the local randomization inference, which is based on a 'stronger' alternative identification assumption. Third, we perform placebo tests by employing alternative cutoff values of $40, $60, $70, $80, $90, and $110 billion in total assets as the criterion for BHCs to be included in the stress tests. Fourth, we include in our sample BHCs with foreign parents and those with total assets exceeding $10 billion. Our empirical results remain robust to these additional checks.

Our chapter contributes to two strands of literature: the literature on bank liquidity creation and the literature on the impact of stress tests on bank conduct. Motivated by the work of Berger & Bouwman (2009), recent studies have investigated the relationship between liquidity creation and the following variables: regulatory capital (e.g., Casu et al. 2019, Fu et al. 2016, Fungáčová et al. 2017, Horvath et al. 2014, Tran et al. 2016), competition (e.g., Horvath et al. 2016, Jiang et al. 2019), corporate governance (e.g., Andreou et al. 2016, Diaz & Huang 2017, Huang et al. 2018), monetary policy (e.g., Berger & Bouwman 2017), enforcement actions (e.g., Danisewicz et al. 2018), and real economic output (e.g., Berger &

Sedunov 2017). Moreover, Bowe et al. (2019) investigate the impact of capital requirement reforms (incorporated in the Third Basel Capital Accord), the Troubled Asset Relief Program, and unconventional monetary policy on bank liquidity creation. The strand of literature on regulatory stress tests has investigated the impact of stress tests on banks' lending and risk exposure (Acharya et al. 2018), and banks' capital and dividend payouts (Cornett et al. 2020). However, despite the important implications of regulatory stress tests on banks' business practices, to the best of our knowledge, there is no empirical study documenting the impact of stress tests on U.S. bank liquidity creation.

Our empirical findings indicate that there might be a trade-off between the positive effects of stress tests, in terms of enhanced long-term financial stability, and the temporary negative effects on liquidity creation. This finding is important because Berger & Sedunov (2017) find that there is a positive relation between bank liquidity creation and real economic output. Thus, our findings have important implications for policy makers and bank regulators, given that stress tests might temporarily have an unintended adverse impact on the real economy. In this respect, our study is similar to the recent paper by Danisewicz et al. (2018), which reports a reduction in bank liquidity creation in response to regulatory enforcement actions, which ultimately leads to temporary adverse effects on local economic growth.[2] In addition to stress tests and enforcement actions, changes in regulatory requirements can influence the real economy via the lending channel. For example, Bindal et al. (2020) suggest that the size-based regulatory thresholds introduced by the Dodd-Frank Act of 2010 have had an impact on small-business lending and, ultimately, the real economy. Importantly, our empirical findings do not imply that stress tests should be avoided. In the long-term, the improved stability in the financial system arising from stress test exercises might offset the temporary economic costs resulting from a reduction in liquidity creation by banks.

An additional contribution of this chapter to the literature on the impact of stress tests on bank conduct is the extended sample period. While previous empirical studies focus solely on the first stress test (e.g., Connolly 2018) or extend

[2]Recent contributions also investigate the potential impact of enforcement actions on the syndicated loans' market and mergers and acquisitions in the banking industry. See, for example, Delis et al. (2020), Papadimitri et al. (2019).

the analysis to include the 2014 stress test (e.g., Acharya et al. 2018, Shahhosseini 2015), our chapter covers more recent stress tests in 2015 and 2016. Moreover, Acharya et al. (2018) and Connolly (2018) examine the lending implications *after* the implementation of the stress tests, whereas our chapter explores the response of banks as they enter the stress tests. Finally, our research goes beyond the empirical analyses conducted by Acharya et al. (2018) and Connolly (2018), because not only do we consider bank lending, we also investigate the impact of stress tests on bank liquidity creation on both sides of the balance sheet (assets and liabilities) as well as liquidity creation originated by off-the-balance sheet items.

From a policy viewpoint, this chapter suggests that, in the short-term, stress tests may be detrimental to financial intermediation. Our findings, however, also show that banks tend to increase liquidity creation on the liability-side in response to the stress tests. Since liquid liabilities consist mainly of customer deposits, our results indicate that banks may shift to a more stable funding structure as a result of stress tests. This finding is very important because literature on the impact of stress tests has so far neglected the liability-side of banks' balance sheets.

The remainder of this chapter is organized as follows. Section 2.2 provides background on regulatory stress testing. Section 2.3 offers a literature review on regulatory stress testing and hypothesis development. Section 2.4 introduces the data and the variables of interest. Section 2.5 discusses the methodology, the empirical results, and the findings. Section 2.6 presents the study summary and provides policy implications.

2.2 Institutional background

Stress testing of large and systemically important financial institutions is one of the main prudential tools for enhanced supervision in the post-crisis regulatory reforms, many of which came from the passage of the well-known Dodd-Frank Act (DFA). After the financial crisis of 2007–2009, the U.S. banking system suffered from low capital positions and substantial risk exposures due to deteriorating macroeconomic conditions. In 2010, the DFA required that all BHCs with total consolidated assets exceeding $50 billion and non-bank financial institutions that

are deemed systemically important by the Financial Stability Oversight Council be subject to the annual stress tests conducted by the Federal Reserve. Supervisory stress tests involve estimation of banks' expected capital levels according to their fundamentals under the baseline and various adverse economic scenarios (Hirtle & Lehnert 2015), while allowing for simultaneous assessment and comparison of exposures across banks (Hirtle et al. 2009). The results are then disclosed to the public and banks that fail the stress tests are subject to corrective actions.

The first stress test under the SCAP was launched by the Federal Reserve System in 2009 in response to the 2007–2009 financial crisis. The SCAP is a forward-looking exercise, which departs from traditional supervisory exercises based on backward-looking information. The purpose of the SCAP is to assess additional capital buffer that is deemed necessary to maintain credit supply under deteriorating economic conditions. All BHCs with assets exceeding $100 billion were subject to the stress test. Their revenues, expenses, losses, and capital ratios were projected under several economic scenarios. The outcomes of the stress test were disclosed to the public in May 2009. These include BHCs' Tier 1 capital, Tier 1 common capital and risk-weighted assets as of year-end 2008. Then, the capital levels for year-end 2010 were estimated on the basis of projections of banks' fundamentals under adverse scenarios.[3] The BHCs involved in the stress test were expected to have the Tier 1 risk-based capital and the Tier 1 common capital ratios at the end of 2010 above the supervisory benchmarks of 6% and 4%, respectively. The required SCAP additional capital buffer, which is the difference between the supervisory capital benchmark and the capital level estimated under the adverse scenario, was also included in the public release.

The results of the SCAP suggested that the aggregate capital needed for the 19 BHCs to meet the SCAP requirements was $185 billion, the majority of which was in the form of Tier 1 common capital. The aggregate supplemental capital needs were $75 billion after adjusting for the operating performance of the first quarter of 2009 for ten BHCs that were deemed insufficiently capitalized. Banks with an insufficient capital buffer were required to submit plans, which include

[3] Such banks' fundamentals comprise the following variables: pre-provision net revenues, losses on different loan categories, securities and trading positions, and allowance for loan and lease losses for 2009 and 2010.

details regarding how the capital buffer gap problem would be addressed. Nine out of ten BHCs that failed the stress test subsequently managed to raise sufficient capital privately. The substantial recapitalization of BHCs following the SCAP was widely regarded as a success of post-crisis regulatory actions in improving financial health of the U.S. banking system.

From 2011, the Federal Reserve started conducting the annual CCAR for the same BHCs that participated in the SCAP with an aim to determine if large U.S. banks had sufficient capital to withstand negative economic shocks and maintained credit lending under adverse conditions. From 2014, the stress test expanded to all BHCs with total consolidated assets of $50 billion or more. The CCAR requires participating BHCs to submit their internal stress test results and capital plans. The BHCs also go through a qualitative review of their risk management and internal capital planning processes. The quantitative assessment of CCAR requires that BHCs' capital ratios must be maintained at or above the regulatory levels. The capital plans of BHCs submitted to the authority describe details of their capital adequacy assessing processes, intended capital actions and distributions (e.g., dividend payments, capital issuances, and repurchases) for the next nine quarters. With BHCs' planned capital actions, the Federal Reserve System carries out the stress tests to project revenues, expenses, losses, and post-stress capital ratios for each bank under the three defined scenarios (i.e., 'baseline', 'adverse', and 'severely adverse'). The scenarios place more emphasis on the system-wide rather than the idiosyncratic risks of banks with an aim to reduce the likelihood of banks collectively facing constraints on capital under severe economic conditions. The ability of banks to maintain the post-stress capital ratios above the regulatory requirements is assessed by the Federal Reserve. The outcome of the CCAR is determined by the Federal Reserve System, taking into consideration the stress test results and the qualitative assessments of the banks' capital plans. In the CCAR, the Federal Reserve can object to a bank's capital plan and distributions on either quantitative or qualitative grounds or both. The objection of the plan may lead to restrictions in the distributions of bank capital, such as share repurchases or dividend payments.

Overall, the purpose of stress testing exercises is to provide a comprehensive

assessment of capital adequacy and incentives for banks to undertake better risk management practices. Stress tests also take into account macroprudential risks in the assessment of bank capital positions, which depart from traditional supervision and regulation practices that involve setting capital rules that place more emphasis on bank idiosyncratic risks. By requiring banks to operate with sufficient capital buffers so that their financial intermediation function in stressed economic scenarios is maintained, it is argued that stress testing promotes the resilience of BHCs and reduces the systemic risk of the entire financial system in U.S.

2.3 Literature review and hypothesis development

2.3.1 Literature on stress testing models

The literature on stress tests is relatively new and still growing. Several recent papers highlight the importance of stress tests as a supervisory tool and evaluate the costs and benefits of different design choices (see, for example, Hirtle & Lehnert 2015, Schuermann 2014, and references therein). Other studies attempt to develop alternative models and approaches to carry out stress tests (see, among others, Acharya, Engle & Pierret 2014, Covas, Rump & Zakrajsek 2014, Kapinos & Mitnik 2016, Kupiec 2018). Recent theoretical contributions focus on how stress tests can affect bank lending (Shapiro & Zeng 2018) and how to develop an optimal disclosure policy for the stress test results (Leitner & Williams 2018). The latter topic is very important because of a debate on whether disclosing the results of stress tests enhances financial stability. For example, while Goldstein & Sapra (2014) argue that disclosure of the stress test results promotes financial stability but may worsen inefficiencies of individual banks. In this regard, Corona et al. (2017) suggest that it may lead to excessive bank risk-taking and an increase in bank failures.

2.3.2 Stress tests and market implications

Recent empirical research on the impact of stress tests mostly relies on event studies to investigate the information content of stress tests and their financial

market implications. Studying the events related to the SCAP, Morgan et al. (2014) show that stress test banks with larger capital deficiencies experience more negative abnormal returns. Fernandes et al. (2020) examine the price and trade reactions around the stress tests and document positive market reactions to the test announcements. Similarly, Flannery et al. (2017) find that stress tests provide information not only about the participating BHCs but also the fundamentals of the banking industry. Studies using data on European banks also confirm that stress tests offer valuable information to market participants (Petrella & Resti 2013) and may help the market detect fragile banks (Carboni et al. 2017).[4] Finally, several recent studies focus on the potential spillover effects of the release of the stress test results – either to other banks or to sovereigns (Breckenfelder & Schwaab 2018, Goncharenko et al. 2018).

2.3.3 Stress tests, bank capital and lending

As the consequence of failing stress tests can be severe, stress tests are likely to influence the behavior of participating banks. An emerging strand of literature attempts to quantify the effects of stress tests on bank credit provision and loan pricing (Acharya et al. 2018, Berrospide & Edge 2019, Calem et al. 2019, Connolly 2018, Cortés et al. 2020, Lambertini & Mukherjee 2016), capital ratios (Cornett et al. 2020), loan loss provisions and non-performing loans (Shahhosseini 2015), risk taking (Pierret & Steri 2018), and entrepreneurship and innovation (Doerr 2019). Other studies (see Bindal, Bouwman, Hu & Johnson 2020, Bordo & Duca 2018, Bouwman, Hu & Johnson 2018, Kovner & Van Tassel 2018) focus on the impact of the DFA on banks conduct, merger and acquisition behavior, and lending and the cost of capital. Studies focusing on European banks find that anticipation of stress tests can lead banks to reduce their risk-weighted assets instead of raising their levels of equity to increase capital ratios (Eber & Minoiu 2017, Gropp et al. 2018). A summary of the literature documenting the effects of stress tests on banks' behavior is given in Table A1 of the Appendix.

[4] However, these findings are at odds with the results provided by Lazzari et al. (2017).

2.3.4 Hypotheses development: Impact of stress tests on bank liquidity creation

Banks that participate in the stress tests are required to have more capital relative to their credit risk exposure. Higher capital ratios can be achieved by reducing credit supply and substituting loans with relatively safer assets such as Treasury securities, especially when raising capital is costly (Acharya et al. 2018, Berger & Udell 1994, Brinkmann & Horvitz 1995, Thakor 1996). Higher capital ratios induced by the stress tests can also affect bank lending through other channels. Thakor (1996), among others, maintains that tighter capital requirement leads to increased banks' funding costs. Higher capital reduces creditors' risk which could result in weakened market discipline, reduced monitoring incentive, and increased costs of funding (Calomiris & Kahn 1991). With limited ability to pass these costs to borrowers due to competition, lending becomes less attractive to banks. For this reason, tighter capital requirements result in credit contractions. Supporting this view, De Jonghe et al. (2020) find evidence that higher capital requirements correspond to lower credit supply to firms and this credit contraction largely affects risky borrowers. Furthermore, as stress test banks are required to hold more capital against their risky lending, they may reduce moral hazard, induced by limited liability or government protection/guarantee, by restricting credit supply to risky borrowers (Acharya, Mehran & Thakor 2016, Berger & Bouwman 2013). In other words, the risk-management hypothesis predicts that the higher capital requirement of the stress tests may lead to the adjustment of banks' portfolios that involves reductions in lending activities – particularly to risky borrowers (Acharya et al. 2018). Since credit lending is a key component of liquidity creation, bank liquidity creation declines as a result.

On the other hand, the moral hazard hypothesis suggests that requiring certain BHCs to participate in the stress tests may increase the moral hazard incentives of banks to take on more credit risk as these BHCs may be deemed systemically important to maintain a healthy banking industry (Acharya et al. 2018). Also, stress test banks may have lower returns as a result of increased capital and may engage in reaching-for-yield behavior by expanding credit lending to riskier borrowers (Acharya et al. 2018). Furthermore, it is argued that as capital enhances

banks' safety and resilience, higher capital buffers as a consequence of the new regulatory framework are likely to improve their ability to expand credit provision (Berger & Udell 1994, Berger & Bouwman 2009, Bhattacharya & Thakor 1993, Coval & Thakor 2005). In a recent paper, Bahaj & Malherbe (2018) predict that the positive relationship between capital requirements and provision of credit is more likely at high levels of capital where banks have a low probability of failure. Although higher capital requirement reduces the value of implicit subsidy from a government guarantee, the extent to which the marginal loan is subsidized can increase, which leads to a lower marginal funding cost and increased bank credit lending. Similarly, higher capital can reduce banks' costs of funding, especially wholesale funding which is more sensitive to banks' risk (Berger & Bouwman 2013), improve banks' access to the risky debt markets (Carlson et al. 2013), thereby increasing the provision of credit (Chu et al. 2019). Higher capital can also strengthen market discipline, providing stronger incentives for banks to monitor borrowers (Mehran & Thakor 2011). These lead to improved credit access for borrowers. As a consequence of increased credit provision, bank liquidity creation may increase in response to regulatory stress tests.

Theories on the role of regulatory capital on bank liquidity creation yield conflicting predictions. Liquidity creation can be related to regulatory capital in two opposing ways. First, according to the 'financial fragility – crowding out' hypothesis, the relationship between liquidity creation and capital is negative. As banks gather funds from depositors to issue loans, they are inherently fragile, because they are exposed to the risk of bank runs in the absence of complete deposit insurance (Diamond & Rajan 2000, 2001). With the informational advantage obtained from monitoring borrowers, the bank may extract rents from depositors, withhold monitoring or repayment collection efforts. Given the agency problem between the bank and depositors, depositors may be reluctant to provide funds. Therefore, such fragility is necessary because threats of premature withdrawal of demand deposits act as a disciplinary device (Calomiris & Kahn 1991). This fragility commits the banks to monitor borrowers and collect repayments, allowing them to create liquidity by granting more loans with more deposits. Because a higher capital ratio reduces the probability of financial distress, regulators can

impose capital requirements to reduce fragility in the banking system. However, capital requirements, if binding, force banks to shift from deposit holdings to equity (Gorton & Winton 2000). Since deposits are liquid liabilities, liquidity creation decreases eventually.

On the contrary, the 'risk absorption' hypothesis points to a positive relationship between bank capital and liquidity creation. Bank risk increases with liquidity creation because it increases the expected loss resulting from sales of illiquid assets for liquidity reasons (see, among others, Allen & Gale 2004, Allen & Santomero 1997). In other words, given the mismatch between liquid liabilities and illiquid assets, the more liquidity banks create, the higher default risk they may face. Therefore, banks' liquidity creation increases their exposure to the risk of being unable to satisfy unexpected liquidity demands from customers and the associated losses of liquidating illiquid assets to meet such demands. For this reason, banks need to hold more capital to improve their solvency, which may allow them to obtain external funding on short notice or at lower costs. In addition, since well-capitalized banks tend to have higher risk absorption capacity, they are in a stronger position to create liquidity (Bhattacharya & Thakor 1993, Repullo 2004, von Thadden 2004, Coval & Thakor 2005). A recent study by Donaldson et al. (2018), which does not provide support for either hypothesis, shows that higher capital ratios enhance bank liquidity creation.

Following these two competing theories, regulatory stress tests may either increase or reduce bank liquidity creation. This leads to two alternative hypotheses to be tested in this chapter:

> **Hypothesis 1: Risk-management/crowding out hypothesis** – Regulatory stress tests have a negative impact on bank liquidity creation.

> **Hypothesis 2: Moral hazard/risk absorption hypothesis** – Regulatory stress tests have a positive impact on bank liquidity creation.

2.4 Data and variables

2.4.1 Data

We collect data from a number of sources. Financial data is obtained from the Consolidated Financial Statements for BHCs (FR-Y9C). Bank liquidity creation measures are obtained from Christa Bouwman's website.[5] All variables are aggregated to the highest holder level. Our sample period starts in 2007Q1 and ends in 2016Q4. The 19 BHCs considered for the SCAP are: Ally Financial Inc, American Express Company, Bank of America Corporation, Bank of New York Mellon Corporation, BB&T Corporation, Capital One Financial Corporation, Citigroup Inc., Fifth Third Bancorp, Goldman Sachs Group, Inc., JPMorgan Chase & Co., KeyCorp, Metlife Inc., Morgan Stanley, PNC Financial Services Group Inc., Regions Financial Corporation, State Street Corporation, Suntrust Banks Inc., U.S. Bancorp, and Wells Fargo & Company.

Metlife Inc. did not participate in the 2013 CCAR as its commercial banking division was sold out and was not deemed a BHC in 2012. The 2014 CCAR was expanded to all BHCs with total assets exceeding $50 billion, increasing the total number of eligible BHCs, which were subject to the stress tests to 30. The new 12 BHCs include: BBVA Compass Bancshares Inc., BMO Financial Corp., Comerica Incorporated, Discover Financial Services, HSBC North America Holdings Inc., Huntington Bancshares Incorporated, M&T Bank Corporation, Northern Trust Corporation, RBS Citizens Financial Group Inc., Santander Holdings USA Inc., UnionBanCal Corporation, and Zions Bancorporation. The 2015 CCAR added Deutsche Bank Trust Corporation to the list of stress test banks. BancWest and TD Group were included in the 2016 CCAR. Metlife Inc. is removed from the sample as it is an insurance company and not comparable to other BHCs. This study relies on the website of the Federal Reserve's National Information Center to identify BHCs with assets greater than $20 billion as non-stress test banks.[6] The complete list of stress test banks over the sample period is provided in Table A2 of the Appendix.

[5] We would like to thank Christa Bouwman for making these data available in the public domain. For details, see https://sites.google.com/a/tamu.edu/bouwman/data.

[6] See, www.ffiec.gov/nicpubweb/nicweb/nichome.aspx.

2.4.2 Liquidity creation measures

Our liquidity creation measures are based on the methodology proposed by Berger & Bouwman (2009). Specifically, liquidity creation (LC) is defined as the 'cat fat' liquidity creation measure and accounts for both on-balance sheet and off-balance sheet items, which are classified by category. Loan items are classified by category rather than by maturity because for the construction of liquidity creation measures, loan maturity is less important than the ability of banks to securitize and sell loans. LC measure is further broken down into on- and off-balance sheet liquidity creation measures as Berger & Bouwman (2009) find that, for large banks, half of the liquidity is created off the balance sheet. We utilize $LCON$, which is the liquidity creation measure that only includes on-balance sheet items and $LCOFF$, which is the off-balance sheet component of LC. Furthermore, we employ LCA and LCL, which are the asset and the liability components of liquidity creation, respectively. All the measures of liquidity creation are normalized by gross total assets, denoted by GTA. Table A3 in the Appendix provides details of the construction of liquidity creation measures.

2.4.3 Explanatory variables

We define *Stress* as a dummy variable for the treatment status which equals 1 if a bank is in the stress test group and 0 otherwise. As there was no stress test in 2010, *Stress* takes the value of 0 for all banks in that year. *Assignment* represents the distance between a bank's size (natural logarithm of gross total assets) and the cutoffs (normalized by natural logarithm).

2.4.4 Control variables

To control for bank-specific characteristics, a number of bank control variables are included in the liquidity creation regressions. One of them is the bank size ($SIZE$), which is the natural logarithm of gross total assets. It is important to account for credit risk as it helps to isolate the effect of capital on liquidity creation from the role of capital in supporting the risk transformation function of banks (Berger & Bouwman 2009). We proxy for credit risk using the ratio of non-performing

loans to total loans (NPL) as in Du & Palia (2018). We also control for bank capitalization, denoted by CAP, which is measured by the ratio of equity to total assets (Berger & Bouwman 2009). To account for bank profitability, we use return on equity (ROE), which is the ratio of net income to equity (Casu et al. 2019). In robustness checks, we further include banks with foreign parents. The information about foreign banks can be found on the website of the Federal Reserve's National Information Center. The definitions of the variables used in our empirical analyses are given in Table 2.1.

Table 2.1: Variable definitions

Variables	*Notation*	*Definitions*	*Data source*
Dependent variables			
Liquidity creation	*LC*	Total amount of 'cat fat' liquidity creation normalized by gross total assets. This liquidity creation measure classifies loans according to category and includes off-balance sheet items.	Bouwman's website
	LCON	Total amount of 'cat nonfat' liquidity creation normalized by gross total assets. This liquidity creation measure classifies loans according to category and excludes off-balance sheet items.	Bouwman's website
	LCOFF	Total amount of 'fat' liquidity creation normalized by gross total assets. This measures off-balance sheet liquidity creation.	Bouwman's website
	LCA	Asset-side liquidity creation	Bouwman's website
	LCL	Liability-side liquidity creation	Bouwman's website
Explanatory variables			
	Stress	Dummy taking value 1 if a bank is in the stress test group and 0 otherwise.	Federal Reserve's SCAP & CCAR reports
	Assignment	Distance between bank size (natural logarithm of gross total assets) and the normalized cutoffs.	FR-Y9C
Control variables			
Bank size	*SIZE*	Natural logarithm of gross total assets	FR-Y9C
Bank capitalization	*CAP*	Equity to total assets	FR-Y9C
Return on equity	*ROE*	Net income to equity	FR-Y9C
Non-performing loans	*NPL*	Total non-performing loans to total loans	FR-Y9C

2.4.5 Data description

Table 2.2 reports the descriptive statistics for the liquidity creation measures as well as the control variables of interest. The average liquidity creation, LC, appears to be 54.44%, while the averages of $LCON$ and $LCOFF$ are 26.34% and 28.10%, respectively. Consistent with Berger & Bouwman (2009), who find that for large banks half of the liquidity is created off the balance sheet, the mean value of $LCOFF$ in our sample is greater than that of $LCON$. It can be seen from Table 2.2 that the average of LCL is 20.33%, which is much higher than the average of LCA (6.01%), suggesting that the banks in our sample appear to create more liquidity on the liability side than on the asset side of the balance sheet. As for the control variables, the average of return on equity, ROE, is 4.39%. Table 2.2 also shows that the average capital ratio, CAP, of the banks over the sample period is 10.95%, while the mean of non-performing loans to total loans ratio, NPL, is 2.36%.

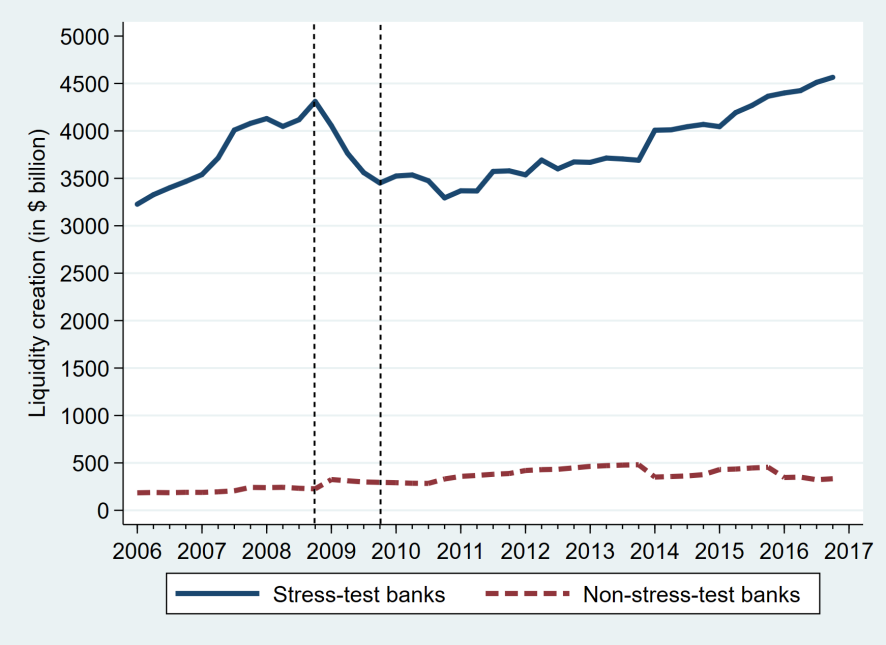
Figure 2.1 plots the evolution of LC, over time, for the stress test banks and the non-stress test banks. The graph shows a marked reduction in LC from around \$4,300 billion in 2008:Q4 to \$3,500 billion in 2009:Q4 for the stress test banks, but not for the non-stress test banks. Such a pattern, however, is not clear in the following periods. For this reason, in the subsequent econometric analysis we present tests that exclude the first stress testing exercise to ensure the robustness of our results.

Table 2.2: Summary statistics

Variable	*Mean*	*S.D.*	*Min*	*Max*	*Obs.*
Dependent variables					
LC	0.5444	0.3362	-0.2744	2.3620	1397
LCON	0.2634	0.1975	-0.4579	0.6433	1397
LCOFF	0.2810	0.3373	-0.0233	2.3704	1397
LCA	0.0601	0.1523	-0.3849	0.3851	1397
LCL	0.2033	0.1030	-0.2005	0.3945	1397
Explanatory variables					
Stress	0.5175	0.4999	0.0000	1.0000	1397
Assignment	0.3732	1.4175	-1.7158	3.9424	1397
CAP	0.1095	0.0240	0.0456	0.2134	1397
NPL	0.0236	0.0209	0.0000	0.1418	1397
ROE	0.0439	0.0605	-0.5396	0.2919	1397
SIZE	18.5234	1.4072	16.7049	21.6700	1397

The table reports summary statistics of all variables for the period 2007–2016. *LC* is the liquidity creation. *LCON* is the on-the balance sheet liquidity creation measure. *LCOFF* is the off-balance sheet liquidity creation. *LCA* and *LCL* denote asset and liability components of liquidity creation, respectively. *Stress* is the dummy equal to 1 if the bank is subject to the stress test and 0 otherwise. *Assignment* represents the distance between bank size (natural logarithm of gross total assets) and the normalized cutoffs. *ROE* is the return on equity, *SIZE* is the natural logarithm of gross total assets, *CAP* is the equity to total assets, and *NPL* is the total non-performing loans to total loans.

Figure 2.1: Liquidity creation over time



The figure shows the dollar amount of total liquidity creation of stress test banks and non-stress test banks from 2006:Q1–2016:Q4. All dollar values are expressed in 2016 dollars. The solid line refers to stress test banks and the dashed line represents non-stress test banks.

2.5 Empirical results

2.5.1 Univariate analysis

The results of the univariate analysis for the differences in the means and the medians of the main variables of the banks in the sample are reported in Table 2.3. The empirical examination includes all stress test and non-stress test banks in sample. Following Cornett et al. (2020), we divide our sample into three subperiods: year 2007, which is the year before the financial crisis and before the stress testing exercises; year 2009, which is the first year of the stress testing program; and the 2009–2016 period, which includes data for the full-sample. Once a BHC is classified as a stress test bank in a particular year, its quarterly observations in that year are included in the stress test category.

Table 2.3 shows that in 2007, which is the year before the stress tests, the BHCs that go into the stress test in 2009 have higher liquidity creation ratios than non-stress test banks. For example, the LC ratios are 92.19% for stress test

banks versus 47.78% for non-stress test banks. Similarly, *LCOFF* ratios are 71.07% and 17.78% for stress test banks and non-stress test banks, respectively. This is consistent with the finding of Berger & Bouwman (2009) that large banks create more than half of their liquidity off the balance sheet. Nevertheless, non-stress test banks as a group appear to have a higher average *LCON* ratio than stress test banks (29.99% versus 22.12%). Stress test banks also have a lower average *LCA* ratio (7.73%) in comparison with non-stress test banks (14.7%).

In 2009, which is the first year of stress testing, non-stress test banks see no significant changes in the liquidity creation ratios when comparing column (5) to column (1). As for stress test banks, by comparing column (7) to column (3), it can be seen that their liquidity creation ratios have been significantly reduced during 2007 and 2009. Notably, the mean of *LC* in 2007 for stress test banks is 92.19%, which decreases to 59.61% in 2009. Similarly, both *LCON* and *LCOFF* ratios also decrease from 21.12% to 14.49% and from 71.07% to 45.12%, respectively, and both are statistically significant at the 10% and the 5% levels, respectively. Stress test banks appear to cut down their asset-side liquidity creation, *LCA*, from 7.73% in 2007 to 1.14% in 2009. The difference between the two estimates is statistically significant at the 5% level.

Table 2.3: Univariate analysis of stress test and non-stress test banks

	2007				*2009*				*2009-2016*			
	Non-stress test		*Stress test*		*Non-stress test*		*Stress test*		*Non-stress test*		*Stress test*	
	Mean	*Median*	*Mean*	*Median*	*Mean*	*Median*	*Mean*	*Median*	*Mean*	*Median*	*Mean*	*Median*
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
LC	0.4778	0.4938	0.9219***	0.6995***	0.5819	0.4365*	0.5961***	0.5234**	0.5225	0.5147	0.5181***	0.5572**
LCON	0.2999	0.3276	0.2112**	0.2902	0.2767	0.2998	0.1449*	0.1965	0.3469*	0.3641	0.1867	0.2495
LCOFF	0.1778	0.1787	0.7107***	0.3615***	0.3052	0.1361***	0.4512**	0.2327**	0.1756	0.1342***	0.3314***	0.2185***
LCA	0.1470	0.1632	0.0773**	0.1235**	0.1312	0.1469	0.0114**	0.0439	0.1043*	0.1234*	0.0010***	0.0429
LCL	0.1529	0.1660	0.1338	0.1470*	0.1455	0.1595	0.1335	0.1420	0.2426***	0.2586***	0.1857***	0.1892***

The table reports the univariate analysis for stress test and non-stress test banks. Columns (3) and (4) test if the mean and median values of the variables are significantly different from those in columns (1) and (2), respectively. Columns (5) and (6) test if the mean and median values of the variables are significantly different from those in columns (1) and (2), respectively. Columns (7) and (8) test if the mean and median values of the variables are significantly different from those in columns (3) and (4), respectively. Columns (9) and (10) test if the mean and median values of the variables are significantly different from those in columns (1) and (2), respectively. Columns (11) and (12) test if the mean and median values of the variables are significantly different from those in columns (3) and (4), respectively. *LC* is the liquidity creation, *LCON* is the on-the balance sheet liquidity creation measure, *LCOFF* is the off-balance sheet liquidity creation, *LCA* is the asset component of liquidity creation, and *LCL* is the liability component of liquidity creation. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Comparing the results for 2007 (column (1)) and the period between 2009 and 2016 (column (9)), there are no significant changes in the total liquidity creation ratio, LC, for non-stress test banks, while there is a marginal increase in the liquidity creation on the balance sheet, $LCON$ (34.69% versus 29.99%). In contrast, when comparing column (11) to column (3), stress test banks appear to have a lower liquidity creation, LC, on average during 2009–2016, decreasing from 92.19% in 2007 to 51.81%. The $LCOFF$ ratio also falls from 71.07% in 2007 to 33.14% (also statistically different at the 1% significance level). Similarly, there is a decrease in the asset-side liquidity creation, LCA, to 0.1% in 2009–2016 (also statistically different at the 1% significance level). However, the liability-side liquidity creation, LCL, appears to increase during 2009–2016 to 18.57% in comparison with 13.38% in 2007 (again, statistically different at the 1% significance level). Overall, it appears that stress test banks reduce their liquidity creation as they enter the stress test, while no significant changes are observed for non-stress test banks.

Table A4 of the Appendix further presents the univariate analysis for the differences in the means of bank balance sheet items. When comparing columns (4) and (6) to column (2), the results suggest that stress test banks reduce illiquid assets following the stress tests. For example, in 2009 and during the 2009–2016 period, the ratios of commercial real estate loans, loans to finance agricultural production, commercial and industrial loans, and intangible assets and premises are smaller than those in 2007. The table also shows an increase in saving deposits ratio of stress test banks after the stress tests. As saving deposits are more liquid and tend to account for a large proportion of banks' total liquid liabilities, the finding is consistent with the reported increase in stress test banks' LCL. Finally, by comparing column (6) to column (2), there is evidence that stress test banks reduce illiquid off-balance sheet items (e.g., unused commitments, net standby letters of credit, and commercial and similar letters of credit), while increase more liquid components (e.g., interest rate derivatives and foreign exchange derivatives) following the stress tests.

2.5.2 Regression discontinuity design

We exploit the Federal Reserve System's selection criterion for the stress tests as an exogenous source of variation to estimate the causal impact of stress tests on bank liquidity creation. Banks are selected on the basis of their size, and therefore stress test banks do not have counterparts that are not part of the stress test (Acharya et al. 2018, Cornett et al. 2020). In other words, the treatment status, which is conditional on bank size, is not driven by the outcome variables. This set-up allows us to employ a regression discontinuity (RD) approach to investigate the effect of regulatory stress tests on bank liquidity creation. The RD setting requires a known cutoff of a running variable in order to determine the treatment. The regulatory rule that obligates certain banks to participate in the stress tests provides a natural threshold and allows us to exploit the cross-sectional variation in the liquidity creation of stress test banks and non-stress test banks. The BHCs with total assets below the threshold fall naturally into the control group, while the treatment group consists of BHCs with total assets exceeding the threshold and therefore are subject to regulator stress tests.

The RD method focuses on the treatment effect induced by the variation in the treatment assignment around the cutoff and overcomes the effects of other potential confounders. The average effect of the treatment on banks that are close to the cutoff can be obtained by comparing the average outcomes of observations just below and above the threshold.[7] That is, the liquidity creation of banks just above the size cutoff subsequent to entering the stress tests is compared to the liquidity creation of banks that are exempt from the tests. In the absence of treatment, banks belonging to the treatment and the control groups are assumed to behave in a similar way. The identification strategy assumes that the assignment/running variable cannot be manipulated around the known threshold (see Lee & Lemieux 2010). In other words, the validity of our RD estimation method rests on the assumption that banks do not have control over whether they are over the size limits or not, which in turn, determines whether or not they are subject to the stress tests.[8]

[7] Cornett et al. (2020) also use a RD approach to examine bank behavior around Federal Reserve stress tests.

[8] The first round of the stress tests was announced and conducted in 2009. Participated banks

In this chapter, the local linear regression discontinuity is estimated non-parametrically, following Hahn et al. (2001), using the data closer to the cutoffs of $100 billion and $50 billion. The use of non-parametric approach is to mitigate the risk of misspecification, which is common in parametric analysis. The empirical approach is appealing as it reduces the bias arising from using the data farther away from the cutoff to estimate the discontinuity at the cutoff and the variation in the liquidity creation of banks near the size limits is attributable to the effect of the stress tests. The regression takes the following specification (see Lee & Lemieux 2010, Roberts & Whited 2013):

$$Y_{it} = \alpha + \beta_1 Stress_{it} + \beta_2 Assignment_{it} + \beta_3 (Stress_{it} \times Assignment_{it}) + \delta X_{it} + \upsilon_i + \gamma_t + \epsilon_{it}, \tag{2.1}$$

where Y_{it} is a proxy for bank liquidity creation for bank i at time t. The dummy variable, $Stress_{it}$, defines the treatment status and equals 1 if a bank is in the stress test group and 0 otherwise. As there was no stress test in 2010, $Stress_{it}$ takes the value of 0 for all banks in that year. The variable, $Assignment_{it}$, represents the distance between bank i's size (natural logarithm of gross total assets) and the cutoffs (normalized by natural logarithm). The interaction term, $Stress_{it} \times Assignment_{it}$, is included to capture the possible differences in the slope of the regression on both sides of the cutoff as explained in Bonner & Eijffinger (2016). X_{it} is a vector of control variables, and υ_i and γ_t represent bank fixed effects and time fixed effects, respectively.[9] In our regression discontinuity estimations, robust standard errors are clustered at the bank level. We exclude bank size, *SIZE*, from the RD regressions because of its high correlation with the *Assignment* variable.

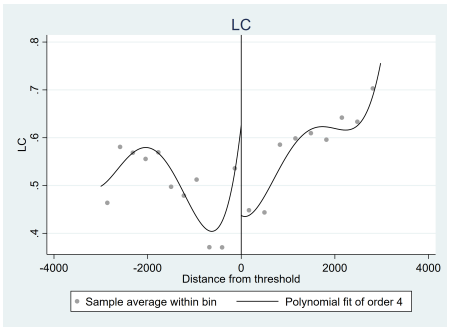
Choosing a bandwidth in the local linear non-parametric RD model involves a

were those whose total assets exceed $100 billion in 2008. The $100 billion and the $50 billion size requirements in 2009 and in 2014, respectively, were determined by the Federal Reserve System rather than BHCs. Therefore, it can be argued that banks had no control over whether it is in or out of the stress test group.

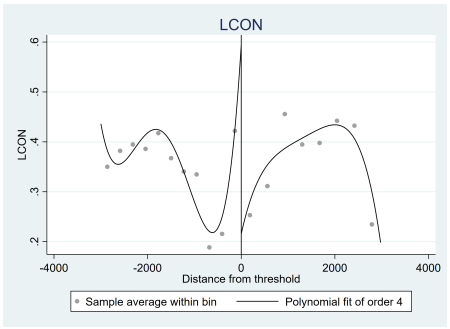
[9] Bank fixed effects are included to take into account unobserved heterogeneity across banks in our sample. In particular, bank fixed effects wipe out unobserved time-invariant bank characteristics affecting bank liquidity creation. The main variation across banks comes from two sources: the bank fixed effects and the effects of participating in the stress tests. However, this is not a cause for concern as these two effects are not perfectly linearly correlated. For example, in 2009, 2011, and 2012, the same 15 out of 34 banks did not participate in the stress tests – representing around 44% of the sample of the stress test banks. In 2013, Metlife Inc., dropped out of the sample for the stress test banks and was the only BHC not participating in the stress test in 2016.

bias-variance trade-off. On the one hand, a smaller bandwidth uses a fewer number of observations around the cutoff, thereby reducing the potential estimator's bias that arises from specifying an incorrect functional form. But this comes at the expense of reduced statistical precision due to a smaller sample size. On the other hand, a wider bandwidth employs more observations, thus improving estimation precision at the expense of increased risk of bias. While there are a variety of approaches for choosing the optimal bandwidth for the RD model in the literature, the selection of bandwidth remains a subjective decision. It is, therefore, suggested that the best practice is to experiment with different bandwidths to demonstrate the robustness of the findings (Roberts & Whited 2013). In this chapter, the RD estimation is implemented using the optimal mean squared error (MSE-optimal) bandwidth that minimizes the mean square error following Imbens & Kalyanaraman (2012). As the choice of weighting kernel has been shown to have negligible impact on estimation in practice, we use the rectangular kernel as the weighting kernel.

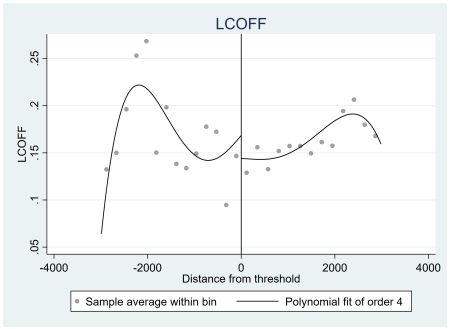
Figure 2.2: Regression discontinuity estimation using bank size to assign the treatment group



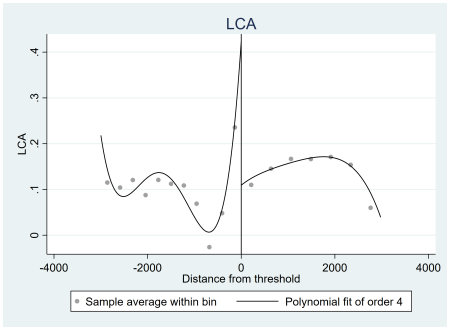
(a) RD Plot: LC



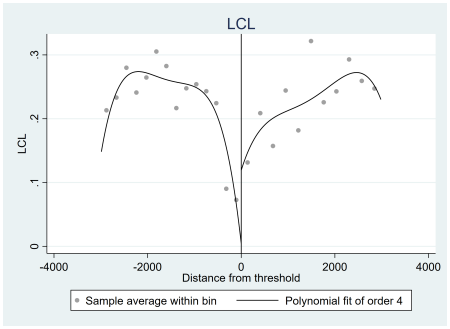
(b) RD Plot: LCON



(c) RD Plot: LCOFF



(d) RD Plot: LCA



(e) RD Plot: LCL

The figure shows the regression discontinuity (RD) results using a non-parametric approach that estimates the change in bank liquidity creation given that the bank is in the treatment group (stress test banks). The purpose is to show whether there is discontinuity in banks' measures of liquidity creation at the size cutoff ($100 billion or $50 billion). Distance from threshold is expressed in $ ten million. *LC* is the liquidity creation, *LCON* is the on-the balance sheet liquidity creation measure, *LCOFF* is the off-balance sheet liquidity creation, *LCA* is the asset component of liquidity creation, and *LCL* is the liability component of liquidity creation. Observations to the left (right) of the threshold belong to control group (treatment group).

Graphical analysis

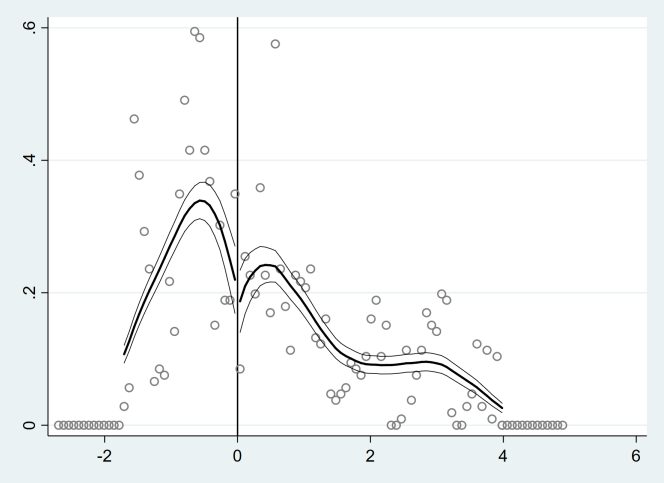
Figure 2.2 plots the discontinuity estimates at the threshold for bank liquidity creation measures. The x-axis measures the distance between banks' size at the cutoff. Banks with size above the cutoff are to the right of the threshold, while those below the cutoff are to the left. The lines represent the fitted regression lines for models, which include up to the fourth-order polynomial term. Figure 2.2 shows a clear discontinuity in bank liquidity creation measures at the cutoff. Specifically, within the proximity of the cutoff, stress test banks have lower total liquidity creation ratio, LC, than non-stress test banks. Similarly, other liquidity creation ratios ($LCON$, $LCOFF$, and LCA) of stress test banks are also lower than those of non-stress test banks, pointing to the negative impact of stress testing on bank liquidity creation. In contrast, the figure illustrates that the liability-side liquidity creation ratio, LCL, of stress test banks is higher than that of non-stress test counterparts.

Regression discontinuity estimation

We use a RD approach that exploits the bank size cutoff and separates stress test banks from non-stress test banks. By comparing banks around this cutoff, we can identify the effect of regulatory stress tests on U.S. bank liquidity creation. As mentioned earlier, the RD method assumes that banks in the vicinity of the threshold cannot manipulate the treatment status. This requires that the density of the running variable be continuous around the threshold. We follow the methodology proposed by McCrary (2008) to test for the discontinuity of the density of the running variable. Figure 2.3 plots the density of the running variable (in our case, *Assignment*). The x-axis represents the distance of banks' size from the stress test threshold and the y-axis represents the density of the running variable. The dots depict the density and the solid line represents the fitted density function of the running variable with a 95% confidence interval around the fitted line. A jump in the density at the threshold, if observed, is indicative of discontinuity and manipulations. The figure gives little indication of a strong discontinuity at the threshold. The discontinuity estimate of the density of the running variable is -0.1317 and is statistically insignificant at conventional

levels. Therefore, the null hypothesis that the density of *Assignment* at the cutoff threshold is continuous cannot be rejected. Overall, it appears that banks do not manipulate their size with an aim to avoid being subject to the regulator stress tests.

Figure 2.3: Density distribution of the bank size distance from the stress test threshold



The figure shows the density of the running variable to test for the discontinuity in the running variable following McCrary (2008). The x-axis represents the distance between the bank size and the threshold (*Assignment*) and the y-axis represents the density of the running variable. The dots represent the density and the solid line depicts the fitted density function of the running variable with a 95% confidence interval around the fitted line.

We resort to a non-parametric local linear estimation with a rectangular kernel and the MSE-optimal bandwidth following Imbens & Kalyanaraman (2012). Table 2.4 reports the estimation results for the liquidity creation measures. The variable of interest is *Stress*, which captures the difference between stress test and non-stress test banks. For each of the measures of bank liquidity creation, we show the estimation results with and without control variables. We find that there is a negative and statistically significant discontinuity at the cutoff across all the measures of liquidity creation with the exception of the liability-side liquidity creation, LCL. For example, the estimated coefficients of *Stress* for the total liquidity creation, LC, (columns (1) and (2)) are -0.1161 and -0.1279, respectively, suggesting that banks reduce their liquidity creation when they are subject to the regulatory stress tests. The estimated effects are significant at the 1% significance level. Economically, the estimated coefficient of *Stress* in column (1) indicates that stress test banks reduce LC on average by around 11 percentage points relative to

non-stress test banks. Since the sample mean for LC is around 54 percentage points, this reduction is around 21.4% of the sample mean. In column (2) the estimated reduction is around 23.5% of the sample mean. Considering the coefficient estimate of -0.6225 on *Assignment* and the coefficient estimate of 0.7019 on the interaction term, $Stress \times Assignment$, in column (1), our result suggests that the reduction in LC actually becomes smaller as the bank becomes bigger, provided that the bank is included in the stress tests. In particular, an increase of $(-0.6225 + 0.7019) \times 1.4175 = 0.1125 \approx 11\%$ in the value of LC, evaluated at the sample mean, is associated with an increase of one-standard deviation in *Assignment* for stress test banks. The coefficient on the interaction term is interesting because it indicates that the impact of stress tests on LC is more pronounced for smaller banks closer to the cutoff than bigger banks, located farther away from the size cutoff. Similarly, the coefficient estimates of *Stress* for liquidity creation on the balance sheet, $LCON$, (columns (3) and (4)) are -0.0853 and -0.0914 and are statistically significant at the 5% and 1% levels, respectively.

Stress also reduces bank off-balance sheet liquidity creation. Specifically, the coefficient estimates of *Stress* for the liquidity creation off the balance sheet, $LCOFF$, (columns (5) and (6)) are -0.0362 and -0.0307, respectively (both are statistically significant at the 1% level). These results suggest that stress test banks reduce their off-balance sheet liquidity creation in response to regulatory stress tests, which may be due to the fact that off-balance sheet risk can materialize and contribute to the on-balance sheet risk. This may, in turn, affect the capital ratios of those banks that participate in the stress tests. As can be seen from Table 2.4, the coefficient estimates of *Stress* for the asset-side liquidity creation, LCA, (columns (7) and (8)) are -0.0849 and -0.0764, respectively, both of which are significant at the 1% significance level. These empirical findings are generally in line with Acharya et al. (2018), who document a reduction of credit supply of banks, especially to relatively risky borrowers. Stress test banks may attempt to cut down their risk exposure by shrinking their asset-side liquidity creation in an effort to increase their capital ratios. This is also consistent with Hyun & Rhee (2011) and Gropp et al. (2018), who provide evidence that banks shrink their risky assets instead of issuing new equity to meet higher capital requirements.

Table 2.4: Regression discontinuity estimation for bank liquidity creation

	(1) *LC*	(2) *LC*	(3) *LCON*	(4) *LCON*	(5) *LCOFF*	(6) *LCOFF*	(7) *LCA*	(8) *LCA*	(9) *LCL*	(10) *LCL*
Stress	-0.1161***	-0.1279***	-0.0853**	-0.0914***	-0.0362***	-0.0307***	-0.0849***	-0.0764***	0.1090***	0.1140***
	(0.0352)	(0.0346)	(0.0385)	(0.0306)	(0.0112)	(0.0115)	(0.0257)	(0.0281)	(0.0113)	(0.0120)
Assignment	-0.6225**	-0.5921**	-0.5353*	-0.4950*	-0.1220	-0.1231	-0.0787	-0.0874	0.0820	0.0677*
	(0.2706)	(0.2503)	(0.2971)	(0.2693)	(0.0847)	(0.0724)	(0.1339)	(0.1372)	(0.0535)	(0.0376)
Stress×*Assignment*	0.7019***	0.7021***	0.6358**	0.6181**	0.0688	0.0675	0.2344	0.2410	-0.0516	-0.0776
	(0.2604)	(0.2517)	(0.3069)	(0.2686)	(0.1141)	(0.1069)	(0.1752)	(0.1785)	(0.1248)	(0.0815)
CAP		0.0312		0.1177		-0.3906		-0.4554		-0.2359
		(0.7700)		(0.6863)		(0.6701)		(0.6691)		(0.2918)
ROE		0.1652**		0.1174*		0.0223		0.0059		0.0208
		(0.0747)		(0.0604)		(0.0381)		(0.0578)		(0.0643)
NPL		-0.9096		-1.9502***		0.6803		-0.1841		-2.1713***
		(1.1760)		(0.6244)		(0.6460)		(0.4161)		(0.6050)
Constant	0.4638***	0.4778***	0.2448***	0.2664***	0.2313***	0.2571***	0.0826***	0.1292**	0.1551***	0.2204***
	(0.0076)	(0.0830)	(0.0058)	(0.0698)	(0.0048)	(0.0633)	(0.0162)	(0.0597)	(0.0038)	(0.0296)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	151	151	156	156	173	173	223	223	211	211
Adjusted R^2	0.1683	0.1986	0.1298	0.2391	0.0441	0.0889	0.1959	0.1939	0.3149	0.5647

The table reports the regression discontinuity estimates of change in the measures of bank liquidity creation as a result of the treatment (being included in the stress test group). The results are obtained using a pooled non-parametric approach with the rectangular kernel. All estimations use the optimal bandwidth following Imbens & Kalyanaraman (2012). The variable of interest is *Stress*, which defines the treatment status and is a dummy variable equal to 1 if a bank is in the stress test group and 0 otherwise. *Assignment* represents the distance between bank size (natural logarithm of gross total assets) and the normalized cutoffs. Robust standard errors are clustered at the bank level and reported in parentheses. *LC* is the liquidity creation, *LCON* is the on-the balance sheet liquidity creation measure, *LCOFF* is the off-balance sheet liquidity creation, *LCA* is the asset component of liquidity creation, *LCL* is the liability component of liquidity creation, *CAP* is the equity to total assets, *ROE* is the return on equity, and *NPL* is the total non-performing loans to total loans. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

On the contrary, the coefficient estimates of *Stress* for the liability-side liquidity creation, LCL, (columns (9) and (10)) are both positive (0.1090 and 0.1140, respectively) and statistically significant at the 1% level. The results imply that banks increase their liability-side liquidity creation in response to stress tests. Table A4 in the Appendix shows the univariate analysis of liquid and illiquid components of both on- and off-balance sheet items of stress test and non-stress test banks. It appears that stress test banks increase their savings deposits following the stress tests. Table A5 in the Appendix shows that savings deposits account for a large proportion (around 70–80%) of stress test banks' total liquid liabilities. With a decline in liquidity mismatch as a result of the reduction in asset-side liquidity creation, banks may rely more on stable funding sources, which leads to an increase in liability-side liquidity creation. Furthermore, Cornett et al. (2020) report that stress test banks increase their capital ratios to avoid failing the stress tests. With the improved capital ratios and the reduced probability of default, banks may have incentives to increase liquidity creation on the liability side of the balance sheet. This can subsequently lead to enhanced bank profitability, which may compensate for the forgone profits from the reduced asset-side liquidity creation. Enhanced profitability may also result in increased retained earnings and capital. Consistent with our results, Berger et al. (2016) find that capital support, which improves banks' capital ratios increases bank liability-side liquidity creation. It should be noted that equity is also included in the calculation of liability-side liquidity creation and the increased equity should reduce LCL. Therefore, it is not clear whether or not banks issue more equity in response to regulatory stress tests.

Table 2.5: Regression discontinuity estimation for bank liquidity creation with banks entering the stress tests for the first time

	(1) *LC*	(2) *LC*	(3) *LCON*	(4) *LCON*	(5) *LCOFF*	(6) *LCOFF*	(7) *LCA*	(8) *LCA*	(9) *LCL*	(10) *LCL*
New Stress	-0.0849***	-0.0594***	-0.0587***	-0.0559***	-0.0257***	-0.0043	-0.0536***	-0.0605***	0.0190***	0.0324***
	(0.0138)	(0.0183)	(0.0122)	(0.0174)	(0.0036)	(0.0129)	(0.0081)	(0.0170)	(0.0042)	(0.0109)
Assignment	-0.3952**	-0.4156**	-0.3443	-0.3436*	-0.0370	-0.0484*	-0.1423	-0.1472	0.1122*	0.1016
	(0.1891)	(0.1886)	(0.2036)	(0.1944)	(0.0265)	(0.0255)	(0.1132)	(0.1121)	(0.0599)	(0.0605)
New Stress×Assignment	0.2410*	0.1074	0.1492*	0.1399	0.0730	-0.0822	0.1757*	0.1869**	0.0294	0.0056
	(0.1361)	(0.1686)	(0.0780)	(0.0931)	(0.0467)	(0.0842)	(0.1026)	(0.0839)	(0.0441)	(0.0432)
CAP		-0.5866		-0.5173		0.4460		0.3341		-0.2641
		(1.0386)		(0.8956)		(0.4824)		(0.5031)		(0.2950)
ROE		0.0422		0.1225		-0.1139		0.1030		-0.0306
		(0.1296)		(0.1097)		(0.0945)		(0.0622)		(0.0522)
NPL		-0.8643		0.4371		-1.9625*		-0.3212		-0.4765
		(1.4696)		(0.8854)		(1.0600)		(0.3706)		(0.4388)
Constant	0.5136***	0.5763***	0.2862***	0.3401***	0.2319***	0.1882***	0.0999***	0.0612	0.1939***	0.2227***
	(0.0287)	(0.0909)	(0.0146)	(0.0879)	(0.0208)	(0.0385)	(0.0117)	(0.0464)	(0.0059)	(0.0303)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	136	136	146	146	137	137	158	158	160	160
Adjusted R^2	0.1122	0.0982	0.2332	0.2363	-0.0019	-0.0111	0.1764	0.1991	0.2935	0.2967

The table reports the regression discontinuity estimates of change in the measures of bank liquidity creation as a result of the treatment (being included in the stress test group for the first time). The results are obtained using a pooled non-parametric approach with the rectangular kernel. All estimations use the optimal bandwidth following Imbens & Kalyanaraman (2012). The variable of interest is *New Stress*, which defines the treatment status and is a dummy variable equal to 1 if a bank is in the stress test group for the first time and 0 otherwise. Banks that are subject to the stress tests in subsequent years are excluded from the sample. *Assignment* represents the distance between bank size (natural logarithm of gross total assets) and the normalized cutoffs. Robust standard errors are clustered at the bank level and reported in parentheses. *LC* is the liquidity creation, *LCON* is the on-the balance sheet liquidity creation measure, *LCOFF* is the off-balance sheet liquidity creation, *LCA* is the asset component of liquidity creation, *LCL* is the liability component of liquidity creation, *CAP* is the equity to total assets, *ROE* is the return on equity, and *NPL* is the total non-performing loans to total loans. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 2.5 reports the RD estimation results for those banks that enter the stress tests for the first time. In all regressions, *New Stress* is the dummy variable which is equal to 1 if the bank is required to participate in the stress test in a particular year but not the year before, and is equal to 0 otherwise. Banks that are subject to the stress tests in subsequent years are excluded from the sample. Similar empirical findings are reported indicating that stress tests lead to a reduction in bank total liquidity creation. Specifically, Table 2.5 presents evidence that for those banks that enter the stress tests for the first time, they tend to cut down on asset-side liquidity creation to reduce their risk exposure while adjusting funding activities to increase liability-side liquidity creation. Consistent with prior empirical findings, banks' off-balance sheet liquidity creation is also reduced in response to regulatory stress tests. When controlling for the covariates, the estimated coefficients of *New Stress* remain consistent across the model specifications. Taken together, the empirical results suggest that regulatory stress tests have a positive or negative impact on different components of liquidity creation, but the total effect is negative.

2.5.3 Bank liquidity creation when they enter the stress test for the first time

We have shown that there are differences in liquidity creation measures between stress test versus non-stress test banks. In this subsection, we investigate the change in banks' liquidity creation as they enter the stress tests for the first time. If stress test banks avoid failing the stress tests, we expect that their liquidity creation measures to change as they enter the stress tests. The following regression is estimated using the ordinary least squares (OLS). To improve their chances of passing the stress tests, banks may manage their financial statements, thereby changing their liquidity creation. We follow Cornett et al. (2020) and estimate:

$$Y_{it} = \alpha + \beta_1 First\ Stress_{it} + \delta X_{it} + \gamma_t + \epsilon_{it}, \tag{2.2}$$

where Y_{it} is the measure of bank liquidity creation for bank i at time t. The dummy variable of interest is *First Stress*, which takes a value of 1 if the bank is subject to the stress test in a particular year, but not the year before. X_{it} is a

vector of control variables. All the variables are measured as changes from the periods just before entering into the stress tests to the first year of stress testing. Because the starting point of each of the stress tests is in the third quarter, the focus of the analysis is the changes during the third quarter prior to each of the stress tests and the first year of the stress test. The analysis allows us to identify the difference-in-difference (DiD) between stress test banks and non-stress test banks as they enter the stress tests for the first time. In all of our regressions for this subsection, time fixed effects are included and standard errors are double clustered by both bank and time to control for unobserved heterogeneity within the variables.[10]

Table 2.6 presents the results from the OLS regressions of bank liquidity creation measures as they enter the stress tests for the first time. The variable of interest is *First Stress*, which is equal to 1 if the bank is subject to the stress test in a particular year but not the year before. This allows us to examine the differences in the liquidity creation of non-stress test banks and stress test banks as the latter enters the stress tests for the first time. All the variables are measured as changes from quarter 3 of the year $t-1$ to quarter 3 of year t as the starting point of the stress tests is quarter 3. Controlling for other bank-specific characteristics, the estimated coefficient of *First Stress* of -0.0843 is statistically significant at the 5% level in the regression (1) for total liquidity creation, LC. This suggests that as banks participate in the stress test for the first time, they tend to alter their behaviors and reduce their total liquidity creation from quarter 3 prior to joining the stress test group to quarter 3 in the first year of stress testing. Similarly, in the regression for the liquidity creation on the balance sheet, $LCON$, as banks enter the stress tests, there is a significant (at the 1% level) reduction in the liquidity creation of banks on the balance sheet with an estimated coefficient of -0.0303. Similar findings are presented in columns (3) and (4) for liquidity creation off the balance sheet, $LCOFF$, and asset liquidity creation, LCA. The coefficient estimates of *First Stress* are -0.0540 and -0.0232, respectively. The reduction in the asset-side liquidity creation, LCA, that is found in the table is consistent with the risk-management

[10] Consistent with Cornett et al. (2020), we exclude bank fixed effects to avoid that the variation that we explore derive solely from the banks that enter the stress test for the first time. Moreover, clustering standard errors at the bank level only does not change qualitatively our empirical results.

hypothesis proposed by Acharya et al. (2018). The hypothesis suggests that stress test banks manage their risk exposure more prudently by reducing credit supply, particularly to risky borrowers to increase their capital ratios. Furthermore, Table 2.6 shows that the risk-management hypothesis also applies to liquidity creation off the balance sheet because banks adjust their off-balance sheet activities as they enter the stress tests. Nevertheless, as for the liability-side liquidity creation, LCL, the estimated coefficient on *First Stress* is statistically insignificant even though it remains negative in column (5).

Table 2.7 reports the results for the same regressions after excluding the first stress test. Consistent with the results in Table 2.6, the results in Table 2.7 confirm that (with the exception of LCL) all liquidity creation measures decrease as a result of banks entering the stress tests for the first time.

Table 2.6: Changes in bank liquidity creation measures as they enter the stress tests for the first time

	(1) *LC*	(2) *LCON*	(3) *LCOFF*	(4) *LCA*	(5) *LCL*
First Stress	-0.0843**	-0.0303***	-0.0540*	-0.0232***	-0.0071
	(0.0398)	(0.0082)	(0.0320)	(0.0043)	(0.0103)
SIZE	-0.1047	-0.1356***	0.0309	-0.0969***	-0.0386*
	(0.0673)	(0.0124)	(0.0634)	(0.0169)	(0.0198)
CAP	2.9729**	-0.8411***	3.8140***	-0.4013	-0.4398**
	(1.3129)	(0.3170)	(1.3229)	(0.2720)	(0.2145)
ROE	-0.0944	0.0803	-0.1747	0.0799*	0.0004
	(0.1458)	(0.0498)	(0.1676)	(0.0470)	(0.0119)
NPL	-1.7642	-1.2295	-0.5347	-1.1965	-0.0330
	(2.2298)	(1.5416)	(2.6521)	(1.1046)	(0.6662)
Constant	-0.0264	-0.0131	-0.0133	-0.0360*	0.0229**
	(0.0304)	(0.0289)	(0.0287)	(0.0197)	(0.0105)
Time FE	Yes	Yes	Yes	Yes	Yes
Observations	142	142	142	142	142
Adjusted R^2	0.1988	0.0753	0.2448	0.1343	0.0889

The table reports results from the ordinary least squares regressions examining the changes of bank liquidity creation as they enter the stress test group with changes in other observable control variables included as independent variables. All variables are measured as changes from quarter 3 of year *t−1* to quarter 3 of year *t*. The variable of interest is *First Stress*, which is a dummy equal to 1 if a bank is subject to the stress test in a particular year but not the year before and 0 otherwise. Time fixed effects are included in all regressions and robust standard errors reported in parentheses are double clustered by bank and time. *LC* is the liquidity creation, *LCON* is the on-the balance sheet liquidity creation measure, *LCOFF* is the off-balance sheet liquidity creation, *LCA* is the asset component of liquidity creation, *LCL* is the liability component of liquidity creation, *SIZE* is the natural logarithm of gross total assets, *CAP* is the equity to total assets, *ROE* is the return on equity, and *NPL* is the total non-performing loans to total loans. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 2.7: Changes in bank liquidity creation measures as they enter the stress tests for the first time excluding the first stress test

	(1) *LC*	(2) *LCON*	(3) *LCOFF*	(4) *LCA*	(5) *LCL*
First Stress	-0.0321***	-0.0206***	-0.0115***	-0.0290***	0.0084***
	(0.0035)	(0.0034)	(0.0022)	(0.0021)	(0.0009)
SIZE	-0.1610***	-0.0844**	-0.0766**	-0.1344***	0.0500**
	(0.0464)	(0.0408)	(0.0362)	(0.0329)	(0.0220)
CAP	-0.5232	-0.1795	-0.3437	0.2706	-0.4501**
	(0.4446)	(0.2590)	(0.3308)	(0.3836)	(0.1861)
ROE	0.1015	0.1130	-0.0115	0.1739	-0.0609
	(0.1662)	(0.1700)	(0.0448)	(0.1172)	(0.0641)
NPL	-0.3519	-2.0079*	1.6560**	-1.0517	-0.9562**
	(0.8044)	(1.1293)	(0.6568)	(1.0498)	(0.4139)
Constant	-0.0131	-0.0256	0.0125	-0.0348**	0.0092*
	(0.0134)	(0.0167)	(0.0080)	(0.0149)	(0.0053)
Time FE	Yes	Yes	Yes	Yes	Yes
Observations	107	107	107	107	107
Adjusted R^2	0.0774	0.0326	0.2012	0.1792	0.1426

The table reports results from the ordinary least squares regressions examining the changes of bank liquidity creation as they enter the stress test group with changes in other observable control variables included as independent variables. In all regressions, the first stress test is excluded. All variables are measured as changes from quarter 3 of year *t−1* to quarter 3 of year *t*. The variable of interest is *First Stress*, which is a dummy equal to 1 if a bank is subject to the stress test in a particular year but not the year before and 0 otherwise. Time fixed effects are included in all regressions and robust standard errors reported in parentheses are double clustered by bank and time. *LC* is the liquidity creation, *LCON* is the on-the balance sheet liquidity creation measure, *LCOFF* is the off-balance sheet liquidity creation, *LCA* is the asset component of liquidity creation, *LCL* is the liability component of liquidity creation, *SIZE* is the natural logarithm of gross total assets, *CAP* is the equity to total assets, *ROE* is the return on equity, and *NPL* is the total non-performing loans to total loans. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

2.5.4 Bank liquidity creation around the stress test quarter

From 2009–2015, the starting point of the stress test is the third quarter, Q3, while the starting point of the stress test in 2016 is the first quarter, Q1. We examine the liquidity creation of stress test banks around the starting point of the stress tests by employing a DiD regression method following Cornett et al. (2020). At the starting point of the stress tests (i.e., $Q = t$), all the variables are measured as changes from quarter 2 to quarter 3 in 2009–2015 and from quarter 4 to quarter 1 in 2016. Similarly, we measure the changes in all the variables in the quarters before (i.e., $Q = t - 2$ and $Q = t - 1$) and after the starting point quarters (i.e., $Q = t + 1$). In all regressions, the variable *Stress*, which is equal to 1 if the bank participates in the stress test in a particular year and 0 otherwise, is the focus of our interest. The coefficient of the interaction between *Stress* and the quarters around the starting points of the stress tests captures the behavior of stress test banks around the stress tests. In all regressions conducted for this subsection, time fixed effects are included and standard errors are double clustered by bank and time to control for unobserved heterogeneity.

In this subsection, we empirically examine the liquidity creation of banks around the stress test starting points. Table 2.8 presents the regression results for changes in bank liquidity creation by quarters around the stress test starting points. The interaction variable, $Stress \times Q = t$, captures the effect of stress testing on the starting point quarters (between quarters 2 and 3 in 2009–2015, and between quarter 4 in 2015 and quarter 1 in 2016), $Stress \times Q = t + 1$ isolates the changes in liquidity creation in the quarter after the starting points (between quarters 3 and 4 in 2009-2015, and between quarter 1 and 2 in 2016). $Stress \times Q = t - 2$ and $Stress \times Q = t - 1$ isolate the changes in liquidity creation two quarters and one quarter before the stress tests, respectively.

Table 2.8: Regressions of changes in bank liquidity creation around the stress test quarter

	(1) *LC*	(2) *LCON*	(3) *LCOFF*	(4) *LCA*	(5) *LCL*
Stress × $Q = t-2$	-0.0019	-0.0002	0.0021	0.0021*	-0.0023
	(0.0044)	(0.0013)	(0.0046)	(0.0011)	(0.0016)
Stress × $Q = t-1$	-0.0074	-0.0015	-0.0060	0.0014	-0.0029
	(0.0060)	(0.0025)	(0.0051)	(0.0019)	(0.0018)
Stress × $Q = t$	-0.0125***	-0.0034***	-0.0091**	-0.0034**	-0.0000
	(0.0047)	(0.0013)	(0.0043)	(0.0014)	(0.0019)
Stress × $Q = t+1$	-0.0105	-0.0090**	-0.0015	-0.0064**	-0.0026
	(0.0068)	(0.0040)	(0.0075)	(0.0027)	(0.0027)
SIZE	-0.3025***	-0.1457***	-0.1568*	-0.1217***	-0.0240
	(0.0990)	(0.0285)	(0.0952)	(0.0310)	(0.0213)
CAP	1.5130*	-0.8317***	2.3447**	-0.3286	-0.5031***
	(0.8857)	(0.2114)	(1.0258)	(0.3073)	(0.1318)
ROE	-0.0035	0.0182	-0.0217	0.0127	0.0056
	(0.0475)	(0.0178)	(0.0440)	(0.0184)	(0.0108)
NPL	0.1354	-0.1053	0.2406	-0.0437	-0.0615
	(0.6869)	(0.1945)	(0.5775)	(0.2457)	(0.1771)
Constant	-0.0169***	0.0039	-0.0208***	-0.0027	0.0067***
	(0.0045)	(0.0029)	(0.0033)	(0.0024)	(0.0016)
Time FE	Yes	Yes	Yes	Yes	Yes
Observations	1,156	1,156	1,156	1,156	1,156
Adjusted R^2	0.1095	0.0492	0.1035	0.0554	0.0336

The table reports results from the ordinary least squares regressions examining the changes in measures of bank liquidity creation around the stress tests (quarter 3 in 2009–2015 and quarter 1 in 2016) controlling for changes in bank-specific independent variables. *Stress* is the dummy variable, which is equal to 1 if the bank is subject to the stress test in a particular year and 0 if it is not. The interaction term, *Stress* × $Q = t$, isolates changes in the measures of liquidity creation in the stress test starting point quarter (changes between quarter 2 and quarter 3 in 2009–2015 and between quarter 4 and quarter 1 in 2016). *Stress* × $Q = t+1$ captures changes in quarter after the stress tests (between quarter 3 and quarter 4 in 2009–2015 and between quarter 1 and quarter 2 in 2016. *Stress* × $Q = t-1$ captures changes in quarter preceding the stress tests (between quarter 1 and quarter 2 in 2009–2015 and between quarter 3 and quarter 4 in 2015) and *Stress* × $Q = t-1$ isolates the changes in two quarters preceding the stress tests. All variables are measured as changes from $t-1$ to t. Time fixed effects are included in all regressions and robust standard errors reported in parentheses are double clustered by bank and time. *LC* is the liquidity creation, *LCON* is the on-the balance sheet liquidity creation measure, *LCOFF* is the off-balance sheet liquidity creation, *LCA* is the asset component of liquidity creation, *LCL* is the liability component of liquidity creation, *SIZE* is the natural logarithm of gross total assets, *CAP* is the equity to total assets, *ROE* is the return on equity, and *NPL* is the total non-performing loans to total loans. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Consistent with prior empirical findings, it can be seen that the coefficient estimates of $Stress \times Q = t$ are negative and statistically significant for all measures of liquidity creation, except for LCL, indicating that banks reduce their liquidity creation at the starting points of the stress tests to improve their chances of passing the tests. The findings point to differences between stress and non-stress test banks at the starting point of the stress tests as liquidity creation of stress test banks is reduced in comparison with that of non-stress test banks. Specifically, the coefficient estimate of $Stress \times Q = t$ for LC is -0.0125 and significant at the 1% significance level. The coefficient estimates of $Stress \times Q = t$ for $LCON$ and $LCOFF$ are -0.0034 and -0.0091, respectively (significant at the 1% and the 5% levels), indicating that stress testing appears to have a stronger effect on off-balance sheet liquidity creation of banks than on-balance sheet liquidity creation. The results are consistent with prior empirical analyses in which evidence in support of the risk-management hypothesis is reported. Stress test banks cut down their risk exposure, thereby reducing liquidity creation both on- and off-the-balance sheet. While the coefficient estimate for LCA is -0.0034 and significant at the 5% level, the coefficient estimate for LCL is statistically insignificant at conventional levels. For the quarters after the stress test starting points, Table 2.8 also shows that the coefficient estimates of $Stress \times Q = t + 1$ are negative and statistically significant at the 5% level for only $LCON$ and LCA (-0.0090 and -0.0064, respectively). Thes empirical results indicate that the impact of regulatory stress tests on bank liquidity creation appears to be strongest at the starting quarter of the stress tests as banks reduce their liquidity creation to improve the chances of passing the stress tests. The impact of stress tests on liquidity creation on the quarter after the stress tests is more pronounced but is only observed in some components of liquidity creation.

Table 2.9 presents the results after excluding the first stress test. The coefficient estimates on $Stress \times Q = t$ are slightly smaller than those reported in Table 2.8, but they are still negative and statistically significant at the 5% or 1% level for LC, $LCON$, and LCA. Other findings are also worth noting. The coefficient estimates on $Stress \times Q = t - 2$ and $Stress \times Q = t - 1$ are positive and negative in columns (3) and (5), respectively. These imply that there are differences in liquidity creation

measures between stress test and non-stress test banks in quarters preceding the stress tests. Nevertheless, the coefficients of $Stress \times Q = t$ in these columns are not statistically significant.

Table 2.9: Regressions of changes in bank liquidity creation around the stress test quarter excluding the first stress test

	(1) *LC*	(2) *LCON*	(3) *LCOFF*	(4) *LCA*	(5) *LCL*
Stress × $Q = t-2$	0.0039	-0.0005	0.0044*	0.0015	-0.0020
	(0.0027)	(0.0016)	(0.0025)	(0.0014)	(0.0017)
Stress × $Q = t-1$	-0.0040	-0.0023	-0.0018	0.0012	-0.0034**
	(0.0048)	(0.0021)	(0.0039)	(0.0017)	(0.0016)
Stress × $Q = t$	-0.0080**	-0.0023***	-0.0057	-0.0031**	0.0008
	(0.0040)	(0.0003)	(0.0043)	(0.0014)	(0.0021)
Stress × $Q = t+1$	-0.0176***	-0.0066*	-0.0110***	-0.0059**	-0.0007
	(0.0061)	(0.0039)	(0.0042)	(0.0029)	(0.0023)
SIZE	-0.1944***	-0.1380***	-0.0564***	-0.1202***	-0.0179
	(0.0341)	(0.0329)	(0.0155)	(0.0332)	(0.0233)
CAP	-0.4595*	-0.4621**	0.0026	0.1915	-0.6536***
	(0.2723)	(0.1898)	(0.2289)	(0.2549)	(0.1339)
ROE	-0.0043	0.0163	-0.0206	0.0113	0.0050
	(0.0121)	(0.0213)	(0.0191)	(0.0223)	(0.0174)
NPL	-0.0140	-0.2064	0.1924	-0.1085	-0.0979
	(0.4645)	(0.3342)	(0.1949)	(0.3180)	(0.1803)
Constant	0.0064***	0.0058***	0.0006	-0.0018**	0.0076***
	(0.0016)	(0.0011)	(0.0009)	(0.0007)	(0.0007)
Time FE	Yes	Yes	Yes	Yes	Yes
Observations	1,046	1,046	1,046	1,046	1,046
Adjusted R^2	0.0399	0.0469	0.0079	0.0761	0.0487

The table reports results from the ordinary least squares regressions examining the changes in measures of bank liquidity creation around the stress tests (quarter 3 in 2011–2015 and quarter 1 in 2016) controlling for changes in bank-specific independent variables. In all regressions, the first stress test is excluded. *Stress* is the dummy variable, which is equal to 1 if the bank is subject to the stress test in a particular year and 0 if it is not. The interaction term, *Stress* × $Q = t$, isolates changes in the measures of liquidity creation in the stress test starting point quarter (changes between quarter 2 and quarter 3 in 2011–2015 and between quarter 4 and quarter 1 in 2016). *Stress* × $Q = t+1$ captures changes in quarter after the stress tests (between quarter 3 and quarter 4 in 2011–2015 and between quarter 1 and quarter 2 in 2016. *Stress* × $Q = t-1$ captures changes in quarter preceding the stress tests (between quarter 1 and quarter 2 in 2011–2015 and between quarter 3 and quarter 4 in 2015) and *Stress* × $Q = t-1$ isolates the changes in two quarters preceding the stress tests. All variables are measured as changes from $t-1$ to t. Time fixed effects are included in all regressions and robust standard errors reported in parentheses are double clustered by bank and time. *LC* is the liquidity creation, *LCON* is the on-the balance sheet liquidity creation measure, *LCOFF* is the off-balance sheet liquidity creation, *LCA* is the asset component of liquidity creation, *LCL* is the liability component of liquidity creation, *SIZE* is the natural logarithm of gross total assets, *CAP* is the equity to total assets, *ROE* is the return on equity, and *NPL* is the total non-performing loans to total loans. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

2.5.5 Robustness checks

For robustness checks, we begin with testing the parallel trends assumption, which in our case implies that in the absence of the stress tests, the trend growth rates for the liquidity creation measures of stress test and non-stress test banks are not statistically different. Table 2.10 presents t-tests for differences in mean between treatment and control groups in eight quarters prior to the stress test following Roberts & Whited (2013). The test examines the differences in the growth rate in liquidity creation measures between the treatment and control groups during each pre-treatment quarter. We find that the null of equality of means cannot be rejected in 34 out of 40 cases at conventional levels, which largely confirms the validity of the parallel trends assumption.

Next, we present the estimates of RD under the local randomization inference, which is based on a 'stronger' alternative identification assumption. The local randomization assumption holds that, within a narrow bandwidth around the threshold, observations are as good as randomly assigned to treatment and control groups. That is, the treatment assignment could be regarded as a randomization mechanism near the cutoff (Lee 2008). Following the procedure in Cattaneo et al. (2015, 2016), a small neighborhood around the cutoffs where the local randomization assumption is deemed most plausible is selected. Table 2.11 presents the results of the difference-in-means tests for the measures of liquidity creation between the stress test banks and the non-stress test banks using the randomization inference. The estimates of the treatment effects are largely consistent with our main findings. For example, the difference in the means of LC between stress test and non-stress test banks is statistically significant at the 1% significance level.

Table 2.10: Tests for parallel trends

Tests for parallel trends before SCAP 2009								
	t−1		*t−2*		*t−3*		*t−4*	
	Difference means	Wilcoxon *p*-value	Difference means	Wilcoxon *p*-value	Difference means	Wilcoxon *p*-value	Difference means	Wilcoxon *p*-value
LC	0.0382	0.2126	-0.0162	0.7252	0.0766	0.2673	0.0252	0.7697
LCON	0.0110	0.6893	-0.0132	0.4821	0.0552	0.0759*	-0.0218	0.1432
LCOFF	0.0271	0.3118	-0.0030	0.5468	0.0214	0.6978	0.0471	0.7697
LCA	0.0093	0.9812	-0.0152	0.1196	0.0410	0.0401**	0.0004	0.9533
LCL	0.0017	0.7242	0.0019	0.5468	0.0141	0.8244	-0.0223	0.1139
	t−5		*t−6*		*t−7*		*t−8*	
	Difference means	Wilcoxon *p*-value	Difference means	Wilcoxon *p*-value	Difference means	Wilcoxon *p*-value	Difference means	Wilcoxon *p*-value
LC	0.1209	0.0610*	-0.0639	0.0790*	0.0750	0.0890*	-0.0934	0.1710
LCON	-0.0055	0.3488	-0.0027	0.5982	0.0293	0.3135	0.0000	0.7638
LCOFF	0.1264	0.3798	-0.0611	0.2416	0.0457	0.2077	-0.0934	0.3006
LCA	-0.0236	0.4465	0.0046	0.3488	0.0122	0.5708	-0.0010	0.8152
LCL	0.0181	0.2659	-0.0073	0.1432	0.0170	0.0198**	0.0010	0.8674

The table reports tests for parallel trends for the eight quarters preceding the stress tests by showing differences in mean changes of bank liquidity creation variables. The difference in means at *t−1* is the difference in mean change for *t−2* to *t−1* between treatment and control groups. *LC* is the liquidity creation, *LCON* is the on-the balance sheet liquidity creation measure, *LCOFF* is the off-balance sheet liquidity creation, *LCA* is the asset component of liquidity creation, and *LCL* is the liability component of liquidity creation. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

To test whether the actual cutoff fits the data better than other nearby cutoffs, placebo tests are conducted to see if discontinuity in bank liquidity creation is still observed at artificially determined thresholds. The following alternative thresholds other than $100 and $50 billion are selected: $40, $60, $70, $80, $90, and $110 billion. These artificial cutoffs are used in this study because they do not coincide with other regulatory/policy actions that took place around the same time. When using these cutoffs, any discontinuity in bank liquidity creation implies that the change in liquidity creation might be random and cannot be attributed to the stress tests. Using the alternative thresholds as the artificial cutoffs, all banks in the sample are re-assigned into the treatment or the control groups, based on whether or not the banks' gross total assets exceed the artificial cutoffs, respectively. Table 2.12 presents the estimation results using the alternative cutoffs. Using the alternative cutoff of $40 billion, the estimated coefficient of *Stress* is negative in column (3). Using the alternative cutoff of $60 billion, even though the estimated coefficients of *Stress* are negative for LCA in both columns (7) and (8), we find that the estimated coefficient is positive for LC in column (2). Overall, the results suggest that the treatment effect is not observed at the artificially determined thresholds in most regressions.

Our analyses so far are limited to comparing liquidity creation measures between stress test banks and non-stress test banks with assets above $20 billion. We perform a robustness check by running the RD regressions that include banks with assets larger than $10 billion to determine if our conclusion still holds with a larger number of banks in the sample and provide further justification for the choice of the stress test cutoffs. Table 2.13 presents the results of RD when banks with assets larger than $10 billion are included. Overall, the results are consistent with our main empirical findings. Finally, we run the RD regressions and include banks with foreign parents. Table 2.14 presents the results of RD when banks with foreign parents are included. Collectively, we still find that stress tests have a significantly negative impact on bank liquidity creation. Banks appear to reduce all components of liquidity creation with the exception of liability-side liquidity creation.

Table 2.11: Regression discontinuity estimation under local randomization

		Statistic	*Control obs.*	*Treatment obs.*
LC		-0.130***	107	82
	p-value	(0.000)		
	95% Confidence interval	[-0.211, -0.045]		
LCON		-0.018	107	82
	p-value	(0.576)		
	95% Confidence interval	[-0.080 , 0.048]		
LCOFF		-0.112***	107	82
	p-value	(0.000)		
	95% Confidence interval	[-0.182, -0.038]		
LCA		-0.029	107	82
	p-value	(0.299)		
	95% Confidence interval	[-0.084, 0.023]		
LCL		0.011	107	82
	p-value	(0.517)		
	95% Confidence interval	[-0.021, 0.042]		

The table reports the effect of stress testing on measures of bank liquidity creation the under local randomization inference following Cattaneo et al. (2015, 2016). *Statistic* is the difference-in-means estimate between the treatment group and control group within a narrow bandwidth near the cutoffs where the local randomization assumption is most plausible. *LC* is the liquidity creation, *LCON* is the on-the balance sheet liquidity creation measure, *LCOFF* is the off-balance sheet liquidity creation, *LCA* is the asset component of liquidity creation, and *LCL* is the liability component of liquidity creation. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 2.12: Falsification tests for estimated effect using different cutoff values

	(1) *LC*	(2) *LC*	(3) *LCON*	(4) *LCON*	(5) *LCOFF*	(6) *LCOFF*	(7) *LCA*	(8) *LCA*	(9) *LCL*	(10) *LCL*
Cutoff \$40 billion	-0.0731	-0.0381	-0.0567**	-0.0234	0.0101	0.0076	-0.0148	-0.0133	-0.0212	0.0054
	(0.0591)	(0.0510)	(0.0242)	(0.0250)	(0.0297)	(0.0272)	(0.0278)	(0.0272)	(0.0144)	(0.0131)
Cutoff \$60 billion	0.1576	0.1173*	-0.0087	-0.0031	0.1527	0.1580*	-0.0317**	-0.0212*	0.0118	0.0148
	(0.1162)	(0.0670)	(0.0228)	(0.0213)	(0.1071)	(0.0901)	(0.0140)	(0.0124)	(0.0128)	(0.0120)
Cutoff \$70 billion	0.2234	0.2310	0.0101	0.0077	0.2123	0.2740	-0.0081	-0.0028	0.0154	0.0106
	(0.2324)	(0.2259)	(0.0283)	(0.0315)	(0.2553)	(0.2544)	(0.0171)	(0.0180)	(0.0150)	(0.0156)
Cutoff \$80 billion	-0.2767	-0.3131	-0.0768	-0.0884	-0.1983	-0.2164	-0.0404	-0.0504	-0.0182	-0.0193
	(0.2051)	(0.2242)	(0.0786)	(0.0830)	(0.1614)	(0.1819)	(0.0461)	(0.0482)	(0.0256)	(0.0304)
Cutoff \$90 billion	-0.0732	-0.0456	0.0257	0.0463	-0.0889	-0.1274	-0.0039	0.0001	0.0061	0.0257*
	(0.1174)	(0.0860)	(0.0420)	(0.0478)	(0.1034)	(0.1023)	(0.0182)	(0.0213)	(0.0127)	(0.0146)
Cutoff \$110 billion	-0.0268	-0.0596	0.0125	-0.0338	-0.0168	-0.0168	-0.0016	-0.0235	-0.0314	0.0203
	(0.0338)	(0.0363)	(0.0204)	(0.0317)	(0.0142)	(0.0133)	(0.0164)	(0.0171)	(0.0286)	(0.0269)
Control variables	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES

The table reports regression results for measures of bank liquidity creation using different cutoffs. Robust standard errors are reported in parentheses. *LC* is the liquidity creation, *LCON* is the on-the balance sheet liquidity creation measure, *LCOFF* is the off-balance sheet liquidity creation, *LCA* is the asset component of liquidity creation, and *LCL* is the liability component of liquidity creation. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 2.13: Regression discontinuity estimation for bank liquidity creation including banks with asset size greater than $10 billion

	(1) *LC*	(2) *LC*	(3) *LCON*	(4) *LCON*	(5) *LCOFF*	(6) *LCOFF*	(7) *LCA*	(8) *LCA*	(9) *LCL*	(10) *LCL*
Stress	-0.1105***	-0.0976***	-0.0827**	-0.0806**	-0.0362***	-0.0321***	-0.0836***	-0.0756***	0.1094***	0.1140***
	(0.0358)	(0.0366)	(0.0380)	(0.0314)	(0.0111)	(0.0109)	(0.0209)	(0.0205)	(0.0113)	(0.0119)
Assignment	-0.5803**	-0.5416**	-0.5155*	-0.4748*	-0.1214	-0.1199*	-0.0267	-0.0426	0.0830	0.0677*
	(0.2765)	(0.2615)	(0.2932)	(0.2673)	(0.0839)	(0.0697)	(0.0833)	(0.0913)	(0.0539)	(0.0375)
Stress×*Assignment*	0.6635**	0.6246**	0.6149*	0.5920**	0.0672	0.0696	0.1721	0.1839	-0.0559	-0.0776
	(0.2807)	(0.2679)	(0.2988)	(0.2655)	(0.1080)	(0.1022)	(0.1235)	(0.1304)	(0.1254)	(0.0799)
CAP		-0.6622		-0.1238		-0.3511		-0.5584		-0.2359
		(0.7963)		(0.5827)		(0.6337)		(0.6488)		(0.2908)
ROE		0.0936		0.0927*		0.0321		0.0110		0.0208
		(0.0627)		(0.0498)		(0.0348)		(0.0603)		(0.0644)
NPL		-1.5214		-2.0864***		0.6592		-0.2411		-2.1717***
		(1.1601)		(0.5994)		(0.6476)		(0.4009)		(0.5858)
Constant	0.4711***	0.5621***	0.2451***	0.2934***	0.2301***	0.2522***	0.0952***	0.1534**	0.1550***	0.2210***
	(0.0059)	(0.0870)	(0.0055)	(0.0593)	(0.0040)	(0.0600)	(0.0101)	(0.0612)	(0.0039)	(0.0296)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	177	177	170	170	177	177	241	241	213	213
Adjusted R^2	0.1499	0.2077	0.1235	0.2459	0.0479	0.0888	0.1895	0.1947	0.3131	0.5669

The table reports the regression discontinuity estimates of change in the measures of bank liquidity creation as a result of the treatment (being included in the stress test group) including banks with asset size greater than $10 billion. The results are obtained using a pooled non-parametric approach with the rectangular kernel. All estimations use the optimal bandwidth following Imbens & Kalyanaraman (2012). The variable of interest is *Stress*, which defines the treatment status and is a dummy variable equal to 1 if a bank is in the stress test group and 0 otherwise. *Assignment* represents the distance between bank size (natural logarithm of gross total assets) and the normalized cutoffs. Robust standard errors in parentheses are clustered at the bank level. *LC* is the liquidity creation, *LCON* is the on-the balance sheet liquidity creation measure, *LCOFF* is the off-balance sheet liquidity creation, *LCA* is the asset component of liquidity creation, *LCL* is the liability component of liquidity creation, *CAP* is the equity to total assets, *ROE* is the return on equity, and *NPL* is the total non-performing loans to total loans. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 2.14: Regression discontinuity estimation for bank liquidity creation including banks with foreign parents

	(1) *LC*	(2) *LC*	(3) *LCON*	(4) *LCON*	(5) *LCOFF*	(6) *LCOFF*	(7) *LCA*	(8) *LCA*	(9) *LCL*	(10) *LCL*
Stress	-0.1332**	-0.1564***	-0.1148**	-0.1339***	-0.0152	-0.0189*	-0.0598*	-0.0655**	0.0431	0.0122
	(0.0606)	(0.0526)	(0.0449)	(0.0458)	(0.0175)	(0.0099)	(0.0318)	(0.0322)	(0.1003)	(0.0741)
Assignment	0.1957	0.1173	0.2289	0.1695	0.0021	-0.0161	0.0636	0.0497	0.8837	0.7698
	(0.3211)	(0.2791)	(0.2981)	(0.2635)	(0.0369)	(0.0337)	(0.1814)	(0.1524)	(0.6099)	(0.5193)
Stress×*Assignment*	-0.2692	-0.0349	-0.2836	-0.0984	-0.0164	0.0246	0.0610	0.0894	-1.1891	-0.8852
	(0.4191)	(0.3635)	(0.3382)	(0.3244)	(0.1027)	(0.0632)	(0.2274)	(0.2151)	(0.7505)	(0.5978)
CAP		-1.0061		-0.5445		-0.2213		0.9638		-1.7989
		(2.1065)		(1.6509)		(0.4372)		(1.0943)		(1.6597)
ROE		-0.3624**		-0.2701**		-0.1075**		-0.2313**		0.0597
		(0.1551)		(0.1320)		(0.0417)		(0.1024)		(0.1861)
NPL		-6.3264***		-4.9556***		-1.2220***		-1.0326		-4.3616***
		(1.2605)		(1.1841)		(0.2197)		(0.8234)		(0.5595)
Constant	0.5292***	0.7863***	0.3488***	0.5189**	0.1849***	0.2373***	0.1151***	0.0242	0.2032***	0.5010**
	(0.0117)	(0.2866)	(0.0097)	(0.2288)	(0.0034)	(0.0526)	(0.0047)	(0.1410)	(0.0222)	(0.1970)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	208	208	217	217	197	197	226	226	134	134
Adjusted R^2	0.0323	0.1550	0.0511	0.1503	-0.0086	0.1126	0.0025	0.0550	0.2543	0.4322

The table reports the regression discontinuity estimates of change in the measures of bank liquidity creation as a result of the treatment (being included in the stress test group) for domestic banks as well as banks with foreign parents. The results are obtained using a pooled non-parametric approach with the rectangular kernel. All estimations use the optimal bandwidth following Imbens & Kalyanaraman (2012). The variable of interest is *Stress*, which defines the treatment status and is a dummy variable equal to 1 if a bank is in the stress test group and 0 otherwise. *Assignment* represents the distance between bank size (natural logarithm of gross total assets) and the normalized cutoffs. Robust standard errors reported in parentheses are clustered at the bank level. *LC* is the liquidity creation, *LCON* is the on-the balance sheet liquidity creation measure, *LCOFF* is the off-balance sheet liquidity creation, *LCA* is the asset component of liquidity creation, *LCL* is the liability component of liquidity creation, *CAP* is the equity to total assets, *ROE* is the return on equity, and *NPL* is the total non-performing loans to total loans. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

2.6 Concluding remarks

In this chapter, we investigate the impact of Federal Reserve stress tests from 2009 to 2016 on U.S. bank liquidity creation. To do so, we employ a regression discontinuity approach to provide evidence that regulatory stress tests may lead to a reduction in bank liquidity creation both on and off the balance sheet. In particular, we show that asset-side liquidity creation decreases in response to the stress tests, a finding that is in line with the risk-management hypothesis: stress test banks cut down credit lending, particularly to risky borrowers, to reduce their risk exposures (Acharya et al. 2018). However, on the liability-side there is an increase of liquidity creation, driven by more customer deposit funding. This finding suggests that banks seek to offset the increase in funding costs resulting from the stress tests by moving from non-deposit funding to cheaper funding sources.

From a policy perspective, to the extent that stress testing discourages bank liquidity creation, an important bank output which contributes to economic growth (Bhattacharya & Thakor 1993), stress tests might lead to a reduction in the amount available for financing, thereby slowing economic growth. Nevertheless, as excessive liquidity creation increases the probability of default (Imbierowicz & Rauch 2014), which can result in financial instability and may lead to financial crises (Acharya, Shin & Yorulmazer 2011, Acharya & Naqvi 2012, Berger & Bouwman 2017), the reduction of excessive liquidity creation as a consequence of regulatory stress tests can be socially desirable in terms of enhancing the safety and soundness of the banking system. For these reasons, it is important for policymakers and bank regulators to consider the trade-off between the benefits of greater financial stability and the benefit of greater liquidity creation when designing a regulatory framework that promotes the soundness of the banking system but also minimizes the impact on economic activity.

Appendices

Table A1: Summary of the literature on the effects of stress tests on banks' behaviors

Author(s)	*Stress tests*	*Findings*
Acharya et al. (2018)	SCAP & CCAR	Those banks that are subject to the stress tests cut down their credit supply, particularly to relatively risky borrowers, thereby bringing down credit risk. Banks became safer in terms of capital ratios as well as risk-weighted asset ratios.
Berrospide & Edge (2019)	CCAR	Stress tests reduce commercial and industrial and small business lending. However, firms' overall debt, investment spending, and employment are largely unaffected.
Bindal et al. (2020)	DFA	Banks that are right below the size threshold increase the likelihood of doing acquisitions and the number of acquisitions.
Bordo & Duca (2018)	DFA	The passage of the DFA has induced a reduction in banks' lending to small businesses.

Table A1 continued

Bouwman et al. (2018)	DFA	Those banks that are near below certain thresholds have incentives to alter their behaviors to avoid crossing the thresholds and incurring greater regulatory costs. These behaviors include growing assets and credits more slowly and charging higher interest rates on commercial loans.
Calem et al. (2019)	CCAR	The 2011 CCAR resulted in a decrease in the share of jumbo mortgage originations of stress-test banks and the effect was more pronounced for weakly capitalized banks.
Connolly (2018)	SCAP	Stress-test banks shift their lending toward relatively safer firms after the SCAP. Stress-test banks are found to be less likely to enter into new syndicated loans after the first stress test, which led to a change in the composition of syndicate members away from tested banks. However, the overall borrowing and firm outcomes were not dramatically affected.

Table A1 continued

Cornett et al. (2020)	SCAP & CCAR	A significant increase in capital ratios for stress-test banks at the starting point of the tests but not for non-stress test banks is reported. Banks that are subject to the stress tests also reduced their dividends considerably more than non-stress test banks as they entered the tests. Stress-test banks have incentives to spend on lobbying activities significantly more than non-stress test banks.
Cortés et al. (2020)	CCAR	An increase in interest rates and a reduction in credit supply to small businesses is documented. The loan portfolios of stress-test banks are also rebalanced away from riskier borrowers. Small non-stress test banks increased their market share, and the aggregate credit remained unchanged.
Doerr (2019)	SCAP & CCAR	Stress test banks reduce lending to small businesses, which negatively affects entrepreneurship and innovation by young firms.
Eber & Minoiu (2017)	ECB's Comprehensive Assessment	Eurozone banks shrank their assets, particularly securities in anticipation of stricter supervision and the CA program. A decline in loan supply is found for only banks with low levels of capital.

Table A1 continued

Gropp et al. (2018)	2011 EBA Capital Exercise	Stress-test banks reduce their risk-weighted assets including loans to both corporate and retail customers instead of raising their levels of equity to increase capital ratios.
Kovner & Van Tassel (2018)	DFA	Banks' cost of capital has fallen after the passage of the DFA, implying a decrease in banks' systematic risk.
Lambertini & Mukherjee (2016)	SCAP & CCAR	Stress test failure resulted in higher loan spreads, pointing to the cost associated with increased capital requirements.
Pierret & Steri (2018)	CCAR & DFA	The CCAR exercises reduce excessive risk-taking by enhancing banks' level of supervision and highlight the importance of bank supervision that cannot be substituted by stringent capital requirements in promoting prudent lending.
Shahhosseini (2015)	SCAP & CCAR	To meet the capital requirements of the stress tests, banks restructured by reducing their net loan charge-offs and increasing non-performing loans, leading to increases in loan loss provisions and loan loss reserves.

Table A2: List of stress test bank holding companies

	2009	2011	2012	2013	2014	2015	2016
Ally Financial Inc.	1	1	1	1	1	1	1
American Express Company	1	1	1	1	1	1	1
Bancwest Corporation	0	0	0	0	0	0	1
Bank of America Corporation	1	1	1	1	1	1	1
Bank Of New York Mellon Corporation	1	1	1	1	1	1	1
BB&T Corporation	1	1	1	1	1	1	1
BBVA Compass Bancshares, Inc.	0	0	0	0	1	1	1
BMO Financial Corp.	0	0	0	0	1	1	1
Capital one Financial Corporation	1	1	1	1	1	1	1
Citigroup Inc.	1	1	1	1	1	1	1
Comerica Incorporated	0	0	0	0	1	1	1
Deutsche Bank Trust Corporation	0	0	0	0	0	1	1
Discover Financial Services	0	0	0	0	1	1	1
Fifth Third Bancorp	1	1	1	1	1	1	1
Goldman Sachs Group, Inc.	1	1	1	1	1	1	1
HSBC North America Holdings Inc.	0	0	0	0	1	1	1
Huntington Bancshares Incorporated	0	0	0	0	1	1	1
JPMorgan Chase & Co.	1	1	1	1	1	1	1
Keycorp	1	1	1	1	1	1	1
Metlife, Inc.	1	1	1	0	0	0	0
M&T Bank Corporation	0	0	0	0	1	1	1
Morgan Stanley	1	1	1	1	1	1	1
Northern Trust Corporation	0	0	0	0	1	1	1
PNC Financial Services Group, Inc.	1	1	1	1	1	1	1
RBS Citizens Financial Group, Inc.	0	0	0	0	1	1	1
Regions Financial Corporation	1	1	1	1	1	1	1
Santander Holdings USA	0	0	0	0	1	1	1
State Street Corporation	1	1	1	1	1	1	1
Suntrust Banks, Inc.	1	1	1	1	1	1	1
TD Group US Holdings	0	0	0	0	0	0	1
U.S. Bancorp	1	1	1	1	1	1	1
UnionBanCal Corporation	0	0	0	0	1	1	1
Wells Fargo & Company	1	1	1	1	1	1	1
Zions Bancorporation	0	0	0	0	1	1	1
Total	19	19	19	18	30	31	33

The table reports the name of stress test bank holding companies (BHCs) with value 1 indicating that the BHC participated in a particular stress test and 0 otherwise. UnionBanCal Corporation changed its name to MUFG Americas Holdings Corporation in 2014.

Table A3: Definitions of liquidity creation measures

Assets		
Illiquid assets (weight=1/2)	Semiliquid assets (weight=0)	Liquid assets (weight=-1/2)
Commercial real estate loans (CRE)	Residential real estate loans (RRE)	Cash and due from other institutions
Loans to finance agricultural production	Consumer loans	All securities (regardless of maturity)
Commercial and industrial institutions loans	Loans to depository institutions	Trading assets
Other loans and lease financing receivables	Loans to state and local governments	Fed funds sold
Other real estate owned (OREO)	Loans to foreign governments	
Customers' liability on bankers' acceptances		
Investment in unconsolidated subsidiaries		
Intangible assets		
Premises		
Other assets		
Liabilities plus equity		
Liquid liabilities (weight=1/2)	Semiliquid liabilities (weight=0)	Illiquid liabilities (weight=-1/2)
Transactions deposits	Time deposits	Bank's liability on bankers' acceptances
Savings deposits	Other borrowed money	Subordinated debt
Overnight federal funds purchased		Other liabilities
Trading liabilities		Equity
Off-balance sheet guarantees (notional values)		
Illiquid guarantees (weight=1/2)	Semiliquid guarantees (weight=0)	Liquid guarantees (weight=-1/2)
Unused commitments	Net credit derivatives	Net participations acquired
Net standby letters of credit	Net securities lent	
Commercial and similar letters of credit		

Table A3 continued
All other off-balance sheet liabilities

Off-balance sheet derivatives (gross fair values)	
	Liquid derivatives (weight=-1/2)
	Interest rate derivatives
	Foreign exchange derivatives
	Equity and commodity derivatives

Source: Berger & Bouwman (2009). $LC = 1/2 \times$ illiquid assets $- 1/2 \times$ liquid assets $+ 1/2 \times$ liquid liabilities $- 1/2 \times$ illiquid liabilities $- 1/2 \times$ equity $+ 1/2 \times$ illiquid guarantees $- 1/2 \times$ liquid guarantees $- 1/2 \times$ liquid derivatives.

Table A4: Univariate analysis of liquidity creation components

	2007		2009		2009-2016	
	Non-stress test	Stress test	*Non-stress test*	*Stress test*	*Non-stress test*	*Stress test*
	Mean	*Mean*	*Mean*	*Mean*	*Mean*	*Mean*
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Assets						
Commerical real estate loans/Total assets	0.4215	0.3019***	0.3881	0.2479*	0.2491***	0.1134***
Loans to finance agricultural production/Total assets	0.0024	0.0020***	0.0018	0.0013*	0.0011**	0.0006***
Commercial and industrial loans/Total assets	0.1609	0.1140**	0.1441	0.0961*	0.0962***	0.0478***
Other loans and lease financing receivables/Total assets	0.0020	0.0033	0.0019	0.0022	0.0065***	0.0044
Other real estate owned (OREO)	0.0008	0.0005*	0.0028***	0.0017***	0.0020***	0.0010***
Investment in unconsolidated subsidiaries/Total assets	0.0002	0.0019***	0.0001	0.0016	0.0001	0.0008***
Intangible assets/Total assets	0.0346	0.0484**	0.0209***	0.0319***	0.0143***	0.0159***
Premises/Total assets	0.0101	0.0098	0.0095	0.0076**	0.0086***	0.0054***
Other assets/Total assets	0.0449	0.0520**	0.0552***	0.0657***	0.0525	0.0752***
Cash and due from other institutions/Total assets	0.0578	0.0401	0.0733	0.0959***	0.0601	0.0553**
All securities/Total assets	0.1464	0.1598	0.1619	0.1688	0.1212**	0.0890***
Trading assets/Total assets	0.0142	0.0490***	0.0122	0.0805	0.0186	0.0582
Fed funds sold/Total assets	0.0294	0.0365	0.0169*	0.0338	0.0086***	0.0131***
Liabilities plus equity						
Transactions deposits/Total liabilities	0.0774	0.0528***	0.0774	0.0504	0.0234***	0.0210***
Savings deposits/Total liabilities	0.2947	0.2970	0.2595	0.3586**	0.3353*	0.4504***
Overnight federal funds purchased/Total liabilities	0.0332	0.0195***	0.0228*	0.0044***	0.0093***	0.0022***
Trading liabilities/Total liabilities	0.0056	0.0297***	0.0064	0.0395	0.0041	0.0335
Subordinated debt/Total liabilities	0.0212	0.0183	0.0199	0.0152	0.0045***	0.0046***
Other liabilities/Total liabilities	0.0027	0.0049***	0.0044*	0.0081**	0.0027	0.0057*

Table A4 continued

Equity/Total assets	0.0980	0.1124**	0.1026	0.1172	0.1167	0.2479***
Off-balance sheet						
Unused commitments/Total assets	0.3045	0.5833***	0.5928	0.5628	0.3040	0.2627***
Net standby letters of credit/Total assets	0.0443	0.0599	0.0355	0.0475**	0.0221**	0.0270***
Commercial and similar letters of credit/Total assets	0.0014	0.0019	0.0006***	0.0011**	0.0006***	0.0009***
All other off-balance sheet liabilities/Total assets	0.0068	0.0411**	0.0041	0.0313	0.0020**	0.0420
Interest rate derivatives/Total assets	0.0033	0.0889***	0.0091***	0.7740**	0.0052***	0.4370***
Foreign exchange derivatives/Total assets	0.0036	0.0269***	0.0066	0.0758*	0.0045	0.0480*
Equity and commodity derivatives/Total assets	0.0060	0.0121	0.0030	0.0101	0.0015*	0.0043**

The table reports the univariate analysis of liquidity creation components between stress test and non-stress test banks. Column (2) tests if the mean values of the variables are significantly different from those in column (1). Column (3) tests if the mean values of the variables are significantly different from those in column (1). Column (4) tests if the mean values of the variables are significantly different from those in column (2). Column (5) tests if the mean values of the variables are significantly different from those in column (1). Column (6) tests if the mean values of the variables are significantly different from those in column (2). Only liquid and illiquid balance sheet items are reported. Some items are not presented due to their small values. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table A5: Univariate analysis of liquid liabilities

	2007		2009		2009-2016	
	Non-stress test	Stress test	*Non-stress test*	*Stress test*	*Non-stress test*	*Stress test*
	Mean	*Mean*	*Mean*	*Mean*	*Mean*	*Mean*
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Transactions deposits/Total liquid liabilities	0.1822	0.1374**	0.1607	0.1556	0.0426***	0.0574***
Savings deposits/Total liquid liabilities	0.7288	0.6891	0.7692	0.6711	0.9291***	0.7832***
Overnight federal funds purchased/Total liquid liabilities	0.0727	0.0584	0.0551	0.0168***	0.0169***	0.0080***
Trading liabilities/Total liquid liabilities	0.0161	0.1150***	0.0148	0.1563	0.0112	0.1511

The table reports the univariate analysis of liquid liabilities between stress test and non-stress test banks. Column (2) tests if the mean values of the variables are significantly different from those in column (1). Column (3) tests if the mean values of the variables are significantly different from those in column (1). Column (4) tests if the mean values of the variables are significantly different from those in column (2). Column (5) tests if the mean values of the variables are significantly different from those in column (1). Column (6) tests if the mean values of the variables are significantly different from those in column (2). ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Chapter 3

How do banks price liquidity? The role of market power.

Abstract

We empirically examine the effects of different measures of liquidity on interest margins of a sample of U.S. commercial banks from 2001 to 2018. Overall, the results reveal that liquidity ratios exert a positive influence on bank margins. Furthermore, the study investigates the role of market power in the relationship between liquidity and interest margins. It is documented that dominant banks incorporate the costs associated with investing in liquidity into the bank margins to a lesser extent than banks with less market power, suggesting that the cost of complying with regulatory liquidity standards is reduced when the competition in the banking sector is less intense. The study highlights that market competition might be important in the design and implementation of liquidity regulations.

3.1 Introduction

The important role that banks play in financing economic activities has been long recognised and emphasised in the literature. By accepting deposits from savers on the one hand and extending credits or lines of credits to borrowers on the other, banks channel funds from depositors to investors and manage to fulfil multiple and seemingly opposing liquidity needs (Kashyap et al. 2002). This has been considered as the primary financial intermediation function of banks.

From the social welfare perspective, it is crucial that this financial intermediation function of banks is undertaken at a low cost. The efficiency of the intermediation process performed by the banking system is often measured by bank spread which is the difference between loan and deposit rates. That is, as a performance benchmark, bank spread or interest margin represents the cost of financial intermediation or the economic cost of the banking sector's output. Large margins usually suggest that the banking sector is inefficient in carrying out its intermediation function of channelling resources (Demirguc-Kunt et al. 2004) which has several economic implications. On the one hand, large bank margins represent high funding costs to businesses and may adversely affect investment; on the other hand, low returns on deposits also discourage savings. This may distort the financial intermediation function of banks as well as increase financing costs of the real sectors which subsequently undermine economic activities.

For this reason, the banking literature has placed considerable emphasis on examining bank interest margin and its determinants (e.g. Ho & Saunders 1981, McShane & Sharpe 1985, Angbazo 1997). For instance, while lack of competitive pressure in the banking market could result in large interest margin, relatively small margins could be indicative of intense competition in the banking business (Saunders & Schumacher 2000).

Economic theories attribute investments in liquidity to precautionary, transactional and speculative motives, given unexpected exogenous shocks and market constraints (Keynes 1936). The transaction motive suggests that banks' liquidity needs arise from the transactions that are performed as part of their business activities. Banks also invest in asset liquidity as a buffer against negative shocks to their cash flow for precautionary purposes. By holding more liquidity for specu-

lative purposes, banks may be able to reap the potential profit from investment opportunities that may arise in the future. Later studies such as Bhattacharya & Thakor (1993) show that the presence of explicit/implicit deposit guarantees and 'lender of last resort' gives rise to the underinvestment in liquidity.

Due to the nature of their business, however, it is important that banks hold a sufficient amount of liquidity to withstand liquidity shocks emanating from adverse economic conditions. For example, banks may face the risk that depositors suddenly withdraw their deposits. In fact, liquidity shocks are often deemed to be primarily responsible for the 2008 Global Financial Crisis which revealed the weaknesses in bank risk management. Together with credit risk, liquidity risk has been identified as a major cause of commercial bank failures during the crisis (Imbierowicz & Rauch 2014). Against this backdrop, the Basel III, which is a new set of regulatory standards, was introduced by the Basel Committee on Banking Supervision (BCBS) to address both short-run and long-run liquidity risks, highlighting the importance of liquidity regulation in the banking system.

Despite the fact that there is no general consensus regarding the accurate measurement of liquidity that is able to capture all dimensions of liquidity risk, the objective of liquidity standards is to minimise the likelihood and intensity of banks' liquidity dry-ups, to enhance the resilience of banks during downturn periods (e.g., Hong et al. 2014, Dietrich et al. 2014, Vazquez & Federico 2015, Du 2017, Chiaramonte & Casu 2017). Nevertheless, Acharya & Viswanathan (2011) highlight that in competitive banking markets, the higher opportunity costs associated with holding low-yielding liquid assets adversely affect bank wealth creation. This suggests that although investment in liquidity assets reduces the likelihood of bank failure due to sudden liquidity shortage, it comes with a cost that should be incorporated into bank interest margins.

This chapter studies the effect of measures of liquidity on bank interest margins for a sample of U.S. banks from 2001 to 2018. We construct the conventional liquid assets ratio, the Basel III Net Stable Funding Ratio (NSFR) and the Liquidity Coverage Ratio (LCR) and find these liquidity ratios exert a positive impact on bank interest margins, indicating that there is a cost associated with complying with liquidity rules. Furthermore, this study examines how market power affects

banks' valuation of liquidity. In particular, it seeks to understand how banks with varying market power take liquidity into account when determining their interest margins.

Our results indicate that banks with greater market power as measured by the Lerner index incorporate the costs of liquidity into the interest margins to a lesser extent relative to those banks with less market power. The findings suggest that the cost of investing in liquidity becomes less expensive as banks achieve more market power. Further investigation reveals that the role of market power in affecting banks' valuation of liquidity appears to be more important for small banks than for large banks. We perform a number of robustness checks including using an alternative measure of interest margins, employing the funding-adjusted Lerner index as a proxy of market power and the System Generalized Methods of Moments (SGMM) to tackle the possible endogeneity problem that might arise in our estimations. Our findings remain robust to all these tests.

This study contributes to the existing literature in several ways. First, prior studies have identified various bank-specific characteristics that play important roles in determining bank interest margins. In particular, most studies seek to understand the impacts of market power and liquidity on bank interest margins (e.g., Amidu & Wolfe 2013, Entrop et al. 2015, Birchwood et al. 2017, Cruz-García & de Guevara 2020). To the best of our knowledge, no attention has been paid to their interaction effect on interest margins. This study, therefore, adds to the literature on the determinants of bank interest margins by being the first to examine how banks' valuation of liquidity changes with their market power.

Second, this study enhances the literature on the impact of competition on banks' behaviours, financial intermediation and financial stability (e.g., Beck et al. 2004, Calderon & Schaeck 2016). Prior studies focus on the effect of market power on net interest margins (e.g., Corvoisier & Gropp 2002), financial stability (e.g., Berger et al. 2009, Beck et al. 2013), bank risk-taking (e.g., Agoraki et al. 2011), bank efficiency (e.g., Maudos & de Guevara 2007, Turk-Ariss 2010). This study highlights the importance of market power in reducing the costs associated with liquidity requirements.

Third, we employ several measures of bank liquidity including the Net Stable

Funding Ratio (NSFR), the Liquidity Coverage Ratio (LCR) proposed by the Basel Committee on Banking Supervision (BCBS) in the Basel III accord so as to have a more comprehensive view on the interaction effect of market power and bank liquidity on interest margins. In this regard, this study contributes to the growing literature on the new liquidity standards and their possible effects on the resilience and efficiency of the banking system once these new liquidity requirements are implemented (e.g., Hong et al. 2014, Dietrich et al. 2014, Vazquez & Federico 2015, Du 2017, Chiaramonte & Casu 2017, Sclip et al. 2019).

In terms of policy implications, regulators should consider the resilience-efficiency trade-off in the banking system when designing liquidity standards such as the NSFR and LCR. Furthermore, as the cost of liquidity that is taken into account in interest margins can be reduced when the competition in the banking sector is less intense, this study highlights that market competition might be important in the design of bank liquidity management frameworks, and regulators might not take the 'one size fits all' approach to the implementation of bank liquidity requirements.

The remainder of this chapter is organised as follows. Section 3.2 provides a literature review and hypothesis development. Section 3.3 introduces the data, the variables of interest and methodology. Section 3.4 presents the empirical results and discussions. Section 3.5 presents the study summary and conclusion.

3.2 Literature review and hypothesis development

3.2.1 Determinants of bank interest margins

The literature on bank interest margin and its determinants follows the seminal work by Ho & Saunders (1981) that draws on the inventory model that is well-known in the literature of market microstructure and attempts to understand how banks determine their interest margin. In their paper, a bank can be viewed as a financial intermediary between depositors and borrowers and plays the role of a risk-averse dealer in the lending and depositing market. Banks, therefore, carry inventory risk that emanates from the mismatch between their assets and liabilities due to the asymmetric timing of funding supply and credit demand. Banks will

require compensation for carrying this risk and determine the interest margin, which is the difference between the deposit and lending rates to maximize their profits. That is, similar to the margin of the dealers in the financial markets, economic costs incurred by banking firms when performing their role of financial intermediation should be reflected in the interest margins. Bank spread or interest margin is also known as the price of intermediation, and its optimal size is a function of banks' risk aversion, market structure or degree of competition in the banking sector, the volatility of interest rates and the size of bank transactions.

In their study, Ho & Saunders (1981) employ the two-stage approach decomposes bank spread into a pure spread and a premium which accounts for various risks that banks face. Accordingly, in the first stage regression, the theoretical pure spread is estimated by taking into account the additional factors that influence the bank's actual margin. The authors regress the actual bank margin against the controlling bank-specific variables, including bank default probability, opportunity costs of reserves and implicit interest payments. The constant of this regression represents the estimated pure spread which subsequently enters into the second stage regression. The theoretical determinants including interest rate volatility and market structure appear as the explanatory variables of the pure spread in the second stage regression.

Later studies attempt to extend the 'dealership model' of Ho & Saunders (1981) by including other factors that may have some bearing on bank interest margins. For example, McShane & Sharpe (1985) consider the effects of interest rate risk arising from the uncertainty of the money markets instead of interest rates of deposits and loans. Allen (1988) demonstrates the impact of cross-elasticities of demand between bank products (i.e. different types of loans) in reducing the pure spread while Angbazo (1997) focuses on the importance of loan default risk in addition to interest rate risk. Maudos & de Guevara (2004) explicitly incorporate administrative and operating costs in the theoretical model. Valverde & Fernández (2007) demonstrate that bank margins are significantly related to their non-traditional activities. Entrop et al. (2015) extend the seminal model by considering the interest rate risk of bank assets and liabilities with varying maturities.

Empirical studies that employ the two-stage methodology as in Ho & Saunders (1981) include Brock & Suarez (2000) that investigate the determinants of bank spreads in seven Latin American countries and Saunders & Schumacher (2000) who look into the bank margins of selected OECD countries. While Brock & Suarez (2000) report that besides bank-specific factors such as capital and liquidity risk, macro-level factors such as inflation, interest rate volatility, GDP growth and reserve requirements also affect bank spreads Saunders & Schumacher (2000) decompose interest margins into risk premium component, market structure component as well as regulatory component.

Alternatively, other studies employ a single-stage regression approach that accounts for both the variables in the theoretical model and other factors in the regression. Angbazo (1997) shows that the net interest margins of U.S. banks are positively associated with their loan default risk and interest rate risk exposure. The positive association between banks' net interest margins and their management quality as well as risk preferences is also reported. Studying bank interest margins in the Australian banking sector, Williams (2007) offers evidence in support of the role of market power and the importance of operating costs in determining banks' interest margins, considering the differences between domestic and foreign banks. Using a sample of German banks, Entrop et al. (2015) demonstrate that interest rate risk and expected excess holding period returns are priced into the interest margins.

In their early cross-country study, Demirguc-Kunt & Huizinga (1999) provide a comprehensive analysis of a large set of determinants of bank interest margins in 80 countries from 1988–1995. Similarly, Maudos & de Guevara (2004) examine the interest margin determinants of countries in the European Union and reveal that several bank-specific characteristics such as loan default risk, operating costs, interest rate risk, quality of bank management and bank risk aversion explain the margins which is consistent with prior studies. Notably, they use the measure of market power instead of concentration ratios to control the competitive condition in the European banking sector and find a positive relationship between market power and bank interest margins. Similar findings are also provided by Claeys & Vennet (2008) who explore the factors that explain the relatively high interest

margins of banks in Central and Eastern European (CEE) countries. These factors include imperfect competition in the markets, low capital, low operational efficiency, as well as a high proportion of state and foreign ownership. In an international study, Gelos (2009) provides evidence suggesting that the prevalent high spreads in 14 countries in Latin America can be explained by large reserve requirements, high interest rates and less efficient banking system relative to other economies. Studies such as Lepetit et al. (2008) and Nguyen (2012) emphasise the role of non-traditional fee-based activities on net interest margins. A study by Amidu & Wolfe (2013) sheds light on the implications of funding strategies on interest margins in both developed and emerging markets. Their findings indicate that the interest margins of banks with market power are more sensitive to funds that are generated internally than to wholesale and deposit funding. In another cross-country study, Demirguc-Kunt et al. (2004) find that tighter regulations bank activities and bank entry raise bank spreads. In addition, national indicators such as property rights protection and economic freedom also explain the cost of intermediation. Similarly, in a study on the interest margins of Central American and Caribbean countries, Birchwood et al. (2017) find that significant reductions in bank margins are associated with a higher presence of foreign banks, reductions in entry requirements and increased transparency in the financial statement. In a recent study, Cruz-García & de Guevara (2020) find that deposit insurance and capital requirements are positively associated with bank net interest margins for a sample of banks from 31 OECD countries, implying that the costs of those stricter regulations are ultimately borne by banks' customers.

Overall, the literature on interest margins seeks to identify the factors that determine bank interest margins. These include the degree of market competition, the bank's risk aversion, bank capital and liquidity, operating capacity, administrative and other operating costs, interest rate and credit risk together with regulations and other macro-economic factors. These studies do not investigate how liquidity is priced into bank spread under imperfect competitive environments. For this reason, the present study seeks to fill the gap in the existing literature by examining how banks with varying degree of market power price liquidity into their interest margins.

3.2.2 Hypothesis development

Following the 2008 Global Financial Crisis, the role of liquidity in banks' risk management frameworks has received considerable attention. The literature (e.g., Ratnovski 2013) suggests that an investment in liquidity acts as a buffer against liquidity shocks and improves the resilience of the banking system under adverse economic conditions. Nevertheless, as liquid assets generally generate lower returns compared to illiquid assets, maintaining a higher level of liquidity tends to come with a cost that should be incorporated into bank margins. On the one hand, according to the 'structure - conduct - performance' view in the literature (e.g., Berger & Hannan 1989, Corvoisier & Gropp 2002) banks that acquired more market power may find themselves in a better position to determine their interest margins. In other words, banks exploit their increased market power to extract rents at the expense of customers. Similarly, the 'pricing channel' view (e.g., Boot & Thakor 2000) suggests that banks adjust their pricing policies in response to heightened competition by increasing deposit rates and reducing loan rates, thereby shrinking interest margins. Therefore, it is expected that banks with greater market power take advantage of their pricing power and set a larger interest margin to compensate for the costs associated with investing in liquidity. Market power enhances the effect of liquidity on bank interest margins.

On the other hand, banks with greater market power might experience fewer frictions in assessing funding markets. The 'charter value' paradigm of Keeley (1990) suggests that dominant banks tend to be perceived as less risky. This implies that once banks establish their reputation in the lending and depositing markets and acquire sufficient market power, they may have better access to both wholesale and retail funding sources (Cocco et al. 2009). Those banks are able to obtain funding at relatively cheaper costs as the costs of wholesale funding tend to depend on bank risk (Dinger & von Hagen 2009). Moreover, with better access to funding liquidity, dominant banks might lessen their reliance on asset liquidity which is associated with adverse selection, moral hazard concerns and higher opportunity costs. This is in line with Paal et al. (2013) who document that banks with more market power tend to hold less liquid assets and earn greater profits from high-yield assets. For these reasons, investment in liquidity becomes relatively cheaper for

banks with greater market power.

Furthermore, dominant banking firms in the depositing and lending markets may have a greater advantage in identifying business opportunities. Their bargaining power also allows them to obtain better terms in the contract creation. Dominant banks also realize economies of scale and efficiency gains might be passed onto customers via more beneficial interest rates (Craig & Dinger 2009). Therefore, dominant banks are able to generate more income that can compensate for the costs associated with liquidity investments, thereby reducing their interest margins. Market power moderates the effect of liquidity on bank interest margins.

Following these competing arguments, bank interest margins could have a positive/negative relationship with the interaction between market power and liquidity. This leads to two alternative hypotheses to be tested in this chapter:

> **Hypothesis 1:** Market power enhances the effect of liquidity on bank interest margins.
>
> **Hypothesis 2:** Market power moderates the effect of liquidity on bank interest margins.

3.3 Data and Methodology

3.3.1 Data

The empirical analysis is carried out using quarterly bank-level financial statement and balance sheet data retrieved from the Call reports from the FFIEC (Federal Financial Institutions Examination Council) Central Data Repository's Public Data Distribution. The sample of our study consists of commercial banking institutions in the U.S. for the 2001–2018 period. We do not consider other types of banks to avoid possible bias that may emanate from the differences in terms of business nature and scope. Cooperative banks, investments banks and savings banks may have different business specifications and objectives. The sample period starts from 2001 because Call reports do not have information on bank risk-weighted assets in different categories to calculate the liquidity measures before 2001. A number of filtering rules are applied to arrive at the final sample. Specifically,

bank-quarters with negative expenses, income, total loans reported are omitted. We also exclude from the sample bank-quarters that do not have deposits, loans or assets. In addition, banks that do not have complete information to construct the market power measures and liquidity are excluded. To account for the possible effects of mergers and acquisitions, we exclude observations with greater than 50% or less than –50% quarterly growth in assets. Bank-specific variables are winsorised at the top and bottom 1% of the distribution to prevent the impact of outliers following prior studies (e.g. Berger et al. 2009). After dropping errors and inconsistencies, the final sample consists of 9882 banks and a total of 325073 bank-quarter observations. The macroeconomic variables such as real GDP growth rate, inflation rate and federal fund rate are obtained from Fed Bank of St. Louis. The dummy for the 2007 Financial Crisis is defined according to the definition of the National Bureau of Economic Research (NBER). The definition summary of the variables used in the study and data source are given in Table 3.1.

Table 3.1: Variable definitions

Variables	*Notation*	*Definitions*	*Data source*
Dependent variables			
Net interest margin	NIM_1	Interest income on loans to total loans minus interest expenses of deposits to total deposits	Call reports
	NIM_2	Net interest income to total assets	Call reports
Bank-specific variables			
Liquidity	*LIQUIDITY ASSETS*	Liquid assets to total assets	Call reports
	NSFR2010	The ratio of available stable funding to required stable funding as defined by Basel III 2010	Call reports
	NSFR2014	The ratio of available stable funding to required stable funding as defined by Basel III 2014	Call reports
	LCR	The ratio of stock of HQLA to net cash outflows over the 30-day stress period	Call reports
Market power	*LERNER*	The conventional Lerner index	Call reports
	ADJUSTED LERNER	The funding-adjusted Lerner index	Call reports
	HIGH LERNER	Dummy variable equal to 1 if a bank's *LERNER* is larger than the median value in a quarter and 0 otherwise	Call reports
Credit risk	*CREDIT RISK*	Non-performing loans to total loans	Call reports
Equity ratio	*CAPITALIZATION*	Equity to total assets	Call reports
Expenditure ratio	*EXPENDITURE*	Total non-interest expenses to operating income	Call reports
Income diversification	*DIVERSIFICATION*	Non-interest revenue to operating income	Call reports

Table 3.1 continued

Macroeconomic variables			
Fed fund rate	*FED RATE*	The federal fund rate	Fed Bank of St. Louis
GDP growth	*GDP GROWTH*	Real GDP growth rate	Fed Bank of St. Louis
Inflation	*INFLATION*	Inflation rate	Fed Bank of St. Louis
Crisis dummy	*CRISIS*	Dummy that is equal to 1 from 2007 Q4 to 2009 Q2 and 0 otherwise.	NBER

3.3.2 Methodology

Following the literature that considers the impact of different explanatory factors on bank interest margin, the interest margin of banks is estimated by the following model:

$$Y_{i,t} = \alpha + \beta_0 Market\ power_{i,t-1} + \beta_1 Liquidity_{i,t-1} + \beta_2 Market\ power \times Liquidity_{i,t-1} + \gamma Controls_{i,t-1} + \gamma_t + \varepsilon_{i,t} \tag{3.1}$$

where i denotes individual banks, t represents the time dimension and $\varepsilon_{i,t}$ represents robust standard errors.

For the purpose of the analysis, Y denotes the interest margin. In this study, the main measure of interest margins (NIM_1) is the difference between the lending rate and the deposit rate. While the former is calculated as the ratio of interest income on loans to total loans, the later is obtained by dividing the bank's interest expenses of deposits by total deposits following Birchwood et al. (2017). In the robustness checks, we use an alternative measure of interest margins (NIM_2) which is defined as the net interest income (interest income minus interest expenses) divided by total assets (e.g. Lin et al. 2012, Nguyen 2012). *Market power* represents the measures of bank market power and *Liquidity* denotes the measures of liquidity. The main interest of this study is to understand how banks determine their interest margins with respect to liquidity as their market power changes. Therefore, the measure of liquidity is multiplied by the bank's market power (*Market power* $\times$ *Liquidity*). This interaction term is incorporated into the model specification to capture the heterogeneous effects of liquidity on bank margin for banks with varying pricing power. The positive estimated coefficient of this interaction term suggests that banks will charge larger interest margins for liquidity by leveraging their market power. By contrast, if the estimated coefficient is negative, banks with larger market power will charge less for their liquidity. *Controls* is the vector of bank-specific characteristics. In the subsequent part of the analysis, we replace time fixed effects (γ) with macro-economic variables (*Macros*).

Equation (3.1) is estimated by using the panel fixed-effects technique. The estimation with the fixed effect takes into consideration the heterogeneity of

individual banks as it allows unobserved bank-specific characteristics to arbitrarily correlate with the observed independent variables (Baltagi 2008). The effect of bank time-invariant characteristics is removed and the underlying relationship between bank interest margins and other variables specified in the regression model can be examined. In all estimations, one-quarter lag of each of bank-specific and macro-economic variables is used as in Chen et al. (2017), Birchwood et al. (2017), Khan et al. (2017), Kim & Sohn (2017) to mitigate any possible endogeneity bias. Furthermore, this study assumes that banks take into account their current specific characteristics and macroeconomic conditions when determining the interest margins in the next period. In our regression estimations, robust standard errors are clustered at the bank level.

Construction of liquidity measures

Following the literature, four measures of *Liquidity* are employed in this study. *LIQUID ASSETS* is the ratio of liquid assets to total assets. Banks invest in liquidity as it helps insulate their loans from the effects of monetary shocks (Cornett et al. 2011). Liquidity is expected to have a positive effect on bank interest margin as banks are more likely to adjust their lending rates upwards to reflect the costs associated with investing in liquidity.

Alternatively, the study uses the Net Stable Funding Ratio (*NSFR*) proposed by the Basel Committee on Banking Supervision (BCBS) in the Basel III accord as a measure of liquidity. The aim of NSFR is to promote longer term funding of banking institutions' assets as well as other activities. In other words, NSFR is designed to ensure that a bank relies on more stable and long term sources of funding to finance their liquid assets, which reduces the risk associated with maturity transformation Chiaramonte & Casu (2017). For a certain amount of liquidity of the bank's assets, a minimum acceptable amount of stable funding is required meaning that the required ratio is more than 100 per cent. The NSFR is the ratio between available stable funding (ASF) and the required stable funding (RSF). ASF is the weighted sum of funding sources including capital and other liabilities over a one-year horizon and reflects the contractual maturity of those liabilities. RSF is the weighted sum of the various assets as well as off-balance

sheets (OBS) exposures of the bank. The RSF calculation requires specific RSF factor that indicates the proportion of the exposure that should be backed by stable sources of funding. The weights associated with the ASF and RSR factors are defined in the 2010 version of the Basel III accord (Basel Committee on Banking Supervision 2010) and subsequently revised in 2014 (Basel Committee on Banking Supervision 2014). This study, therefore, follows the literature (e.g. DeYoung & Jang 2016, Hong et al. 2014) to construct two NSFR measures: *NSFR2010* and *NSFR2014*. The ASF and RSR factors are given in Table B1 in the Appendix.

$$NSFR = \frac{ASF}{RSF} \tag{3.2}$$

Finally, the study employs the Liquidity Coverage Ratio (LCR) as a proxy for liquidity (Basel Committee on Banking Supervision 2013). Liquidity Coverage Ratio is designed to ensure that banks maintain an adequate amount of unencumbered high-quality assets (HQLA) to meet their liquidity needs for a 30-calendar-day liquidity stress scenario. The LCR is defined as the ratio of HQLA to total net cash outflows over the 30-day stress period:

$$LCR = \frac{Stock\ of\ HQLA}{Net\ cash\ outflows\ over\ 30\ calendar\ days} \tag{3.3}$$

where HQLA consists of cash or other assets with the potential to be unencumbered over the next 30-day stress scenario and can be immediately converted into cash at little or no loss of value. Net cash outflows is the difference between total expected cash outflows and total expected cash inflows over the 30-day stress period. The LCR, therefore, assesses banks' survivability under extreme liquidity conditions (Du 2017). We follow Hong et al. (2014) to calculate LCR and Table B2 in the Appendix provides the comprehensive construction of LCR.

It should be noted that the banking literature also uses the concept of liquidity creation as a proxy of liquidity risk. However, unlike our three measures of liquidity, liquidity creation of a bank refers to its provision of finance to the real sector. The three liquidity measures employed in this study, on the other hand, refer to either the ability of banks to turn their assets into cash quickly with little impact on their value (Brunnermeier 2009) or the ability to raise funds to meet financial obligations

in a timely fashion. Therefore, liquidity creation measure does not offer insight on how banks with varying market power price the cost of liquidity into their margins. For this reason, this study does not use liquidity creation as a proxy of liquidity.

Construction of market power measures

In this study, two measures of *Market power* (the conventional and the funding-adjusted Lerner index) which are used extensively in the literature are employed. The first measure of bank market power (*LERNER*) is measured by the traditional Lerner index (Lerner 1934) that uses the information on bank assets and funding and captures the pricing power of the banks (Beck et al. 2013). Compared with other measures of competition (e.g. the Panzar and Rosse H-statistic) the Lerner index, which measures the disparity between price and marginal cost expressed as a percentage of price, does not require the market to be in the long-run equilibrium (Beck et al. 2013). The index is also a better measure of bank-specific market power than measures of market concentration or market share (such as the Herfindahl-Hirschman index) as these measures only reflect the level of concentration in a geographically defined market rather than the pricing power of individual banks. This is because the Lerner index focuses on the banks' conduct by incorporating information on the profit and costs from the operations of the banks. Therefore, it reflects better the pricing power on both the asset and funding sides of the banks. Unlike concentration measures, Lerner index does not require information on the geographic product markets. Such information is difficult to obtain as banks often operate in more than one country (Beck et al. 2013). While the banking literature has reached the conclusion that the link between concentration and competition in banking is very weak (Schaeck & Cihak 2013) and, to the best of the author's knowledge, concentration measures are not used as proxies of bank market power, Lerner index is used to capture market power in this study.

The conventional Lerner index is expressed as follows:

$$LERNER_{it} = \frac{P_{it} - MC_{it}}{P_{it}} \tag{3.4}$$

where P_{it} and MC_{it} are the price of a bank's outputs and its marginal cost, respectively. The price of the bank's outputs is the quotient between total bank

revenues (interest and non-interest income) and total assets. Marginal costs can be obtained after estimating the following trans-log total cost function as in Berger et al. (2009), Beck et al. (2013):

$$\begin{aligned}\ln(TC_{it}) = \alpha_0 + \alpha_1 \ln(Q_{it}) + \frac{1}{2}\alpha_2(\ln(Q_{it}))^2 + \sum_{n=1}^{3} \beta_n \ln(W_{n,it}) \\ + \frac{1}{2}\sum_{m=1}^{3}\sum_{n=1}^{3} \gamma_{mn} \ln(W_{m,it}) \ln(W_{n,it}) + \sum_{n=1}^{3} \mu_n \ln(Q_{it}) \ln(W_{n,it}) \\ + \delta_1 T + \delta_2 \frac{1}{2}(T)^2 + \delta_3 T \ln(Q_{it}) + \sum_{n=1}^{3} \rho_n T \ln(W_{n,it}) + \varepsilon_{it}\end{aligned} \tag{3.5}$$

where TC_{it} represents total costs which are the sum of interest expenses, personnel expenses and other operating and administrative expenses. Bank output Q_{it} is total assets and W_{it} denotes the price of three inputs: capital (W_1), labour (W_2) and borrowed funds (W_3). The price of funds is the ratio of interest expenses to total funds (the sum of short-term funding and total deposits), physical capital price is computed as total administrative and operating expenses to total assets, the price of labour is measured as personnel expenses divided by total assets. Changes in the business cycle and technological development are accounted for by a trend (T) and ε_{it} is an error term. Following Beck et al. (2013), a number of restrictions are imposed to achieve the homogeneity of degree one in input prices: $\sum_{n=1}^{3} \beta_n = 1$, $\sum_{n=1}^{3} \mu_n = 0$, $\forall m \in \{1, 2, 3\} : \sum_{n=1}^{3} \gamma_{mn} = 0$. The translog function is estimated using panel fixed-effects technique to capture the specificities of each firm. Marginal costs are calculated as follows:

$$MC_{it} = \frac{\partial TC_{it}}{\partial Q_{it}} = \frac{TC_{it}}{Q_{it}}\left(\hat{\alpha_1} + \hat{\alpha_2} \ln(Q_{it}) + \sum_{n=1}^{3} \hat{\mu_n} \ln W_{n,it} + \hat{\delta_3 T}\right) \tag{3.6}$$

The conventional Lerner index ($LERNER$) is often criticized for the fact that it is likely to reflect the monopoly power emanating from deposit markets which is the ability of banks to raise funds at a relatively less expensive cost (e.g. Maudos & de Guevara 2007, Turk-Ariss 2010). Turk-Ariss (2010) points out that when determining the price of loans, funding costs, a risk premium and another premium to reflect the market power of the bank are taken into consideration. That is, the bank's market power in the deposit market is already taken into account in the price of the loans. Therefore, including financing costs in the cost function when

computing market power may lead to bias in the results. The funding-adjusted Lerner (*ADJUSTED LERNER*) which excludes the funding cost in the computation is used as an alternative measure of market power. That is, in the trans-log cost function (Equation (3.5)) and the marginal cost function (Equation (3.6)), the price of borrowed funds (W_3) is not included. By doing this, the pure pricing power that does not reflect the market power in the deposit market when raising funds can be obtained (Maudos & de Guevara 2007). Numerous studies show that banks operating in markets with less intensive competition charge higher interest margins than those operating in markets with more dispersed market power (McShane & Sharpe 1985, Demirguc-Kunt et al. 2004, Peria & Mody 2004). It is therefore expected that the more market power a bank has (higher Lerner index) the higher its margin will be, pointing to the positive association between market power and interest margin. As a robustness check, we also define *HIGH LERNER* as a dummy variable which equals 1 if a bank's *LERNER* is larger than the median value in a particular quarter and 0 otherwise.

Bank-specific characteristics

The model also includes other bank-specific factors that are considered to be important determinants of bank spreads following the empirical literature. Credit risk (*CREDIT RISK*) is defined as the ratio of non-performing loans to total loans. Credit risk, which reflects the expected loss from loan default, is an important risk factor and is expected to be positively related to bank interest margins. To compensate for the expected losses arising from loan default, banks with a high ratio of non-performing loans to total loans are likely to increase their interest margins by raising loan rates relative to deposit rates more than those with lower credit risk (Peria & Mody 2004).

Bank capitalization (*CAPITALIZATION*) is measured by the ratio of equity to total assets and is expected to have a positive association with bank spreads. Capital enhances the loss-absorbing capacity of banks and those that have sufficient capital have a lower probability of default, especially in times of crisis. Highly capitalised banks are less risky and are able to attract deposits at lower rates. This is consistent with the empirical evidence of Gambacorta & Shin (2018) who find

that higher capital ratios are associated with lower funding costs. Furthermore, as capital is costly and if this cost is priced into the spreads, one should expect that capital increases bank margins. Therefore, banks with more capital may have larger bank spreads.

Bank expenditure (*EXPENDITURE*) is proxied by total non-interest expenses divided by total operating income. It is expected that banks that operate with higher administrative expenditures are less efficient and are likely to incorporate these costs into their spreads. For this reason, bank interest margins may increase with bank expenditure (Peria & Mody 2004, Maudos & de Guevara 2004).

The effect of income diversification (*DIVERSIFICATION*), which is the ratio of bank non-interest revenue to total operating income, on bank spreads is ambiguous. Revenue diversification might be negatively related to bank interest margins. Lepetit et al. (2008) document that the larger income share from commissions and fees is associated with lower interest margins and loan spreads. The authors argue that banks may reduce their spreads to attract customers for their non-traditional business. However, Nguyen (2012) shows that the interest margin is not always inversely related to income from non-traditional activities.

Macroeconomic variables

Macroeconomic variables are included in the model to control for the effects of these factors on interest margins. The growth rate of real GDP (*GDP GROWTH*) captures the effect of the business cycle. According to Peria & Mody (2004), inflation (*INFLATION*) exerts an asymmetric influence on deposit and lending rates, implying that inflation might affect bank interest margins. The federal fund rate (*FED RATE*) is included to capture the effects of interest rate policy which is related to bank risk-taking (e.g., Ioannidou et al. 2014), and in turn net interest margins. *CRISIS* is a dummy variable that equals to 1 for the period of the Global Financial Crisis, 2007 Q4 to 2009 Q2.

3.4 Empirical results and Discussions

3.4.1 Summary descriptive statistics

The descriptive statistics for all the variables used in the regression are shown in Table 3.2. Averaging across all observations, the mean values of NIM_1 and NIM_2 are 3.02% and 2.26%, respectively. The interest margins (NIM_1 and NIM_2) of the banks in the sample are relatively small, with 7.18%, 5.11% being the highest and 0.72% and 0.57% being the lowest.

Within the sample period, the mean of market power, which is proxied by the Lerner index (*LERNER*), is around 0.41 suggesting that banks on average priced their product at around 41% above marginal cost. The alternative measure of market power, which is the funding-adjusted Lerner index (*ADJUSTED LERNER*) also averages at 0.38, indicating a 38% mark-up. However, there is a great disparity in the degree of market power when the bank with the largest *LERNER* can charge 68% above its marginal cost while the one with the least market power can only charge an addition of 13%. The figures for the *ADJUSTED LERNER* are 62% and 10%, respectively. Overall, the *ADJUSTED LERNER* is smaller than the conventional *LERNER*, which indicates that the latter overestimates the degree of market power. This suggests that the use of an alternative measure of market power in this study is necessary.

As for the measures of liquidity, while the 2010 Net Stable Funding Ratio (*NSFR2010*) averages at 1.54 and ranges from 0.76 to 5.02 in the sample, the mean of *NSFR2014* is 1.43 with the highest and lowest being 4.70 and 0.71, respectively. The figures demonstrate that banks in the U.S. appear to have more available stable funding than the amount that is required. Similarly, the mean of the Liquidity Coverage Ratio (*LCR*) across the sample is 1.39, with the highest and the lowest investment in high quality liquid assets in proportion to net cash outflows being 3.09 and 0.16, respectively. *LIQUIDITY ASSETS* which is the ratio of liquidity assets over total assets averages at 27.76%, with the highest and the lowest being 71.59% and 2.86%, respectively.

Table 3.2: Summary statistics for the regression variables

Variable	*Mean*	*S.D.*	*Min*	*Max*	*Obs.*
$NIM_{1,t}$	2.9833	1.5240	0.7235	7.1893	325073
$NIM_{2,t}$	2.2368	1.1115	0.5799	5.1112	325073
$LERNER_{t-1}$	0.4109	0.1027	0.1336	0.6841	310033
$ADJUSTED\ LERNER_{t-1}$	0.3802	0.1000	0.1080	0.6288	310033
$HIGH\ LERNER_{t-1}$	0.5000	0.5000	0.0000	1.0000	310033
$NSFR2010_{t-1}$	1.5482	0.6704	0.7627	5.0246	310033
$NSFR2014_{t-1}$	1.4387	0.6274	0.7156	4.7047	310033
LCR_{t-1}	1.3910	0.4513	0.1613	3.0982	310033
$LIQUIDITY\ ASSETS_{t-1}$	27.7628	14.8760	2.8616	71.5972	310033
$CAPITALIZATION_{t-1}$	10.7055	3.4844	5.7177	25.4941	310033
$EXPENDITURE_{t-1}$	47.6791	13.9406	19.6217	94.2795	310033
$DIVERSIFICATION_{t-1}$	11.5957	8.3190	0.8000	53.5450	310033
$CREDIT\ RISK_{t-1}$	1.4324	1.9408	0.0006	11.0698	310033
$FED\ RATE_{t-1}$	2.2074	1.8305	0.0700	5.5900	310033
$GDP\ GROWTH_{t-1}$	0.4370	0.6679	-2.1638	1.6982	310033
$INFLATION_{t-1}$	2.4731	1.0849	-0.3555	3.8391	310033
CRISIS	0.1523	0.3593	0.0000	1.0000	310033

This table reports the descriptive statistics for key variables in the regressions from 2001 to 2018. NIM_1 is defined as interest income on loans to total loans minus interest expenses of deposits to total deposits. NIM_2 is net interest income to total assets. *LIQUIDITY ASSETS* is liquid assets to total assets. *NSFR2010* is the ratio of available stable funding to required stable funding as defined by Basel III 2010. *NSFR2014* is the ratio of available stable funding to required stable funding as defined by Basel III 2014. *LCR* is the ratio of stock of HQLA to net cash outflows over the 30-day stress period. *LERNER* represents the conventional Lerner index and *ADJUSTED LERNER* denotes the funding-adjusted Lerner index. *HIGH LERNER* is a dummy variable equal to 1 if a bank's *LERNER* is larger than the median value in a quarter and 0 otherwise. *CREDIT RISK* is the ratio of non-performing loans to total loans. *CAPITALIZATION* is defined as equity to total assets. *EXPENDITURE* is the ratio of total non-interest expenses to operating income. *DIVERSIFICATION* is non-interest revenue divided by operating income. *FED RATE* is the federal fund rate. *GDP GROWTH* represents real GDP growth rate and *INFLATION* denotes inflation rate. *CRISIS* is a dummy variable that equals to 1 for the period of the Global Financial Crisis, 2007 Q4 to 2009 Q2. Bank-specific variables are winsorised at the top and bottom 1% of the distribution

Regarding credit risk, which is proxied by the ratio of non-performing loan over total loans, the mean of *CREDIT RISK* is 1.43% which is relatively low. The highest percentage of credit risk is 11.06, while the lowest is 0.06. As can be seen from the table, the degree of capitalization (*CAPITALIZATION*) of the banks in the sample, on average, is 10.70% while the figure for the highest capitalised bank is 25.49% and the lowest capitalised one is 5.71%. Within the sample period, those banks appear to be relatively efficient with the ratio of non-interest expenses to operating income (*EXPENDITURE*) averages at 47.67% with the highest and the lowest figure being 94.27% and 19.62%, respectively. On average, only 11.59% of the income of U.S. banks is generated from non-interest charging activities while the highest and lowest ratios of *DIVERSIFICATION*) are 53.54% and 0.80%, respectively.

The correlation matrix of the regression variables is given in Table B3 in the Appendix. Overall, the pair-wise correlation coefficients among the explanatory variables in each regression specification are less than 0.7, indicating that those explanatory variables are not highly correlated and multicollinearity is not a major problem in our empirical set-up.

3.4.2 Main estimation results

The interaction of bank market power and liquidity measures on net interest margins

In this section, we conduct a multivariate regression analysis of bank net interest margins from 2001 to 2018 to understand how banks with varying degree of market power price their liquidity. Net interest margin (NIM_1) is the ratio of interest income on loans to total loans minus interest expenses of deposits to deposits. Bank liquidity is measured by *LIQUID ASSETS*, *NSFR2010*, *NSFR2014* and *LCR* which are the ratio of liquid assets to total assets, the 2010 Net Stable Funding Ratio, the 2014 Net Stable Funding Ratio and the Liquidity Coverage Ratio, respectively. Bank market power is proxied by the conventional Lerner index (*LERNER*). We also include a number of bank-specific variables including credit risk (*CREDIT RISK*), bank capitalization (*CAPITALIZATION*), expenditure

ratio (*EXPENDITURE*) and income diversification (*DIVERSIFICATION*) to evaluate how much of the variation in bank net interest margins are explained by firm-specific characteristics. All variables are winsorised at the 1st and 99th percentiles. Bank and time fixed effects are included in all regressions and robust standard errors are clustered at the bank level.

Table 3.3 presents the empirical results of the panel estimation of Equation (3.1) with eight specifications. Columns (1), (3), (5), (7) present the baseline regression results while columns (2), (4), (6), (8) include the interaction between measures of liquidity and bank market power. Across all model specifications, market power (*LERNER*) has a significant and positive influence on bank margins which is consistent with the expectation that banking firms in less competitive markets tend to have larger margins. The positive association between market power and interest margin is consistent with the argument that banking firms take advantage of their pricing power at the expense of their depositors and borrowers. The positive coefficients of *LIQUID ASSETS* and *LCR* (significant at 1% level) across the model specifications indicate that bank margins and their investments in liquid assets are positively associated. It should be noted that as banks hold more liquid assets, their liquidity risk is reduced, which points to the negative association between liquidity risk of banks and their interest margins. This relationship can be explained by the fact that holding liquid assets represents opportunity costs to banks as they have to forego interest earnings from lending, and these costs are priced into interest margins. Similarly, *NSFR2010* and *NSFR2014* also exert a positive influence on bank margins as evidenced by their significant coefficients at 1% significance level. Net Stable Funding Ratio represents the assets and off-balance sheet activities of the banks that should be backed by stable funding sources. As stable funding sources such as equity and other long-term liabilities are more expensive relative to other short-term funding sources, the banks' interest margins should reflect those costs. The finding is interesting as it has implications for the regulatory authority. That is, although from a banking regulation perspective banks benefit from holding liquid assets as the likelihood of liquidity crisis is reduced, increased costs associated with strict liquidity requirement are likely to be passed on to banks' customers in the form of higher interest margins.

Table 3.3: The impact of liquidity measures on bank net interest margins

NIM_1	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$LERNER_{t-1}$	2.3316***	2.7675***	2.3241***	2.7988***	2.3250***	2.7900***	2.3129***	2.3643***
	(0.0344)	(0.0632)	(0.0340)	(0.0789)	(0.0340)	(0.0786)	(0.0336)	(0.0364)
$LIQUID\ ASSETS_{t-1}$	0.0030***	0.0038***						
	(0.0007)	(0.0011)						
$LERNER\ X\ LIQUID\ ASSETS_{t-1}$		-0.0160***						
		(0.0020)						
$NSFR2010_{t-1}$			0.0541***	0.0855***				
			(0.0118)	(0.0244)				
$LERNER\ X\ NSFR2010_{t-1}$				-0.3086***				
				(0.0484)				
$NSFR2014_{t-1}$					0.0595***	0.0878***		
					(0.0126)	(0.0263)		
$LERNER\ X\ NSFR2014_{t-1}$						-0.3251***		
						(0.0519)		
LCR_{t-1}							0.2422***	0.5390***
							(0.0282)	(0.0983)
$LERNER\ X\ LCR_{t-1}$								-0.6920***
								(0.2592)
$CAPITALIZATION_{t-1}$	0.0011	0.0009	0.0004	0.0006	0.0004	0.0006	0.0005	0.0005
	(0.0013)	(0.0014)	(0.0014)	(0.0014)	(0.0014)	(0.0014)	(0.0013)	(0.0013)
$EXPENDITURE_{t-1}$	0.0025***	0.0023***	0.0024***	0.0024***	0.0024***	0.0024***	0.0023***	0.0023***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
$DIVERSIFICATION_{t-1}$	-0.0122***	-0.0124***	-0.0121***	-0.0122***	-0.0121***	-0.0122***	-0.0121***	-0.0121***

	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)
CREDIT RISK$_{t-1}$	-0.0011	-0.0011	-0.0017	-0.0014	-0.0017	-0.0014	-0.0015	-0.0015
	(0.0014)	(0.0014)	(0.0014)	(0.0014)	(0.0014)	(0.0014)	(0.0014)	(0.0014)
Constant	1.3381***	1.1440***	1.2868***	1.0538***	1.2895***	1.0616***	1.0405***	1.0170***
	(0.0714)	(0.0738)	(0.0509)	(0.0628)	(0.0504)	(0.0625)	(0.0315)	(0.0333)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	310,033	310,033	310,033	310,033	310,033	310,033	310,033	310,033
R-squared	0.8875	0.8876	0.8875	0.8876	0.8875	0.8876	0.8876	0.8876

The table reports the fixed effects panel regressions of the impacts of different measures of liquidity on bank net interest margins with varying degree of market power from 2001 to 2018. NIM_1 is defined as interest income on loans to total loans minus interest expenses of deposits to total deposits. *NSFR2010* is the ratio of available stable funding to required stable funding as defined by Basel III 2010. *NSFR2014* is the ratio of available stable funding to required stable funding as defined by Basel III 2014. *LCR* is the ratio of stock of HQLA to net cash outflows over the 30-day stress period. *LERNER* represents the conventional Lerner index. *CREDIT RISK* is the ratio of non-performing loans to total loans. *CAPITALIZATION* is defined as equity to total assets. *EXPENDITURE* is the ratio of total non-interest expenses to operating income. *DIVERSIFICATION* is non-interest revenue divided by operating income. Bank and time fixed effects are included in all regressions. Robust standard errors are clustered at the bank level and are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

The main interest of the chapter is the interaction terms of *LERNER* and asset liquidity measures, and it is found that the interaction terms (*LERNER X LIQUID ASSETS* and *LERNER X LCR*) have a negative effect on bank margins in columns (2) and (8) of Table 3.3. Specifically, the estimation results suggest that although banks price the cost of holding liquid assets into the margins, market power reduces this effect. For example, a standard deviation increase in *LERNER* reduces the effects of a 1-percentage-point increase in *LIQUID ASSETS* on NIM_1 by approximately 0.16 ($= 0.0160 \times 0.1027$) percentage points in a quarter. This finding implies that as market power increases, holding more liquid assets appears to be less costly to banks. In other words, banks incorporate the cost associated with holding liquid assets into their margins to a lesser extent as they achieve more market power. This result may be due to the fact that with more market power, banks may find themselves in a better position to price their products and services, to obtain better terms in the contracts with customers, to exploit more business opportunities, thereby earning more income which can compensate for the costs of holding more liquid assets. These arguments are in line with prior studies. For example, according to Acharya & Viswanathan (2011), investing in low-yielding liquid assets imposes opportunity costs to banks and these costs tend to rise in competitive banking markets. A similar finding is also reported in columns (4) and (6), the multiplications of *LERNER* and *NSFR2010* or *NSFR2014* are statistically significant at 1% level and negatively affect bank interest margins. It should be noted that the Net Stable Funding Ratios proposed in the Basel III are different from *LIQUID ASSETS* and *LCR* in the sense that while the former take into account required funding liquidity from the liability side of the balance sheet, *LIQUID ASSETS* and *LCR* only account for asset liquidity of banks. The finding is consistent with prior literature. Dinger & von Hagen (2009) point out that as uninsured wholesale lenders can either charge higher interest rates to risky banks or ration their funds, the cost of wholesale funding depends upon the level of bank risk. Therefore, banks with greater market power are able to access to wholesale funding at a relatively lower cost as market power is often perceived as lower risk according to the classic 'charter value' paradigm (Keeley 1990). In line with these arguments, Cocco et al. (2009) argue that as banks' bargaining power increases

with their market power, dominant banks are likely to be charged lower interest rates on their borrowings, particularly in the interbank market. Investment in liquidity becomes less costly for banks with greater market power.

Some other findings are also worth noting. Bank expenditure (*EXPENDITURE*) that is measured by the ratio of non-interest expenses to operating income appears to be an important determinant of bank margins. The positive and statistically significant effect of bank expenditure on interest margins is found in all model specifications. This is because bank expenditure is considered to be the cost of financial intermediation and should be priced into the spreads (e.g. Maudos & de Guevara 2004). Additionally, the impact of revenue diversification (*DIVERSIFICATION*) of bank earnings on interests margins is negative and significant across the estimation models, which suggests that banks with a higher level of non-traditional income reduce their margins. Similar findings are found for European banks (see Lepetit et al. 2008). The authors argue that in order to increase their earnings from transaction-based fee business, banks may reduce their interest margins in the traditional banking business.

Does bank size matter?

The effect of the interaction between bank market power and liquidity on net interest margins might differ considerably among banks of different sizes as the literature has documented differences in bank behaviours by bank size (e.g. Cornett et al. 2011). Our sample comprises numerous small banks and a minority of large banks. We are concerned that the regression results for the full sample could be driven by the behaviours of small banks. In this sub-section, we split our sample into subsamples: large banks, medium banks and small banks and re-estimate the regression models for each subsample following the criteria used by Kashyap & Stein (2000). In the unreported results, we observe that the size of banks in the top 1% is dramatically larger than those of other groups. Therefore, large banks are defined as those with total assets above the 99^{th} percentile, medium banks are those with total assets ranging from the 95^{th} to 99^{th} percentiles, and small banks are those with total assets less than the 95^{th} percentile in each quarter period. Table 3.4 summarises the regression results for three groups of banks, that

are large, medium and small banks, respectively. In all regressions, bank-specific characteristics, bank and time fixed effects are included and robust standard errors are clustered at the bank level.

Columns (1)–(4) report the regression results using different measures of liquidity for large banks. While the coefficients of *LIQUID ASSETS* and *LCR* are not significant, the estimated coefficients of *NSFR2010* or *NSFR2014* are both positive and statistically significant at 10%. The multiplication variables of *NSFR2010* and *NSFR2014* with *LERNER*, however, appear to be negative and statistically significant determinants of bank margins at 1% level. Similar findings are documented in columns (5)–(8). As for medium banks, the estimated coefficients of the interaction terms of bank liquidity measures and market power are negative and statistically significant at conventional levels. Columns (9)–(12) report the regression results for small banks. Consistent with prior findings, the interaction terms of liquidity measures and bank market power are negatively associated with bank interest margins, and the effect is significant at 1% significant level across model specifications. The findings indicate that U.S. banks' pricing behaviour with respect to liquidity costs is sensitive to the degree of market power, and the effect appears to be more important for smaller banks. Our results highlight the differences in bank behaviours for different groups of bank size. Small banks might be more concerned with the competition in the market and reduce their interest margins when possible to attract more customers. This might lead to a relatively stronger effect of market power on their pricing behaviour with respect to liquidity costs than very large banks that already dominate the market.

Table 3.4: The impact of liquidity measures on bank net interest margins for small, medium and large banks

	Large banks (≥ 99%)				*Medium banks (95% ∼ 99%)*				*Small banks (≤ 95%)*			
NIM_1	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$LERNER_{t-1}$	1.8075	2.8415***	2.8555***	2.1814***	2.7677***	3.1243***	3.1186***	2.1369***	2.7629***	2.7495***	2.7420***	2.3849***
	(1.1843)	(0.7102)	(0.7115)	(0.5327)	(0.3235)	(0.3626)	(0.3595)	(0.2047)	(0.0612)	(0.0792)	(0.0789)	(0.0362)
$LIQUID\ ASSETS_{t-1}$	0.0079				0.0050				0.0034***			
	(0.0114)				(0.0056)				(0.0011)			
$LERNER\ X\ LIQUID\ ASSETS_{t-1}$	-0.0013				-0.0205**				-0.0155***			
	(0.0269)				(0.0084)				(0.0020)			
$NSFR2010_{t-1}$		0.1891*				0.2055***				0.0730***		
		(0.1036)				(0.0740)				(0.0255)		
$LERNER\ X\ NSFR2010_{t-1}$		-0.6558***				-0.6529***				-0.2718***		
		(0.2021)				(0.1878)				(0.0486)		
$NSFR2014_{t-1}$			0.2138*				0.2215***				0.0742***	
			(0.1107)				(0.0789)				(0.0274)	
$LERNER\ X\ NSFR2014_{t-1}$			-0.7210***				-0.7031***				-0.2862***	
			(0.2202)				(0.2014)				(0.0521)	
LCR_{t-1}				1.7283				0.9200				0.5984***
				(1.0873)				(1.1144)				(0.0908)
$LERNER\ X\ LCR_{t-1}$				-2.6927*				-4.2963*				-0.8489***
				(1.5743)				(2.5167)				(0.2354)
Constant	1.1427*	1.5349***	1.5192***	1.4432***	1.3074***	1.0379***	1.0370***	1.1007***	1.1579***	1.0649***	1.0738***	1.0088***
	(0.6823)	(0.5199)	(0.5178)	(0.3912)	(0.3805)	(0.2235)	(0.2219)	(0.1371)	(0.0723)	(0.0657)	(0.0654)	(0.0337)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,891	2,891	2,891	2,891	11,927	11,927	11,927	11,927	294,567	294,567	294,567	294,567
R-squared	0.6881	0.6893	0.6893	0.6899	0.8615	0.8620	0.8620	0.8625	0.8921	0.8920	0.8920	0.8921

The table reports the fixed effects panel regressions of the impacts of different measures of liquidity on bank net interest margins with varying degree of market power from 2001 to 2018 for large, medium and small banks. Large banks are those with total assets above the 99th percentile, medium banks are those with total assets ranging from the 95th to 99th percentiles, and small banks are those with total assets less than the 95th percentile. NIM_1 is defined as interest income on loans to total loans minus interest expenses of deposits to total deposits. *NSFR2010* is the ratio of available stable funding to required stable funding as defined by Basel III 2010. *NSFR2014* is the ratio of available stable funding to required stable funding as defined by Basel III 2014. *LCR* is the ratio of stock of HQLA to net cash outflows over the 30-day stress period. *LERNER* represents the conventional Lerner index. Bank and time fixed effects are included in all regressions. Robust standard errors are clustered at the bank level and are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Macroeconomic factors

In this section, we include macroeconomic variables into the regressions to investigate their potential influence on the findings. Following the literature, we consider federal fund rate (*FED RATE*), real GDP growth rate (*GDP GROWTH*), inflation rate (*INFLATION*) and crisis dummy (*CRISIS*) that may affect bank net interest margins. Our regressions also include other bank-specific characteristics and bank fixed effects. Robust standard errors are clustered at the bank level.

In general, Table 3.5 documents that all the variables that are considered in this study are shown to significantly influence bank margins. The results show that across the models, interest margins increase when banks have more market power. This is consistent with the well-known 'structure - conduct - performance' view in the literature which suggests that with increase market power, banks tend to charge higher interest rates at the expense of their customers in a monopolistic setting (e.g. Berger & Hannan 1989, Corvoisier & Gropp 2002). Similar to prior findings, *LIQUID ASSETS*, *NSFR2010*, *NSFR2014* and *LCR* exert a positive and significant influence on bank spreads, suggesting the opportunity costs of investing in liquidity that should be incorporated into the margins. The interaction terms between these liquidity measures and *LERNER* appear to negatively affect interest margins, implying that liquidity is less costly to dominant banks with more market power. Overall, the findings are largely consistent with prior analyses when macroeconomic variables are not considered.

Table 3.5: The impact of liquidity measures on bank net interest margins including macroeconomic factors

NIM_1	(1)	(2)	(3)	(4)
$LERNER_{t-1}$	2.6882***	3.1087***	3.0935***	3.1094***
	(0.0479)	(0.0916)	(0.0914)	(0.0572)
$LIQUID\ ASSETS_{t-1}$	0.0081***			
	(0.0008)			
$LERNER\ X\ LIQUID\ ASSETS_{t-1}$	-0.0027**			
	(0.0014)			
$NSFR2010_{t-1}$		0.1561***		
		(0.0315)		
$LERNER\ X\ NSFR2010_{t-1}$		-0.0998*		
		(0.0570)		
$NSFR2014_{t-1}$			0.1769***	
			(0.0341)	
$LERNER\ X\ NSFR2014_{t-1}$			-0.1199*	
			(0.0614)	
LCR_{t-1}				0.7416***
				(0.1328)
$LERNER\ X\ LCR_{t-1}$				-0.7960**
				(0.3203)
$CAPITALIZATION_{t-1}$	0.0374***	0.0296***	0.0297***	0.0297***
	(0.0012)	(0.0017)	(0.0017)	(0.0018)
$EXPENDITURE_{t-1}$	-0.0035***	-0.0031***	-0.0031***	-0.0032***
	(0.0002)	(0.0004)	(0.0004)	(0.0004)
$DIVERSIFICATION_{t-1}$	-0.0121***	-0.0130***	-0.0130***	-0.0124***

	(0.0005)	(0.0008)	(0.0008)	(0.0008)
$CREDIT\ RISK_{t-1}$	0.0133***	0.0380***	0.0379***	0.0360***
	(0.0011)	(0.0017)	(0.0017)	(0.0017)
CRISIS	-0.0947***	-0.2212***	-0.2210***	-0.2165***
	(0.0027)	(0.0044)	(0.0044)	(0.0045)
$FED\ RATE_{t-1}$	0.0471***	0.0208***	0.0209***	0.0268***
	(0.0010)	(0.0016)	(0.0016)	(0.0017)
$GDP\ GROWTH_{t-1}$	-0.0664***	-0.0990***	-0.0990***	-0.1114***
	(0.0013)	(0.0019)	(0.0019)	(0.0020)
$INFLATION_{t-1}$	0.0128***	0.0374***	0.0374***	0.0384***
	(0.0008)	(0.0012)	(0.0012)	(0.0013)
Constant	-0.5143***	2.1164***	2.1328***	2.1451***
	(0.0649)	(0.0807)	(0.0806)	(0.0476)
Firm FE	Yes	Yes	Yes	Yes
Observations	310,033	310,033	310,033	310,033
R-squared	0.4790	0.3566	0.3565	0.3664

The table reports the fixed effects panel regressions of the impacts of different measures of liquidity on bank net interest margins with varying degree of market power from 2001 to 2018, including macroeconomic factors. NIM_1 is defined as interest income on loans to total loans minus interest expenses of deposits to total deposits. *LIQUIDITY ASSETS* is liquid assets to total assets. *NSFR2010* is the ratio of available stable funding to required stable funding as defined by Basel III 2010. *NSFR2014* is the ratio of available stable funding to required stable funding as defined by Basel III 2014. *LCR* is the ratio of stock of HQLA to net cash outflows over the 30-day stress period. *LERNER* represents the conventional Lerner index and *ADJUSTED LERNER* denotes the funding-adjusted Lerner index. *CREDIT RISK* is the ratio of non-performing loans to total loans. *CAPITALIZATION* is defined as equity to total assets. *EXPENDITURE* is the ratio of total non-interest expenses to operating income. *DIVERSIFICATION* is non-interest revenue divided by operating income. *FED RATE* is the federal fund rate. *GDP GROWTH* represents real GDP growth rate and *INFLATION* denotes inflation rate. *CRISIS* is a dummy variable that equals to 1 for the period of the Global Financial Crisis, 2007 Q4 to 2009 Q2. Bank fixed effects are included in all regressions. Robust standard errors are clustered at the bank level and are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

The impacts of macroeconomic factors on bank margins are consistent with the prior literature. As expected, the impact of the 2007 Global Financial Crisis (*CRISIS*) on interest margins is negative and significant at 1% level. It is documented that real GDP growth (*GDP GROWTH*) has a negative relationship with bank margins that points to the countercyclicality of bank margins. Similar findings are reported in Mamatzakis & Bermpei (2016). Higher bank margins when the economy experiences a contraction limit the credit opportunities, which will in turn deepen the economic downturn. This effect is known as the financial accelerator and has important macroeconomic implications (see Bernanke et al. 1996). Another possible explanation may be that during economic upswings, greater competition on the credit markets tends to drive down the credit standards (Entrop et al. 2015). Inflation (*INFLATION*), on the other hand, exerts a positive influence on interest margins in all model specifications as in Entrop et al. (2015). Last but not least, the results document the positive influence of federal fund rate (*FED FUND*) on bank margins which is consistent with the results of prior studies (e.g., Mamatzakis & Bermpei 2016).

As for bank-specific characteristics, the impact of capitalization (*CAPITALIZATION*) on bank margins is positive and significant as capital is costly, and this cost may be reflected in higher interest margins. Moreover, capital represents the amount of available fund to support the bank's business and a safety net in adverse business conditions. As banks acquire a sufficient amount of capital and become less risky, depositors are more willing to provide funds at a lower deposit rate, which subsequently allows banks to raise their margins. The results are consistent with the depositor discipline literature (e.g. Disli et al. 2013). Bank revenue diversification (*DIVERSIFICATION*) has a negative and significant sign which suggests that interest income from traditional business and non-interest income are substitutes. Furthermore, the results show that *CREDIT RISK* has a positive impact on bank interest margins, implying that a larger amount of non-performing loans is associated with larger margins. As credit risk increases, banks tend to increase their margins to compensate for the higher expected losses in the portfolios which is in line with the results of other studies (e.g. Peria & Mody 2004, Amidu & Wolfe 2013). In other words, the positive and significant sign of credit risk indicates

that a risk premium is applied by banks to the interest rates that they charge for their operations (Amidu & Wolfe 2013). Finally, the regression results document the negative significant association between bank expenditure (*EXPENDITURE*) and interest margins which suggests that management inefficiency also affects bank profitability.

3.4.3 Robustness checks

Alternative measure of net interest margins

For robustness checks, we use an alternative measure of net interest margin (NIM_2), which is the ratio of net interest income to total assets. Table 3.6 summarises the regression results examining the impact of the interaction between market power and bank liquidity on net interest margins. In all regressions, we include bank-specific variables, time and bank fixed effects. Robust standard errors are clustered at the firm level. The results are largely consistent with the main empirical findings.

Table 3.6: The impact of liquidity measures on bank net interest margins using an alternative measure of net interest margin

NIM_2	(1)	(2)	(3)	(4)
$LERNER_{t-1}$	3.3381***	3.4992***	3.5020***	2.9434***
	(0.0441)	(0.0505)	(0.0504)	(0.0304)
$LIQUID\ ASSETS_{t-1}$	0.0079***			
	(0.0006)			
$LERNER\ X\ LIQUID\ ASSETS_{t-1}$	-0.0167***			
	(0.0012)			
$NSFR2010_{t-1}$		0.1704***		
		(0.0133)		
$LERNER\ X\ NSFR2010_{t-1}$		-0.3948***		
		(0.0269)		
$NSFR2014_{t-1}$			0.1838***	
			(0.0143)	
$LERNER\ X\ NSFR2014_{t-1}$			-0.4263***	
			(0.0289)	
LCR_{t-1}				0.3369***
				(0.0614)
$LERNER\ X\ LCR_{t-1}$				-0.7340***
				(0.1585)
Constant	-1.0183***	-1.0111***	-1.0109***	-0.7732***
	(0.0490)	(0.0376)	(0.0374)	(0.0221)
Control variables	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Observations	310,033	310,033	310,033	310,033
R-squared	0.9191	0.9191	0.9191	0.9188

The table reports the fixed effects panel regressions of the impacts of different measures of liquidity on bank net interest margins with varying degree of market power from 2001 to 2018, using an alternative measure of net interest margins. NIM_2 is net interest income to total assets. *LIQUIDITY ASSETS* is liquid assets to total assets. *NSFR2010* is the ratio of available stable funding to required stable funding as defined by Basel III 2010. *NSFR2014* is the ratio of available stable funding to required stable funding as defined by Basel III 2014. *LCR* is the ratio of stock of HQLA to net cash outflows over the 30-day stress period. *LERNER* represents the conventional Lerner index. Bank and time fixed effects are included in all regressions. Robust standard errors are clustered at the bank level and are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 3.7: The impact of liquidity measures on bank net interest margins using an alternative measure of market power

NIM_1	(1)	(2)	(3)	(4)
$ADJUSTED\ LERNER_{t-1}$	2.9245***	2.9764***	2.9672***	2.5101***
	(0.0673)	(0.0836)	(0.0833)	(0.0384)
$LIQUID\ ASSETS_{t-1}$	0.0043***			
	(0.0011)			
$ADJUSTED\ LERNER\ X\ LIQUID\ ASSETS_{t-1}$	-0.0168***			
	(0.0022)			
$NSFR2010_{t-1}$		0.0983***		
		(0.0250)		
$ADJUSTED\ LERNER\ X\ NSFR2010_{t-1}$		-0.3352***		
		(0.0512)		
$NSFR2014_{t-1}$			0.1012***	
			(0.0269)	
$AJUSTED\ LERNER\ X\ NSFR2014_{t-1}$			-0.3533***	
			(0.0549)	
LCR_{t-1}				0.5735***
				(0.0999)
$ADJUSTED\ LERNER\ X\ LCR_{t-1}$				-0.7817***
				(0.2722)
Constant	1.0199***	0.9276***	0.9361***	0.9134***
	(0.0738)	(0.0631)	(0.0628)	(0.0337)
Control variables	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Observations	310,033	310,033	310,033	310,033
R-squared	0.8876	0.8876	0.8876	0.8876

The table reports the fixed effects panel regressions of the impacts of different measures of liquidity on bank net interest margins with varying degree of market power from 2001 to 2018, using an alternative measure of market power (*ADJUSTED LERNER*). For brevity, the definitions of the variables are given in Table 3.1. Bank and time fixed effects are included in all regressions. Robust standard errors are clustered at the bank level and are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Alternative measure of bank market power

Next, we employ the funding-adjusted Lerner index (*ADJUSTED LERNER*) as an alternative measure for bank market power. It should be noted that the Lerner index employed in this study as a measure of market power may also reflect some form of pricing power emanating from deposit markets. Therefore it is possible that banks are able to raise interest margins due to their ability to acquire funding at a relatively low price. Berlin & Mester (1999) documents that penetration to a local deposit market enables banks that have more market power to have considerable access to relatively cheap deposit funding, thereby allowing them to maintain large interest margins. The *ADJUSTED LERNER* does not take into account the funding cost in its computation and does not reflect the market power in the deposit market, thereby reducing less bias in the regression results. Table 3.7 presents the estimation results employing the funding-adjusted Lerner index as a proxy for bank market power. The table provides consistent findings which suggest that banks leverage their market power to increase interest margins. The results also reveal that the pricing of the costs associated with liquidity into interest margins of banks differs with varying pricing power. Banks tend to incorporate the costs of liquidity into the interest margins to a lesser extent as their market power increases.

For ease of interpretation the results, we employ the dummy Lerner index (*HIGH LERNER*) as an alternative measure for bank market power. We define the variable as a dummy which equals to 1 if the *LERNER* value of a bank is larger than the median value in one particular quarter and 0 otherwise. Table 3.8 presents the estimation results and our conclusion holds across the estimation specifications.

Table 3.8: The impact of liquidity measures on bank net interest margins for banks with high and low market power

NIM_1	(1)	(2)	(3)	(4)
$HIGH\ LERNER_{t-1}$	0.3199***	0.3159***	0.3133***	0.2541***
	(0.0094)	(0.0121)	(0.0120)	(0.0049)
$LIQUID\ ASSETS_{t-1}$	0.0034***			
	(0.0007)			
$HIGH\ LERNER\ X\ LIQUID\ ASSETS_{t-1}$	-0.0029***			
	(0.0003)			
$NSFR2010_{t-1}$		0.0282**		
		(0.0115)		
$HIGH\ LERNER\ X\ NSFR2010_{t-1}$		-0.0490***		
		(0.0075)		
$NSFR2014_{t-1}$			0.0284**	
			(0.0122)	
$HIGH\ LERNER\ X\ NSFR2014_{t-1}$			-0.0510***	
			(0.0080)	
LCR_{t-1}				0.2956***
				(0.0269)
$HIGH\ LERNER\ X\ LCR_{t-1}$				-0.1637***
				(0.0313)
Constant	1.5159***	1.6741***	1.6790***	1.6623***
	(0.0720)	(0.0491)	(0.0487)	(0.0315)
Control variables	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Observations	310,033	310,033	310,033	310,033
R-squared	0.8808	0.8807	0.8807	0.8808

The table reports the fixed effects panel regressions of the impacts of different measures of liquidity on bank net interest margins with high and low degree of market power from 2001 to 2018, using an alternative measure of market power (*HIGH LERNER*). For brevity, the definitions of the variables are given in Table 3.1. Bank and time fixed effects are included in all regressions. Robust standard errors are clustered at the bank level and are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

System Generalized Methods of Moments

This study employs the two-step System Generalized Methods of Moments (SGMM) method (Arellano & Bover 1995, Blundell & Bond 1998) as an alternative approach to address the endogeneity concerns that might be present in our empirical set-up. The endogeneity problem may arise due to the reverse-causality issue. For example, the literature suggests that dominant banks are able to take advantage of their market power to earn higher interest margins. On the other hand, those banks that have high interest margins can use those earnings to increase their market, thereby gaining more market power. For this reason, the measure of market power is likely to be endogenous. In addition, according to Maudos & Solis (2009), banks may reduce their margins when offering traditional products to boost their income from non-traditional fee-generating businesses. Therefore, income diversification variable might also be endogenous.

We employ a dynamic model which includes the first lag of the dependent variable in the estimation. An advantage of this dynamic model is that it captures the effect of the previous values of interest margins on the current values. That is, the persistence in bank profits is accounted for by including the lagged dependent variable as one of the explanatory variables. Estimating a dynamic model using OLS would produce 'dynamic panel bias' due to the correlation of the lagged dependent variable and the error term. Therefore, we use the SGMM technique, which is efficient in dealing with endogeneity and provides consistent estimation for dynamic panel model in which lags of the dependent variable are included. Unlike the Difference GMM (DGMM) which is weak for unbalanced panels, SGMM allows for fixed effect in the panel (Roodman 2009*a*). Instead of transforming the regressors to eliminate the fixed effects as in DGMM, SGMM transforms the instruments to make them exogenous to the fixed effects (Roodman 2009*a*), thereby accounting for bank heterogeneity in the estimation. The SGMM estimator estimates simultaneously a set of equations in levels and differences. While the equation in levels is instrumented by the first-difference of the lagged values, the instruments in the equation in differences are the lagged level values (Roodman 2009*b*). All bank-specific characteristics are treated as endogenous variables, and used as instruments in the estimation. The optimal number of instruments

employed in the estimation is based on the selection criteria following Arellano & Bond (1991), Roodman (2009*b*,*a*). In order to test for the validity of the models, several checks have been performed. The Arellano–Bond test ensures that there is no second-order serial correlation in the residuals (Arellano & Bond 1991). Hansen (1982) test of over-identification restrictions for which the null hypothesis is that instruments are exogenous is conducted.

Table 3.9: System General Method of Moment (SGMM) regressions for the impact of liquidity measures on bank net interest margins

NIM_1	(1)	(2)	(3)	(4)
NIM_{1t-1}	0.0187***	0.0183***	0.0182***	0.0234***
	(0.0006)	(0.0006)	(0.0006)	(0.0006)
$LERNER_{t-1}$	2.9240***	2.8661***	2.8125***	2.6880***
	(0.1105)	(0.1446)	(0.1442)	(0.0738)
$LIQUID\ ASSETS_{t-1}$	0.0144***			
	(0.0017)			
$LERNER\ X\ LIQUID\ ASSETS_{t-1}$	-0.0364***			
	(0.0034)			
$NSFR2010_{t-1}$		0.1124**		
		(0.0506)		
$LERNER\ X\ NSFR2010_{t-1}$		-0.5252***		
		(0.0910)		
$NSFR2014_{t-1}$			0.0981*	
			(0.0544)	
$LERNER\ X\ NSFR2014_{t-1}$			-0.5249***	
			(0.0975)	
LCR_{t-1}				0.8817***
				(0.1288)
$LERNER\ X\ LCR_{t-1}$				-1.4086***
				(0.3144)
Constant	1.0768***	1.7502***	1.8096***	0.5135***
	(0.0993)	(0.1297)	(0.1292)	(0.0784)
Control variables	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Observations	310,033	310,033	310,033	310,033
Banks	9703	9703	9703	9703
AR(1) p-value	0.004	0.002	0.001	0.003
AR(2) p-value	0.817	0.869	0.878	0.797
Hansen p-value	0.318	0.364	0.371	0.353

The table reports the System General Method of Moment (SGMM) regressions of the impacts of different measures of liquidity on bank net interest margins with varying degree of market power from 2001 to 2018, using an alternative measure of net interest margins. NIM_1 is defined as interest income on loans to total loans minus interest expenses of deposits to total deposits. *LIQUIDITY ASSETS* is liquid assets to total assets. *NSFR2010* is the ratio of available stable funding to required stable funding as defined by Basel III 2010. *NSFR2014* is the ratio of available stable funding to required stable funding as defined by Basel III 2014. *LCR* is the ratio of stock of HQLA to net cash outflows over the 30-day stress period. *LERNER* represents the conventional Lerner index. Time fixed effects are included in all regressions. Robust standard errors are clustered at the bank level and are reported in parentheses. The null hypothesis of the Hansen test is that the instruments are valid. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

The regression results from the SGMM estimation with the same variables considered in previous sections are shown in Table 3.9. Statistical diagnostics suggest that there is no second-order serial correlation. In addition, the Hansen (1982) J-statistics for over-identification restrictions are insignificant across the columns. The table documents the significant effect of the lag of interest margins (NIM_1). Bank margins are positively correlated over time, implying that banks tend to smooth their interest margins. This justifies the use of the dynamic model to capture the persistence effect of bank interest margins. Additionally, the positive and significant impacts of market power and liquidity measures are found across model specifications. Similar results in terms of sign and magnitude of the coefficients of the interaction variables are also obtained. Collectively, the findings are consistent with previous results from the main tables.

3.5 Concluding remarks

This chapter examines the impact of different measures of liquidity on bank interest margins and the role of market power as measured by the Lerner index in the relationship between liquidity and interest margins for a sample of U.S. banks from 2001 to 2018. Overall, the results reveal that liquidity ratio, the NSFR and LCR exert a positive influence on bank margins, stressing the costs associated with complying with regulatory liquidity standards.

Furthermore, the study is the first to investigate how banks with different level of market power price their liquidity into the interest margins. The findings highlight the importance of market power as it is documented that dominant banks with more pricing power incorporate the costs associated with investing in liquidity into the bank margins to a lesser extent relative to other banks with less market power. As a further step, we extend our analysis and find that the results are robust when considering the effects of a number of macroeconomic factors on bank margins. Our findings also show that the role of market power in affecting banks' valuation of liquidity appears to be more important for small banks than for large banks. We perform a number of robustness checks including employing an alternative measure of interest margins, alternative measures of market power

and SGMM method to address possible endogeneity concerns, and find that the main results hold.

The results of this study suggest important policy implications. While regulatory authorities require banks to invest in an adequate amount of liquidity to be able to withstand liquidity shocks, this comes with a cost that is incorporated into the banks' margins. In this regard, regulators should aim at the best possible trade-off between efficiency and resilience in the financial system when designing liquidity standards such as the NSFR and LCR. This study suggests that the cost of liquidity that is taken into account in interest margins can be reduced when the competition in the banking sector is less intense. It is, therefore, important for policy-makers and bank regulators to consider the role of market competition when implementing liquidity regulations that enhance the stability of the banking system and minimize the cost of financial intermediation.

Appendices

Table B1: Summary of Net Stable Funding Ratio calculation

	2010	*2014*
Available stable funding (ASF)		
Tier 1 capital	100%	100%
Tier 2 capital		
Time deposits with a remaining maturity of one year or more		
Other borrowed money with a remaining maturity of one year or more		
Stable retail transaction deposits	90%	95%
Small time deposits with a remaining maturity of less than one year		
Stable retail saving deposits		
Less stable retail transaction deposits	80%	90%
Less stable retail saving deposits		
Wholesale transaction deposits	50%	50%
Wholesale saving deposits		
Large time deposits with a remaining maturity of less than one year		
Foreign deposits		
Other borrowed money with a remaining maturity of less than one year		
Transaction deposits of U.S. government		
Transaction deposits of states and political subdivisions in the United States		
Transaction deposits of foreign governments and official institutions		
Required stable funding (RSF)		
Unused commitments	5%	5%
Letter of credit		
Securities in 0% risk weight category		
Securities in 20% risk weight category	20%	20%
Securities in 50% risk weight category	50%	50%
Loans in 0% risk weight category		
Trading securities in 0% risk weight category		
Other assets in 0% risk weight category		
Loans in 20% risk weight category	65%	65%
Trading securities in 20% risk weight category		
Other assets in 20% risk weight category		
Loans in 50% risk weight category	85%	85%
Trading securities in 50% risk weight category		
Other assets in 50% risk weight category		
Securities in 100% risk weight category and no risk weight	100%	100%
Loans in 100% risk weight category and no risk weight category		

Table B1 continued

Trading securities in 100% risk weight category and no risk weight category	
Other assets in 100% risk weight category and no risk weight category	

Source: Hong et al. (2014). In this study, the measures of *NSFR* are constructed following Basel Committee on Banking Supervision (2010), Basel Committee on Banking Supervision (2014), Hong et al. (2014), DeYoung & Jang (2016).

Table B2: Summary of Liquidity Coverage Ratio calculation

Panel 1: Stock of high-quality liquidity assets	100%
A. Level 1 assets	
Cash	
Securities in 0% risk weight category	
Reverse repos in 0% risk weight category	
B. Level 2 assets	85%
Securities in 20% risk weight category	
Reverse repos in 20% and 100% risk weight categories	
Panel 2: Cash outflows	
Stable retail transaction deposits	3%
Stable small time deposits with a remaining maturity of one month or less	3%
Stable saving deposits	3%
Stable foreign deposits with a remaining maturity of one month or less	5%
Less stable retail transaction deposits	10%
Less stable small time deposits with a remaining maturity of one month or less	10%
Less stable retail saving deposits	10%
Less stable foreign deposits with a remaining maturity of one month or less	25%
Stable wholesale transaction deposits	5%
Less stable wholesale transaction deposits	25%
Stable wholesale saving deposits	20%
Stable large time deposits with a remaining maturity of one month or less	20%
Less stable wholesale saving deposits	40%
Less stable large time deposits with a remaining maturity of one month or less	40%
Secured lending backed by level 2 assets	15%
All other secured funding transactions	100%
Other liabilities	100%
Negative fair value of derivatives	100%
Unused commitments of home equity line of credit	5%
Unused commitments of credit cards	5%
Unused commitments of commercial real estate	10%
Unused commitments for securities underwriting	100%
Other unused commitments	100%
Letters of credit	5%
Panel 3: Cash inflows	
50% of loans with a remaining maturity less than one month	100%
Positive fair value of derivatives	100%

Source: Hong et al. (2014). In this study, the measure of LCR is constructed following Basel Committee on Banking Supervision (2013), Hong et al. (2014).

Table B3: Correlations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1)NIM_1	1.0000															
(2)NIM_2	0.9270	1.0000														
(3)*LERNER*	0.2090	0.2070	1.0000													
(4)*ADJUSTED LERNER*	0.1890	0.1960	0.8900	1.0000												
(5)*LIQUIDITY ASSETS*	0.1060	0.1050	0.0965	0.0676	1.0000											
(6)*NSFR2010*	0.1070	0.0882	0.1280	0.0900	0.8050	1.0000										
(7)*NSFR2014*	0.1090	0.0870	0.1290	0.0908	0.8030	0.9480	1.0000									
(8)*LCR*	0.0883	0.0110	0.0410	-0.0017	0.2800	0.3620	0.3630	1.0000								
(9)*CAPITALIZATION*	0.0310	0.0217	0.1200	0.0910	0.1650	0.2070	0.2160	0.2380	1.0000							
(10)*EXPENDITURE*	0.0971	0.0238	-0.1470	-0.2290	0.0423	0.0775	0.0803	0.0536	0.0539	1.0000						
(11)*DIVERSIFICATION*	0.0825	0.0346	0.3120	0.3130	0.0163	0.0319	0.0331	-0.0346	-0.0222	0.3040	1.0000					
(12)*CREDIT RISK*	0.0109	-0.0148	-0.0533	-0.0551	-0.0327	-0.0496	-0.0493	-0.0062	-0.0272	0.2180	0.0420	1.0000				
(13)*FED RATE*	-0.0812	-0.0279	-0.2880	-0.2460	-0.0926	-0.0546	-0.0543	0.0109	0.0197	-0.3300	-0.1080	-0.2510	1.0000			
(14)*GDP GROWTH*	0.1260	0.0953	0.1920	0.1700	0.0470	0.0416	0.0410	0.0308	-0.0103	0.0676	0.0634	-0.0804	0.0151	1.0000		
(15)*INFLATION*	0.0002	0.0205	-0.0570	-0.0471	-0.0250	-0.0110	-0.0106	0.0036	0.0175	-0.1160	-0.0312	-0.1620	0.4880	-0.0503	1.0000	
(16)*CRISIS*	-0.0913	-0.0561	-0.1760	-0.1550	-0.0764	-0.0488	-0.0477	-0.0417	0.0190	-0.0289	-0.0394	0.0770	-0.0912	-0.5840	0.0166	1.0000

This table reports the pairwise correlation matrix of variables used in our regression models. NIM_1 is defined as interest income on loans to total loans minus interest expenses of deposits to total deposits. NIM_2 is net interest income to total assets. *LIQUIDITY ASSETS* is liquid assets to total assets. *NSFR2010* is the ratio of available stable funding to required stable funding as defined by Basel III 2010. *NSFR2014* is the ratio of available stable funding to required stable funding as defined by Basel III 2014. *LCR* is the ratio of stock of HQLA to net cash outflows over the 30-day stress period. *LERNER* represents the conventional Lerner index and *ADJUSTED LERNER* denotes the funding-adjusted Lerner index. *CREDIT RISK* is the ratio of non-performing loans to total loans. *CAPITALIZATION* is defined as equity to total assets. *EXPENDITURE* is the ratio of total non-interest expenses to operating income. *DIVERSIFICATION* is non-interest revenue divided by operating income. *FED RATE* is the federal fund rate. *GDP GROWTH* represents real GDP growth rate and *INFLATION* denotes inflation rate. *CRISIS* is a dummy variable that equals to 1 for the period of the Global Financial Crisis, 2007 Q4 to 2009 Q2. Bank-specific variables are winsorised at the top and bottom 1% of the distribution

Chapter 4

Dividend announcements and stock price reactions.

Abstract

We revisit the signalling effects of dividend announcements for a sample of U.S. firms from 2000 to 2018. The study finds that increasing (decreasing) dividend announcements are associated with positive (negative) cumulative abnormal stock returns around the announcement day. On average, financial firms and banks appear to have lower abnormal stock returns around increasing dividend announcements than non-financial firms. Nevertheless, banks have higher abnormal returns around unchanged payout announcements than non-financial firms, especially during the Financial Crisis period. Such differences in stock returns between firm types are not observed for dividend reduction announcements. The panel regressions reveal that the reactions of stock prices to dividend changes are found to be stronger for financial and banking firms than for non-financial firms only when the payout changes are positive. Furthermore, the effects of dividend changes on cumulative abnormal stock returns are amplified in the Financial Crisis period, stressing the importance of such signalling motive in times of high uncertainty and severe informational asymmetry than in normal times. Finally, the study documents that the market's reactions to banks' dividend announcements tend to be weaker/stronger when banks understate/overstate their earnings.

4.1 Introduction

Payout policy is one of the key topics in corporate finance literature. Since the seminal work of Miller & Modigliani (1961) on the irrelevance of dividends to the value of the firm, there has been a long-standing debate regarding the value-adding role of dividend payouts. According to Miller & Modigliani (1961), in the context of complete information, perfect capital markets without taxes and other frictions, rational agents, dividend policy is irrelevant for shareholder wealth. Nevertheless, the capital market is not perfect, and firms still pay dividends.

The dividend signalling theories assert that managers are more informed about the firms' future performance relative to outside investors. Therefore, a change in dividends might be interpreted as the expectations of managers about the firms' future prospects (e.g., Bhattacharya 1979, Miller & Rock 1985, John & Williams 1985). Extensive literature has examined the importance of the use of dividends as a means of signalling information to the public and stock price responses to the information content of dividends. Dividend change announcements convey useful information about the management's assessment of the firm's prospects and stock prices move in the same direction as dividend changes (e.g., Charest 1978, Eades 1982, Woolridge 1983, Divecha & Morse 1983, Denis et al. 1994). In this regard, the signalling motive is expected be more prevalent among firms that face high degrees of information asymmetry (Leary & Michaely 2011), among firms in the banking industry than in other unregulated businesses due to the inherent opaqueness of banks' assets (Floyd et al. 2015). As information asymmetries arising from bank opacity hinder the ability of outsiders to accurately assess banks' risk and value, thereby undermining the market disciplines (Danisewicz et al. 2020), the signalling role of dividends is expected to be more important for those banks with higher degrees of earnings opacity, for which the benefit of signalling is large. This study is the first to compare the market reactions to dividend announcements of non-financials, financials and banking firms, and investigate the impact of bank earnings opacity on such reactions.

Our chapter examines the stock price reactions to the announcements of dividend changes of a sample of U.S. firms for the recent period of 2000 to 2018. We measure stock reactions as the cumulative abnormal returns of stocks for a five-day and

seven-day window around the dividend announcement days. Consistent with prior literature (e.g., Pettit 1972, Charest 1978, Aharony & Swary 1980), we find that increasing dividend announcements are associated with positive cumulative abnormal stock returns while decreasing dividend announcements are associated with negative cumulative abnormal stock returns. The findings lend support to the notion that the market values the information content of dividends and forms some expectations about the firm's future prospects. The increasing (decreasing) dividend announcement is an indication of the firm's positive (negative) future performance. We next conduct a univariate analysis to compare cumulative abnormal returns of stocks in response to dividend announcements for non-financial and financial firms. The results suggest that financial firms and banks appear to have lower cumulative abnormal returns around increasing dividend announcements in comparison with non-financial firms and these findings are not observed for dividend reduction announcements. Nevertheless, the stock price reactions to unchanged dividend announcements are on average stronger for banks than for non-financial firms, especially during the Financial Crisis period.

The chapter examines the importance of firm-specific determinants of stock cumulative abnormal returns around dividend change announcements. We find that stock prices respond significantly to changes in dividends for both industrial and financial firms. Dividend payout change has a positive and significant impact on abnormal stock returns across different groups of dividend payers, regardless of positive or negative payout news. Furthermore, the effects of dividend changes appear to be stronger for financials and banking firms than for non-financials only when the change in dividend is positive. The findings are consistent with the idea that signalling motive of dividends for banks might be more important than for non-financial firms as the unique features of banks make it hard to assess the quality of their assets (Floyd et al. 2015). Nevertheless, we do not observe similar differences between non-financials, financials and banks as for dividend cut announcements, contradicting the conclusion of Bessler & Nohel (1996) who report a stronger effect of dividend reductions for bank firms than for non-financials.

This study also evaluates the possible effect of the 2007–2009 Financial Crisis that is characterised by great uncertainty on the reactions of stock prices on dividend

payout change announcements. While the Crisis is found to have a negligible effect on cumulative stock returns, the impacts of dividend announcements on stock price movements appear to be intensified in the crisis period only when dividend changes are positive for financials and banking firms, indicating that such signalling motive becomes particularly more relevant in times of greater uncertainty and exacerbated informational asymmetry when it is important to reassure the market of the firm's financial strength than in normal times. Finally, as bank earnings opacity limits the ability of outsiders to properly assess banks' risk and value, this study documents evidence that the market tends to respond to banks' dividend announcements to a lesser extent as banks become more opaque and understate their earnings and react more when banks overstate their earnings.

Our paper makes several contributions to the existing literature. First, this study contributes to the understanding of stock price movements around dividend change announcements. This study is related to the previous work (e.g., Michaely et al. 1995, Amihud & Li 2006, Chemmanur & Tian 2014) on the reactions of stock prices to announcements of dividend changes. Prior studies analyse the information content of dividends as a mechanism to mitigate asymmetric information between corporate insiders and outsiders in the case of non-financial firms, largely ignoring this issue for financial firms, and more specifically banks. Our work is the first to compare the magnitude of stock prices reactions to dividend announcement events between non-financial firms and financial firms, non-financials and banks[1].

Second, recent years are characterised with improved information technology, significant economic changes and increased scrutiny of financial supervisions and regulations which are expected to affect the degree of stock price reactions to dividend announcements. While these prior studies generally employ the data before the 2007–2009 Global Financial Crisis, we employ a large dataset of U.S. firms for the recent period from 2000 to 2018 that covers the periods before, during, and after the Crisis. Tsai & Wu (2015) examine the stock and bond prices reactions to firms' dividend announcements for a shorter period of 2005–2012 with much fewer announcement events. This allows us to examine the impact of the Crisis on the stock price movements in response to dividend announcements to evaluate the

[1]In this study, we do not consider share repurchases as the signalling content of share repurchases is less pronounced in comparison with dividends (Hirtle 2014).

signalling effect of dividend announcements in the period of greater uncertainty and informational asymmetry as compared to normal times.

Third, our paper adds to the conversations on bank uniqueness and the justification for bank regulation (e.g., Diamond & Dybvig 1983, Kashyap et al. 2002, Dang et al. 2017). Morgan (2002) finds that Moody's and S&P rating split more often for banks than other firms, and the disagreement between bondraters suggest that banks are inherently more opaque. In contrast, Flannery et al. (2004) compare the equity market microstructure properties and analysts' earnings forecasts of banks and non-banks, and conclude that banking assets are not unusually opaque. Flannery et al. (2013) examine bank equity's trading characteristics during 'normal' and 'crisis' periods and show evidence that seems to suggest that banks are more opaque compared to non-financials in economic downturns. In contrast to these studies, we highlight that the market reactions to dividend announcements differ between industrials and banks only for dividend increases. Therefore, we are tentative to conclude that banks are unusually opaque.

Fourth, this paper contributes to the broader literature on bank dividends and bank dividends as signals to outsiders (e.g., Abreu & Gulamhussen 2013, Floyd et al. 2015, Acharya, Le & Shin 2016, Onali et al. 2016, Juelsrud & Nenov 2019, Tripathy et al. 2021). While there is an extensive literature on the payout policies of industrials, bank dividends have received relatively less attention until recently. Forti & Schiozer (2015), Tripathy et al. (2021) provide evidence that banks use dividends as a means of informing their financial health. Juelsrud & Nenov (2019) show that banks pay higher dividends during a financial crisis in response to rollover risk. Our paper is directly related to Bessler & Nohel (1996, 2000) that examine stock abnormal returns around the announcements of bank dividend reductions and omissions. Our work differs from these two studies by examining the effects of both dividend increase and decrease announcement events.

Finally, this study adds to the literature on bank opacity. Jiang et al. (2016) show that greater competition following the deregulation of state banking markets reduces bank opacity, enhancing markets' ability to exert discipline. Danisewicz et al. (2020) find that legislative changes that incentivize nondepositor monitoring significantly reduce banks' earnings opacity, stressing the importance of debtholders'

monitoring incentives in increasing the quality of banks' information disclosure. Recent papers investigate the implications of bank opacity on credit lending (Zheng 2020) and risk-taking behaviors (Cao & Juelsrud 2020). Unlike these studies, we evaluate the extent to which bank opacity affects the market's reactions to dividend announcements.

The remainder of this chapter is organised as follows. Section 4.2 provides a literature review. Section 4.3 introduces the data, the variables of interest and methodology. Section 4.4 presents the empirical results and discussions. Section 4.5 presents the study summary and conclusion.

4.2 Literature review

Dividend policy plays a prominent role in the corporate finance literature. The seminal dividend irrelevance proposition theory proposed by Miller & Modigliani (1961) holds that under the perfect capital market assumptions, complete information and full rationality of agents, payouts should be a matter of indifference to firms and shareholders. Dividend policies should not affect firms' stock prices, and the value of the firm is determined by its investment opportunities and the ability to generate earnings of its assets. Nevertheless, the capital markets are characterised by asymmetric information, irrational investor behaviours, taxes, agency costs, transaction costs and other imperfections. Extensive literature has evolved to provide both theoretical and empirical evidence on different aspects of dividend payouts, to test whether dividends are relevant and what determines firms' payout policies. These studies relate firms' payouts with signalling effects (Bhattacharya 1979, Miller & Rock 1985, John & Williams 1985), tax preference and clientele effects (Elton & Gruber 1970, Miller & Scholes 1978, Litzenberger & Ramaswamy 1979) agency costs (Rozeff 1982, Easterbrook 1984), firms' life-cycle theory (DeAngelo et al. 2006), catering incentives (Baker & Wurgler 2004*a*,*b*). Yet over half of the decade, dividend policy remains one of the most puzzling subjects in corporate finance.

The dividend irrelevance proposition rests on the assumption of perfect information. However, there often exists the problem of asymmetric information

between the firm's insiders and outsiders where the management possesses superior information pertinent to the firm's operations and future prospects as compared to investors. The idea that due to this information advantage of the firm's insiders over outsiders, dividends can be used to convey information about the firm's future prospects to the market has a long tradition. Early studies (e.g., Bhattacharya 1979, Miller & Rock 1985, John & Williams 1985) develop dividend signalling models under asymmetry information assumptions between insider managers of firms and outsider investors, where dividend payments act as a signal that reveals private information and communicate the future prospects of the firm to investors. These traditional signalling models predict that changes in dividend payouts should be followed by changes in earnings and profits accordingly. The evidence on the relationship between firms' dividends and cash flows dates back to Lintner (1956) whose findings suggest that dividend payout policies reflect the manager's long-term commitment taking into consideration the firm's investment opportunities, current profits and internal fund flows. Firms gradually adjust dividends in response to changes in earnings, and the decision to increase dividend is in line with the management's belief in a permanent increase in earnings. In other words, dividend payouts are perceived by the markets as the management's assessment of the firm's cash flow in the long-run (Pettit 1972) and dividend changes reflect the information that is beyond what is already known to the public. Lintner (1956) contends that firms' managers are primarily concerned with the stability of dividends and reluctant to cut dividends. They also tend to avoid payouts volatility which is an indicator of unstable earnings and financial performance to the market. An unexpected increase in dividend payments can be used to convey positive information about the firm's future prospects to the market in a credible way (e.g., Bhattacharya 1979, Miller & Rock 1985, John & Williams 1985), thereby mitigating the asymmetric information between corporate insiders and outsider investors and avoiding undervaluation of the firm. Signalling theories, therefore, can explain why changes in dividends are usually associated with large announcement returns even if paying dividends is a costly means of signalling (e.g., Brav et al. 2005).

Empirical studies testing the signalling theories assess the informational content of dividends by using stock price reactions to dividend announcements. The

general consensus in the literature is that the market reaction is positively related to dividend changes. An announcement of unexpected increasing (decreasing) payouts should produce a positive (negative) market response. Early studies (e.g., Healy & Palepu 1988, Yoon & Starks 1995, Amihud & Murgia 1997) provide evidence in favour of the signalling effects of dividends; stock prices move in the same direction as dividend changes. Pettit (1972), among others, provides empirical evidence that dividend change announcements are used by the markets to value the securities. Pettit (1976), Laub (1976), Aharony & Swary (1980) present further evidence in favour of the view that dividend announcements provide the markets with useful information about the firm's future performance beyond that provided by published earnings. Later studies demonstrate that positive (negative) dividend change announcements are associated with positive (negative) stock price changes (e.g., Charest 1978, Eades 1982, Woolridge 1983, Divecha & Morse 1983, Denis et al. 1994, Grullon et al. 2002).

Other studies investigate the reactions of the market to dividend initiations and obmissions. Asquith & Mullins (1983) examine the effects of dividend payments of the firms that have not paid dividends before or in the last 10 years and document a significant excess return. In a similar vein, while Benesh et al. (1984) show that announcements of dividend omissions and large dividend reductions produce a large downward impact on stock prices, Richardson et al. (1986) report a significant increase in firm value around dividend initiation announcements. Ghosh & Woolridge (1991) desmonstrate that there is a significant capital loss associated with the first dividend omission announcement but not with the successive omission announcements, implying that investors only react to unexpected information of payout announcements. Similar findings are illustrated in later studies. Michaely et al. (1995) report the long-term drift patterns of stock price returns following dividends initiation and omission announcements. Similarly, Akhigbe & Madura (1996) find that firms that initiate dividends experience favourable long-term share price performance while dividend omissions are followed by unfavourable long-term share price performance. Liu et al. (2008), however, contend that the long-term abnormal returns following dividend omission or reduction announcements are driven by the post-earnings-announcement drift. Leveraging the payout policies of

a sample of British firms during the unregulated and low-tax period of 1985–1905, Braggion & Moore (2011) find that firms that announced dividend reductions or omissions suffered from negative abnormal stock returns whereas those that initiated or raised dividends experienced positive abnormal returns around the announcements.

An important implication that can be drawn from the dividend signalling theories is that positive changes in firms' payouts should be followed by improved operating performance. The literature so far, however, provides mixed results. Numerous studies (e.g., Brickley 1983, Healy & Palepu 1988, Aharony & Dotan 1994, Nissim & Ziv 2001) show that firms' earnings increase in the same year of and the years after positive payout changes. For example, Healy & Palepu (1988) demonstrate the association between dividend initiations (omissions) and the firms' earnings performance and document the correlation between the abnormal stock price reactions and those earnings changes, indicating that investors interpret dividend initiations (omissions) announcements as management's forecasts of future earnings. Aharony & Dotan (1994) report that firms that increased (decreased) experience greater (smaller) unexpected earnings in subsequent quarters than those that did not change their payout policies. Nissim & Ziv (2001) show that payout changes are positively related to earnings changes up to two years following the dividend change, and contend that there is a positive link between dividend changes and firms' future profitability.

A number of studies, on the other hand, cast doubt on this predictive content of dividends (e.g., Watts 1973, Penman 1983, Gonedes 1978). Watts (1973) reports that the information related to future earnings that unexpected dividend changes convey to the market is trivial. Although the author's findings are in favour of the information hypothesis of dividends, he argues that the size of future earnings changes associated with unexpected dividend changes is very small. Gonedes (1978) finds that dividends do not reflect information beyond what is already reflected in the firm's current income, which is inconsistent with the notion that dividend changes convey the information that is not currently available to investors. Later studies (e.g., DeAngelo et al. 1996, Benartzi et al. 1997) and more recently (e.g., Grullon et al. 2005, Liu & Chen 2015) also fail to find empirical evidence supporting

the information conveying mechanism of dividends. For instance, DeAngelo et al. (1996) investigate a sample of firms that experience earnings downturn after 9 or more consecutive years and conclude that their favourable dividend decisions are not informative signal of future improved earnings performance. Benartzi et al. (1997) assess the information content of changes in dividend payouts and show that an increase in dividends is not followed by an increase in earnings. Instead, the authors document a strong past and concurrent association between earnings and payout changes. However, future earnings are less likely to fall following an increase in dividends. Liu & Chen (2015) employ a simultaneous-equation approach and find that dividend changes have no significant ability to predict future earnings changes.

Other related studies examine the interaction effect of dividend announcements and earnings announcements on stock prices and find that the two announcements are not perfect substitutes (e.g., Aharony & Swary 1980, Venkatesh & Chiang 1986, Eddy & Seifert 1992). For example, Kane et al. (1984) examine the abnormal stock returns surrounding the contemporaneous earnings and dividend announcements and find that the effect of one announcement on stock returns depends on the value of the other announcement, which suggests that the market evaluates the two in relation to each other. However, Asquith & Mullins (1983) report that the effects of dividend announcements on stock prices are not caused by contemporaneous earnings announcements, implying that dividends convey unique and valuable information.

Overall, the vast literature on the payout policies of firms suggests that companies still employ dividends as a tool to convey messages regarding their future performance. The markets respond to dividend announcements and stock prices move in the same direction with dividend changes. However, it appears that, despite voluminous empirical research, no consensus has been reached on whether dividend changes accurately predict the future earnings changes of firms. In a recent study, Michaely et al. (2021), show that dividends do convey information as dividend changes signal changes in cash-flow volatility, but not changes in the level of future cash flows.

While there is an extensive literature on information content of dividends of

non-financial firms (e.g., Sant & Cowan 1994, Michaely et al. 1995, Nissim & Ziv 2001, Koch & Sun 2004), few studies examine the signalling power of bank dividends (e.g., Filbeck & Mullineaux 1993, Boldin & Leggett 1995, Bessler & Nohel 1996, 2000). Bessler & Nohel (1996) document significant negative abnormal returns around the dividend cut or reduction announcements of banks. The authors contend that such reactions of the market are stronger for banks than for non-financial firms. This study adds to the literature by investigating the U.S. stock price reactions to dividend announcements with recent data from 2000 to 2018. The study further examines the determinants of stock cumulative abnormal returns around dividend announcements and compares such reactions between non-financial firms, financial firms and banks. Finally, this study adds to the recent literature on bank opacity (e.g., Beatty & Liao 2014, Jiang et al. 2016, Danisewicz et al. 2020) by evaluating the extent to which bank opacity affects the market's response to dividend announcements.

4.3 Data and Methodology

4.3.1 Data

We collect stock returns and quarterly dividend announcements dates of firms whose primary exchange is the NYSE, AMEX (now NYSE MKT), or NASDAQ for the period 01/01/2000 – 31/12/2018 from the Center for Research in Security Prices (CRSP) database. Firms that belong to regulated utilities (SIC codes 4900 to 4949) are excluded for comparability with previous literature on dividend policy. Dividend data are retrieved from CRSP monthly file for ordinary common shares (share codes 10 or 11) adjusted for splits and stock dividends (CRPS distribution code 1232). Consistent with recent literature, ADRs, foreign incorporated firms, shares of Beneficial Interest, units or Limited Partnerships, REITs and closed-end funds are removed from the sample. Firm-specific variables are collected from Compustat database. Macroeconomic variables are retrieved from the Federal Reserve Bank of St. Louis. To minimise the effects of outliers, all firm-specific variables are winsorised at the 1^{st} and 99^{th} percentiles.

4.3.2 Methodology

Cumulative abnormal returns

A standard event study methodology to estimate cumulative abnormal returns (CAR) around the event days following Fama et al. (1969) is employed to measure stock price reactions to dividend announcements. The market model is commonly used in estimating abnormal returns in event studies (Armitage 1995) and has been shown to perform better than CAMP and other models (Cable & Holland 1999). The daily abnormal return of each stock ($AR_{i,t}$) is estimated as follows:

$$AR_{i,t} = R_{i,t} - (\alpha_i + \beta_i R_{mt}) \tag{4.1}$$

where $R_{i,t}$ is the stock return of firm i and R_{mt} is the value-weighted return of the market portfolio on day t. The CRSP value-weighted index is used as a proxy for the market portfolio. We employ an estimation window of 100 trading days, excluding the 5 days prior to the event for the market model to estimate α and β. The cumulative abnormal return for a given event window day t_1 to day t_2 is computed as follows:

$$CAR_{i(t_1;t_2)} = \sum_{t=t_1}^{t_2} AR_{i,t} \tag{4.2}$$

This study uses the following event windows: (–2;+2) and (–3;+3) where the dividend announcement day is defined as day 0. We next examine how much of the variation in cumulative abnormal returns is explained by firm-level characteristics by running regressions of the CARs on a number of firm-specific variables. The model specification is as follows:

$$CAR_{i,t} = \alpha + \beta DIVCHANGE_{i,t} + \delta X_{i,t} + \gamma_t + \epsilon_{i,t}, \tag{4.3}$$

where $CAR_{i,t}$ is the cumulative abnormal returns for stock i at time t. *DIVCHANGE* is the percentage change in the dividend payment of one quarter compared to the dividend payment in the previous quarter. $X_{i,t}$ is a vector of firm-specific control variables.

Table 4.1: Variable definitions

Variables	*Notation*	*Definitions*	*Data source*
Dependent variables			
Cumulative abnormal returns	*CAR(–2;+2)*	Cumulative abnormal returns from day –2 to day +2 around dividend announcement s where the dividend announcement is on day 0.	CRSP
	CAR(–3;+3)	Cumulative abnormal returns from day –3 to day +3 around dividend announcement s where the dividend announcement is on day 0.	CRSP
Explanatory variables			
Dividend change	*DIVCHANGE*	The percentage change in dividend payment of one quarter compared to the previous quarter.	Compustat
Profitability	*PROFITABILITY*	Operating income before depreciation divided by book value of firm total assets.	Compustat
Firm size	*SIZE*	The natural logarithm of the book value to total assets.	Compustat
Firm leverage ratio	*LEVERAGE*	The sum of long-term debt and short-term debt divided by firm total assets.	Compustat
Payout ratio	*PAYOUT*	Common dividend divided by net income before extraordinary items.	Compustat
Asset tangibility	*TANGIBILITY*	Plant, property and equipment divided by firm total assets.	Compustat
Dividend yield	*DIVYIELD*	Dividend per share divided by share price.	Compustat
Market-to-book ratio	*MTB*	Market value divided by book value of firm total assets.	Compustat
Crisis dummy	*GFC*	Dummy that is equal to 1 from 2007 Q4 to 2009 Q2 and 0 otherwise.	NBER

Table 4.1 continued

Earnings opacity	EO_1	Absolute value of the residual obtained from Equation 4.4	Compustat
	EO_{1+}	Positive signed value of the residual obtained from Equation 4.4	Compustat
	EO_{1-}	Negative signed value of the residual obtained from Equation 4.4	Compustat
	EO_2	Absolute value of the residual obtained from Equation 4.5	Compustat
	EO_{2+}	Positive signed value of the residual obtained from Equation 4.5	Compustat
	EO_{2-}	Negative signed value of the residual obtained from Equation 4.5	Compustat
Loan loss provisions	LLP	Loan loss provisions divided by lagged total loans	Compustat
Non-performing assets	ΔNPA	Change in non-performing assets scaled by lagged total loans	Compustat
Loans	$\Delta LOAN$	Change in total loans to lagged total loans	Compustat
Loan loss allowance	AWL	Loan loss allowance to total loans	Compustat
GDP growth	ΔGDP	Change in GDP over the quarter	Fed Bank of St. Louis
Unemployment rate	$\Delta UNEMP$	Change in unemployment rate	Fed Bank of St. Louis
Case-Shiller Real Estate Index	$CSRET$	Return on the Case-Shiller Real Estate Index	Fed Bank of St. Louis

Control variables

Following the literature (e.g., Leary & Michaely 2011, Chemmanur & Tian 2014), this study specifies a number of firm characteristics that are related to stock cumulative abnormal returns in response to dividend announcements. We define profitability ($PROFITABILITY$) as the ratio of operating income before depreciation and book total assets. Firm size ($SIZE$) is the natural logarithm of firms' book value of total assets. Firms' leverage ($LEVERAGE$) is the total of long-term debt plus short-term debt divided by total assets. We also control for payout ratio ($PAYOUT$) which equals to common dividends divided by net income before extraordinary items. Asset tangibility ($TANGIBILITY$) is defined as plant, property and equipment scaled by the book value of total assets. Dividend yield ($DIVYIELD$) equals dividend per share divided by share price. Finally, market-to-book (MTB) is the ratio of the market value and the book value of total assets. GFC is a dummy variable that equals to 1 for the period of the Global Financial Crisis, 2007 Q4 to 2009 Q2. Detailed variable definitions are provided in Table 4.1 and the summary statistics of those control variables are given in Table 4.2.

Bank opacity

We further test if bank earnings opacity affects the extent to which the market responds to bank dividend announcements. We employ the bank opacity measures that reflect the discretion in loan loss provisioning which is a major mechanism through which earnings and regulatory capital can be managed. Bank loan loss provisions (LLP) are regressed on a set of independent variables, and the residuals obtained from the models are an indicator of the abnormal accrual of loan loss provisions. The higher abnormal accrual of loan loss provisions indicates greater earnings manipulation and bank opacity. Following the literature (e.g., Beatty & Liao 2014, Jiang et al. 2016, Danisewicz et al. 2020) we estimate the following models:

$$
\begin{aligned}
LLP_{i,t} = \alpha_0 &+ \alpha_1 \Delta NPA_{i,t+1} + \alpha_2 \Delta NPA_{i,t} + \alpha_3 \Delta NPA_{i,t-1} + \alpha_4 \Delta NPA_{i,t-2} \\
&+ \alpha_5 SIZE_{i,t-1} + \alpha_6 \Delta LOAN_{i,t} + \alpha_7 \Delta GDP_t + \alpha_8 CSRET_t \\
&+ \alpha_9 \Delta UNEMP_t + \epsilon_{i,t},
\end{aligned} \tag{4.4}
$$

$$
\begin{aligned}
LLP_{i,t} = \alpha_0 &+ \alpha_1 \Delta NPA_{i,t+1} + \alpha_2 \Delta NPA_{i,t} + \alpha_3 \Delta NPA_{i,t-1} + \alpha_4 \Delta NPA_{i,t-2} \\
&+ \alpha_5 SIZE_{i,t-1} + \alpha_6 \Delta LOAN_{i,t} + \alpha_7 \Delta GDP_t + \alpha_8 CSRET_t \\
&+ \alpha_9 \Delta UNEMP_t + \alpha_{10} AWL_{i,t-1} + \epsilon_{i,t},
\end{aligned} \tag{4.5}
$$

where LLP is the loan loss provisions divided by lagged total loans, ΔNPA is the change in non-performing assets scaled by lagged total loans, $SIZE$ is the natural log of total assets, $\Delta LOAN$ is the ratio of change in total loans to lagged total loans, ΔGDP is the change in GDP over the quarter, $CSRET$ is the return on the Case-Shiller Real Estate Index, $\Delta UNEMP$ is the change in the unemployment rate and AWL is the ratio of loan loss allowance to total loans. Bank earnings opacity measures EO_1 and EO_2 are the residuals obtained from Equations 4.4 and 4.5, respectively. We obtain the signed earnings opacity measures by not taking the absolute values of the residuals: EO_{1+}, EO_{2+}, EO_{1-} and EO_{2-}. Positive/negative signed earnings opacity indicates discretionary accounting choices that understate/overstate earnings.

Table 4.2: Summary statistics of control variables

Variables	*Obs.*	*Mean*	*S.D.*	*P25*	*Median*	*P75*
Panel A: Non-Financials						
DIVCHANGE	54813	0.0224	0.1504	0.0000	0.0000	0.0000
PROFITABILITY	54813	0.0385	0.0238	0.0239	0.0356	0.0495
MTB	54813	1.8465	1.0315	1.1649	1.5317	2.1605
SIZE	54813	7.5056	1.8404	6.3039	7.4911	8.7173
PAYOUT	54813	0.3856	0.9951	0.1139	0.2681	0.4986
DIVYIELD	54813	0.0056	0.0047	0.0026	0.0044	0.0071
LEVERAGE	54813	0.2322	0.1801	0.0831	0.2199	0.3417
TANGIBILITY	54813	0.2797	0.2166	0.1145	0.2176	0.3920
Panel B: Financials						
DIVCHANGE	33827	0.0199	0.1496	0.0000	0.0000	0.0000
PROFITABILITY	33827	0.0092	0.0143	0.0045	0.0058	0.0075
MTB	33827	1.1358	0.4943	1.0035	1.0394	1.0921
SIZE	33827	7.7177	1.7192	6.5080	7.3972	8.7047
PAYOUT	33827	0.4395	0.7969	0.2032	0.3501	0.5161
DIVYIELD	33827	0.0069	0.0045	0.0040	0.0062	0.0086
LEVERAGE	33827	0.1568	0.1367	0.0666	0.1240	0.2055
TANGIBILITY	33827	0.0262	0.0762	0.0091	0.0144	0.0217
Panel C: Banks						
DIVCHANGE	8664	0.0133	0.1193	0.0000	0.0000	0.0000
PROFITABILITY	8664	0.0059	0.0027	0.0050	0.0059	0.0069
MTB	8664	1.0582	0.0581	1.0182	1.0507	1.0888
SIZE	8664	7.6316	1.2105	6.7093	7.5505	8.3708
PAYOUT	8664	0.4186	0.6129	0.2490	0.3667	0.4928
DIVYIELD	8664	0.0069	0.0035	0.0046	0.0066	0.0087
LEVERAGE	8664	0.1149	0.0741	0.0606	0.1015	0.1551
TANGIBILITY	8664	0.0164	0.0088	0.0108	0.0150	0.0206
EO_1	5188	0.1338	0.1853	0.0454	0.0895	0.1463
EO_{1+}	1525	0.2072	0.2969	0.0363	0.0939	0.2255
EO_{1-}	3663	-0.0988	0.0699	-0.1324	-0.0883	-0.0489
EO_2	5186	0.1159	0.1709	0.0304	0.0666	0.1279
EO_{2+}	1757	0.1459	0.2391	0.0259	0.0608	0.1392
EO_{2-}	3429	-0.0962	0.0989	-0.1233	-0.0695	-0.0337
LLP	5188	0.1378	0.2552	0.0224	0.0619	0.1349
ΔNPA	5188	0.0004	0.0052	-0.0011	0.0000	0.0013
$\Delta LOAN$	5188	0.0240	0.0544	-0.0031	0.0162	0.0388
AWL	5186	0.0142	0.0082	0.0095	0.0124	0.0161
ΔGDP	5188	1.0058	0.6841	0.7040	1.0672	1.3762
CSRET	5188	1.0632	2.1457	-0.0594	1.4111	2.6217
$\Delta UNEMP$	5188	0.0133	0.3148	-0.1667	-0.0667	0.1333

The table reports the summary statistics firm-specific control variables from 2000 to 2018. All variable definitions are given in Table 4.1.

4.4 Empirical results and Discussions

4.4.1 Market reactions to dividend announcements

Descriptive statistics

Table 4.3 reports the average of cumulative abnormal returns of stocks around increasing dividend announcements between different types of firms in the sample over the years. The empirical examination includes all firms in the sample from 2000 to 2018. Firms in the sample are classified as non-financial firms, financial firms, non-bank financials and banks. For non-financial firms, the average of CAR(-2;+2) around the increasing dividend announcements are positive, ranging from 0.17% in 2018 to 1.26% in 2000. Notably, the CAR(-2;+2) jumps from 0.56% in 2007 to 0.98% in 2008 before returning to 0.67% in 2009. After 2009, the average CAR(-2;+2) of non-financial firms increases further and reaches its peak at 1.16% in 2011 before declining to 0.17% in 2017. As can be seen from the table, financial firms have average positive CAR(-2;+2) over the sample period except for year 2006 (-0.20%) – the year before the financial crisis. In 2007, CAR(-2;+2) increases to 0.54% before reaching its peak in 2009 at 1.36%. After 2009, the average CAR(-2;+2) of financial firms declines to 0.37% in the end of the sample period. Similar patterns are observed for non-bank financials with the lowest CAR(-2;+2) of -0.13% in 2006, increasing to 0.60% in 2007 and reaching its peak at 1.18% in 2010. Interestingly, banks are documented to have the lowest average CAR(-2;+2) in 2008 at -1.27% which jumps to its maximum of 2.39% in 2009 and gradually declines in the subsequent years. Table 4.3 also provides the average of CAR(-3;+3) over the years for all firms in the sample. The patterns of CAR(-3;+3) are similar to those of CAR(-2;+2) for all groups of firms and are depicted in Figure 4.1.

Table 4.3: Summary of cumulative abnormal returns in response to increasing dividend announcements

Year	*Non-Financials*			*Financials*			*Non-Bank Financials*			*Banks*		
Panel A	*CAR(-2;+2)*	*Obs*	*Firms*	*CAR(-2;+2)*	*Obs*	*Firms*	*CAR(-2;+2)*	*Obs*	*Firms*	*CAR(-2;+2)*	*Obs*	*Firms*
2000	0.0126	177	167	0.0043	311	266	0.0053	205	172	0.0023	106	94
2001	0.0074	200	189	0.0042	481	374	0.0053	341	260	0.0014	140	114
2002	0.0047	228	211	0.0086	522	401	0.0077	355	273	0.0104	167	128
2003	0.0061	346	297	0.0062	564	422	0.0080	391	286	0.0021	173	136
2004	0.0055	466	398	0.0074	454	367	0.0066	319	256	0.0092	135	111
2005	0.0036	499	430	0.0038	480	371	0.0039	339	261	0.0038	141	110
2006	0.0050	497	433	-0.0020	449	357	-0.0013	307	245	-0.0034	142	114
2007	0.0056	489	427	0.0054	405	327	0.0060	298	242	0.0037	107	85
2008	0.0098	408	361	0.0003	213	181	0.0054	153	126	-0.0127	60	56
2009	0.0067	259	240	0.0136	70	63	0.0102	53	47	0.0239	17	16
2010	0.0078	456	383	0.0123	118	103	0.0118	94	83	0.0142	24	20
2011	0.0116	519	451	0.0083	192	149	0.0087	146	115	0.0068	46	34
2012	0.0115	646	524	0.0063	257	188	0.0089	193	145	-0.0015	64	43
2013	0.0066	615	515	0.0045	263	215	0.0052	198	166	0.0025	65	49
2014	0.0056	639	556	0.0058	290	232	0.0051	232	185	0.0087	58	47
2015	0.0084	603	532	0.0082	302	253	0.0101	238	198	0.0012	64	55
2016	0.0038	577	505	0.0070	286	236	0.0076	228	189	0.0045	58	47
2017	0.0017	546	484	0.0028	311	253	0.0023	249	201	0.0048	62	52
2018	0.0017	579	498	0.0037	374	282	0.0033	297	226	0.0051	77	57
Total		8749	7601		6342	5040		4636	3676		1706	1368

Table 4.3 continued

Panel B	*CAR(-3;+3)*	*Obs*	*Firms*	*CAR(-3;+3)*	*Obs*	*Firms*	*CAR(-3;+3)*	*Obs*	*Firms*	*CAR(-3;+3)*	*Obs*	*Firms*
2000	0.0145	177	167	0.0033	311	266	0.0045	205	172	0.0010	106	94
2001	0.0080	200	189	0.0020	481	374	0.0035	341	260	-0.0017	140	114
2002	0.0048	228	211	0.0119	522	401	0.0107	355	273	0.0144	167	128
2003	0.0100	346	297	0.0066	564	422	0.0090	391	286	0.0013	173	136
2004	0.0061	466	398	0.0088	454	367	0.0081	319	256	0.0107	135	111
2005	0.0042	499	430	0.0038	480	371	0.0038	339	261	0.0039	141	110
2006	0.0057	497	433	-0.0034	449	357	-0.0027	307	245	-0.0049	142	114
2007	0.0050	489	427	0.0070	405	327	0.0067	298	242	0.0077	107	85
2008	0.0097	408	361	0.0013	213	181	0.0073	153	126	-0.0140	60	56
2009	0.0061	259	240	0.0119	70	63	0.0055	53	47	0.0319	17	16
2010	0.0083	456	383	0.0134	118	103	0.0126	94	83	0.0166	24	20
2011	0.0125	519	451	0.0124	192	149	0.0135	146	115	0.0086	46	34
2012	0.0101	646	524	0.0057	257	188	0.0096	193	145	-0.0058	64	43
2013	0.0070	615	515	0.0053	263	215	0.0056	198	166	0.0042	65	49
2014	0.0049	639	556	0.0075	290	232	0.0064	232	185	0.0122	58	47
2015	0.0116	603	532	0.0089	302	253	0.0105	238	198	0.0029	64	55
2016	0.0045	577	505	0.0079	286	236	0.0076	228	189	0.0090	58	47
2017	0.0021	546	484	0.0020	311	253	0.0022	249	201	0.0009	62	52
2018	0.0008	579	498	0.0039	374	282	0.0037	297	226	0.0048	77	57
Total		8749	7601		6342	5040		4636	3676		1706	1368

The table reports the the mean of cumulative abnormal returns (CAR(-2;+2) in Panel A and CAR(-3;+3) in Panel B) of stocks around increasing dividend announcements between different types of firms in the sample over the years. Non-financials are defined as all firms with Standard Industrial Classification (SIC) codes except 4900–4949 and 6000–6999, Financials with SIC codes 6000–6999 and Banks with SIC code 6020.

Table 4.4: Summary of cumulative abnormal returns in response to decreasing dividend announcements

Year	*Non-Financials*			*Financials*			*Non-Bank Financials*			*Banks*		
Panel A	*CAR(-2;+2)*	*Obs*	*Firms*	*CAR(-2;+2)*	*Obs*	*Firms*	*CAR(-2;+2)*	*Obs*	*Firms*	*CAR(-2;+2)*	*Obs*	*Firms*
2000	-0.0151	59	55	-0.0097	42	40	-0.0118	33	31	-0.0019	9	9
2001	-0.0085	97	91	0.0067	58	56	0.0063	46	44	0.0082	12	12
2002	0.0005	52	47	0.0078	81	80	0.0040	58	57	0.0173	23	23
2003	-0.0028	42	41	0.0003	71	68	0.0012	48	47	-0.0016	23	21
2004	-0.0072	86	85	0.0019	73	71	0.0021	50	48	0.0015	23	23
2005	0.0046	96	90	-0.0064	61	60	-0.0039	42	41	-0.0120	19	19
2006	0.0029	92	88	-0.0011	60	59	0.0010	42	41	-0.0061	18	18
2007	0.0072	63	59	-0.0209	40	37	-0.0248	32	29	-0.0054	8	8
2008	-0.0043	83	78	-0.0120	126	103	-0.0179	95	77	0.0061	31	26
2009	-0.0340	113	99	-0.0217	216	179	-0.0189	156	133	-0.0290	60	46
2010	-0.0072	51	49	0.0013	55	51	-0.0021	42	38	0.0122	13	13
2011	-0.0060	89	83	-0.0083	34	32	-0.0109	30	28	0.0107	4	4
2012	0.0054	72	68	-0.0079	45	39	-0.0035	40	35	-0.0427	5	4
2013	-0.0112	134	124	-0.0003	69	65	0.0017	58	54	-0.0109	11	11
2014	-0.0038	85	78	0.0065	46	44	0.0019	36	34	0.0231	10	10
2015	-0.0036	83	79	-0.0050	44	42	-0.0063	40	38	0.0086	4	4
2016	-0.0084	74	73	0.0046	40	35	0.0031	35	30	0.0147	5	5
2017	-0.0013	64	60	-0.0048	53	49	-0.0063	46	42	0.0053	7	7
2018	-0.0120	63	58	-0.0019	44	39	-0.0037	40	35	0.0159	4	4
Total		1498	1405		1258	1149		969	882		289	267

Table 4.4 continued

Year	*CAR(-3;+3)*	*Obs*	*Firms*	*CAR(-3;+3)*	*Obs*	*Firms*	*CAR(-3;+3)*	*Obs*	*Firms*	*CAR(-3;+3)*	*Obs*	*Firms*
2000	-0.0160	59	55	-0.0032	42	40	-0.0061	33	31	0.0075	9	9
2001	-0.0058	97	91	-0.0034	58	56	-0.0073	46	44	0.0117	12	12
2002	0.0058	52	47	0.0057	81	80	0.0011	58	57	0.0175	23	23
2003	-0.0037	42	41	-0.0025	71	68	-0.0026	48	47	-0.0023	23	21
2004	-0.0064	86	85	0.0017	73	71	0.0028	50	48	-0.0009	23	23
2005	0.0065	96	90	-0.0051	61	60	0.0003	42	41	-0.0169	19	19
2006	0.0044	92	88	-0.0022	60	59	-0.0038	42	41	0.0014	18	18
2007	0.0078	63	59	-0.0294	40	37	-0.0353	32	29	-0.0060	8	8
2008	0.0013	83	78	-0.0228	126	103	-0.0278	95	77	-0.0076	31	26
2009	-0.0392	113	99	-0.0345	216	179	-0.0349	156	133	-0.0333	60	46
2010	0.0012	51	49	-0.0021	55	51	-0.0070	42	38	0.0135	13	13
2011	-0.0131	89	83	-0.0033	34	32	-0.0070	30	28	0.0239	4	4
2012	0.0002	72	68	-0.0116	45	39	-0.0051	40	35	-0.0633	5	4
2013	-0.0132	134	124	-0.0029	69	65	0.0003	58	54	-0.0196	11	11
2014	-0.0044	85	78	0.0040	46	44	0.0002	36	34	0.0176	10	10
2015	-0.0131	83	79	-0.0081	44	42	-0.0089	40	38	0.0000	4	4
2016	-0.0115	74	73	0.0082	40	35	0.0070	35	30	0.0165	5	5
2017	-0.0057	64	60	-0.0040	53	49	-0.0034	46	42	-0.0083	7	7
2018	-0.0201	63	58	-0.0018	44	39	-0.0045	40	35	0.0247	4	4
Total		1498	1405		1258	1149		969	882		289	267

The table reports the the mean of cumulative abnormal returns (CAR(-2;+2) in Panel A and CAR(-3;+3) in Panel B) of stocks around decreasing dividend announcements between different types of firms in the sample over the years. Non-financials are defined as all firms with Standard Industrial Classification (SIC) codes except 4900–4949 and 6000–6999, Financials with SIC codes 6000–6999 and Banks with SIC code 6020.

Table 4.5: Summary of cumulative abnormal returns in response to stable dividend announcements

Year	*Non-Financials*			*Financials*			*Non-Bank Financials*			*Banks*		
Panel A	*CAR(-2;+2)*	*Obs*	*Firms*	*CAR(-2;+2)*	*Obs*	*Firms*	*CAR(-2;+2)*	*Obs*	*Firms*	*CAR(-2;+2)*	*Obs*	*Firms*
2000	0.0039	1585	720	0.0087	1358	635	0.0094	930	434	0.0072	428	204
2001	0.0011	2127	713	-0.0013	1735	638	-0.0018	1175	438	-0.0003	560	206
2002	0.0033	2154	668	0.0018	1761	617	0.0016	1215	431	0.0022	546	186
2003	-0.0005	2161	734	0.0007	1686	608	0.0010	1174	428	0.0000	512	181
2004	0.0016	2332	792	0.0025	1697	594	0.0026	1188	419	0.0024	509	175
2005	0.0011	2432	838	0.0007	1671	584	0.0002	1176	416	0.0021	495	168
2006	0.0003	2513	851	-0.0008	1681	577	-0.0012	1213	416	0.0002	468	162
2007	0.0012	2459	827	0.0035	1674	561	0.0019	1224	418	0.0077	450	146
2008	0.0016	2377	789	0.0012	1556	536	0.0009	1176	407	0.0020	380	129
2009	0.0014	2250	698	0.0001	1276	421	0.0001	967	320	-0.0001	309	101
2010	0.0013	2206	717	0.0046	1253	381	0.0041	961	294	0.0061	292	87
2011	0.0021	2240	768	0.0016	1169	374	0.0008	924	298	0.0045	245	76
2012	-0.0003	2305	815	-0.0017	1079	361	-0.0018	869	293	-0.0012	210	68
2013	-0.0012	2358	847	0.0011	1093	383	0.0004	888	310	0.0040	205	73
2014	0.0010	2611	877	0.0012	1140	390	0.0017	921	317	-0.0009	219	74
2015	0.0002	2728	897	0.0025	1159	393	0.0032	934	319	-0.0003	225	74
2016	0.0018	2633	868	0.0020	1159	386	0.0020	934	314	0.0018	225	72
2017	-0.0001	2636	857	-0.0016	1087	381	-0.0015	879	310	-0.0019	208	71
2018	-0.0021	2459	854	-0.0007	993	366	-0.0017	810	300	0.0038	183	67
Total		44566	15130		26227	9186		19558	6882		6669	2320

Table 4.5 continued

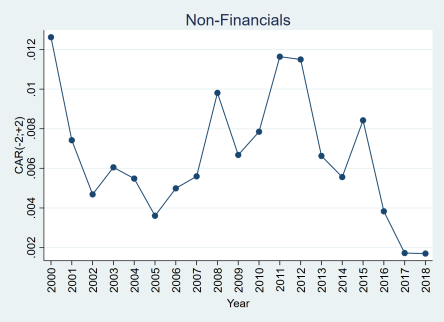
Year	*CAR(-3;+3)*	*Obs*	*Firms*	*CAR(-3;+3)*	*Obs*	*Firms*	*CAR(-3;+3)*	*Obs*	*Firms*	*CAR(-3;+3)*	*Obs*	*Firms*
2000	0.0032	1585	720	0.0099	1358	635	0.0096	930	434	0.0107	428	204
2001	0.0033	2127	713	-0.0023	1735	638	-0.0041	1175	438	0.0013	560	206
2002	0.0032	2154	668	0.0025	1761	617	0.0031	1215	431	0.0012	546	186
2003	0.0000	2161	734	0.0006	1686	608	0.0007	1174	428	0.0004	512	181
2004	0.0007	2332	792	0.0033	1697	594	0.0032	1188	419	0.0035	509	175
2005	0.0014	2432	838	-0.0002	1671	584	-0.0006	1176	416	0.0007	495	168
2006	-0.0001	2513	851	-0.0014	1681	577	-0.0021	1213	416	0.0004	468	162
2007	0.0016	2459	827	0.0034	1674	561	0.0019	1224	418	0.0076	450	146
2008	0.0014	2377	789	0.0001	1556	536	0.0004	1176	407	-0.0007	380	129
2009	0.0012	2250	698	-0.0012	1276	421	-0.0012	967	320	-0.0009	309	101
2010	0.0021	2206	717	0.0041	1253	381	0.0032	961	294	0.0070	292	87
2011	0.0022	2240	768	0.0017	1169	374	0.0017	924	298	0.0016	245	76
2012	-0.0008	2305	815	-0.0009	1079	361	-0.0005	869	293	-0.0027	210	68
2013	-0.0019	2358	847	0.0012	1093	383	0.0001	888	310	0.0057	205	73
2014	0.0009	2611	877	0.0010	1140	390	0.0016	921	317	-0.0016	219	74
2015	0.0006	2728	897	0.0044	1159	393	0.0050	934	319	0.0022	225	74
2016	0.0015	2633	868	0.0032	1159	386	0.0031	934	314	0.0035	225	72
2017	-0.0014	2636	857	-0.0027	1087	381	-0.0027	879	310	-0.0025	208	71
2018	-0.0023	2459	854	-0.0009	993	366	-0.0020	810	300	0.0039	183	67
Total		44566	15130		26227	9186		19558	6882		6669	2320

The table reports the the mean of cumulative abnormal returns (CAR(-2;+2) in Panel A and CAR(-3;+3) in Panel B) of stocks around stable dividend announcements between different types of firms in the sample over the years. Non-financials are defined as all firms with Standard Industrial Classification (SIC) codes except 4900–4949 and 6000–6999, Financials with SIC codes 6000–6999 and Banks with SIC code 6020.

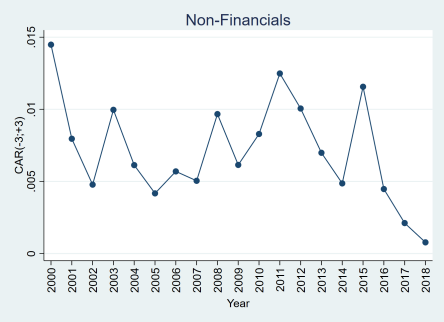
The average of cumulative abnormal returns of stocks around decreasing dividend announcements between different types of firms in the sample over the years is given in Table 4.4 and depicted in Figure 4.2. Consistent with prior literature (e.g., Michaely et al. 1995, Grullon et al. 2002, Jensen et al. 2010) and the view that dividend reductions convey negative signals to investors, the CAR(-2;+2) is negative in most years which suggests the negative reactions of the markets to decreasing dividend announcements. For non-financial firms, CAR(-2;+2) falls from 0.72% in 2007 to -3.40% in 2009 before increasing to its maximum of 0.54% in 2012. Similar patterns are observed for both financial firms and non-bank financial firms. As for financials, there is a reduction in CAR(-2;+2) from -0.11% in 2006 to -2.17% in 2009 and an increase back to 0.13% in 2010. As for non-bank financials, the average CAR(-2;+2) decreases from 0.10% in 2006 and plummets to -2.48% in 2007 before recovering to -0.21% in 2010. Notably, the average CAR(-2;+2) of banks in 2008 is positive 0.61% and falls to -2.90% in 2009. There is a recovery in CAR(-2;+2) to 1.22% in 2010 followed by a plunge to -4.27% in 2012. Table 4.4 also shows the average of CAR(-3;+3) over the years for all firms in the sample. The patterns of CAR(-3;+3) are similar to those of CAR(-2;+2) for all groups of firms and are depicted in Figure 4.2.

Table 4.5 documents the mean of cumulative abnormal returns of stocks around stable dividend announcements between different types of firms in the sample over the years. The table document positive average CAR(-2;+2) around the dividend announcements for most of the years. The cumulative abnormal returns (CAR(-2;+2)) of non-financial firms fluctuate around 0.1% ranging from -0.21% in 2018 to 0.39% in 2000 while the average CAR(-3;+3) varies from -0.23% in 2018 to 0.32% in 2000. As for financial firms, the table shows that CAR(-2;+2) varies from -0.07 in 2018 to 0.87 in 2000. Similar patterns are observed for non-bank financials with CAR(-2;+2) falling from 0.94% in 2000 to -0.13 in 2018. Finally, the average CAR(-2;+2) of banks increases from 0.02% in 2006 to 0.77% in 2007 before decreasing to -0.01% in 2009. As can be seen from the table, the CAR(-3;+3) of banks also exhibits similar trends which are depicted in Figure 4.3.

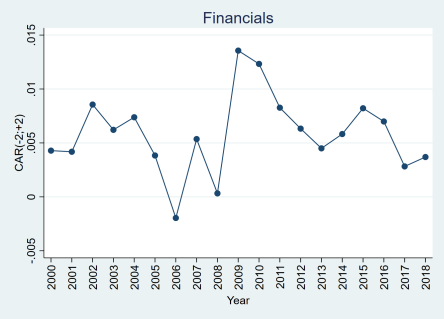
Figure 4.1: Cumulative abnormal returns in response to increasing dividend announcements



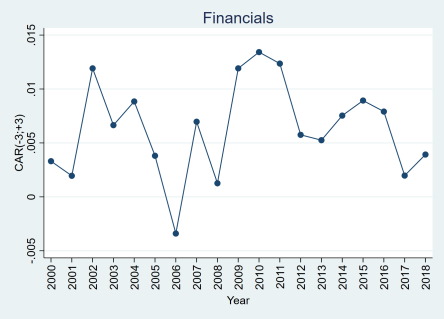
(a) CAR(-2;+2): Non-Financials



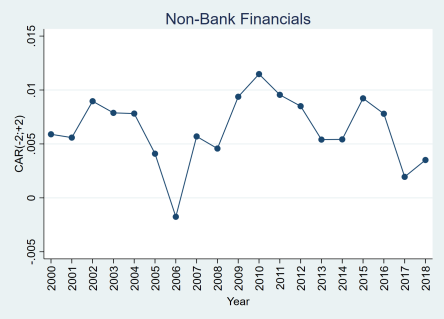
(b) CAR(-3;+3): Non-Financials



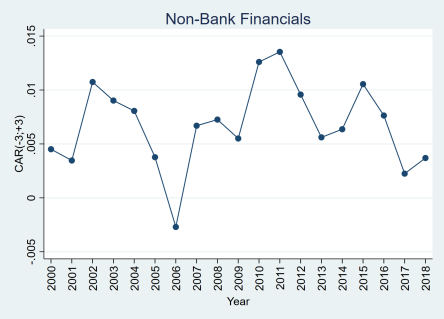
(c) CAR(-2;+2): Financials



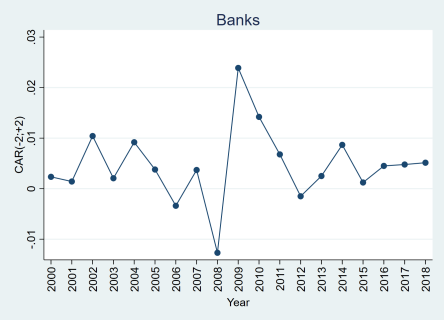
(d) CAR(-3;+3): Financials



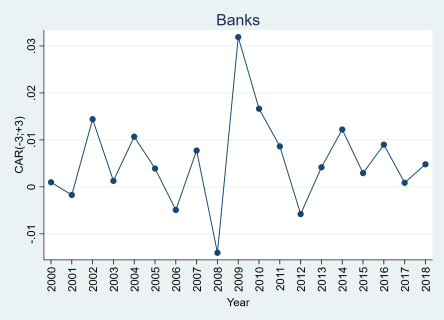
(e) CAR(-2;+2): Non-Bank Financials



(f) CAR(-3;+3): Non-Bank Financials



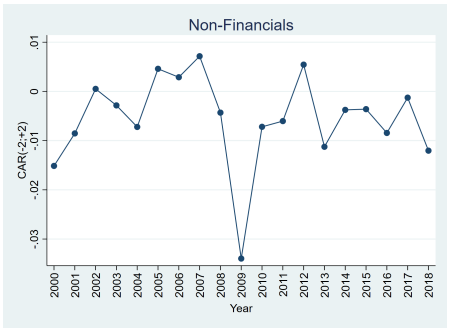
(g) CAR(-2;+2): Banks



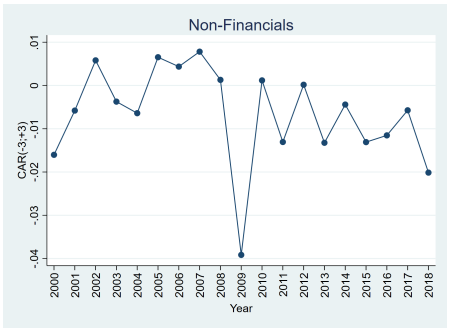
(h) CAR(-3;+3): Banks

The figure shows cumulative abnormal returns (CAR(-2;+2) and CAR(-3;+3)) in response to increasing dividend announcements for non-financials, financials, non-bank financials and banks.

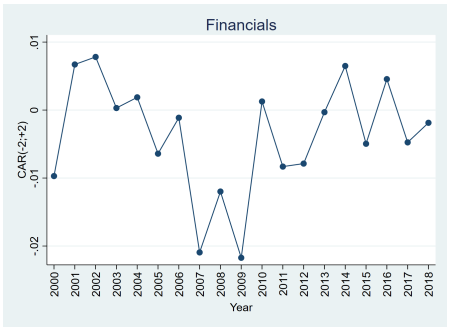
Figure 4.2: Cumulative abnormal returns in response to decreasing dividend announcements



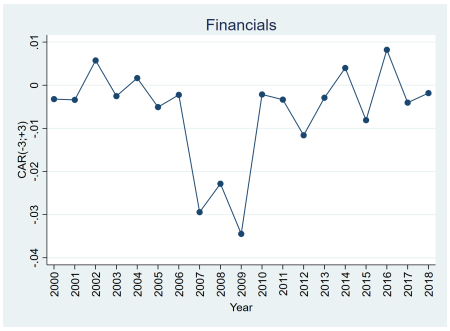
(a) CAR(-2;+2): Non-Financials



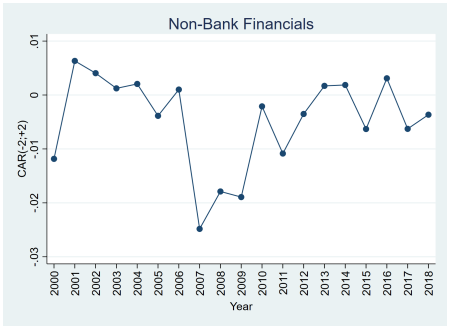
(b) CAR(-3;+3): Non-Financials



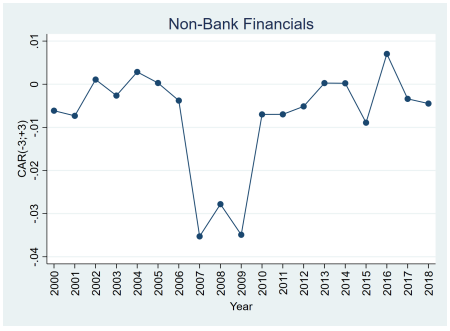
(c) CAR(-2;+2): Financials



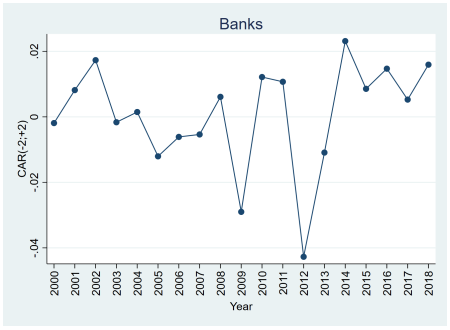
(d) CAR(-3;+3): Financials



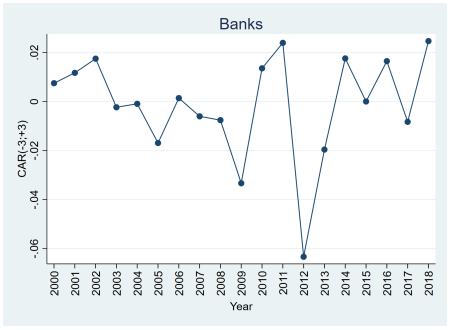
(e) CAR(-2;+2): Non-Bank Financials



(f) CAR(-3;+3): Non-Bank Financials



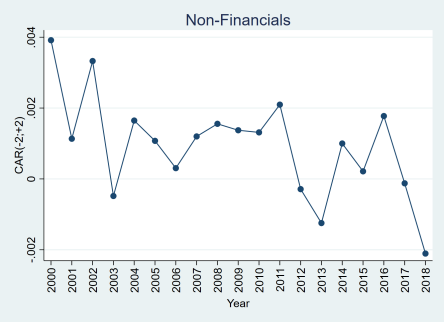
(g) CAR(-2;+2): Banks



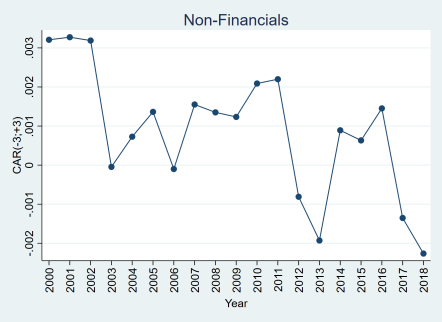
(h) CAR(-3;+3): Banks

The figure shows cumulative abnormal returns (CAR(-2;+2) and CAR(-3;+3)) in response to decreasing dividend announcements for non-financials, financials, non-bank financials and banks.

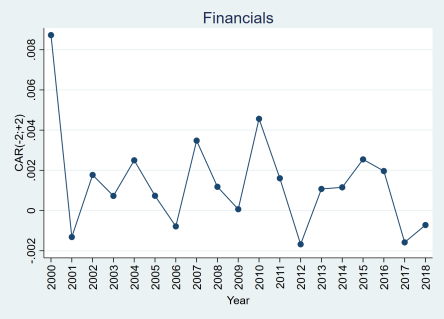
Figure 4.3: Cumulative abnormal returns in response to stable dividend announcements



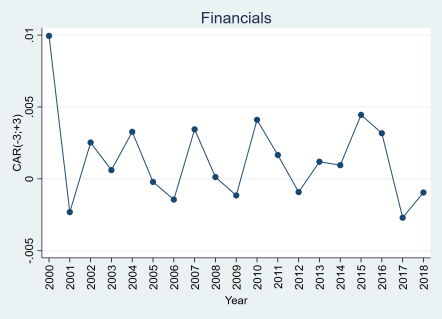
(a) CAR(-2;+2): Non-Financials



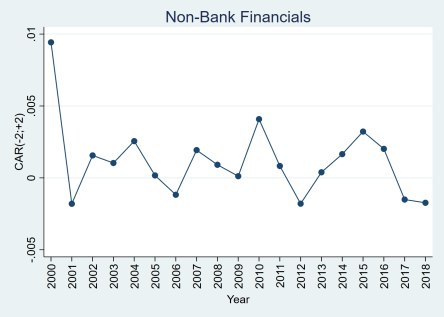
(b) CAR(-3;+3): Non-Financials



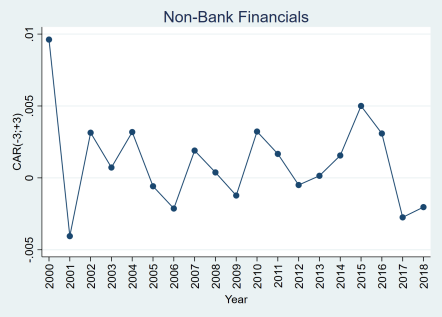
(c) CAR(-2;+2): Financials



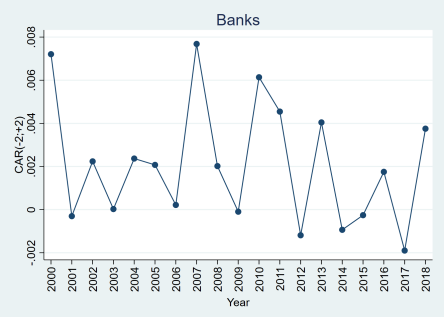
(d) CAR(-3;+3): Financials



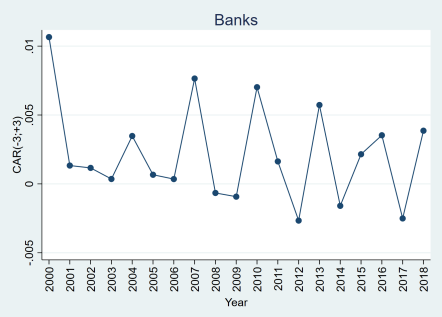
(e) CAR(-2;+2): Non-Bank Financials



(f) CAR(-3;+3): Non-Bank Financials



(g) CAR(-2;+2): Banks



(h) CAR(-3;+3): Banks

The figure shows cumulative abnormal returns (CAR(-2;+2) and CAR(-3;+3)) in response to stable dividend announcements for non-financials, financials, non-bank financials and banks.

Univariate analysis

In this section, we examine the market reactions to dividend announcements of firms through an event study and compare the cumulative abnormal returns in response to dividend announcements of different payer groups. The results of the univariate analysis for the differences in the means of cumulative abnormal returns of stocks around increasing dividend announcements between different types of firms in the sample are reported in Table 4.6. The empirical examination includes all firms in the sample from 2000 to 2018. Firms in the sample are classified as non-financial firms, financial firms, non-bank financials and banks.

Table 4.6 provides the mean of the cumulative abnormal returns for a five-day window (CAR(-2;+2)) in columns (1)–(4) and for a seven-day window (CAR(-3;+3)) in columns (6)–(10). Column (2) shows that the average of the cumulative abnormal returns for a five-day window (CAR(-2;+2)) of financial firms is lower than that of non-financial firms in 2006 (-0.20% compared to 0.5%) at 1% statistical significance level. Financial firms also have lower CAR(-2;+2) than non-financial firms in 2008 (0.03% compared to 0.98%) at 10% level. During the sample period of 2000–2018, the average of CAR(-2;+2) for financial firms is lower than that of non-financial firms (0.52% versus 0.64%), and the difference is significant at 5% level. Similarly, when comparing column (3) to column (1), banks appear to have lower CAR(-2;+2) than that of non-financials in 2006 (-0.34% versus 0.50%) and in 2008 (-1.27% versus 0.98%) at 5% significance level. In 2012, the average CAR(-2;+2) of banks is significantly lower than that of non-financial firms (-0.15% versus 1.15%) at 1% level. During the sample period of 2000–2018, the average of CAR(-2;+2) for banks is 0.36% and is statistically lower than that of non-financial firms (0.64%) at 1% significance level. Notably, during the 2007–2008 financial crisis period, banks have negative CAR(-2;+2) of -0.22%, which is smaller than that of non-financial firms of 0.75% at 5% level. As for non-bank financial firms, column (4) shows that the mean of CAR(-2;+2) of non-bank financials is slightly larger than that of banks (0.58% compared to 0.36%) for the sample period 2000–2018. Similar findings can be observed for CAR(-3;+3) in columns (6)–(10). Overall, the results suggest that financial firms and banks appear to have lower cumulative abnormal returns around increasing dividend announcements in comparison with

non-financial firms and the effect seems to be stronger for banks than for financial firms.

Table 4.7 reports the results of the univariate analysis for the differences in the means of cumulative abnormal returns of stocks around dividend reduction announcements between different types of firms in the sample. Comparing column (2) to column (1), the table shows that the average of CAR(-2;+2) of financial firms is lower than that of non-financial firms in 2007 (-2.09 compared to 0.72%) at 5% level. However, financial firms appear to have higher CAR(-2;+2) in comparison with that of non-financial firms in 2013. The table suggests that there is no significant difference in CAR(-2;+2) between financials and non-financials for the sample period 2000-2018. As for banks, column (3) in Table 4.7 reports similar findings. Specifically, banks are found to have lower CAR(-2;+2) than that of non-financials in 2005 (-1.20% compared to 0.46%) at 10% level and in 2012 (-4.27% versus 0.54%) at 10%. However, the CAR(-2;+2) of banks are higher than non-financial firms (2.31% compared to -0.38%) in 2014 at 10% level, making no significant difference in cumulative abnormal returns for the 2000–2018 period. Columns (6)–(10) document similar results for CAR(-3;+3) suggesting no significant difference in cumulative abnormal returns between firm types around decreasing dividend announcements.

Table 4.8 documents the results of the univariate analysis for the differences in the means of cumulative abnormal returns of stocks around stable dividend announcements between different types of firms in the sample. Column (2) compares the CAR(-2;+2) around stable dividend announcements of financial firms to that of non-financial firms reported in column (1). The results suggest that there is no significant difference in CAR(-2;+2) between the two groups of firms during the sample period except for 2000, 2010, 2013 and 2015. Financials on average have higher CAR(-2;+2) in comparison with non-financial firms in those years and the differences are statistically significant at 10% level. Column (3) compares the CAR(-2;+2) around stable dividend announcements of banks to that of non-financial firms reported in column (1). Interestingly, the table documents that the cumulative abnormal returns of banking firms around dividend announcements of banking firms are higher than those of non-financial firms. Specifically, in 2007,

Table 4.6: Univariate analysis of cumulative abnormal returns in response to increasing dividend announcements

The table reports the univariate analysis of cumulative abnormal returns in response to increasing dividend announcements for different types of firms from 2000 to 2018. Column (2) tests if the mean values of CAR(-2;+2) are significantly different from those in column (1). Column (3) tests if the mean values of CAR(-2;+2) are significantly different from those in column (1). Column (4) tests if the mean values of CAR(-2;+2) are significantly different from those in column (3). Column (5) tests if the mean values of CAR(-2;+2) are significantly different from those in column (3). Column (7) tests if the mean values of CAR(-3;+3) are significantly different from those in column (6). Column (8) tests if the mean values of CAR(-3;+3) are significantly different from those in column (6). Column (9) tests if the mean values of CAR(-3;+3) are significantly different from those in column (8). Column (10) tests if the mean values of CAR(-3;+3) are significantly different from those in column (8). ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	CAR(-2;+2)					*CAR(-3;+3)*				
Year	*Non-Fins* (1)	*Financials* (2)	*Banks* (3)	*Non-Bank Fins* (4)	*Non-Banks* (5)	*Non-Fins* (6)	*Financials* (7)	*Banks* (8)	*Non-Bank Fins* (9)	*Non-Banks* (10)
2000	0.0126	0.0043	0.0023*	0.0053	0.0087	0.0145	0.0033*	0.0010*	0.0045	0.0091
2001	0.0074	0.0042	0.0014	0.0053	0.0061	0.0080	0.0020	-0.0017	0.0035	0.0051
2002	0.0047	0.0086	0.0104	0.0077	0.0065	0.0048	0.0119	0.0144*	0.0107	0.0084
2003	0.0061	0.0062	0.0021	0.0080*	0.0071*	0.0100	0.0066	0.0013**	0.0090**	0.0095**
2004	0.0055	0.0074	0.0092	0.0066	0.0059	0.0061	0.0088	0.0107	0.0081	0.0069
2005	0.0036	0.0038	0.0038	0.0039	0.0037	0.0042	0.0038	0.0039	0.0038	0.0040
2006	0.0050	-0.0020***	-0.0034**	-0.0013	0.0026**	0.0057	-0.0034***	-0.0049**	-0.0027	0.0025*
2007	0.0056	0.0054	0.0037	0.0060	0.0057	0.0050	0.0070	0.0077	0.0067	0.0057
2008	0.0098	0.0003*	-0.0127**	0.0054*	0.0086**	0.0097	0.0013	-0.0140**	0.0073*	0.0090**
2009	0.0067	0.0136	0.0239	0.0102	0.0073	0.0061	0.0119	0.0319	0.0055	0.0060
2010	0.0078	0.0123	0.0142	0.0118	0.0085	0.0083	0.0134	0.0166	0.0126	0.0090
2011	0.0116	0.0083	0.0068	0.0087	0.0110	0.0125	0.0124	0.0086	0.0135	0.0127
2012	0.0115	0.0063	-0.0015***	0.0089**	0.0109***	0.0101	0.0057	-0.0058***	0.0096***	0.0099***
2013	0.0066	0.0045	0.0025	0.0052	0.0063	0.0070	0.0053	0.0042	0.0056	0.0067
2014	0.0056	0.0058	0.0087	0.0051	0.0054	0.0049	0.0075	0.0122	0.0064	0.0053
2015	0.0084	0.0082	0.0012	0.0101*	0.0089*	0.0116	0.0089	0.0029*	0.0105	0.0113*
2016	0.0038	0.0070	0.0045	0.0076	0.0049	0.0045	0.0079	0.0090	0.0076	0.0054
2017	0.0017	0.0028	0.0048	0.0023	0.0019	0.0021	0.0020	0.0009	0.0022	0.0022
2018	0.0022	0.0037	0.0051	0.0033	0.0022	0.0008	0.0039	0.0048	0.0037	0.0018
2007–2008	0.0075	0.0036	-0.0022**	0.0058*	0.0069**	0.0071	0.0050	-0.0001	0.0069	0.0071
2000–2018	0.0064	0.0052**	0.0036***	0.0058**	0.0062***	0.0068	0.0057	0.0040**	0.0063*	0.0067**

Table 4.7: Univariate analysis of cumulative abnormal returns in response to decreasing dividend announcements

The table reports the univariate analysis of cumulative abnormal returns in response to decreasing dividend announcements for different types of firms from 2000 to 2018. Column (2) tests if the mean values of CAR(-2;+2) are significantly different from those in column (1). Column (3) tests if the mean values of CAR(-2;+2) are significantly different from those in column (1). Column (4) tests if the mean values of CAR(-2;+2) are significantly different from those in column (3). Column (5) tests if the mean values of CAR(-2;+2) are significantly different from those in column (3). Column (7) tests if the mean values of CAR(-3;+3) are significantly different from those in column (6). Column (8) tests if the mean values of CAR(-3;+3) are significantly different from those in column (6). Column (9) tests if the mean values of CAR(-3;+3) are significantly different from those in column (8). Column (10) tests if the mean values of CAR(-3;+3) are significantly different from those in column (8). ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	CAR(-2;+2)					*CAR(-3;+3)*				
Year	*Non-Fins* (1)	*Financials* (2)	*Banks* (3)	*Non-Bank Fins* (4)	*Non-Banks* (5)	*Non-Fins* (6)	*Financials* (7)	*Banks* (8)	*Non-Bank Fins* (9)	*Non-Banks* (10)
2000	-0.0151	-0.0097	-0.0019	-0.0118	-0.0140	-0.0160	-0.0032	0.0075	-0.0061	-0.0125
2001	-0.0085	0.0067	0.0082	0.0063	-0.0038	-0.0058	-0.0034	0.0117	-0.0073	-0.0063
2002	0.0005	0.0078	0.0173	0.0040	0.0024	0.0058	0.0057	0.0175	0.0011	0.0033
2003	-0.0028	0.0003	-0.0016	0.0012	-0.0007	-0.0037	-0.0025	-0.0023	-0.0026	-0.0031
2004	-0.0072	0.0019	0.0015	0.0021	-0.0038	-0.0064	0.0017	-0.0009	0.0028	-0.0030
2005	0.0046	-0.0064	-0.0120*	-0.0039	0.0020*	0.0065	-0.0051	-0.0169*	0.0003	0.0046
2006	0.0029	-0.0011	-0.0061	0.0010	0.0023	0.0044	-0.0022	0.0014	-0.0038	0.0018
2007	0.0072	-0.0209**	-0.0054	-0.0248	-0.0036	0.0078	-0.0294***	-0.0060	-0.0353*	-0.0067
2008	-0.0043	-0.0120	0.0061	-0.0179	-0.0116	0.0013	-0.0228	-0.0076	-0.0278	-0.0142
2009	-0.0340	-0.0217	-0.0290	-0.0189	-0.0252	-0.0392	-0.0345	-0.0333	-0.0349	-0.0367
2010	-0.0072	0.0013	0.0122	-0.0021	-0.0049	0.0012	-0.0021	0.0135	-0.0070	-0.0025
2011	-0.0060	-0.0083	0.0107	-0.0109	-0.0072	-0.0131	-0.0033	0.0239	-0.0070	-0.0115
2012	0.0054	-0.0079	-0.0427*	-0.0035	0.0022	0.0002	-0.0116	-0.0633*	-0.0051	-0.0017
2013	-0.0112	-0.0003*	-0.0109	0.0017	-0.0073	-0.0132	-0.0029	-0.0196	0.0003**	-0.0092
2014	-0.0038	0.0065	0.0231*	0.0019	-0.0021*	-0.0044	0.0040	0.0176*	0.0002	-0.0030*
2015	-0.0036	-0.0050	0.0086	-0.0063***	-0.0045**	-0.0131	-0.0081	0.0000	-0.0089	-0.0117
2016	-0.0084	0.0046	0.0147	0.0031	-0.0047	-0.0115	0.0082	0.0165	0.0070	-0.0056
2017	-0.0013	-0.0048	0.0053	-0.0063	-0.0034	-0.0057	-0.0040	-0.0083	-0.0034	-0.0048
2018	-0.0120	-0.0019	0.0159	-0.0037	-0.0088	-0.0201	-0.0018	0.0247*	-0.0045	-0.0141
2007–2008	0.0006	-0.0141	0.0038	-0.0196	-0.0088	0.0041	-0.0244**	-0.0073	-0.0297	-0.0116
2000–2018	-0.0064	-0.0059	-0.0040	-0.0064	-0.0064	-0.0077	-0.0103	-0.0069	-0.0113	-0.0091

Table 4.8: Univariate analysis of cumulative abnormal returns in response to stable dividend announcements

The table reports the univariate analysis of cumulative abnormal returns in response to stable dividend announcements for different types of firms from 2000 to 2018. Column (2) tests if the mean values of CAR(-2;+2) are significantly different from those in column (1). Column (3) tests if the mean values of CAR(-2;+2) are significantly different from those in column (1). Column (4) tests if the mean values of CAR(-2;+2) are significantly different from those in column (3). Column (5) tests if the mean values of CAR(-2;+2) are significantly different from those in column (3). Column (7) tests if the mean values of CAR(-3;+3) are significantly different from those in column (6). Column (8) tests if the mean values of CAR(-3;+3) are significantly different from those in column (6). Column (9) tests if the mean values of CAR(-3;+3) are significantly different from those in column (8). Column (10) tests if the mean values of CAR(-3;+3) are significantly different from those in column (8). ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	CAR(-2;+2)					*CAR(-3;+3)*				
Year	*Non-Fins* (1)	*Financials* (2)	*Banks* (3)	*Non-Bank Fins* (4)	*Non-Banks* (5)	*Non-Fins* (6)	*Financials* (7)	*Banks* (8)	*Non-Bank Fins* (9)	*Non-Banks* (10)
2000	0.0039	0.0087*	0.0072	0.0094	0.0060	0.0032	0.0099***	0.0107**	0.0096	0.0056
2001	0.0011	-0.0013	-0.0003	-0.0018	0.0001	0.0033	-0.0023***	0.0013	-0.0041*	0.0007
2002	0.0033	0.0018	0.0022	0.0016	0.0027	0.0032	0.0025	0.0012	0.0031	0.0032
2003	-0.0005	0.0007	0.0000	0.0010	0.0001	0.0000	0.0006	0.0004	0.0007	0.0002
2004	0.0016	0.0025	0.0024	0.0026	0.0020	0.0007	0.0033*	0.0035	0.0032	0.0016
2005	0.0011	0.0007	0.0021	0.0002	0.0008	0.0014	-0.0002	0.0007	-0.0006	0.0007
2006	0.0003	-0.0008	0.0002	-0.0012	-0.0002	-0.0001	-0.0014	0.0004	-0.0021	-0.0008
2007	0.0012	0.0035	0.0077***	0.0019**	0.0014***	0.0016	0.0034	0.0076**	0.0019**	0.0017**
2008	0.0016	0.0012	0.0020	0.0009	0.0013	0.0014	0.0001	-0.0007	0.0004	0.0010
2009	0.0014	0.0001	-0.0001	0.0001	0.0010	0.0012	-0.0012	-0.0009	-0.0012	0.0005
2010	0.0013	0.0046*	0.0061	0.0041	0.0022	0.0021	0.0041	0.0070	0.0032	0.0024
2011	0.0021	0.0016	0.0045	0.0008	0.0017	0.0022	0.0017	0.0016	0.0017	0.0020
2012	-0.0003	-0.0017	-0.0012	-0.0018	-0.0007	-0.0008	-0.0009	-0.0027	-0.0005	-0.0007
2013	-0.0012	0.0011*	0.0040**	0.0004	-0.0008**	-0.0019	0.0012**	0.0057***	0.0001**	-0.0014***
2014	0.0010	0.0012	-0.0009	0.0017	0.0012	0.0009	0.0010	-0.0016	0.0016	0.0011
2015	0.0002	0.0025*	-0.0003	0.0032*	0.0010	0.0006	0.0044**	0.0022	0.0050	0.0017
2016	0.0018	0.0020	0.0018	0.0020	0.0018	0.0015	0.0032	0.0035	0.0031	0.0019
2017	-0.0001	-0.0016	-0.0019	-0.0015	-0.0005	-0.0014	-0.0027	-0.0025	-0.0027	-0.0017
2018	-0.0021	-0.0007	0.0038*	-0.0017*	-0.0020*	-0.0023	-0.0009	0.0039*	-0.0020*	-0.0022*
2007–2008	0.0014	0.0024	0.0051*	0.0014	0.0014*	0.0015	0.0018	0.0038	0.0012	0.0014
2000–2018	0.0009	0.0014	0.0022**	0.0011*	0.0009**	0.0008	0.0014	0.0023**	0.0010*	0.0009**

the average of CAR(-2;+2) of banks is 0.77% and is significantly higher than that of non-financials (0.12%) at 1% level of significance. The findings imply that stable dividend announcements in the year of the Financial Crisis are perceived as positive news and the reactions of the market to such information are stronger for banks than for non-financials. In 2013, the mean of CAR(-2;+2) of banks is 0.40% and is significantly higher than that of non-financials (-0.12%) at 5% level. Similarly, banks are shown to have higher CAR(-2;+2) (0.38%) than non-financials (-0.21%) in 2018. The difference is significant at 10% level. Similar findings are also documented during the 2007-2008 financial crisis period in which the CAR(-2;+2) of banks and non-financials are 0.51% and 0.14%, respectively. For the sample period 2000–2018, the average of CAR(-2;+2) for banks is 0.22% and is statistically higher than that of non-financials of 0.09% at 5% level of significance. Columns (6)–(10) of Table 4.8 also show similar findings for CAR(-3;+3). Overall, the results suggest that banks appear to have higher cumulative abnormal returns around the stable dividend announcements in comparison with non-financials.

4.4.2 Determinants of stock price reactions

In this section, we conduct a multivariate regression analysis with CARs around the dividend announcement day as the dependent variable to evaluate how much of the variation in stock price reactions are explained by firm-specific variables. The variable of interest is dividend change ($DIVCHANGE$) which is the change in the dividend payment of one quarter compared to the dividend payment in the previous quarter. Following the literature (e.g., Leary & Michaely 2011, Chemmanur & Tian 2014), we include a number of firm-specific variables that explain the variation in announcement returns including profitability ($PROFITABILITY$), firm size ($SIZE$), firm leverage ($LEVERAGE$), payout ratio ($PAYOUT$), asset tangibility ($TANGIBILITY$), dividend yield ($DIVYIELD$) and market-to-book ratio (MTB). We also control for the 2008 Global Financial crisis by including the dummy variable (GFC) in the regressions. We include the interaction term of dividend change and the Crisis dummy ($DIVCHANGE\ X\ GFC$) to examine how the Crisis might affect the sensitivity of CARs to the magnitude of dividend changes. All variables are winsorised at the 1st and 99th percentiles. Table 4.9 shows how firm-specific

variables correlate with the stock price reactions in response to increase dividend announcements for non-financials, financials and banking firms[2]. In columns (1)–(3) and (7)–(9), the panel regressions include all firms in the sample from 2000 to 2018 while in columns (4)–(6) and (10)–(12) we exclude the 2008 Global Financial Crisis period. Quarter fixed effects are included in all regressions, and robust standard errors are reported in parentheses.

The reported results for CAR(–2;+2) in columns (1)–(3) of Table 4.9 show that the estimated coefficients of dividend change (*DIVCHANGE*) is positive and statistically significant at 1% level. The results suggest that the market reacts positively to positive dividend change for all types of firms in the sample. In other words, firms with a larger percentage increasing dividend experience a larger increase in the stock returns. This is consistent with numerous studies that document significant stock price reactions to dividend changes (e.g., Pettit 1972, Charest 1978, Aharony & Swary 1980, Tsai & Wu 2015). The estimated coefficient of *DIVCHANGE* for non-financials is 0.0104 while the coefficients for financials and banking firms are 0.0082 and 0.0230, respectively. The Chi-squared statistic and P-value of the test for the equality in those coefficients suggest that the estimated coefficient of *DIVCHANGE* for banks is larger than that of non-financials at 10% significance level. The finding is consistent with the view that dividends are more important for banks as the signalling content of dividends might be stronger for banks than for non-financials (Floyd et al. 2015). This is because a large part of banks' assets is intangible (e.g. loans) and hard to value, making banks inherently opaque (Floyd et al. 2015). Nevertheless, there is no evidence indicating that there is any difference in the estimated coefficients between non-financials and financial firms at conventional significance levels.

In columns (4)–(6), the 2008 Global Financial Crisis period is excluded from the regressions to see if the findings are driven by the crisis period. As can be seen from the table, the findings remain unchanged and the estimated coefficients of *DIVCHANGE* are quantitatively similar to those in columns (1)–(3). Similar results are presented in columns (7)–(12) for CAR(–3;+3) where the estimated coefficients of *DIVCHANGE* are positive and strongly significant at 1% level

[2]For brevity, we do not report the results for non-bank financials which are quantitatively similar to those of financial firms.

Table 4.9: Determinants of cumulative abnormal returns in response to increasing dividend announcements

Sample Period	*CAR(-2;+2)* *All*			*Excluding GFC*			*CAR(-3;+3)* *All*			*Excluding GFC*		
	(1) *Non-Financials*	(2) *Financials*	(3) *Banks*	(4) *Non-Financials*	(5) *Financials*	(6) *Banks*	(7) *Non-Financials*	(8) *Financials*	(9) *Banks*	(10) *Non-Financials*	(11) *Financials*	(12) *Banks*
DIVCHANGE	0.0104***	0.0082***	0.0230***	0.0108***	0.0084***	0.0231***	0.0121***	0.0112***	0.0270***	0.0124***	0.0117***	0.0277***
	(0.0024)	(0.0025)	(0.0066)	(0.0025)	(0.0025)	(0.0066)	(0.0028)	(0.0029)	(0.0075)	(0.0028)	(0.0029)	(0.0075)
GFC	-0.0448	0.0308	-0.0054				-0.0576	0.0424*	0.0178			
	(0.0401)	(0.0208)	(0.0288)				(0.0429)	(0.0243)	(0.0314)			
DIVCHANGE X GFC	-0.0004	0.0284***	0.0225*				-0.0005	0.0326***	0.0227*			
	(0.0010)	(0.0079)	(0.0127)				(0.0011)	(0.0084)	(0.0134)			
PROFITABILITY	0.0377	-0.0464	1.2710*	0.0459	-0.0202	0.8316	0.0712**	-0.0215	1.2433	0.0745**	0.0095	0.7921
	(0.0322)	(0.0842)	(0.6969)	(0.0326)	(0.0840)	(0.6254)	(0.0363)	(0.0920)	(0.8640)	(0.0370)	(0.0919)	(0.8221)
MTB	-0.0006	-0.0003	-0.0138	-0.0008	-0.0017	-0.0075	-0.0016**	-0.0020	-0.0119	-0.0018**	-0.0033	-0.0076
	(0.0007)	(0.0019)	(0.0200)	(0.0007)	(0.0019)	(0.0189)	(0.0008)	(0.0022)	(0.0248)	(0.0008)	(0.0022)	(0.0240)
SIZE	-0.0008***	-0.0005	-0.0014	-0.0008**	-0.0004	-0.0016*	-0.0008**	-0.0007**	-0.0017	-0.0008**	-0.0005	-0.0015
	(0.0003)	(0.0003)	(0.0009)	(0.0003)	(0.0003)	(0.0009)	(0.0003)	(0.0003)	(0.0011)	(0.0004)	(0.0003)	(0.0011)
PAYOUT	0.0004	-0.0006	0.0022	0.0003	-0.0008	0.0021	0.0000	-0.0005	0.0031	0.0000	-0.0009	0.0016
	(0.0007)	(0.0009)	(0.0024)	(0.0007)	(0.0009)	(0.0023)	(0.0008)	(0.0010)	(0.0027)	(0.0008)	(0.0010)	(0.0025)
DIVYIELD	0.1898	0.3036**	0.4700	0.2506*	0.3426**	0.5275	0.2173	0.1858	0.3076	0.2474	0.2560	0.6746
	(0.1463)	(0.1478)	(0.3932)	(0.1475)	(0.1542)	(0.3780)	(0.1721)	(0.1667)	(0.5072)	(0.1730)	(0.1682)	(0.4491)
LEVERAGE	-0.0027	0.0023	0.0034	-0.0050	0.0014	0.0023	-0.0019	0.0041	0.0013	-0.0047	0.0033	-0.0007
	(0.0034)	(0.0044)	(0.0130)	(0.0035)	(0.0045)	(0.0124)	(0.0039)	(0.0052)	(0.0167)	(0.0040)	(0.0053)	(0.0165)
TANGIBILITY	-0.0014	-0.0091	0.0331	-0.0014	-0.0077	0.0165	-0.0033	-0.0191*	0.0493	-0.0036	-0.0159	0.0608
	(0.0027)	(0.0079)	(0.1201)	(0.0027)	(0.0081)	(0.1177)	(0.0031)	(0.0103)	(0.1494)	(0.0031)	(0.0109)	(0.1509)
Constant	0.0614	-0.0145	0.0157	0.0612	-0.0139	0.0136	0.0753*	-0.0300	-0.0050	0.0758*	-0.0303	-0.0108
	(0.0393)	(0.0156)	(0.0281)	(0.0393)	(0.0156)	(0.0279)	(0.0417)	(0.0185)	(0.0347)	(0.0418)	(0.0185)	(0.0345)
Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8,749	6,342	1,706	8,114	6,010	1,612	8,749	6,342	1,706	8,114	6,010	1,612
R-squared	0.0167	0.0327	0.0969	0.0185	0.0269	0.0975	0.0175	0.0408	0.1114	0.0195	0.0355	0.1025
Chi-squared		0.40	3.37		0.47	3.18		0.05	3.59		0.03	3.85
P-value		0.5265	0.0666		0.4932	0.0745		0.8147	0.058		0.8571	0.0499

The table reports the regressions of the determinants of cumulative abnormal returns in response to increasing dividend announcements for different types of firms from 2000 to 2018. *DIVCHANGE* is the percentage change in the dividend payment of one quarter compared to the dividend payment in the previous quarter. *GFC* is a dummy variable that equals to 1 for the period of the Global Financial Crisis, 2007 Q4 to 2009 Q2. *PROFITABILITY* is the ratio of operating income before depreciation and book total assets. *SIZE* is the natural logarithm of firms' book value of total assets. *LEVERAGE* is the total of long-term debt plus short-term debt divided by total assets. *PAYOUT* equals to common dividends divided by net income before extraordinary items. *TANGIBILITY* is defined as plant, property and equipment scaled by the book value of firm total assets. *DIVYIELD* equals dividend per share divided by share price. *MTB* is the ratio of the market value and the book value of firm total assets. Chi-squared and P-value test the equality in the *DIVCHANGE* coefficient between Non-financials and Financials, Non-financials and Banks. Quarter fixed effects are included in all regressions and robust standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 4.10: Determinants of cumulative abnormal returns in response to decreasing dividend announcements

Sample Period	*CAR(-2;+2)* *All*			*Excluding GFC*			*CAR(-3;+3)* *All*			*Excluding GFC*		
	(1) *Non-Financials*	(2) *Financials*	(3) *Banks*	(4) *Non-Financials*	(5) *Financials*	(6) *Banks*	(7) *Non-Financials*	(8) *Financials*	(9) *Banks*	(10) *Non-Financials*	(11) *Financials*	(12) *Banks*
DIVCHANGE	0.0348***	0.0397***	0.0244	0.0376***	0.0264**	0.0089	0.0389***	0.0363***	0.0294	0.0441***	0.0229*	0.0172
	(0.0120)	(0.0110)	(0.0243)	(0.0120)	(0.0104)	(0.0235)	(0.0137)	(0.0130)	(0.0292)	(0.0135)	(0.0126)	(0.0290)
GFC	0.0447**	-0.0357	-0.0361				0.0706***	-0.1666***	0.0068			
	(0.0221)	(0.0339)	(0.0314)				(0.0238)	(0.0362)	(0.0330)			
DIVCHANGE X GFC	0.0049	0.0340	0.0108				0.0089	0.0382	0.0332			
	(0.0391)	(0.0252)	(0.0528)				(0.0455)	(0.0273)	(0.0567)			
PROFITABILITY	0.0235	0.2006	-0.0149	0.0768	0.0665	3.1952	-0.0090	0.1325	-2.0570	0.0605	0.0510	1.1860
	(0.0855)	(0.1679)	(1.9090)	(0.0837)	(0.1454)	(2.1092)	(0.0974)	(0.2020)	(2.1784)	(0.0965)	(0.1940)	(2.2148)
MTB	-0.0013	-0.0047	0.0630	-0.0021	-0.0001	0.0046	0.0001	-0.0040	0.0454	-0.0010	0.0002	-0.0145
	(0.0019)	(0.0046)	(0.0722)	(0.0018)	(0.0040)	(0.0728)	(0.0022)	(0.0060)	(0.0887)	(0.0021)	(0.0056)	(0.0933)
SIZE	0.0005	0.0001	0.0022	0.0006	0.0013	0.0004	0.0001	0.0009	0.0044	0.0003	0.0016	0.0053
	(0.0010)	(0.0013)	(0.0049)	(0.0010)	(0.0010)	(0.0036)	(0.0012)	(0.0015)	(0.0048)	(0.0012)	(0.0013)	(0.0040)
PAYOUT	-0.0004	-0.0031	-0.0070	-0.0001	-0.0003	-0.0024	-0.0009	-0.0031	-0.0137*	-0.0004	-0.0024	-0.0131
	(0.0018)	(0.0021)	(0.0075)	(0.0018)	(0.0022)	(0.0086)	(0.0019)	(0.0023)	(0.0080)	(0.0019)	(0.0026)	(0.0127)
DIVYIELD	-0.6557**	-1.4836***	-2.0777	-0.7123**	-1.1796***	-1.2173	-0.4976	-1.5497***	-1.2222	-0.6060*	-1.0520**	-0.0005
	(0.3311)	(0.4392)	(1.4489)	(0.3394)	(0.3809)	(1.4753)	(0.3613)	(0.4794)	(1.5770)	(0.3565)	(0.4416)	(1.6893)
LEVERAGE	0.0074	0.0096	-0.0070	0.0045	0.0030	0.0068	0.0091	-0.0032	-0.0419	0.0102	-0.0041	-0.0588
	(0.0115)	(0.0135)	(0.0731)	(0.0121)	(0.0114)	(0.0628)	(0.0135)	(0.0162)	(0.0791)	(0.0138)	(0.0150)	(0.0780)
TANGIBILITY	-0.0092	0.0395	-0.7396	-0.0111	0.0119	-1.1143**	-0.0058	0.0558	-0.7484	-0.0085	0.0265	-1.6136**
	(0.0087)	(0.0328)	(0.5951)	(0.0086)	(0.0242)	(0.5580)	(0.0101)	(0.0348)	(0.6828)	(0.0099)	(0.0242)	(0.6323)
Constant	-0.0236*	0.0444**	-0.0555	-0.0231*	0.0255	0.0183	-0.0478***	0.1545***	-0.0192	-0.0469***	0.1313***	0.0551
	(0.0121)	(0.0194)	(0.0756)	(0.0121)	(0.0173)	(0.0755)	(0.0118)	(0.0250)	(0.0930)	(0.0115)	(0.0226)	(0.0991)
Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,498	1,258	289	1,318	961	214	1,498	1,258	289	1,318	961	214
R-squared	0.0724	0.1035	0.2774	0.0671	0.1134	0.3493	0.0691	0.1208	0.2978	0.0687	0.1126	0.3834
Chi-squared		0.09	0.19		0.53	1.60		0.02	0.11		1.41	0.97
P-value		0.7592	0.6623		0.4677	0.2056		0.8867	0.736		0.2354	0.3256

The table reports the regressions of the determinants of cumulative abnormal returns in response to decreasing dividend announcements for different types of firms from 2000 to 2018. *DIVCHANGE* is the percentage change in the dividend payment of one quarter compared to the dividend payment in the previous quarter. *GFC* is a dummy variable that equals to 1 for the period of the Global Financial Crisis, 2007 Q4 to 2009 Q2. *PROFITABILITY* is the ratio of operating income before depreciation and book total assets. *SIZE* is the natural logarithm of firms' book value of total assets. *LEVERAGE* is the total of long-term debt plus short-term debt divided by total assets. *PAYOUT* equals to common dividends divided by net income before extraordinary items. *TANGIBILITY* is defined as plant, property and equipment scaled by the book value of firm total assets. *DIVYIELD* equals dividend per share divided by share price. *MTB* is the ratio of the market value and the book value of firm total assets. Chi-squared and P-value test the equality in the *DIVCHANGE* coefficient between Non-financials and Financials, Non-financials and Banks. Quarter fixed effects are included in all regressions and robust standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 4.11: Determinants of cumulative abnormal returns in response to stable dividend announcements

Sample Period	*CAR(-2;+2)* *All*			*Excluding GFC*			*CAR(-3;+3)* *All*			*Excluding GFC*		
	(1) *Non-Financials*	(2) *Financials*	(3) *Banks*	(4) *Non-Financials*	(5) *Financials*	(6) *Banks*	(7) *Non-Financials*	(8) *Financials*	(9) *Banks*	(10) *Non-Financials*	(11) *Financials*	(12) *Banks*
GFC	-0.0189*	-0.0085	-0.0091				-0.0141	-0.0006	-0.0012			
	(0.0103)	(0.0111)	(0.0221)				(0.0127)	(0.0126)	(0.0243)			
PROFITABILITY	0.0725***	0.0165	-0.5352**	0.0589***	0.0103	-0.2080	0.0885***	0.0047	-0.6330**	0.0738***	-0.0155	-0.0822
	(0.0151)	(0.0366)	(0.2714)	(0.0154)	(0.0359)	(0.2293)	(0.0178)	(0.0423)	(0.3103)	(0.0182)	(0.0413)	(0.2617)
MTB	-0.0005	-0.0011	0.0474***	-0.0003	-0.0011	0.0356***	-0.0007	-0.0011	0.0500***	-0.0004	-0.0006	0.0305**
	(0.0003)	(0.0010)	(0.0124)	(0.0004)	(0.0010)	(0.0118)	(0.0004)	(0.0012)	(0.0145)	(0.0004)	(0.0011)	(0.0137)
SIZE	-0.0002	-0.0004**	-0.0006	-0.0002	-0.0004**	-0.0005	-0.0002	-0.0003	-0.0005	-0.0000	-0.0002	-0.0002
	(0.0001)	(0.0002)	(0.0005)	(0.0001)	(0.0002)	(0.0005)	(0.0002)	(0.0002)	(0.0006)	(0.0002)	(0.0002)	(0.0005)
PAYOUT	0.0001	0.0006	0.0013	-0.0000	0.0004	0.0017	-0.0001	0.0003	0.0011	-0.0002	0.0000	0.0014
	(0.0003)	(0.0004)	(0.0012)	(0.0003)	(0.0004)	(0.0011)	(0.0003)	(0.0005)	(0.0012)	(0.0003)	(0.0005)	(0.0011)
DIVYIELD	-0.1265*	-0.1115	-0.0630	-0.0873	-0.0433	0.1442	-0.1383*	-0.0565	-0.1758	-0.1045	0.0432	0.0912
	(0.0663)	(0.0878)	(0.1989)	(0.0669)	(0.0847)	(0.1946)	(0.0773)	(0.1000)	(0.2304)	(0.0777)	(0.0967)	(0.2138)
LEVERAGE	0.0011	-0.0000	0.0083	-0.0005	-0.0005	0.0112	0.0009	0.0003	0.0176*	-0.0012	-0.0011	0.0187**
	(0.0015)	(0.0025)	(0.0081)	(0.0015)	(0.0025)	(0.0079)	(0.0018)	(0.0029)	(0.0092)	(0.0018)	(0.0029)	(0.0089)
TANGIBILITY	-0.0026**	-0.0001	-0.0432	-0.0024**	-0.0007	-0.0318	-0.0023*	0.0019	-0.0465	-0.0019	0.0006	-0.0200
	(0.0012)	(0.0040)	(0.0602)	(0.0012)	(0.0037)	(0.0568)	(0.0014)	(0.0051)	(0.0711)	(0.0014)	(0.0048)	(0.0671)
Constant	0.0217**	0.0140	-0.0335	0.0216**	0.0134	-0.0265	0.0193	0.0117	-0.0410	0.0190	0.0100	-0.0301
	(0.0098)	(0.0103)	(0.0240)	(0.0098)	(0.0103)	(0.0237)	(0.0121)	(0.0115)	(0.0263)	(0.0121)	(0.0115)	(0.0259)
Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	44,566	26,227	6,669	40,458	23,622	6,031	44,566	26,227	6,669	40,458	23,622	6,031
R-squared	0.0045	0.0131	0.0256	0.0047	0.0139	0.0271	0.0046	0.0161	0.0392	0.0048	0.0179	0.0438

The table reports the regressions of the determinants of cumulative abnormal returns in response to stable dividend announcements for different types of firms from 2000 to 2018. *DIVCHANGE* is the percentage change in the dividend payment of one quarter compared to the dividend payment in the previous quarter. *GFC* is a dummy variable that equals to 1 for the period of the Global Financial Crisis, 2007 Q4 to 2009 Q2. *PROFITABILITY* is the ratio of operating income before depreciation and book total assets. *SIZE* is the natural logarithm of firms' book value of total assets. *LEVERAGE* is the total of long-term debt plus short-term debt divided by total assets. *PAYOUT* equals to common dividends divided by net income before extraordinary items. *TANGIBILITY* is defined as plant, property and equipment scaled by the book value of firm total assets. *DIVYIELD* equals dividend per share divided by share price. *MTB* is the ratio of the market value and the book value of firm total assets. Quarter fixed effects are included in all regressions and robust standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 4.12: Determinants of cumulative abnormal returns in response to all dividend announcements

Sample Period	*CAR(-2;+2)* *All*			*Excluding GFC*			*CAR(-3;+3)* *All*			*Excluding GFC*		
	(1) *Non-Financials*	(2) *Financials*	(3) *Banks*	(4) *Non-Financials*	(5) *Financials*	(6) *Banks*	(7) *Non-Financials*	(8) *Financials*	(9) *Banks*	(10) *Non-Financials*	(11) *Financials*	(12) *Banks*
DIVCHANGE	0.0179***	0.0131***	0.0160***	0.0172***	0.0126***	0.0150***	0.0202***	0.0164***	0.0199***	0.0195***	0.0157***	0.0189***
	(0.0017)	(0.0017)	(0.0045)	(0.0017)	(0.0017)	(0.0045)	(0.0019)	(0.0020)	(0.0053)	(0.0019)	(0.0020)	(0.0053)
GFC	-0.0224**	-0.0058	-0.0137				-0.0228*	-0.0002	-0.0043			
	(0.0099)	(0.0096)	(0.0176)				(0.0120)	(0.0114)	(0.0198)			
DIVCHANGE X GFC	0.0004	0.0293***	0.0188				0.0002	0.0420***	0.0310*			
	(0.0010)	(0.0077)	(0.0171)				(0.0011)	(0.0085)	(0.0184)			
PROFITABILITY	0.0690***	0.0199	-0.4356*	0.0601***	0.0100	-0.0302	0.0868***	0.0108	-0.6100**	0.0769***	-0.0059	0.0460
	(0.0136)	(0.0329)	(0.2584)	(0.0137)	(0.0323)	(0.2210)	(0.0159)	(0.0379)	(0.2942)	(0.0161)	(0.0371)	(0.2545)
MTB	-0.0005*	-0.0012	0.0387***	-0.0004	-0.0011	0.0283***	-0.0008**	-0.0013	0.0413***	-0.0007**	-0.0009	0.0227**
	(0.0003)	(0.0009)	(0.0103)	(0.0003)	(0.0008)	(0.0098)	(0.0004)	(0.0010)	(0.0121)	(0.0004)	(0.0010)	(0.0114)
SIZE	-0.0002**	-0.0004**	-0.0007	-0.0002	-0.0003**	-0.0007*	-0.0002	-0.0003**	-0.0005	-0.0001	-0.0002	-0.0003
	(0.0001)	(0.0001)	(0.0004)	(0.0001)	(0.0001)	(0.0004)	(0.0001)	(0.0002)	(0.0005)	(0.0001)	(0.0002)	(0.0005)
PAYOUT	0.0002	0.0003	0.0007	0.0000	0.0003	0.0014	-0.0001	-0.0000	0.0003	-0.0002	-0.0002	0.0009
	(0.0003)	(0.0004)	(0.0011)	(0.0003)	(0.0004)	(0.0010)	(0.0003)	(0.0004)	(0.0011)	(0.0003)	(0.0004)	(0.0011)
DIVYIELD	-0.1195**	-0.1124	-0.0682	-0.0671	-0.0230	0.1262	-0.1244*	-0.1038	-0.1506	-0.0876	0.0260	0.1363
	(0.0591)	(0.0759)	(0.1796)	(0.0595)	(0.0726)	(0.1744)	(0.0687)	(0.0856)	(0.2074)	(0.0688)	(0.0823)	(0.1923)
LEVERAGE	0.0008	0.0007	0.0035	-0.0009	-0.0001	0.0075	0.0007	0.0008	0.0082	-0.0013	-0.0003	0.0106
	(0.0014)	(0.0022)	(0.0068)	(0.0014)	(0.0022)	(0.0066)	(0.0016)	(0.0025)	(0.0079)	(0.0016)	(0.0025)	(0.0077)
TANGIBILITY	-0.0028***	-0.0004	-0.0590	-0.0026**	-0.0013	-0.0457	-0.0028**	-0.0003	-0.0606	-0.0026**	-0.0016	-0.0389
	(0.0011)	(0.0036)	(0.0526)	(0.0011)	(0.0034)	(0.0493)	(0.0013)	(0.0046)	(0.0626)	(0.0013)	(0.0044)	(0.0596)
Constant	0.0239**	0.0106	-0.0239	0.0237**	0.0095	-0.0184	0.0225*	0.0096	-0.0355*	0.0223*	0.0074	-0.0260
	(0.0096)	(0.0087)	(0.0190)	(0.0096)	(0.0087)	(0.0188)	(0.0116)	(0.0104)	(0.0212)	(0.0116)	(0.0104)	(0.0209)
Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	54,813	33,827	8,664	49,890	30,593	7,857	54,813	33,827	8,664	49,890	30,593	7,857
R-squared	0.0070	0.0174	0.0309	0.0070	0.0148	0.0293	0.0069	0.0230	0.0459	0.0070	0.0203	0.0448
Chi-squared		3.91	0.15		3.53	0.20		1.93	0.00		1.91	0.01
P-value		0.0481	0.7025		0.0604	0.6539		0.1653	0.9527		0.1672	0.9097

The table reports the regressions of the determinants of cumulative abnormal returns in response to all dividend announcements for different types of firms from 2000 to 2018. *DIVCHANGE* is the percentage change in the dividend payment of one quarter compared to the dividend payment in the previous quarter. *GFC* is a dummy variable that equals to 1 for the period of the Global Financial Crisis, 2007 Q4 to 2009 Q2. *PROFITABILITY* is the ratio of operating income before depreciation and book total assets. *SIZE* is the natural logarithm of firms' book value of total assets. *LEVERAGE* is the total of long-term debt plus short-term debt divided by total assets. *PAYOUT* equals to common dividends divided by net income before extraordinary items. *TANGIBILITY* is defined as plant, property and equipment scaled by the book value of firm total assets. *DIVYIELD* equals dividend per share divided by share price. *MTB* is the ratio of the market value and the book value of firm total assets. Chi-squared and P-value test the equality in the *DIVCHANGE* coefficient between Non-financials and Financials, Non-financials and Banks. Quarter fixed effects are included in all regressions and robust standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

for all types of firms. The test for the equality of the coefficients indicates that stock prices of banks exhibit stronger reactions to positive dividend changes in comparison with non-financials at 10% and 5% significance levels (in columns (9) and (12), respectively) while there is no evidence suggesting the difference between the coefficients of *DIVCHANGE* between financials and non-financials.

Some other findings are also worth noting. The *GFC* dummy is included in columns (1)–(3) and (7)–(9) to capture the effects of the 2008 Global Financial Crisis. As can be seen from the table, the GFC appears to have no effects on the cumulative abnormal returns. Nevertheless, the estimated coefficients of the interaction term *DIVCHANGE X GFC* are both positive and statistically significant for financials and banking firms at 1% and 10%, respectively. The findings imply that during the Crisis period, stock prices of financial and banking firms react stronger to positive dividend changes than in normal times. The amplifying effect of the Crisis on stock price reactions, however, is not found in non-financials. The results are in line with the argument that dividends appear to have stronger signalling content for banks than for non-financials, especially in times of high uncertainty and severe informational asymmetry. Floyd et al. (2015) document that while the propensity to pay dividends of non-financials declined during the 2008 financial turmoil, banks were reluctant to cut dividends even during the crisis. Flannery et al. (2013) further conclude that banks become opaquer during financial periods than in normal times. Across the model estimations, the coefficients of *DIVYIELD* are positive, implying that dividend yield plays an important role in determining stock price reactions to dividend announcements. Dividend changes tend to convey more information in high dividend-paying firms that have low growth prospects (Amihud & Li 2006). Hence, shareholders of firms with higher dividend yields might value dividends more, leading to a stronger reaction in share prices to payout changes (Andres et al. 2013). Consistent with Fuller (2003), Amihud & Li (2006), *SIZE* is found to have a negative impact on stock abnormal returns, which suggests that small firms might earn higher abnormal returns than large firms. Andres et al. (2013) argue that the signalling role of dividends is more important for smaller firms as they are usually not adequately covered by financial analysts.

Table 4.10 summarises the results from the panel data regressions examining

the determinants of the estimated CARs for different event windows in response to decreasing dividend announcements. We run the regressions for non-financials, financials and banks with and without the Crisis period. The table shows that the estimated coefficients of *DIVCHANGE* are positive and strongly significant at either 1% or 5% levels of significance across most specifications. The results indicate that there is a positive correlation between changes in dividend payment and stock price reactions and are consistent with prior studies (e.g., Henry et al. 2017). Firms that have a larger percentage dividend reduction experience a larger drop in their stock price returns. For instance, the estimated coefficients of dividend change for non-financial firms and financial firms (column (1) and (2)) are 0.0348 and 0.0397, respectively. Both are statistically significant at 1% level. Unlike the regressions of increasing dividend announcements in Table 4.9, the Chi-squared statistic and P-value of the equality test of the coefficients suggest that there is no difference between the coefficients of dividend change between non-financials and financials. However, dividend change does not appear to have any effects on cumulative abnormal returns for banking firms (column (3)). The findings contradict those in Bessler & Nohel (1996) who document evidence of stronger effects of dividend reductions for banking firms than for non-financials. Similar results of the regressions that exclude the Crisis period are presented in columns (4)–(6). As for the impact of dividend changes on CAR(–3;+3), columns (7)–(12) document a positive association between dividend change *DIVCHANGE* and cumulative abnormal returns for non-financials as well as financial firms. Consistent with the prior results, the estimated coefficients of dividend change for non-financials and financials (columns (7) and (8)) are 0.0389 and 0.0363, respectively. The result do not change quantitatively when the Crisis period is removed from the sample. However, the positive association between dividend change and CAR(–3;+3) is not found for banking firms across the model specifications.

The 2008 Global Financial Crisis appears to have a positive impact on CARs for non-financial firms as evidenced by the coefficient estimates of *GFC* are 0.0447 and 0.0706 and significant at 5% and 1% levels, respectively (columns (1) and (7)). While similar effects are not found in Table 4.9, this suggests that the market seems to react more strongly to dividend cut announcements during the Crisis

period when it is more important for firms to demonstrate their financial health. Nonetheless, the estimated coefficient of *GFC* is negative for financial firms (-0.1666 in column (8)). This finding highlights the difference in the signalling content of dividend cuts between non-financials and financials, especially during economic downturns. For instance, regulators worldwide have suspended or restricted bank dividends in the wake of the COVID–19 pandemic[3]. Interestingly, the interaction term *DIVCHANGE X GFC* does not appear to have any significant effects on CARs across model specifications, implying that the Crisis does not amplify or dampen the effects of dividend change on CARs when comparing with normal times. Moreover, the estimated coefficients of *DIVYIELD* are negative in all regressions, pointing to the negative correlation between dividend yield and stock abnormal returns in response to negative dividend changes.

Table 4.11 summarises the results from the panel data regressions examining the determinants of the estimated CARs for different event windows in response to stable dividend announcements. We run the regressions for non-financials, financials and banks with and without the Crisis period. As can be seen from the table, *GFC* does not appear to have any impacts on the cumulative abnormal returns of stocks across the model specifications. Overall, the results of the regressions reported in the table are quantitatively similar to the prior tables.

We next run the regressions on the determinants of CARs for financials, non-financials and banking firms without differentiating increasing, decreasing or stable dividend announcements. The results are presented in Table 4.12. The table documents the positive association between dividend change and cumulative abnormal returns across all model specifications. For instance, columns (1)–(3) shows that the coefficient estimates for *DIVCHANGE* are 0.0179, 0.0131 and 0.0160 for non-financials, financials and banking firms, respectively (all of which are statistically significant at 1% level). The test for equality suggests that the magnitude of the estimated coefficients of *DIVCHANGE* is different when comparing between financials and non-financial firms (column (2)) at 5% significance level. However, there is no evidence pointing to the difference in the coefficients *DIVCHANGE* between non-financials and banks (column (3)). Excluding the Crisis period from

[3] For details, see https://internationalbanker.com/banking/accounting-for-curbs-on-bank-dividends-during-the-pandemic/.

the regressions, columns (4)–(6) report quantitatively similar results regarding the effects of dividend change on CAR(–2;+2). Columns (7)–(12) of the table present the regression results for CAR(–3;+3). Across all model specifications, our conclusions remain unchanged as we document the positive effect of dividend change on CAR(–3;+3). The estimated coefficients of *DIVCHANGE* are all significant at 1% level. The results indicate that stock prices react stronger to larger dividend changes. Nevertheless, we do not find any differences in the coefficient estimates between non-financials and financials, non-financials and banking firms.

The 2008 Global Financial Crisis appears to affect cumulative abnormal returns of stocks for only non-financial firms as evidenced by the negative coefficients of *GFC* in columns (1) and (7), which are significant at 5% and 10% levels, respectively. Interestingly, consistent with the findings in Table 4.9, the coefficients of the interaction variable *DIVCHANGE X GFC* are positive only for financial firms (columns (2) and (8)) and are significant at 1% level, and for banking firms (column (9) at 10% significant level. The finding implies that the Crisis period amplifies the effects of dividend changes on CARs in comparison with normal times for financials and banking firms only.

Overall, the results of the regressions discussed so far suggest that dividend changes exert a positive effect on stock price reactions measured by cumulative abnormal returns around dividend announcement days. The effects of dividend changes appear to be stronger for financials and banking firms than for non-financials only when the change in dividend is positive. The findings provide evidence in support of the notion that the signalling motive of dividends for banks might be more important than for non-financial firms as the unique features of banks make it hard to assess the quality of their assets (Floyd et al. 2015). Moreover, the effects appear to be intensified in the Crisis period, indicating that such signalling motive becomes particularly more relevant in times of high uncertainty and intense informational asymmetry when it is important to reassure the market of the firm's financial strength than in normal times. However, this effect is not observed for dividend cut announcements.

4.4.3 Bank opacity and of stock price reactions

In this section, as bank opacity hinders the ability of the market to accurately assess banks' value and risk, thereby exacerbating the information asymmetries, we examine the impact of bank earnings opacity on the stock prices reactions around the dividend announcement day. Several measures of bank earnings opacity are included in the regressions. EO_1 is the measure of bank opacity, defined as the absolute value of the residual obtained from Equation 4.4. EO_{1+} is the measure of bank opacity, defined as the positive signed value of the residual obtained from Equation 4.4. EO_{1-} is the measure of bank opacity, defined as the negative signed value of the residual obtained from Equation 4.4. EO_2 is the measure of bank opacity, defined as the absolute value of the residual obtained from Equation 4.5. EO_{2+} is the measure of bank opacity, defined as the positive signed value of the residual obtained from Equation 4.5. EO_{2-} is the measure of bank opacity, defined as the negative signed value of the residual obtained from Equation 4.5. Columns (1)–(6) and (7)–(12) in Tables 4.13, 4.14 and 4.15 show the results with CAR(–2;+2) and CAR(–3;+3) as the dependent variables, respectively. Quarter fixed effects are included in all regressions and robust standard errors are reported in parentheses.

Table 4.13 presents the results of the regressions for all bank dividend announcements and suggests that there is no association between the degree of bank earnings opacity and their stock price responses to dividend announcements. Tables 4.14 and 4.15 report the results for increasing and decreasing dividend announcements, respectively. Interestingly, Table 4.14 shows that the estimated coefficients of bank opacity measures (EO_1, EO_2, EO_{1+}, EO_{2+}) are negative and statistically significant in most of the regressions. The results suggest that the market reacts to increasing dividend announcements to a lesser extent as banks become more opaque and understate their earnings. On the contrary, the estimated coefficient of EO_{1-} in column (11) is positive and significant at 5% level, implying that the market responds more to dividend increasing announcements when banks overstate their earnings. Most of the interaction terms between *DIVCHANGE* and bank opacity are not significant, except for *DIVCHANGE X* EO_2 and *DIVCHANGE X* EO_{2-}. Table 4.15 documents similar results.

Table 4.13: Bank opacity and cumulative abnormal returns in response to all dividend announcements

	CAR(-2;+2)						*CAR(-3;+3)*					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
DIVCHANGE	0.0060	0.0056	0.0021	0.0105	0.0129	-0.0098	0.0155*	0.0155*	0.0073	0.0222*	0.0415***	0.0018
	(0.0071)	(0.0071)	(0.0117)	(0.0116)	(0.0137)	(0.0097)	(0.0087)	(0.0087)	(0.0138)	(0.0135)	(0.0154)	(0.0125)
GFC	0.0036	0.0037	0.0036	0.0006	0.0063	0.0067*	0.0028	0.0029	0.0039	0.0007	0.0039	0.0048
	(0.0035)	(0.0035)	(0.0074)	(0.0070)	(0.0039)	(0.0039)	(0.0041)	(0.0041)	(0.0085)	(0.0081)	(0.0045)	(0.0045)
EO_1	0.0001						0.0039					
	(0.0072)						(0.0084)					
DIVCHANGE X EO_1	0.0466						0.0403					
	(0.0428)						(0.0545)					
EO_2		-0.0036						0.0005				
		(0.0069)						(0.0082)				
DIVCHANGE X EO_2		0.0539						0.0437				
		(0.0493)						(0.0619)				
EO_{1+}			-0.0003						0.0064			
			(0.0069)						(0.0081)			
DIVCHANGE X EO_{1+}			0.0613						0.0679			
			(0.0471)						(0.0591)			
EO_{2+}				-0.0035						0.0015		
				(0.0070)						(0.0085)		
DIVCHANGE X EO_{2+}				0.0355						0.0273		
				(0.0547)						(0.0680)		
EO_{1-}					0.0165						0.0026	
					(0.0130)						(0.0150)	
DIVCHANGE X EO_{1-}					0.0063						0.1978	
					(0.1326)						(0.1523)	
EO_{2-}						0.0090						-0.0018
						(0.0106)						(0.0130)
DIVCHANGE X EO_{2-}						-0.1994**						-0.1575
						(0.0945)						(0.1233)
Constant	-0.0268**	-0.0265**	-0.0273	-0.0311	-0.0368**	-0.0334**	-0.0284*	-0.0282*	-0.0617*	-0.0572*	-0.0249	-0.0266
	(0.0135)	(0.0135)	(0.0289)	(0.0273)	(0.0148)	(0.0150)	(0.0158)	(0.0158)	(0.0335)	(0.0313)	(0.0178)	(0.0180)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,188	5,186	1,525	1,757	3,663	3,429	5,188	5,186	1,525	1,757	3,663	3,429
R-squared	0.0110	0.0112	0.0200	0.0161	0.0136	0.0140	0.0112	0.0112	0.0242	0.0222	0.0103	0.0087

The table reports the regressions of the determinants of cumulative abnormal returns in response to all dividend announcements for all banks from 2000 to 2018. *DIVCHANGE* is the percentage change in the dividend payment of one quarter compared to the dividend payment in the previous quarter. *GFC* is a dummy variable that equals to 1 for the period of the Global Financial Crisis, 2007 Q4 to 2009 Q2. EO_1 is the measure of bank opacity, defined as the absolute value of the residual obtained from Equation 4.4. EO_{1+} is the measure of bank opacity, defined as the positive signed value of the residual obtained from Equation 4.4. EO_{1-} is the measure of bank opacity, defined as the negative signed value of the residual obtained from Equation 4.4. EO_2 is the measure of bank opacity, defined as the absolute value of the residual obtained from Equation 4.5. EO_{2+} is the measure of bank opacity, defined as the positive signed value of the residual obtained from Equation 4.5. EO_{2-} is the measure of bank opacity, defined as the negative signed value of the residual obtained from Equation 4.5. Quarter fixed effects are included in all regressions and robust standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 4.14: Bank opacity and cumulative abnormal returns in response to increasing dividend announcements

	CAR(-2;+2)						*CAR(-3;+3)*					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
DIVCHANGE	-0.0032	-0.0045	-0.0028	-0.0074	-0.0016	-0.0073	-0.0039	-0.0041	-0.0203	-0.0041	0.0073	-0.0104
	(0.0131)	(0.0099)	(0.0187)	(0.0220)	(0.0184)	(0.0108)	(0.0151)	(0.0115)	(0.0229)	(0.0242)	(0.0200)	(0.0131)
GFC	-0.0041	-0.0045	-0.0284	-0.0186	0.0020	0.0006	-0.0006	-0.0009	-0.0236	-0.0089	0.0072	0.0029
	(0.0086)	(0.0085)	(0.0194)	(0.0182)	(0.0093)	(0.0094)	(0.0085)	(0.0084)	(0.0200)	(0.0203)	(0.0092)	(0.0091)
EO_1	-0.0616***						-0.0663***					
	(0.0210)						(0.0254)					
DIVCHANGE X EO_1	0.1265						0.1567					
	(0.0988)						(0.1195)					
EO_2		-0.0561***						-0.0628***				
		(0.0180)						(0.0205)				
DIVCHANGE X EO_2		0.1569*						0.1784*				
		(0.0852)						(0.0973)				
EO_{1+}			-0.0630**						-0.0700**			
			(0.0285)						(0.0347)			
DIVCHANGE X EO_{1+}			0.1792						0.2311			
			(0.1361)						(0.1713)			
EO_{2+}				-0.0654**						-0.0541		
				(0.0332)						(0.0394)		
DIVCHANGE X EO_{2+}				0.1403						0.1064		
				(0.1788)						(0.2110)		
EO_{1-}					0.0480						0.0717**	
					(0.0306)						(0.0358)	
DIVCHANGE X EO_{1-}					-0.0924						-0.0808	
					(0.1566)						(0.1743)	
EO_{2-}						0.0184						0.0319
						(0.0229)						(0.0260)
DIVCHANGE X EO_{2-}						-0.1869*						-0.2321**
						(0.0957)						(0.1074)
Constant	0.0032	0.0020	0.0377	0.0545	-0.0193	-0.0233	0.0261	0.0246	0.0965*	0.1123*	-0.0046	-0.0098
	(0.0270)	(0.0271)	(0.0531)	(0.0558)	(0.0322)	(0.0332)	(0.0313)	(0.0315)	(0.0544)	(0.0617)	(0.0384)	(0.0397)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,090	1,089	262	337	828	752	1,090	1,089	262	337	828	752
R-squared	0.0197	0.0192	0.1350	0.0784	0.0154	0.0306	0.0192	0.0198	0.0799	0.0716	0.0233	0.0343

The table reports the regressions of the determinants of cumulative abnormal returns in response to increasing dividend announcements for all banks from 2000 to 2018. *DIVCHANGE* is the percentage change in the dividend payment of one quarter compared to the dividend payment in the previous quarter. *GFC* is a dummy variable that equals to 1 for the period of the Global Financial Crisis, 2007 Q4 to 2009 Q2. EO_1 is the measure of bank opacity, defined as the absolute value of the residual obtained from Equation 4.4. EO_{1+} is the measure of bank opacity, defined as the positive signed value of the residual obtained from Equation 4.4. EO_{1-} is the measure of bank opacity, defined as the negative signed value of the residual obtained from Equation 4.4. EO_2 is the measure of bank opacity, defined as the absolute value of the residual obtained from Equation 4.5. EO_{2+} is the measure of bank opacity, defined as the positive signed value of the residual obtained from Equation 4.5. EO_{2-} is the measure of bank opacity, defined as the negative signed value of the residual obtained from Equation 4.5. Quarter fixed effects are included in all regressions and robust standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 4.15: Bank opacity and cumulative abnormal returns in response to decreasing dividend announcements

	CAR(-2;+2)						*CAR(-3;+3)*					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
DIVCHANGE	0.0534	0.0574*	0.0815	0.1110	0.0054	-0.0652*	0.0783*	0.0873**	0.1432	0.1444*	0.0421	-0.0280
	(0.0323)	(0.0323)	(0.0934)	(0.0709)	(0.0382)	(0.0361)	(0.0426)	(0.0409)	(0.1158)	(0.0858)	(0.0491)	(0.0527)
GFC	-0.0018	-0.0011	0.0333	0.0192	-0.0455	-0.0274	-0.0159	-0.0141	0.0016	-0.0114	-0.0791***	-0.0300
	(0.0238)	(0.0234)	(0.0324)	(0.0347)	(0.0310)	(0.0306)	(0.0266)	(0.0260)	(0.0360)	(0.0381)	(0.0266)	(0.0427)
EO_1	-0.1305*						-0.0814					
	(0.0782)						(0.1009)					
DIVCHANGE X EO_1	-0.1188						-0.0980					
	(0.1368)						(0.1936)					
EO_2		-0.1620*						-0.1472				
		(0.0933)						(0.1051)				
DIVCHANGE X EO_2		-0.1785						-0.2188				
		(0.1774)						(0.2132)				
EO_{1+}			-0.1518						-0.0973			
			(0.2060)						(0.2264)			
DIVCHANGE X EO_{1+}			-0.2598						-0.1499			
			(0.4313)						(0.4783)			
EO_{2+}				-0.1391						-0.0482		
				(0.2071)						(0.1937)		
DIVCHANGE X EO_{2+}				-0.2749						-0.1084		
				(0.4428)						(0.4157)		
EO_{1-}					-0.1741**						-0.2103**	
					(0.0810)						(0.1001)	
DIVCHANGE X EO_{1-}					-0.1588						0.2854	
					(0.2701)						(0.3671)	
EO_{2-}						-0.1637**						-0.0692
						(0.0755)						(0.1125)
DIVCHANGE X EO_{2-}						-0.8028***						-0.3369
						(0.2660)						(0.4354)
Constant	0.0639	0.0807	0.2343	0.1712	-0.1954*	-0.0036	-0.0331	-0.0176	0.1323	0.0901	-0.3247**	-0.2528
	(0.1299)	(0.1262)	(0.2559)	(0.2078)	(0.1088)	(0.1212)	(0.1560)	(0.1532)	(0.3154)	(0.2385)	(0.1500)	(0.1987)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	178	178	86	90	92	88	178	178	86	90	92	88
R-squared	0.1694	0.1754	0.2414	0.2414	0.4764	0.4444	0.1497	0.1575	0.2498	0.3096	0.3542	0.3142

The table reports the regressions of the determinants of cumulative abnormal returns in response to decreasing dividend announcements for all banks from 2000 to 2018. *DIVCHANGE* is the percentage change in the dividend payment of one quarter compared to the dividend payment in the previous quarter. *GFC* is a dummy variable that equals to 1 for the period of the Global Financial Crisis, 2007 Q4 to 2009 Q2. EO_1 is the measure of bank opacity, defined as the absolute value of the residual obtained from Equation 4.4. EO_{1+} is the measure of bank opacity, defined as the positive signed value of the residual obtained from Equation 4.4. EO_{1-} is the measure of bank opacity, defined as the negative signed value of the residual obtained from Equation 4.4. EO_2 is the measure of bank opacity, defined as the absolute value of the residual obtained from Equation 4.5. EO_{2+} is the measure of bank opacity, defined as the positive signed value of the residual obtained from Equation 4.5. EO_{2-} is the measure of bank opacity, defined as the negative signed value of the residual obtained from Equation 4.5. Quarter fixed effects are included in all regressions and robust standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

4.5 Concluding remarks

The general consensus regarding the signalling effects of dividends in the literature suggests that the market views dividend announcements as an indication of the firms' future prospects and therefore stock prices move in the same direction as payout changes. This chapter examines the stock price reactions to dividend change announcements of U.S. firms for the recent period of 2000 to 2018. Consistent with prior literature, we find that increasing (decreasing) payout announcements are associated with positive (negative) cumulative abnormal stock returns. The findings are consistent with the notion that the market forms some expectations about the firms' future performance based on the information content of payout changes and reacts accordingly. Our results, therefore, provide support for the dividend signalling hypothesis. Furthermore, financial firms and banks are reported to have lower average cumulative abnormal returns around positive dividend change announcements as compared to non-financial firms. The differences in stock price reactions between firm types are not observed around dividend reduction announcements. Nonetheless, banks are documented to have, on average, higher abnormal returns than non-financial firms around unchanged dividend announcement events, especially during the Financial Crisis period when stable payout announcements might be interpreted as good news.

Conducting a firm-level panel regression to examine the determinants of cumulative abnormal returns around the announcement date, this study documents a positive significant impact of dividend change on abnormal stock returns regardless of positive or negative payout news. The effects appear to be stronger for financial and banking firms than for non-financial firms only when the change in dividend is positive, indicating that the signalling motive might be more important for banks than for non-financial firms due to the opacity of banks' assets (Floyd et al. 2015). The reactions of stock prices of financials and banking firms to payout announcements appear to be intensified during the 2007–2009 Financial Crisis when dividend changes are positive. The results imply that such signalling motive becomes particularly more relevant in times of greater uncertainty and intense informational asymmetry when it is important to reassure the market of the firm's financial strength than in normal times. Overall, our results suggest that investors

can exploit significant abnormal returns around firms' dividend announcement events. Finally, as bank earnings opacity exacerbates the information asymmetries in the market, this study shows that the market tends to respond to banks' dividend announcements to a lesser extent as banks become more opaque and understate their earnings and react more when banks overstate their earnings. The findings of this study have important implications for regulatory authorities who are concerned with promoting the transparency, monitoring of bank behaviours, and enhancing market discipline.

Chapter 5

Concluding remarks

Following the 2008 Financial Crisis, The Federal Reserve, concerned with bank capital levels and their ability to absorb losses, believed that tightening capital standards will maintain financial stability and minimise the likelihood of bank distress even under adverse economic conditions. Therefore, by conducting annual regulatory stress testing exercises, the authorities could restore and promote the resilience of the banking system without resorting to costly bailouts and other forms of interventions. The first chapter of this study looks into the unintended impacts of U.S. regulatory stress testing from 2009 to 2016 on bank liquidity creation. Employing the Regression Discontinuity Design (RDD), the study provides evidence that regulatory stress tests may lead to a reduction in bank liquidity creation both on and off the balance sheet. As the banks enter the stress tests, banks manage their risk exposures by cutting down the asset-side component of liquidity creation, to avoid failing the stress tests. Furthermore, the study reports an increase in the liability-side liquidity creation, driven by more customer deposit funding. A number of robustness checks are performed. First, the parallel trends test for the differences in the liquidity creation growth rate of stress test banks vis-à-vis non-stress test banks in the quarters prior to the stress tests is conducted. Second, the study presents the estimates of regression discontinuity under the local randomization inference, which is based on a 'stronger' alternative identification assumption. Third, alternative cutoff values as the criterion for BHCs to be included in the stress tests are employed. Fourth, BHCs with foreign parents and those with total assets exceeding $10 billion are included in the sample. The empirical results

remain robust to these additional checks. Overall, the findings of the chapter suggest that there might be a trade-off between the positive effects of stress tests, in terms of enhanced long-term financial stability, and the temporary negative effects on liquidity creation. This finding is important because Berger & Sedunov (2017) find that there is a positive relation between bank liquidity creation and real economic output. To the extent that liquidity creation is an important bank output which contributes to economic growth, it is important for policymakers and bank regulators to consider the unintended effects of stress tests on economic activity.

Liquidity shocks are believed to be among the key factors leading to the 2008 financial turmoil and especially its rapid expansion, stressing on the importance of liquidity regulations. The second empirical chapter in this thesis begins with examining the impacts of liquidity measures on bank interest margins and proceeds further by investigating the role of market power in the relationship between liquidity and bank interest margins, providing new insights for bank supervision and regulation. In addition to the conventional liquidity measure, this study employs the Basel III's Liquidity Coverage Ratio (LCR) and the Net Stable Funding Ratio (NSFR) and documents their positive impacts on the net interest margins of a sample of U.S. banks from 2001 to 2018. Furthermore, this study examines how market power affects banks' valuation of liquidity and shows that dominant banks with more pricing power incorporate the costs associated with investing in liquidity into the bank margins to a lesser extent relative to other banks with less market power. The findings suggest that the cost of complying with regulatory liquidity standards is reduced when the competition in the banking sector is less intense. Further investigation reveals that the role of market power in affecting banks' valuation of liquidity appears to be more important for small banks than for large banks. The study performs a number of robustness checks including using an alternative measure of interest margins, employing the funding-adjusted Lerner index as a proxy of market power and the System Generalized Methods of Moments (SGMM) to tackle the possible endogeneity problem that might arise in the estimations. The findings remain robust to all these tests. In terms of policy implications, Acharya & Viswanathan (2011) highlight that in

competitive banking markets, the higher opportunity costs associated with holding low-yielding liquid assets adversely affect bank wealth creation. This suggests that although investment in liquidity assets reduces the likelihood of bank failure due to sudden liquidity shortage, it comes with a cost that should be incorporated into bank interest margins. The current study supports this view. Regulators, therefore, should consider the resilience-efficiency trade-off in the banking system when designing liquidity standards such as the NSFR and LCR. Furthermore, as the cost of liquidity that is taken into account in interest margins can be reduced when the competition in the banking sector is less intense, this study highlights that market competition might be important in the design of bank liquidity management frameworks, and regulators might not take the 'one size fits all' approach to the implementation of bank liquidity requirements.

The past few decades have witnessed significant transformations of the financial markets brought about by improved information technology, far-reaching economic changes and increased scrutiny of financial supervisions and regulations. The last chapter of this thesis focuses on the signalling effects of dividend announcements for a sample of U.S. firms during the recent period from 2000 to 2018. Using an event-study methodology, the study illustrates that increasing (decreasing) payout announcements are associated with positive (negative) cumulative abnormal stock returns. Banks are documented to have, on average, higher abnormal returns than non-financial firms around unchanged dividend announcement events. In support of the notion that signalling motive might be more important for banks than for non-financial firms due to the opacity of banks' assets (Floyd et al. 2015), the study finds that the effects of dividend changes on stock prices reactions are stronger for financial and banking firms than for non-financial firms when the change in dividend is positive. The study also reveals that the reactions of stock prices of financials and banking firms to payout announcements appear to be intensified during the 2008 Financial Crisis when dividend changes are positive, indicating that the importance of such signalling motive in times of high uncertainty and severe informational asymmetry than in normal times. The findings suggest that investors can exploit significant abnormal returns around firms' dividend announcement events. Finally, this study shows that the market tends to respond to banks'

dividend announcements to a lesser extent as banks become more opaque and understate their earnings and react more when banks overstate their earnings. The investigation on the effect of bank earnings opacity on the extent to which the markets respond to banks' payout announcements is important. This is because bank earnings opacity reflects the discretion of banks' managers to manipulate their financial statements, which hinders the ability of the outsiders to accurately assess the banks' risk and value (Danisewicz et al. 2020). As a consequence, the information asymmetries in the markets are exacerbated, and market discipline is impeded. Therefore, the findings of this study have important implications for regulatory authorities who are concerned with the transparency and monitoring of bank behaviours.

Several limitations are worth noting in this thesis. First, while the first chapter documents some unintended consequences of Federal Reserve stress tests on U.S. bank liquidity creation, we acknowledge that it is difficult to precisely gauge the impact of Federal Reserve stress tests on U.S. bank liquidity creation because so many government intervention programs, regulatory/policy actions, and financial market events occurred around the same time. Future research could attempt to quantify the effects of size-based regulatory thresholds introduced by the Dodd-Frank Act in 2010 or the unconventional monetary policies (quantitative easing) on bank liquidity creation. Moreover, as bank liquidity creation has been shown to be positively related to real economic output, more research is needed to examine the impact of stress tests on the real economy. Second, while the second chapter suggests that market power affects the extent to which banks determine their interest margins with respect to liquidity, the underlying mechanism of such effect remains unclear. Future studies could attempt to understand how banks might take advantage of their market power to alter their loan/deposit rates in the face of liquidity costs. Finally, the third chapter of this study documents some differences in the market reactions to dividend announcements of industrials, financials and banks and the effects of bank earnings opacity on the signalling power of bank dividends. However, the chapter does not consider the signalling content of share repurchases as an alternative to dividend payments. Furthermore, the chapter does not take into consideration the role of market opacity (which could be proxied

by a variety of market micro-structure characteristics) in the extent to which the markets react to firms' dividend announcements. We leave these issues for future research.

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