MICHIGAN
ROSS SCHOOL OF BUSINESS

## Working Paper

# Bank Competition: Measurement, Decision-Making and Risk Profiles

Robert M. Bushman
Kenan-Flager Business School
University of North Carolina – Chapel Hill

Bradley E. Hendricks
Stephen M. Ross School of Business
University of Michigan

Christopher D. Williams
Stephen M. Ross School of Business
University of Michigan

Ross School of Business Working Paper
Working Paper No. 1243
January 2015

# Bank Competition: Measurement, Decision-Making and Risk Profiles

Robert M. Bushman
Kenan-Flagler Business School
University of North Carolina-Chapel Hill

Bradley E. Hendricks
Ross School of Business
University of Michigan

Christopher D. Williams
Ross School of Business
University of Michigan

First draft: February 2013
This draft: January 2015

* We thank Christian Leuz, Michael Minnis, Stephen Ryan, Derrald Stice, Larry Wall, Jieyang Zhang (discussant), and workshop participants at Carnegie Mellon, Duke/UNC Fall Camp, Georgetown University, National University of Singapore, New York University, HKUST Accounting Symposium, London Business School Accounting Symposium, MIT Sloan, Northwestern University, Seoul National University, Singapore Management University SOAR Accounting Conference, University of Chicago and University of Toronto for helpful comments. We thank Feng Li for help in computing the competition metric. Bushman thanks Kenan-Flagler Business School, University of North Carolina at Chapel Hill. Hendricks thanks the Paton Accounting Fellowship and the Deloitte Foundation Doctoral Fellowship and Williams thanks the PriceWaterhouseCoopers – Norm Auerbach Faculty Fellowship for financial support.

# Bank Competition: Measurement, Decision-Making and Risk Profiles

This paper investigates how competition impacts the *future* operating decisions and risk profile of banks. We construct a comprehensive, time-varying, bank-specific measure of a bank's competitive environment (*BCE*) using textual analysis of banks' 10-K filings. Using U.S. branch banking deregulation to capture exogenous changes in threats of entry, we provide evidence that *BCE* is a timely measure of real competitive pressures by showing that it significantly increases following decreases in barriers to entry. Measuring competition with *BCE*, we find that higher competition is associated with lower underwriting standards, less timely loan loss recognition and a shift towards non-interest revenue. Further, we find that higher competition is associated with higher stand-alone risk of individual banks, greater sensitivity of a bank's downside equity risk to system-wide distress, and a greater contribution by individual banks to downside risk of the banking sector. We then show that these results using *BCE* are largely robust to replacing *BCE* with branch bank deregulation. Finally, we show that our *BCE* results hold in a post-deregulation analysis restricted to time periods following the final deregulation event in each state. These results combine to suggest that competition increases the risk profile of banks and that BCE can be of value to researchers and analysts for measuring competitive pressure at any point in time, regardless of the existence of a regulatory event.

## 1. Introduction

The centrality of banks in the financial system and the potential for bank failures to impose negative externalities on the economy raise concerns about the relationship between bank competition and both excessive risk-taking by individual banks and buildups of banking system vulnerabilities due to correlations in risk taking behavior across banks. This issue is not only important to bank regulators and policy makers, but also to financial analysts, credit rating agencies and investors who seek to forecast banks' future prospects. Economic theory provides competing hypotheses on whether bank competition enhances or undermines financial stability. The competition-fragility hypothesis posits that downward pressure on bank profits from intense competition creates incentives for banks to take excessive risks (e.g., Keeley [1990], Allen and Gale [2000, chapter 8]). In contrast, the competition-stability hypothesis posits that the interest rates banks charge borrowers increase with banks' market power, where higher rates induce borrowing firms to take on greater risk which increase the risk of banks' portfolios. This leads to the hypothesis that banks become less risky as competition increases (Boyd and De Nicolo [2005]). While prior empirical literature explores these hypotheses, the evidence is inconclusive on whether or not competition leads to greater bank risk.[1]

In this paper, we address three important open questions in the banking literature: How should bank competition be measured? What specific channels does bank competition operate through to increase or decrease risk? Does bank competition increase or decrease individual bank and banking system risk? We make several contributions to the existing literature.

First, we construct a comprehensive, time-varying, bank-specific measure of a bank's competitive environment (*BCE*) using textual analysis of banks' 10-K filings. We validate this

[1] See reviews by Beck (2008), Carletti (2008), Degryse and Ongena (2008), and the discussion in Berger et al. (2004).

measure using U.S. branch banking deregulation to capture exogenous changes in the threat of entry, providing evidence consistent with *BCE* capturing changes in the real competitive environment of specific banks in a more timely fashion than classical competition measures. Second, we investigate how competition influences three key decision-making channels that prior literature links to increased bank risk. We find that higher competition is associated with lower underwriting standards, less timely accounting recognition of expected loan losses, and a greater reliance on non-interest sources of income.[2] Finally, we show that risk at the individual bank level and a bank's contribution to system-wide risk are increasing in competition. Specifically, we find that competition is associated with significantly higher risk of individual banks suffering severe drops in their equity and asset values. At the system level, we find that higher competition is associated with significantly higher co-dependence between downside risk of individual banks and downside risk of the entire banking sector.

Why is there potential value in creating a text-based measure of competition from banks' 10-K filings? As noted by Beck [2008] there is no agreement in the banking literature about how to measure competition as different measures can lead to conflicting results. Two important classes of bank competition measures are (1) measures of industry structure which presume that market structure determines bank conduct, and (2) market power measures that infer competitive conduct without regard to market structure (e.g., Degryse and Ongena [2008], Beck [2008]), Berger et al. [2004]. One limitation of industry structure measures (e.g., Herfindahl Hirschman indices) is that they require industry membership to be explicitly defined, which makes it difficult to capture competition deriving from potential entrants and non-banks. These measures

[2] We also perform a channel attenuation analysis (Baron and Kenny, 1986) and provide evidence that a significant portion (~20%) of the association between competition and measures of systemic risk work through both the accounting channel (i.e., timely loss recognition) and the operating channel (i.e., revenue mix).

also rely on the restrictive assumption that all industry members are continuously subject to identical levels of competition.[3] In contrast, measures of market power estimate competition by examining relationships between factor input prices and revenues. An important example is the Lerner index, a bank-specific measure designed to estimate the gap between marginal costs and revenues.[4] Its construction requires researchers to estimate parameters of the marginal cost function using historical accounting data in a pooled industry regression. Reliance on historical accounting data suggests that the Lerner index may be sluggish in capturing changes in the competitive environment, and the pooled industry estimation necessarily assumes that all banks in the researcher-defined industry have identical marginal cost functions.

The textual analysis approach we take to extract a bank-specific measure of competition from 10-K filings builds directly on Li et al. [2013]. The premise of this measure, *BCE*, is that it captures managers' current perceptions of the competitive pressures facing a bank from any and all sources, including potential entrants and non-bank competitors, and can capture evolving competitive pressures that are not yet fully reflected in a bank's past performance. This measure allows for competitive pressure to vary both across banks in a given year, and across years for any given bank due, for example, to differences in geographic footprints (Dick [2006]), business models (Altunbas et al. [2011]) or product line mixes (Bolt and Humphrey [2012]).[5] Further, this measure requires no equilibrium assumptions, no requirements that market boundaries be defined, and no restrictive assumptions about bank cost functions.

---

3 Further, it is not clear whether industry structure determines bank behavior or is itself the result of bank performance (e.g., Claessens and Laeven [2004], Cetorelli [1999], Berger et al. [2004

4 While we focus on the Lerner index, another measure of market power is the Panzar-Rosse H-statistic (e.g., Claessens and Laeven [2004]; Bikker et al. [2012]). In contrast to the Lerner index, the H-statistic is difficult to estimate at the individual bank level and is typically estimated at the industry level.

5 This measure need not be symmetric across banks. For example, consider a bank holding company with branches in many geographically dispersed markets and a small bank operating in one local market. While the small bank may report facing intense competition, its single market is a small part of the large bank's geographic scope and may have little influence on perceptions of competition from the overall bank holding company's perspective.

Li et al. [2013] make a strong case for the validity of this text-based measure for non-financial firms by showing: 1) that it correlates to some extent with other common competition measures, and 2) that firm profitability more severely mean reverts for firms with higher values of the measure. While we obtain similar results in the banking industry, we are able to significantly extend the validation process by exploiting several salient opportunities unique to banking. First and foremost is our ability to exploit branch bank deregulation in the United States to capture exogenous changes in the threat of entry into a state's banking market.[6] We show that *BCE* significantly increases following reductions in barriers to out-of-state branching. This result holds *after* controlling for both the Lerner and Herfindahl indices. We also find that while the Lerner index is correlated with our *BCE* measure it does not respond to changes in entry threats, suggesting that our measure reflects changes in the competitive environment in a more timely fashion than the Lerner index.[7]

As additional validation, we exploit recurring surveys conducted by the Office of the Comptroller of the Currency and the Federal Reserve in which banks regularly report that changes in competition are the most prevalent reason for easing underwriting standards.[8] We examine associations between *BCE* and characteristics of subsequent syndicated loan deals for which the bank serves as lead arranger. We find that as competition increases, credit quality of borrowers at loan origination decreases, loan interest spreads become less sensitive to borrowers'

---

[6] Specifically, we identify changes in threat of entry based on interstate variation in the timing and extent of adoption by states of the Interstate Banking and Branching Efficiency Act (IBBEA) using a deregulation index developed by Rice and Strahan [2010]. See section 2 for additional details.

[7] We do not examine the response of bank concentration to deregulation as Dick [2006] already shows that IBBEA had little impact on concentration at the metropolitan statistical area level, while increasing at the regional level.

[8] For example, the 2012 Survey of Credit Underwriting Practices conducted by the Office of the Comptroller of the Currency (OCC) indicates that competition is the most prevalent reason that lenders ease their underwriting standards (Refer to Figures 3 and 4 of the survey at: http://www.occ.treas.gov/publications/publications-by-type/survey-credit-underwriting-practices-report/pub-survey-cred-under-2012.pdf).

credit quality, and the number of covenants decreases. These findings are consistent with the regulatory surveys and provide additional evidence that *BCE* captures real competitive pressure.

Moving beyond measure validation, we examine two key decision-making channels through which competition can influence bank stability. First, we examine the association between *BCE* and loan loss provisioning. Competitive pressure on profits can create incentives for managers to prop up reported earnings by delaying recognition of expected loan losses. Prior research suggests that delaying expected loss recognition can have negative implications for credit supply (Beatty and Liao [2011]), risk shifting (Bushman and Williams [2012]), and the vulnerability of banks and the banking system to downside risk (Bushman and Williams [2014]). Consistent with banks managing earnings upward in response to competitive pressure, we find that the extent to which a bank delays recognition of expected loan losses is increasing in *BCE*.

Second, we examine the association between *BCE* and a bank's decisions to shift its revenue mix towards non-interest sources (e.g., investment banking, proprietary trading, insurance underwriting, etc.). A growing literature provides evidence that expanding into such non-traditional banking activities increases the riskiness of individual banks and decreases the stability of the banking system.[9] We extend this literature by showing that the proportion of revenues a bank derives from non-interest sources is significantly increasing in *BCE*.

Given our findings that banks relax lending standards, delay recognition of expected loan losses and shift revenue mix in response to higher competition, prior research would predict an increase in a bank's risk profile (e.g., Bushman and Williams, 2014; Brunnermeir et al., 2012). However, it is possible that banks counteract increases in risk through these channels by engaging in offsetting risk mitigation activities. A bank has multiple levers available to mitigate

---

[9] We discuss this literature in section 3.2 of the paper.

risk, but a primary lever is a bank's capital buffer. Banking theory does not provide clear guidance on this issue and empirical studies provide conflicting results concerning the relation between competition and bank capital (see section 3.3). We examine the association between competition and Tier 1 capital finding that bank capital decreases as competition increases.

Building on our previous analyses of relations between competition and bank decisions we next examine the ultimate effect of these decisions on direct measures of individual bank risk and systemic risk. We first investigate whether increased competition impacts future loan performance. Our previous result that higher competition is associated with reduced lending standards raises the possibility that future loan performance is negatively associated with competition. Consistent with this, we find that the loan growth of banks facing higher competition is associated with higher future loan charge-offs relative to banks facing lower competition.

Next, we find that an individual bank's risk of suffering a severe drop in equity and asset values is increasing in *BCE*. At the banking system level, we focus on codependence in downside risk of changes in both banks' equity and asset values using codependence measures developed by Adrian and Brunnermeier [2011] and Acharya et al. [2010].[10] We find evidence suggesting that banks reporting higher values of *BCE* contribute more to the tail risk of the financial system and have increased exposure to downside equity risk during times of system-wide distress. While these results combine to suggest that competition has overall negative implications for individual bank risk and banking system stability, we acknowledge that we

[10] Competition can increase system-wide fragility by influencing many banks to herd in their decision-making, simultaneously choosing to increase risk by, for example, delaying expected loss recognition, pursuing similar sources of non-interest revenue and easing credit standards.

cannot speak to the overall welfare effects of competition as there are potentially significant positive benefits of competition that we do not address in this paper.

Finally, we break our analyses into two parts, a deregulation and post-deregulation analysis. For the deregulation analyses, we truncate the sample to end after the final deregulation event in the sample and run our analyses using the branch bank deregulation index to measure competition. The post-deregulation analyses measure competition with *BCE* and only include observations subsequent to the last deregulation event in a state. We find that our main results largely hold in both the deregulation and post-deregulation analyses.[11] The fact that we largely replicate our main *BCE* results using the deregulation index supports our claim that our *BCE* results reflect an actual linkage between competition and future decisions and risk. The fact that the post-deregulation analyses using *BCE* replicate the results from both our overall *BCE* and deregulation analyses suggests that *BCE* can be of value to researchers, investors, and analysts seeking to measure competitive pressure at any point in time, regardless of a regulatory event.

The remainder of the paper proceeds as follows. Section 2 describes the construction of our text-based measure of competition and discusses our validation tests of the measure. Section 3 presents our analyses of the relations between competition and banks' accounting decisions and revenue mix choices, and section 4 presents our analyses of connections between competition and bank stability. Section 5 concludes.

[11] Data limitations preclude us from running deregulation analysis for the loan contracting variables as Dealscan is too thinly populated during the years when many of the deregulation events occurred.

## 2. A Text-based Measure of a Bank's Competitive Environment (BCE)

In section 2.1 we detail the construction and interpretation of *BCE.* We then perform two substantive validation exercises. Section 2.2 examines how *BCE* responds to branch banking deregulation, while section 2.3 examines relations between *BCE* and underwriting standards.

### *2.1 Construction and Interpretation of BCE*

#### *2.1.1 Construction of BCE*

A growing literature in accounting and finance provides evidence that valuable information can be extracted from published financial reports by applying textual analysis techniques to the text of these reports (e.g., Ball et al. [2013], Brown and Tucker [2011], and Li [2010, a and b]). To construct *BCE* from a bank's discussion of its competitive situation in its 10-K filing, we follow the two-step algorithm developed by Li et al. [2013] in their analysis of competition in non-banking industries.[12] First, we count the number of occurrences of the words "competition, competitor, competitive, compete, competing," including those words with an "s" appended. Second, we remove all cases where the competition words included in *BCE* are preceded by "not", "less", "few", or "limited" by three or fewer words. This second step is included to increase power and reduce attenuation bias in parameter estimates resulting from false-positives.

The second step of the *BCE* algorithm most certainly does not remove every false-positive. While we could construct additional versions of the *BCE* measure by altering the Li et al. [2013] algorithm, there is no obvious way to compare alternative measures as to their "accuracy" in capturing the competition construct. We envision our contributions to the textual analysis literature as extending Li et al. [2013] by exploiting branch banking deregulation and

[12] We thank Feng Li for helping us implement the textual analysis of banks' 10-Ks.

other unique features of the banking setting to perform new, discriminating validation tests of *BCE*. Further, as we show below, the current construction is shown to have considerable power for predicting bank behavior and risk. We could also employ more sophisticated computational linguistic tools designed to capture meaning. However, as noted by Li et al. [2013], capturing the notion of competition in a more structured way would require much more detailed assumptions about the exact nature of competition, and the context and linguistic structure of the references to competition. On this point, Loughran and McDonald [2014] state that they "have not found more sophisticated techniques to add value", and thus continue to tabulate words rather than use these more sophisticated techniques.[13]

Given the count nature of our metric, we control for the length of the 10-K by scaling by the total number of words in each bank's 10-K, resulting in the following bank-year measure of a bank's competitive environment (*BCE*):

$$BCE = \frac{\#CompWords}{\#TotalWords},$$

where *#CompWords* is the number of occurrences of competition words found in the bank's 10-K and *#TotalWords* is the total number of words in the bank's 10-K. *BCE* is computed on an annual basis for each bank. Accordingly, we use quarterly data and apply our annual *BCE* measure to the four subsequent quarters for our primary analyses. Descriptive statistics for *BCE*

[13] Loughran and McDonald (2014) also highlight two conditions that researchers can use to improve the construct validity of their textual analysis measures. Specifically, they indicate that: 1) researchers should avoid wordlists and algorithms derived in the context of other disciplines and 2) use textual analysis to test hypotheses based on straightforward characteristics of the data that "require the least amount of econometric exorcism to produce the results". *BCE* meets both of these conditions as it is: 1) specifically designed for the purpose of performing accounting research (Li et al., 2013), and 2) designed to capture a straightforward characteristic (competition) that is required to be disclosed as part of each bank's 10-K filing.

and the other measures in our paper are provided in Table 1. *BCE* has a mean (median) value of 0.35 (0.31) and exhibits significant variation with standard deviation of 0.26. [14]

### *2.1.2 What is BCE Designed to Capture?*

Our use of 10-K reports to construct *BCE* is designed to capture perceptions of competition from the perspective of top management of the overall holding company or banking organization. The banking businesses of the publicly traded banks in our sample span a range of different business models and numerous geographic locations including within the state where they are headquartered, across state lines and even internationally for the larger banks. Further, competition is a multi-dimensional construct consistent, for example, with Michael Porter's framework in which competition consists of five forces, with threat of entry representing one of the five (Porter [2008]). We posit that *BCE* encapsulates in a single metric bank managers' overall perceptions of the intensity of competitive pressures deriving from any and all sources. To mitigate concerns that banks may use boilerplate language in the 10-K we incorporate bank and time fixed effects in all of our regression analysis. Including bank fixed effects is also consistent with a financial statement analysis perspective that seeks to exploit within firm variation fundamental to predict future decisions of individual banks.

It is also important to consider the relationship between competition and bank profitability. The competition construct, at a fundamental level, encompasses the idea that more intense behavior from new and existing rivals diminishes a firm's ability to earn profits. As a result, it is quite possible that a bank currently perceiving an increase in competitive pressure is also currently experiencing downward pressure on profits. To the extent that this is the case,

[14] In the online appendix, Table A1 we provide additional descriptive analyses of the impact that each competition word has on the *BCE* measure. This discussion is intended to: 1) highlight how the *BCE* measure was created to minimize the imprecision associated with our use of textual analysis; and 2) be transparent about the construction of the *BCE* variable.

*BCE* and poor performance could be manifestations of the same underlying shift in competitive forces. If current performance captures all information about a shift in competition, then *BCE* at time t would likely not load in our regressions if we also include *ROA* at time t. Another possibility is that *BCE* does not reflect competition but is rather an attempt by bank managers to strategically use their reporting discretion to blame a bank's poor performance on competition. As a result, where appropriate, we control for *ROA* at time t (contemporaneous with our *BCE* measure). This allows us to determine if *BCE* has incremental information about future decision making and risk over and above current performance, and to mitigate concerns about strategic reporting in the 10-K. In this sense we are able to distinguish *BCE* from current profitability.

Using a simple word count algorithm to capture a complex economic construct such as competition confronts us with the challenge of convincing the reader that the measure actually reflects the intended construct. Li et al. (2013) makes a strong case for the validity of this measure in a non-bank setting by showing that it correlates with other common competition measures, and via their main result that firm profitability more severely mean reverts for firms with higher values of the text-based measure. While we obtain similar results when we perform these same validation exercises in the banking setting, in sections 2.2 and 2.3 we significantly extend the validation process by exploiting several salient opportunities unique to banking.[15]

### *2.2. Validating BCE using branch banking deregulation*

In an effort to validate *BCE* as a timely measure of real competitive pressures we examine whether it significantly increases following exogenous increases in one important dimension of bank competition, the threat of entry. We identify changes in the threat of entry based on interstate variation in both the timing and extent of adoption by state legislatures of the

[15] In the online appendix, we show that competition increases the mean reversion intensity of bank profitability (Table A3).

Interstate Banking and Branching Efficiency Act (IBBEA). Passed in 1994, the most crucial provisions of the IBBEA pertained to interstate branch banking. These provisions were designed to allow banks and bank holding companies to acquire out-of-state banks and convert them into branches of the acquiring bank, or to open de novo branches across state borders.

However, while IBBEA eliminated federal restrictions on interstate branching, states were permitted to restrict interstate branching. Specifically, states were free to impose up to four restrictions on interstate branching: requiring a minimum age of three years or more on target institutions, setting a statewide deposit concentration limit of 30%, forbidding *de novo* interstate branching, and prohibiting the acquisition of single branches by out-of-state banks. Prior research shows that these restrictions are significantly associated with the threat of entry by out-of-state banks (e.g., Johnson and Rice [2008]}.

We use the annual state-level index of these four restrictions on interstate branching from 1994 to 2005 created by Rice and Strahan (2010). The index, denoted *RegIndex*, is zero for states without entry restrictions (greatest threat of entry) and increases by one for each of the four restrictions up to a maximum of four (the least threat of entry). We gather quarterly data primarily from Y9-C filings, Compustat, Dealscan and CRSP. Our sample is limited to all bank-quarter observations of commercial banks and bank holding companies (two digit SIC 60-62) that have all the necessary data components. We eliminate observations if the bank was involved in an acquisition during that particular quarter. The time period of our data spans 1996-2010.

Table 2, panel A reports results from OLS regressions of *BCE* on *RegIndex* and control variables, all measured contemporaneously. Recall that *RegIndex* is the number of restrictions on interstate branching, where fewer restrictions imply greater competition. We include two control variables that reflect a state's economic performance, the unemployment rate and the leading index for the state.[16] We also include bank and year fixed effects. From panel A, column one, we see that *BCE* responds to changes in the threat of entry as captured by changes in the restriction index. The coefficient on *RegIndex* is -0.007, and is significantly different from zero (p-value $< 0.05$). This result shows that a reduction in *RegIndex* (an increase in threat of entry) is associated with an increase in a bank's *BCE*. That is, the extent to which banks discuss their competitive environment in 10-K filings significantly increases following a reduction in barriers to out-of-state branching.

In column two of table 2, panel A (entitled *BCE and Geographic Footprint*), we repeat the prior analysis after taking into account that banks may have operations across a number of states. Because *BCE* is extracted from the 10-K report, it reflects a comprehensive view of competition across all of the geographic regions in which the bank operates. We identify the states where a bank has deposits using the Summary of Deposits report from the FDIC, and weight *RegIndex* and other state-level variables by the percentage of the bank's deposits in those states in a given year. As shown in column 2, the results for this analysis are nearly identical to those reported in column 1.

While the previous result shows that *BCE* captures changes in the competitive environment, it does not establish whether *BCE* has incremental value as a measure of competition relative to traditional competition measures. To address this issue, we repeat the prior analysis after replacing *BCE* with a bank's Lerner index whose estimation is described in Appendix A. In panel A of table 2, column 3 (entitled *LI*) we see that the Lerner index does not

[16] The source of these variables is the Philadelphia Federal Reserve Bank's web site. The leading index for each state predicts the six-month growth rate of the state's coincident index, where the coincident index combines four state-level indicators to summarize current economic conditions in a single statistic. The four state-level indicators are nonfarm payroll employment, average hours worked in manufacturing, the unemployment rate, and wage and salary disbursements deflated by the consumer price index.

respond to changes in *RegIndex*. This result does not speak to the validity of the Lerner index as a measure of competition, but does provide evidence that Lerner is sluggish in capturing changes in the competitive environment relative to the more timely *BCE* measure.[17]

To further address this issue, we perform a two-stage regression analysis to investigate whether *BCE* reflects information incremental to that captured by Lerner and state-level Herfindahl Hirschman indices (*HH*).[18] In the first-stage, we estimate an OLS regression of *BCE* on the Lerner and *HH* indices. As documented in column 1 of panel B, the coefficient on Lerner is -0.74 (p-value $< 0.01$), while the coefficient on HH is 0.03, which is not significantly different from zero. The negative coefficient on Lerner is intuitive as larger values of Lerner imply less competition. This result shows that *BCE* and Lerner reflect some common information about a bank's competitive environment. Next, we take the *BCE* residual from the first stage and estimate an OLS regression of this residual against *RegIndex.* In column 2 of panel B, we see that the coefficient of -0.006 on *RegIndex* is significantly different from zero (p-value $< 0.05$). That is, *BCE* contains information about a bank's competitive environment that is independent of any information reflected in Lerner and *HH*.

### 2.3 *Validating BCE Using Changes in Banks' Credit Standards*

As a second validation analysis, we exploit recurring surveys conducted by the Office of the Comptroller of the Currency and the Federal Reserve. These surveys inquire about the extent to which banks have recently eased or tightened credit standards, and their reasons for doing so. Responses indicate that changes in competition are the most prevalent reason for easing their

---

[17] In the online appendix, we perform additional analyses on the timeliness of *BCE* relative to the Lerner index. We document that while the Lerner index does not respond immediately to current changes in competition, it does capture current changes in competition with a lag, where a change in regulation at time t is reflected in the Lerner index in time t+2 (Table A2).

[18] Note that our inclusion of time fixed effects controls out country-level measures of competition such as country-level Herfindahl indices and H-statistics. .

underwriting standards.[19] Accordingly, we can provide additional validation that *BCE* captures real competitive pressures by examining whether higher values of *BCE* are associated with more relaxed underwriting standards. We examine the following three underwriting standards: (1) the quality of borrowers as measured by their risk of default, (2) loan pricing sensitivity to the borrowers' level of risk, and (3) covenant restrictions.[20] In addition to validating our competition measure, this analysis provides information about an important channel that influences bank stability. In fact, Section 2080.1 of the Federal Reserve's Commercial Bank Examination Manual suggests a causal relationship between higher bank competition, lower underwriting standards, and increased bank risk. Specifically, it states: *"[s]ince lenders are subject to pressures related to productivity and competition, they may be tempted to relax prudent credit underwriting standards to remain competitive in the marketplace, thus increasing the potential for risk."*

We examine characteristics of syndicated loan deals for which the bank serves as lead arranger. This information is available in the Dealscan database. We hand match Dealscan data to lender and borrower data in Compustat and in YC-9 reports (Chava & Roberts [2008] and Murfin [2012]). Because many of our variables are measured at the loan package level, we run our analyses at that level. When measuring interest spread, we take the average spread over all facilities within a given package.[21]

---

[19] For example, the summary included in the July 2012 survey indicates that "[a]lmost all domestic banks that reported having eased standards or terms on C&I loans continued to cite more aggressive competition from other banks and nonbank lenders as a reason." The individual responses in support of this statement are tabulated as part of Question 3, Part B of the survey (http://www.federalreserve.gov/boarddocs/snloansurvey/201208/default.htm.) Also, as noted in footnote 5, the survey conducted by the OCC provides similar support for this relationship.

[20] We review every annual Survey of Credit Underwriting Practices conducted by the OCC during our sample period and find that loan pricing (e.g., the spread) is the mechanism most frequently relaxed when more lenders report having eased underwriting standards than tightening them. Covenants are indicated as the second most frequently relaxed mechanism during these periods.

[21] In untabulated results we also use the maximum spread in the package instead of the mean and results are robust.

In addition to a set of appropriate control variables, all empirical specifications in this section and throughout the remainder of our paper include both bank and time fixed effects (borrower fixed effects are also included in the syndicated loan analyses). The inclusion of bank fixed effects provides a within bank design, while time fixed effects provide important controls for time specific outcomes that impact all banks (e.g., time variation in bank sector Herfindahl Hirschman indices and H-Statistics).

***2.3.1 BCE and Borrower Risk***

We first examine whether banks make loans to riskier borrowers in response to increased competition. We compute each borrower's *Z-Score* using Altman's original weighting factors (Altman [1977]), and the borrower's estimated default frequency (*EDF*) as described by Bharath & Shumway [2008]. We also use an indicator variable, *ExtremeZ,* which is set equal to 1 if the borrower's *Z-Score* indicates that the firm is in distress at the time of loan origination.[22] We estimate the following pooled regressions, clustering standard errors by both time and bank to correct for possible time-series and cross-sectional correlation.

$$\begin{aligned} BorrowerRisk_t = {} & \beta_0 + \beta_1 BCE_t + \beta_2 Tier\,1_t + \beta_3 LenderSize_t + \beta_4 BorrowerSize_t + \\ & \beta_5 Revolver_t + \beta_6 Amount_t + \beta_7 Maturity_t + \beta_8 Spread_t + \beta_9 \#Covenants_t + \\ & BankEffects + BorrowerEffects + TimeEffects + \varepsilon_t , \end{aligned} \tag{1}$$

where *BorrowerRisk* is defined as *Z-Score, EDF* or *ExtremeZ*. *Tier 1* is included to control for differences in capital adequacy and is defined as the lead bank's Tier 1 capital prior to the date of the loan. *Lender* (*Borrower*) *Size* is the natural logarithm of total assets of the lender (borrower) prior to the date of the loan. *Revolver* is an indicator variable if the loan includes a revolver. *Amount* is the natural log of the package amount. *Maturity* is the number of months to maturity.

[22] Z-scores lower than 1.81 are considered to be in a "distress" zone whereas Z-Scores greater than 2.99 are deemed to be "safe" and Z-scores in between 1.81 and 2.99 are said to be in a "grey" zone.

*Spread* is measured as the basis points over LIBOR charged on the loan, and is computed by averaging over all loan facilities within a syndicated loan package. *#Covenants* is the number of covenants associated with the package. Finally, we use OLS (a probit model) to estimate Equation 1 when using *Z-Score* and *EDF* (*ExtremeZ*) as the dependent variable.

Table 3, panel A reports the results from the estimation of (1). Columns 1 and 2 in Table 3, panel A indicate that the riskiness of borrowers is increasing in the level of competition faced by the bank. Further, Column 3 indicates that the probability that a borrower is in financial distress at the time of loan origination is also increasing in *BCE*.[23] Thus, Column 3 provides evidence that the results from Columns 1 and 2 are not entirely driven by the bank granting credit to borrowers that are closer to crossing over the distress threshold. Rather, it provides evidence that a bank operating in more competitive environment increases it's lending to borrowers that are already below the threshold. Our results are both statistically and economically meaningful as the marginal effect of a one standard deviation change in *BCE*, holding the other variables at their mean values, is associated with nearly a 5% change in the probability that a borrower is already in distress at the time of loan origination.

### *2.3.2 BCE and Pricing Borrower Risk*

Having shown that banks issue credit to riskier borrowers when faced with increased competition, we now examine the relationship between competition and a bank's pricing of risk. In the face of competitive pressures, theory suggests that banks may reduce the sensitivity of interest spreads to borrower risk in order to maintain their lending volume (Broecker [1990]). To

[23] Because our probit model includes substantial fixed effects in a panel set, the coefficients reported are potentially biased or inconsistent (e.g., Greene [2004]). Accordingly, we also run this model using OLS and find that the signs and statistical significance of our variable of interest is robust to the use of a linear probability model.

examine this conjecture, we estimate the following OLS pooled regressions clustering the standard errors by both time and bank.

$$\begin{aligned}Spread_t = \beta_0 + \beta_1 BCE_t * BorrowerRisk_t + \beta_2 BCE_t + \beta_3 Tier1_t + \beta_4 LenderSize_t + \\ \beta_5 BorrowerRisk_t + \beta_6 BorrowerSize_t + \beta_7 Revolover_t + \beta_8 Amount_t + \\ \beta_9 Maturity_t + \beta_{10} \# Covenants_t + BankEffects + BorrowerEffects + \\ TimeEffects + \varepsilon_t,\end{aligned} \quad (2)$$

where *Spread* is measured as the basis points over LIBOR charged on the loan, averaged over all loans in a loan package. We again use three measures of the borrower's risk (*BorrowerRisk*); *Z-Score, EDF, and ExtremeZ.* All other variables are as defined earlier.

The results are included in Table 3, panel B. Consistent with higher borrower risk driving higher spreads, we find that the main effects (*Z-Score, EDF, ExtremeZ)* are all positive. Our main variable of interest is the interaction of these borrower variables with the lender's *BCE*. We find that each of these interactions is directionally consistent with our predictions and that two of the three measures (*Z-Score* and *ExtremeZ*) are statistically significant. These findings combine with those of panel A to suggest that a lender's competitive environment not only result in lending to riskier borrowers, but also that banks appear willing to receive less compensation per unit of risk when operating in increasingly competitive environments.

***2.3.3 BCE and Loan Restrictions***

Finally, we examine the relationship between *BCE* and the number of covenants. Berlin and Mester [1992] suggest that a lender's ability to monitor is increasing in the number of restrictions that it attaches to the loan. However, an increased number of restrictions may reduce the attractiveness of the arrangement from the borrower's perspective (Dell' Ariccia [2000]). Therefore, banks facing intense competition in the lending market may relax restrictions on loans in an effort to increase loan volume. We test this conjecture by estimating the following OLS pooled regression:

$$\begin{aligned}\#Covenants_t = \beta_0 + \beta_1 BCE_t + \beta_2 Tier1_t + \beta_3 LenderSize_t + \beta_4 BorrowerRisk_t + \\ \beta_5 BorrowerSize_t + \beta_6 Revolver_t + \beta_7 Amount_t + \beta_8 Maturity_t + \\ \beta_9 Spread_t + BankEffects + BorrowerEffects + TimeEffects + \varepsilon_t,\end{aligned} \tag{3}$$

where *#Covenants* is measured as the total number of financial covenants in the contract at the time of origination. All other variables in (3) are as defined previously.

Panel C of Table 3 reveals that the number of covenants attached to loans is decreasing in *BCE*. This finding is consistent with Skinner [2011] who conjectures that one potential reason that so few covenants are included in debt agreements is due to the "nature of competition in debt markets". To the extent that *#Covenants* captures how restrictive the loan terms are for the borrower, this result provides evidence that banks are willing to relax the restrictiveness of loans when facing increased competition. Results in panel C combine with the evidence provided in Panels A and B of Table 3 to show that banks relax their underwriting standards when they face high levels of competition. While prior analytical literature has modeled this relationship (e.g., Dell'Ariccia [2000], Gorton and He [2008]), and surveys have alluded to it as well, we believe that this paper provides the first large sample empirical evidence that the lender's level of competition has a significant effect on the characteristics of lending contracts.

## 3. *BCE* and Bank Decision-Making Channels

The analyses in Section 2 suggest that *BCE* captures valuable information about a bank's competitive environment. We argue that *BCE* reflects managers' assessments of the current and evolving competitive pressure they face from rival banks and non-banks. While increased rivalry will generally exert downward pressure on profitability, a central tenet of theories about relations between competition and risk is that banks respond to increased competitive pressure through their choices of borrowers, lending standards, screening and monitoring efforts, loan contract features (e.g., Wagner, 2010) and leverage (Freixas and Ma, 2014), among other channels. Such operating and investing decisions will be key contributing factors in determining both future profitability and bank risk. In this section, we explore three specific decision-making channels through which competition can work to influence bank stability. Specifically, we examine the associations between *BCE* and a bank's future loan loss provisioning decisions, revenue mix decisions as reflected by its non-interest sources of revenue, and Tier 1 capital levels.

### *3.1 BCE and Accounting Decisions*

Prior research shows that banks differ in their loan loss provisioning policies, with some banks more aggressively delaying expected losses to future periods (Beatty and Liao [2011], Bushman and Williams [2012, 2014]). Such delays provide banks with the current benefit of higher profitability at the expense of lower expected future profitability. If competition puts downward pressure on a bank's profits, a bank manager may seek to prop up the bank's reported earnings by delaying the recognition of expected loan losses. Accordingly, we conjecture that higher competition will lead bank managers to reduce the timeliness of recognizing their banks' expected loan losses.

To test this conjecture, we estimate the following OLS model, clustering standard errors by both bank and time:

$$\begin{aligned} LLP_t = {} & \beta_0 + \beta_1 BCE_{t-1} * \Delta NPL_{t+1} + \beta_2 BCE_{t-1} * \Delta NPL_t + \beta_3 Consumer_{t-1} * \Delta NPL_{t+1} + \\ & \beta_4 Consumer_{t-1} * \Delta NPL_t + \beta_5 Commercial_{t-1} * \Delta NPL_{t+1} + \beta_6 Commercial_{t-1} * \Delta NPL_t + \\ & \beta_7 RealEstate_{t-1} * \Delta NPL_{t+1} + \beta_8 RealEstate_{t-1} * \Delta NPL_t + \beta_9 BCE_{t-1} + \beta_{10} \Delta NPL_{t+1} + \\ & \beta_{11} \Delta NPL_t + \beta_{12} \Delta NPL_{t-1} + \beta_{13} \Delta NPL_{t-2} + \beta_{14} Ebllp_t + \beta_{15} LoanGrowth_t + \\ & \beta_{16} Size_{t-1} + \beta_{17} Tier1_{t-1} + \beta_{18} Consumer_{t-1} + \beta_{19} Commercial_{t-1} + \beta_{20} RealEstate_{t-1} + \\ & BankEffects + TimeEffects + \varepsilon_t \ , \end{aligned} \tag{4}$$

where *LLP* is defined as loan loss provisions scaled by lagged total loans. *ΔNPL* is the change in non-performing loans over the quarter scaled by lagged total loans; *Ebllp* is earnings before loan loss provisions and taxes scaled by lagged total loans; *Loan Growth* is the percentage change in total loans over the quarter; *Commercial, Consumer* and *RealEstate* is the percentage of commercial, consumer and real estate loans (respectively) relative to the bank's total loan portfolio; and *Deposits,* defined as total deposits scaled by lagged loans, is included to control for differences in bank funding. All other variables have been defined previously.

To capture timeliness of expected loan loss recognition, we focus on both the $\beta_{11}$ and $\beta_{12}$ coefficients, where larger values of $\beta_{11}$ and $\beta_{12}$ are indicative of more timely loss recognition (i.e., current loan loss provisions are more sensitive to current and future changes in non-performing loans). We then test the effect of competition on the timeliness of loss recognition by examining the $\beta_1$ and $\beta_2$ coefficients. We conjecture that such pressures will result in $\beta_1 < 0$ and $\beta_2 < 0$ as banks choose to delay loss recognition until future periods.

Results from the estimation of (4) are reported in Table 4. Consistent with our conjectures, we find that banks' accrual choices are a function of competition. Specifically, we find that both $\beta_1$ and $\beta_2$ and significantly different from zero ($p < 0.01$), consistent with decreased timeliness in the recognition of expected losses. These findings suggest that bank managers use their accounting discretion to buoy up profits in highly competitive environments. This behavior can be consequential for a bank as prior research provides evidence consistent with delayed expected loss recognition having negative implications for credit supply (Beatty and Liao [2011]), bank risk shifting (Bushman and Williams [2012]), and both individual bank and systemic risk (Bushman and Williams [2014]). This suggests that competition can operate through bank manager's decision accounting decisions to generate externalities that extend beyond the individual bank's reported profitability.

### *3.2 BCE, Revenue Mix Decisions and Non-interest Income*

In this section, we examine whether banks respond to competitive pressure in the loan market by aggressively seeking out non-interest sources of revenue. Sources of non-interest revenue include investment banking, venture capital and trading activities. Prior research examining banks' pursuit of these activities generally concludes that diversification into these activities increases bank risk. Specifically, Stiroh [2004, 2006] and Fraser et al. [2002] find that non-interest income is associated with more volatile bank returns. DeYoung and Roland [2001] find fee-based activities are associated with increased revenue and earnings variability. Brunnermeier et al. [2012] find that banks with higher non-interest income have a higher contribution to systemic risk than traditional banking. Examining international banks, Demurgic-Kunt and Huizinga [2010] find that bank risk decreases up to the 25th percentile of non-interest income and then increases, and De Jonghe [2010] finds non-interest income to monotonically increase systemic tail risk.

While these prior studies document that increased bank risk is associated with a bank's pursuit of non-interest income, it is not clear why banks choose to pursue these revenue sources. Accordingly, we address this unanswered question by examining the extent to which competition drives banks to seek out these alternative sources of income. We consider two measures of non-interest revenue: *RevMix*, defined as total non-interest revenue divided by interest revenue, and *FeeMix*, the total non-interest income minus deposit service charges and trading revenue divided by interest revenue. We regress both of these measures on *BCE* and other appropriate control variables using the following OLS specification, clustering standard errors by both time and bank:

$$RevMixVariable_{t+1} = \beta_0 + \beta_1 BCE_t + \beta_2 NonIntExp_t + \beta_3 Commercial_t + \beta_4 Consumer_t + \beta_5 RealEstate_t + \beta_6 Deposits_t + \beta_7 Mismatch_t + \beta_8 Tier1_t + \beta_9 Size_t + \beta_{10} ROA_t + TimeEffects + BankEffects + \varepsilon_{t+1}, \quad (5)$$

where the dependent variable is either total revenue mix (*RevMix*) or fee revenue mix (*FeeMix*). We include *NonIntExp*, defined as total non-interest expense divided by interest revenue, to control for the total overhead carried by the bank. *Deposits,* defined as total deposits scaled by lagged loans, is included to control for differences in bank funding. Following Adrian and Brunnermeier [2011], we include the bank's *Mismatch* ((Current liabilities – Cash)/Total liabilities) to control for the bank's reliance on short-term funding sources. *ROA* represents the bank's return on book value of assets. We also include both time and bank fixed effects. All other variables have been defined previously.

Note that an observed coefficient of $\beta_1 > 0$ is consistent with competition leading banks to change their mix of revenue sources by seeking out non-interest revenue activities. As reported in Table 5, the estimated coefficient on *BCE* for *RevMix (FeeMix)* is 0.0153, p-value < 0.01 (0.013, p-value < 0.01), suggesting that banks faced with increased competition shift their revenue mix in an attempt to supplement declining net interest margins. Given the findings from prior research linking a bank's pursuit of non-interest revenue with increased risk, this finding highlights another important channel through which competition influences bank stability.

### 3.3 Risk Mitigation – *Competition and Bank Capital*

Given our findings that banks relax lending standards, delay recognition of expected loan losses and shift revenue mix in response to higher competition, prior research would predict an increase in a bank's risk profile (e.g., Bushman and Williams, 2014; Brunnermeir et al., 2012). However, it is possible that banks counteract increases in risk through these channels by engaging in offsetting risk mitigation activities. One way to mitigate risk would be to increase capital buffers. Because banking theory generally assumes that leverage is exogenous it does not provide clear guidance on this question. Exceptions include Frexias and Ma [2014] who allow bank leverage and risks to be jointly determined by the optimization behavior of banks, and shows that banks may choose higher or lower leverage depending intricately on the parameters of the model (see also Allen et al. [2009]). Empirical studies provide conflicting results concerning the relation between competition and bank capital. For example, Beck et al. [2013] and Berger et al. [2009] find that bank capital is decreasing in competition while Schaeck and Cihák [2012] find the opposite result.

Accordingly, we examine whether banks mitigate risk by increasing capital buffers to offset increased risk-taking driven by competitive pressues. To do so, we run the following OLS regression:

$$\begin{aligned} Tier1_{t+1} = \beta_0 + \beta_1 BCE_t + \beta_2 Trading_t + \beta_3 Commercial_t + \beta_4 Consumer_t + \\ \beta_5 RealEstate_t + \beta_6 Deposits_t + \beta_7 Mismatch_t + \beta_8 MTB_t + \beta_9 Size_t + \\ \beta_{10} ROA_t + \beta_{11} \beta_{mrkt} + TimeEffects + BankEffects + \varepsilon_{t+1}, \end{aligned} \quad (6)$$

where *Tier1* is the bank's tier 1 capital ratio, and all other variables are as previously defined.

Table 6 reports the results from estimating equation (6). Contrary to banks using capital buffers to offset the increased risk associated with higher competition, we find that *BCE* is negatively associated with *Tier1*. Specifically, we find a negative and significant coefficient on

*Tier1* (-0.0032, p-value < 0.01). Thus, our results suggest that bank capital actually decreases with higher competition.[24]

Of course bank capital is only one risk mitigation device and banks can potentially use a range of other mechanisms to increase or decrease risk levels in response to increased competition. To investigate the overall net effect of competition on bank risk, we next examine the relationship between *BCE* and direct measures of overall bank risk.

## 4. Bank Competition and Risk

In the prior sections, we document that competition affects both accounting and operational decision-making channels that have the potential to impact banks' risk profiles. However, looking at each channel in isolation does not allow an overall assessment of the impact of competition on bank risk. In this section, we investigate the possibility that competition, operating through the channels considered earlier and other channels, increases the standalone risk of individual banks and systemic risk by increasing codependence in the tails of banks' equity and asset returns. Section 4.1 investigates relations between competition and standalone risk of individual banks and section 4.2 examines competition and systemic risk.

### *4.1 Competition and Standalone Risk of Individual Banks*

We take two approaches to examining the standalone risk of a bank. First, we consider consequences of increased competition on the future performance of current lending activities. Second, we examine the association between competition and an individual bank's downside risk as reflected in the probability distribution over a bank's equity and asset values.

[24] The question of how corporate governance impacts bank risk taking and capital levels is a significant, unresolved issue that is beyond the scope of our current paper. While the general literature on competition suggests that competition can serve a governance role, banks face distinctive governance challenges owing to tensions involved in balancing the demands of being value-maximizing entities with serving the public interest It is an open question as to whether good corporate governance disciplines risk-taking or encourages risk-shifting by banks. For further discussion of this issue see Mehran and Mollineaux [2012], Mehran et al., [2011], Fahlenbrach and Stulz [2011] and Anginer et al. [2014].

### *4.1.1 Competition, Loan Growth and Future Charge-offs*

In section 2.3, we provide evidence consistent with competition influencing banks to relax their underwriting standards. This finding raises questions about whether this behavior negatively impacts the future performance of banks' loan portfolios. In this section we investigate the effect of competition on the relation between a bank's *current* period loan growth and its *future* loan charge-offs. To the extent that banks' lower underwriting standards in response to competition, we expect that an increase in current period loan growth will have a higher marginal association with future loan charge-offs as competition increases. To investigate this prediction, we estimate the following model, clustering the standard errors by both time and bank.

$$\begin{aligned} LCO_{12m/24m} = {} & \alpha_0 + \beta_1 LoanGrowth_t + \beta_2 BCE_t + \beta_3 LoanGrowth_t * BCE_t + \\ & \beta_4 LoanGrowth_t * Consumer_t + \beta_5 LoanGrowth_t * Commercial_t + \\ & \beta_6 LoanGrowth_t * RealEstate_t + \beta_7 \Delta NPL_t + \beta_8 \Delta NPL_{t-1} + \beta_9 \Delta NPL_{t-2} + \\ & \beta_{10} Size_t + \beta_{11} Tier1_t + \beta_{12} Consumer_t + \beta_{13} Commercial_t + \\ & \beta_{14} RealEstate_t + \beta_{15} ROA_t + \varepsilon_t \end{aligned} \tag{7}$$

where *LCO* is total loan charge-offs divided by total loans at time t over either the next12 months ($LCO_{12m}$) or 24 months ($LCO_{24m}$). Loan growth is defined as the percentage change in total loans over the quarter. All other variables are as defined previously.

Table 7 reports the results of estimating (7). Consistent with our prediction, we find that $\beta_3 > 0$ for each specification. Specifically, Table 7 reports that the portion of a bank's current loans that are charged off both over the next 12 month (coef = 0.096, p-value<0.01) and 24 month (coef = 0.0190, p-value<0.01) horizon are increasing in the bank's competitive environment. This finding is particularly troublesome when considering our previous finding that competition reduces the timeliness of banks' loan loss provisions and capital buffers.

#### 4.1.3 Competition and Value-at-Risk (VaR)

In this section we examine the relationship between competition and characteristics of the probability distributions over changes in the market values of equity returns and total assets.[25] Because the market value of total assets is unobservable, we use a bank's equity returns to transform the book values of assets into market values following the methodology in Adrian and Brunnermeier [2011] (see appendix B for details of this transformation).

We capture a bank's standalone tail risk using estimated value-at-risk (*VaR*). *VaR* measures the potential loss in value of a risky asset over a defined period for a given confidence interval. Let $X^i$ represent bank *i*'s equity returns (or percentage change in asset values), and let $q$ represent a given probability threshold. $VaR_q^i$ is then defined implicitly as $probability(X^i \leq VaR_q^i) = q$.[26] Following prior research (Adrian and Brunnermeier [2011]), Bushman and Williams [2014]), we use quantile regression to estimate time varying *VaR*s.

To compute time-varying *VaR* at the *q*-percentile, we estimate the following quantile regression over the bank's full weekly time series, requiring a minimum of 260 observations:

$$X_t^i = \alpha^i + \beta^i M_{t-1} + \varepsilon_t^i \quad (8a)$$

$M$ in (8b) is a vector of macro state variables.[27] Our conditional weekly time-varying *VaR* at the *q*-percentile is computed as follows, where the coefficients are the estimates from equation (8a):

$$VaR_{q\%,t}^i = \hat{\alpha}^i + \hat{\beta}^i M_{t-1} \quad (8b)$$

[25] These two distributions are economically related as unhedged changes in the market value of a bank's assets will have consequences for equity values. Any differences in the two distributions must derive from the underlying structure of a bank's assets relative to its liabilities.
[26] If the *VaR* of a bank's equity returns is -15% at a one-week, 95% confidence level, there is a only a 5% chance that banks equity value will drop more than 15% over any given week.
[27] See Appendix B for a detailed description of the vector of macro state variables used in this estimation.

We compute a quarterly *VaR* by summing up the weekly $VaR_{q\%}$.

We use three measures to reflect a bank's risk profile. To capture tail risk, we use the 1% quantile *VaR* for equity ($VaR^{E}_{1\%}$) and assets ($VaR^{A}_{1\%}$), where more negative values indicate that the bank has a more severe downside loss threshold for a given probability 1% probability. Our second measure is the distance between the *VaR* at the 1% quantile and the 50% quantile, which we term $\Delta VaR_{Left}$. $\Delta VaR^{E}_{Left}$ ($\Delta VaR^{A}_{Left}$) captures the expected equity returns (percentage change in asset values) when a bank moves from the median to the 1% quantile. Larger values of $\Delta VaR_{Left}$ indicate that the distribution has a longer left tail. Our third measure $\Delta VaR^{E}_{Right}$($\Delta VaR^{A}_{Right}$) is the distance from $VaR^{E}_{50\%}$($VaR^{A}_{50\%}$) *to* $VaR^{E}_{99\%}$($VaR^{A}_{99\%}$), where larger values of $\Delta VaR_{Right}$ indicate that the bank's distribution has a longer right tail.

We estimate the effect of competition on the various measures of *VaR* using the following OLS regression model:

$$\begin{aligned} VaR^{A/E}_{t} = {} & \beta_0 + \beta_1 BCE_{t-1} + \beta_2 Trading_{t-1} + \beta_3 Commercial_{t-1} + \beta_4 Consumer_{t-1} + \\ & \beta_5 Realestate_{t-1} + \beta_6 Mismatch_{t-1} + \beta_7 Deposits_{t-1} + \beta_8 ROA_{t-1} + \\ & \beta_9 Tier1_{t-1} + \beta_{10} Size_{t-1} + \beta_{11}\sigma_{E,t-1} + \beta_{12}\beta^{Mrkt}_{t-1} + \beta_{13} Illiquid_{t-1} + \beta_{14} MTB_{t-1} + \varepsilon_t \end{aligned} \tag{9}$$

where $\sigma_E$ is standard deviation of the bank's equity returns over the prior quarter. $\beta^{Mrkt}$ is the bank's equity beta from a basic CAPM model estimated by bank over the prior quarter. *Illiquid* is defined as the quarterly average of daily absolute value of stock returns divided by the dollar trading volume for the day. All other variables are as defined previously.

Table 8 panels A and B present the results from the estimation of equation (9) for both asset and equity *VaR* measures. The results in both panels A and B show that *BCE* is negatively correlated with both $VaR^{E}_{1\%}$(coefficient=-0.0604, p-value<0.01) and $VaR^{A}_{1\%}$(coefficient = -0.0737, p-value<0.01). These results suggest that banks facing high competition also face more severe downside risk compared to banks facing weaker competitive pressures. Panels A and B in Table 8 also suggests that competition primarily affects the left tail of the distribution. We find that *BCE* is significantly and positively associated with both $\Delta VaR^{E}_{left}$ and $\Delta VaR^{A}_{left}$, while it is not significantly associated with either $\Delta VaR^{E}_{right}$ and $\Delta VaR^{A}_{right}$.

### *4.2. Competition and Systemic Risk*

Finally, we investigate the effects of competition on systemic risk. There is no agreed upon approach to this measurement (e.g., Bisias et al., 2012, Hansen, 2014). One important stream of literature exploits the high frequency observability of bank's equity prices to extract measures of systemic risk. Some papers in this stream use contingent claims analysis (e.g., Gray et al. 2008; Gray and Jobst, 2010), while others focus on codependence in the tails of equity returns using reduced form approaches (Acharya et al., 2010, Adrian and Brunnermeier, 2011). Given that equity prices impound the market's expectations about banks' future prospects, equity-based measures of bank tail risk reflect risk assessments deriving from a wide range of underlying sources of vulnerability. We examine the relation between competition and systemic risk using two different measures of systemic risk that reflect co-dependence in the tails of equity (asset) returns to financial institutions, where co-dependence is used to distinguish the impact of the disturbances to the entire financial sector from firm-specific disturbances..

#### *4.2.1 ΔCoVaR*

We build directly on the earlier *VaR* framework and use the *CoVaR* construct from Adrian and Brunnermeier (2011). *CoVaR* reflects the tail risk of the banking sector in aggregate, *conditional* on the performance of an individual bank *i.* The objective is to measure the extent to which the tail risk of the banking sector is more severe when bank *i* is in distress relative to when bank *i* is operating at normal levels.

Formally, *CoVaR* is the *VaR* of the banking system *conditional* on the state of an individual bank, and $\Delta CoVaR$ captures the marginal contribution of a specific bank to the tail risk of the banking sector. To compute $\Delta CoVaR_q$ we estimate the following quantile regressions equations again using weekly data:

$$X_t^i = \alpha^i + \beta^i M_{t-1} + \varepsilon_t^i \tag{10a}$$

$$X_t^{system} = \gamma_1 + \gamma_2 M_{t-1} + \gamma_3 X_t^i + \varepsilon_t^{system} \quad , \tag{10b}$$

where $X^i$ is bank *i*'s weekly equity return (percent asset change rate), $X^{system}$ is the value-weighted equity return (asset change rate) from the index of all banks in the economy (excluding bank *i*), and *M* is the vector of macro state variable defined in Appendix B. Equation (10a) is just the *VaR* formulation we estimated earlier (i.e., equation (8a)). Equation (10b) extends (10a) to a portfolio of banks and *conditions* on the performance bank i. (10a) is estimated at both *q*% = 1% and 50%, and (10b) at *q%* = 1%. Using the predicted values from (9a) and (9b) we specify

$$VaR_{q\%,t}^i = \hat{\alpha}^i + \hat{\beta}^i M_{t-1} \tag{10c}$$

$$CoVaR_{1\%,t} = \hat{\gamma}_1 + \hat{\gamma}_2 M_{t-1} + \hat{\gamma}_3 VaR_{1\% or\, 50\%,t}^i \ , \tag{10d}$$

$CoVaR_{1\%,t}$ , equation (10d), is the system's time t *VaR* at *q*% = 1%, *conditional* on the *VaR* of the individual bank i being at either the 1% or 50% quantile. To capture the sensitivity of the system's conditional $VaR_{1\%}$ to bank i's events, we compute

$$\begin{aligned}\Delta CoVaR_t &= CoVaR_t^{i=VaR_{1\%}} - CoVaR_t^{i=VaR_{50\%}} \\ &= \hat{\gamma}_1 + \hat{\gamma}_2 M_{t-1} + \hat{\gamma}_3 (VaR^i_{1\%,t} - VaR^i_{50\%,t})\end{aligned} \quad . \tag{10e}$$

We sum weekly *ΔCoVaR* to obtain a quarterly measure, where *more negative* values of $\Delta CoVaR_q$ indicates that a move by bank *i* from a median state of performance to a distressed state produces a larger marginal contribution to overall systemic risk.

Using our estimates of *ΔCoVaR* we estimate the following equation.

$$\begin{aligned}\Delta CoVaR_t^{A/E} = \beta_0 &+ \beta_1 BCE_{t-1} + \beta_2 Trading_{t-1} + \beta_3 Commercial_{t-1} + \beta_4 Consumer_{t-1} + \\ &\beta_5 Realestate_{t-1} + \beta_6 Mismatch_{t-1} + \beta_7 Deposits_{t-1} + \beta_8 ROA_{t-1} + \\ &\beta_9 Tier1_{t-1} + \beta_{10} Size_{t-1} + \beta_{11}\sigma_{E,t-1} + \beta_{12}\beta^{Mrkt}_{t-1} + \beta_{13} Illiquid_{t-1} + \\ &\beta_{14} MTB_{t-1} + \varepsilon_t\end{aligned} \tag{11}$$

where all variables were defined previously. To the extent that the effects of competition ultimately result in increases in systemic risk we expect to $\beta_1$<0.

We estimate equation (11) and report the results in the first two columns in Table 9. The table shows that for $\Delta CoVaR^E$ the coefficient on *BCE* is -0.0124 (p-value <0.01). For $\Delta CoVaR^A$ the coefficient for *BCE* is -0.0156 (p-value <0.01). These results provide evidence that *BCE* is associated with an increase in an individual bank's contribution to systemic risk.

***4.2.2 Marginal Expected Shortfall (MES)***

For our final measure of systemic risk we follow Acharya et al. (2010) and compute the marginal expected shortfall (*MES*) of the bank. *MES* captures the correlation between a bank's equity returns and market equity returns on days where the market return is in the bottom 5% for the year. That is, it measures the extent to which an individual bank's returns are low when the overall (banking) market returns are low. For each quarter end we compute the observed distribution of returns for the market as a whole over the subsequent 12 months. We then isolate the days that fall in the bottom 5% of market returns for the year, and compute the average return for each individual bank over those days. The more negative *MES*, the lower an individual bank's returns are when the return of the banking sector is low (higher marginal expected shortfall). We then estimate the following equation:

$$\begin{aligned} MES_t = {} & \beta_0 + \beta_1 BCE_{t-1} + \beta_2 Trading_{t-1} + \beta_3 Commercial_{t-1} + \beta_4 Consumer_{t-1} + \\ & \beta_5 Realestate_{t-1} + \beta_6 Mismatch_{t-1} + \beta_7 Deposits_{t-1} + \beta_8 ROA_{t-1} + \\ & \beta_9 Tier1_{t-1} + \beta_{10} Size_{t-1} + \beta_{11} \sigma_{E,t-1} + \beta_{12} \beta^{Mrkt}_{t-1} + \beta_{13} Illiquid_{t-1} + \\ & \beta_{14} MTB_{t-1} + \varepsilon_t \end{aligned} \tag{12}$$

If competition increases the systemic risk of the bank we would predict $\beta_1<0$. We estimate equation (12) and report the results in the last column in Table 9. The reported coefficient on *BCE* is -0.0025 (p-value < 0.05), which indicates that competition increases the marginal expected shortfall of the bank. To put economic significance on the results, a one standard deviation increase in *BCE* results in a 12% reduction in the average return over the days in the banking market's bottom 5%.

***4.3 Deregulation and post-deregulation analyses***

In the previous analyses, we used a branch banking deregulation index to validate *BCE* as a timely measure of real competitive pressures (Section 2.2), and then used *BCE* to investigate the extent to which competition impacts the future decision-making and risk profile of banks. In this section, we extend the analysis by breaking our analyses into two parts. First, we perform a deregulation analysis that incorporates the deregulation index directly into our risk analyses. This analysis is intended to bolster our results on the linkages between competition and bank stability. Second, we perform a post-deregulation analysis that uses *BCE* to measure competition. This analysis has the objective of providing additional support for *BCE* as a useful measure of competition.

The main *BCE* results in the paper are based on analyses run over the entire 1996-2010 sample period. The last deregulation event in our sample occurs in 2005. For the deregulation analysis, we truncate the sample at the end of 2005 and run risk analyses using the branch bank deregulation index to measure competition. We perform this analysis for *VaR*, *CoVar, MES,* revenue mix, loan loss provisioning policy, and future charge-offs.[28] As reported in table 10, our results using the deregulation index are qualitatively similar to those using *BCE*. The one exception is our analysis of Revenue Mix where the coefficient on *BCE* is in the right direction but is not statistically significant. These findings provide support that our primary results using *BCE* as a proxy for competition document an actual linkage between bank competition and both future decisions and bank risk.

On the other hand, the post-deregulation analyses only include observations for banks headquartered in a given state for time periods subsequent to the last deregulation event in that state. We then run our analyses using *BCE* as a proxy for competition using this restricted sample. As reported in table 11, we are able to replicate all of our main results in the post-deregulation analyses. The fact that the post-deregulation analyses using *BCE* replicates the results from both our overall *BCE* and deregulation analyses suggests that *BCE* can be of value to researchers, investors, and analysts for measuring competitive pressure at any point in time, regardless of the existence of a regulatory event.

### *4.4 Channel Attenuation Analysis*

The previous analysis indicates that more competition leads to more systemic risk, while section 3 provides evidence that more competition also leads banks to make accounting and operating decisions that prior literature has found to increase systemic risk. If competition is

---

[28] Data limitations preclude us from running deregulation analysis for the loan contracting variables as Dealscan is too thinly populated during the years when many of the deregulation events occurred.

working through these specific channels to influence systemic risk, then the inclusion of these channels in our model should reduce the affect that *BCE* has on systemic risk. Accordingly, we use an attenuation analysis approach (Baron and Kenny, 1986) to examine this conjecture.

To perform this analysis, we include variables in our model that proxy for: (1) the timeliness of each bank's loan loss provisioning, and (2) each bank's revenue mix. While Section 2.3 indicates that competition reduces underwriting standards, another channel that influences systemic risk, data limitations preclude us from including the quality of a bank's underwriting standards. Accordingly, we do not include this channel in our analysis. To capture the timeliness of loan provisions in a single proxy, we follow Beatty and Liao (2011) and use loan loss allowance divided by non-performing loans (*TimelyLLP*). We also use *RevMix* to capture each bank's pursuit of non-interest revenue sources.

We first estimate equations (11) and (12) for the full sample of firms that have all of the variables required for the mitigation analysis. Similar to those results reported in Table 9, Panel A of Table 12 reports that *BCE* is negatively associated with both of the *CoVaR* variables and *MES*. We then re-estimate equations (11) and (12) and include *TimelyLLP* and *RevMix*. Panel B of Table 12 reports the results of estimating these modified equations. Consistent with our prediction, we find that the inclusion of *TimelyLLP* and *RevMix* in equations (11) and (12) reduces the magnitude of the *BCE* coefficient. Specifically, we find that the magnitude of the *BCE* coefficient is reduced by approximately 20% for both *CoVaR* variables and by approximately 40% for the *MES* regression. Further, our results provide additional support that banks' loan loss provisioning and pursuit of non-interest income influence systemic risk in the manner indicated by prior research. Table 12 provides support to our conjecture that competition influences systemic risk through both *TimelyLLP* (accounting channel) and *RevMix* (operations channel).

### 4.5 Robustness Test: *Controlling for the Lerner Index*

We investigate whether our results using *BCE* are robust to the inclusion of the Lerner Index (*LI*). To investigate *BCE*'s ability to explain behavior above and beyond the Lerner Index, we begin by computing the Lerner Index (*LI*) for each bank-year (see Appendix A for details), where higher values are an indication of monopoly like behavior.[29]. We then re-run the primary analyses including both *BCE* and *LI* and report the results in Table A4 of the Online Appendix. Table A4, panel A shows the results for the primary channels analyses. In all three cases, our results with *BCE* are robust to the inclusion of the Lerner index. However the results for *LI* are both weaker and less consistent than those identified with the *BCE* measure. In panels B and C we report results from the various risk analyses. Similar to panel A, we find that *BCE* is robust to the inclusion of the Lerner index. However in the case of two of the three systemic risk measures, the coefficients on *LI* indicate that more competition results in less systemic risk. Overall the results from Table A4 provide strong evidence that *BCE* provides information above and beyond that which is captured by other bank-time specific measures of competition.

## 5. Summary

In this paper, we address three important open questions in the banking literature: How should bank competition be measured? What specific channels does bank competition operate through to increase or decrease risk? Does bank competition increase or decrease individual bank and banking system risk? We make several contributions to the existing literature.

[29] In unreported results we also compute bank-quarter *LI* and results are robust.

First, building on Li et al. [2013], we use textual analysis of banks' 10-K filings to construct a comprehensive, time-varying, bank-specific measure of a bank's competitive environment (*BCE*). We significantly extend Li et al. [2013] and the textual-analysis literature more generally by exploiting several salient opportunities unique to banking to provide validation that *BCE* captures current and evolving changes in the competitive environment of specific banks in a more timely fashion than classical measures of competition. The enhanced timeliness of *BCE* makes it particularly conducive to examine future bank responses to current shifts in competition. Specifically, we use U.S. branch banking deregulation to generate a measure of exogenous changes in the threat of entry. We provide evidence that *BCE* is a timely measure of real competitive pressures by showing that it significantly increases following decreases in barriers to out-of-state branch entry, after controlling for other commonly used competition measures. We also show that changes in *BCE* are associated with reduced underwriting standards on future loans consistent with recurring surveys by bank regulators in which banks regularly report that changes in competition are the most prevalent reason for easing underwriting standards.

Second, we extend the literature by investigating how competition influences three key decision-making channels that prior literature links to increased bank risk, finding that higher competition is associated with lower underwriting standards, less timely accounting recognition of expected loan losses, and greater reliance on non-interest sources of income. Our results on the relation between competition and loan loss provisioning complements and extends Dou et al. [2013], who show that delayed loan loss recognition increases following reductions in out-of-state branching restrictions. In contrast to their study, we use deregulation to validate our measure, and then use this measure to capture competitive pressure at *any* point in time, independent of a regulatory event.

Third, we show that risk at the individual bank level and a bank's contribution to system-wide risk is increasing in competition. We find that competition is associated with significantly higher risk of individual banks suffering severe drops in their equity and asset values. At the system level, we find that higher competition is associated with significantly higher co-dependence between downside risk of individual banks and downside risk of the banking sector. Our within country, within bank analyses of competition and systemic risk complement a recent stream of papers examining this issue in a cross-country setting (e.g., Anginer et al. [2014], Beck et al. [2013], and Schaeck et al. [2009]).

Finally, we show that our results using *BCE* are largely robust to replacing *BCE* with branch bank deregulation. We break our analyses into two parts, a deregulation and post-deregulation analysis. For the deregulation analyses, we truncate the sample to end after the final deregulation event in the sample and run our analyses using the branch bank deregulation index to measure competition. The post-deregulation analyses measure competition with *BCE* and only include observations subsequent to the last deregulation event in a state. We find that our main results largely hold in both the deregulation and post-deregulation analyses. The results of this deregulation analyses represent contributions in their own right as we are the first paper to use bank deregulation to comprehensively investigate relations between changes in the threat of entry and future decisions and the risk profile of banks. Further, the results of our deregulation and post-deregulation analyses taken together provide support for our claim that our *BCE* results reflect an actual linkage between competition and future decisions and bank risk, and suggest that *BCE* can be of value to researchers, investors, and analysts seeking to measure competitive pressure at any point in time, regardless of a regulatory event.

## References:


Acharya, V., Pederson, L., Philippon, T., and M. Richardson, 2010. Measuring systemic risk. Working paper, NYU.

Adrian, T., and M. Brunnermeier, 2011. CoVaR. Fed Reserve Bank of New York Staff Reports.

Allen, F., E. Carletti, and R. Marquez, 2011. Credit market competition and capital regulation. *Review of Financial Studies* 24(4), 983-1018.

Allen, F., and D. Gale, 2000. Comparing Financial Systems. MIT Press, Cambridge, Massachusetts.

Altman, E.I., 1977. *The Z-Score bankruptcy model: past, present, and future*. John Wiley & Sons, New York.

Altunbas, Y., Manganelli, S., and D. Marques-Ibanez, 2011. Bank risk during the financial crisis: do business models matter? European Central Bank working paper 1394.

Anginer, D., Demirguc-Kunt, A., and M. Zhu, 2014. How does competition affect bank systemic risk? *Journal of Financial Intermediation* 23(1), 1-26.

Ball, C., Hoberg, G., and V. Maksimovic, 2013. Disclosure informativeness and the tradeoff hypothesis: A text-based analysis. Working paper, University of Maryland.

Baron, R., and D. Kenny, 1986. The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology* 51(6), 1173-1182.

Beatty, A., and S. Liao, 2011. Do delays in expected loss recognition affect banks' willingness to lend? *Journal of Accounting and Economics* 52, 1-20.

Beck, T., 2008. Bank competition and financial stability: Friends or foes? World Bank Policy Research working paper 4656.

Beck, T., De Jonghe, O., and G. Schepens, 2013. Bank competition and stability: Cross-country heterogeneity. *Journal of Financial Intermediation* 22(2), 218–244.

Berger, A.L., Demirguc-Kunt, A., Levine, R., and J. Haubrich, 2004. Bank concentration and competition: An evolution in the making. *Journal of Money, Credit and Banking* 36(3), 433-453.

Berger, A.N., Klapper, L.F., and R. Turk-Ariss, 2009. Bank competition and financial stability. *Journal of Financial Services Research*, *35*(2), 99-118.

Berlin, M., and L.J. Mester, 1992. Debt covenants and renegotiation. *Journal of Financial Intermediation* 2, 95-133.

Bharath, S., and T. Shumway, 2008. Forecasting default with the Merton distance to default model. *The Review of Financial Studies* 21, 1339-69.

Bikker, J., S. Shaffer, and L. Spierdijk, 2012. Assessing Competition with the Panzar-Rosse Model: The Role of Scale, Costs, and Equilibrium. *The Review of Economics and Statistics*, 94:4. 1025-1044.

Bisias, D., M. Flood, A. Lo, and S. Valavanis, 2012. A survey of systemic risk analytics. *Annual Review of Financial Economics* 4, 255-296.

Bolt, W., and D. Humphrey, 2012. A frontier measure of US banking competition. Working paper, Netherlands Central Bank Number 359.

Boyd, J.H., and G. De Nicolo, 2005. The theory of bank risk-taking and competition revisited. *Journal of Finance* 60, 1329-43

Broecker, T., 1990. Credit-worthiness tests and interbank competition. *Econometrica* 58:2, 429-52.

Brown, S.V., and J.W. Tucker, 2011. Large-sample evidence on firms' year-over-year MD&A modifications. *Journal of Accounting Research* 49, 309-346.

Brunnermeier, M., Dong, G., and D. Palia, 2012. Banks' non-interest income and systemic risk. Princeton University working paper (January 2012).

Bushman, R., and C. Williams, 2012. Accounting discretion, loan loss provisioning, and discipline of banks' risk-taking. *Journal of Accounting and Economics* 54(1): 1-18.

Bushman, R., and C. Williams, 2014. Delayed expected loss recognition and the risk profile of banks. Working paper.

Carletti, E., 2008. Competition and regulation in banking. In: Boot, A.W.A., and A.V. Thakor (Eds.), Handbook of Financial Intermediation and Banking. Elsevier / North Holland, Amsterdam, the Netherlands, 449-482.

Cetorelli, N., 1999. Competitive analysis in banking: Appraisal of the methodologies. *Federal Reserve Bank of Chicago Economic Perspectives* 23, 2 – 15.

Chava, S. and M. Roberts, 2008. How does financing impact investment? The role of debt covenants. *Journal of Finance* 63, 2085-2121.

Claessens, S., and L. Laeven, 2004. What drives bank competition? Some international evidence. *Journal of Money, Credit, and Banking* 36(3), 563-83.

De Jonghe, O., 2010. Back to the basics in banking? A micro-analysis of banking system stability. *Journal of Financial Intermediation* 19(3), 387–417.

Degryse, H., and S. Ongena, 2008, "Competition and regulation in the banking sector: A review of the empirical evidence on the sources of bank rents," in Handbook of Financial Intermediation and Banking, ed. by A. W. A. Boot, and A. V. Thakor. Elsevier, San Diego, 483-554.

Dell'Ariccia, G., 2000. Learning by lending, competition, and screening incentives in the banking industry. Wharton School Center for Financial Institutions working paper 00-10.

Demirguc-Kunt, A., and H. Huizinga, 2010. Bank activity and funding strategies: the impact on risk and returns. *Journal of Financial Economics* 98: 626–650.

DeYoung, R., and K. Roland, 2001. Product mix and earnings volatility at commercial banks: Evidence from a degree of total leverage model, *Journal of Financial Intermediation* 10, 54-84.

Dick, A. A., 2006. Nationwide branching and its impact on market structure, quality, and bank performance. *The Journal of Business*, 79(2), 567-592.

Dou, Y., Ryan, S.G., and Zou, Y., 2013. The effects of credit competition on banks' loan loss provision timeliness. Working paper, NYU.

Fahlenbrach, R., and R. Stulz, 2011. Bank CEO incentives and the credit crisis. *Journal of Financial Economics* 99(1), 11-26.

Fraser, D., Madura, J., and R. Weigand, 2002. Sources of bank interest rate risk, *Financial Review* 37, 351-367.

Freixas, X., and K. Ma, 2014. Banking competition and stability: The role of leverage. Working paper.

Gorton, G., and P. He, 2008. Bank credit cycles. *The Review of Economic Studies* 75, 1181-1214.

Gray, D., and A. Jobst, 2010. Systemic cca-a model approach to systemic risk. *Deutsche Bundesbank/Technische Universitat Dresden Conference: Beyond the Financial Crisis: Systemic Risk, Spillovers and Regulation, Dresden*.

Gray, D., R. Merton, and Z. Bodie, 2008. A contingent claims analysis of the subprime credit crisis of 2007-2008. CREDIT 2008 Conference on Liquidity and Credit Risk, Venice 22-23 September 2008.

Greene, W., 2004. The behaviour of the maximum likelihood estimator of limited dependent variable models in the presence of fixed effects. *Econometrics Journal* 7, 98-119.

Hansen, L. 2014. Challenges in Identifying and Measuring Systemic Risk. In Risk Topography: Systemic Risk and Macro Modeling M.K. Brunnermeier and A. Krishnamurthy, Eds., University of Chicago Press:15 – 30.

Johnson, C., and T. Rice, 2008. Assessing a decade of interstate bank branching. *Washington and Lee Law Review* 65 (1), 73-127.

Li, Feng, 2010a. Textual analysis of corporate disclosures: A survey of the literature, *Journal of Accounting Literature* 29, 143-165.

Li, Feng, 2010b. Information content of the forward-looking statements in corporate filings - A naive Bayesian machine learning approach, *Journal of Accounting Research* 48, 1049-1102.

Li, F., Lundholm, R., and M. Minnis, 2013. A measure of competition based on 10-K filings. *Journal of Accounting Research* 51(2), 399-436.

Loughran, T., and B. McDonald, 2015. Textual analysis in accounting and finance: A survey. Working paper, University of Notre Dame.

Mehran, H., and L. Mollineaux, 2012. Corporate governance of financial institutions. Working paper, Federal Bank Reserve of New York Staff Report No. 539.

Mehran, H., A. Morrison, and J. Shapiro, 2011. Corporate governance and banks: What have we learned from the financial crisis? Federal Bank Reserve of New York Staff Report No. 502.

Murfin, J., 2012. The supply-side determinants of loan contract strictness. *The Journal of Finance* 67, 1565-601.

Porter, Michael E. 2008. The Five Competitive Forces That Shape Strategy." Special Issue on HBS Centennial. Harvard Business Review 86, no. 1, 78–93.

Rice, T., and P. Strahan. 2010. Does credit competition affect small-firm finance? *Journal of Finance* 65: 861-889.

Schaeck, K., M.Cihák, and S. Wolfe, 2009. Are more competitive banking systems more stable? *Journal of Money, Credit and Banking* 41(4), 711–734.

Skinner, D. J., 2011. Discussion of "accounting standards and debt covenants: Has the "balance sheet approach" led to a decline in the use of balance sheet covenants?" *Journal of Accounting and Economics* 52(2), 203-208.

Stiroh, K., 2004. Diversification in banking: Is noninterest income the answer? *Journal of Money, Credit and Banking* 36, 853-882.

Stiroh, Kevin, 2006, A portfolio view of banking with interest and noninterest activities, *Journal of Money, Credit, and Banking* 38, 2131-2161.

Wagner, Wolf, 2010. Loan market competition and bank risk-taking, *Journal of Financial Services Research* 37(1), 71-81.

## Appendix A

This appendix briefly describes the Lerner Index and how we estimate these measures in the current paper.

***Lerner Index*** (see e.g., Beck et al. [2013] for further discussion)*:*

The Lerner index attempts to capture the extent to which banks can increase the marginal price beyond the marginal cost. The Lerner Index (*LI*) as follows:

$$Lerner_{it} = \frac{P_{it} - MC_{it}}{P_{it}} \quad , \tag{b}$$

where $P_{it}$ is defined as operating income (interest revenue plus non-interest revenue) to total assets.

Using a translog cost function, we estimate the marginal cost of the bank (*MC*) as follows:

$$\ln C_{it} = \beta_0 + \beta_1 \ln Q_{it} + \frac{\beta_2}{2} \ln Q_{it}^2 + \sum_{k=1}^{3} \gamma_{kt} \ln W_{w,it} + \sum_{k=1}^{3} \phi_k \ln Q_{it} \ln W_{k,it} + \sum_{k=1}^{3} \sum_{j=1}^{3} \ln W_{k,it} \ln W_{j,it} + \varepsilon_{it} \quad , \tag{c}$$

where $C_{it}$ are the banks total costs (interest expense plus non-interest operating expenses) scaled by total assets. *Q* is the banks total output, which is defined as total assets. $W_1$ is the input price of labor defined as wages divided by total assets; $W_2$ is the input price of funds and is defined as interest expense to total deposits; $W_3$ is the input price of fixed capital and is defined as non-interest expenses divided by total assets.

We estimate (c) using all banks with available data in the cross-section each year to attain predicted coefficients for each year. After estimating (c) we compute the marginal cost for each bank-year as:

$$MC_{it} = \frac{C_{it}}{Q_{it}} \left[ \hat{\beta}_1 + \hat{\beta}_2 \ln Q_{it} + \sum_{k=1}^{3} \hat{\phi}_k \ln W_{k,it} \right] . \tag{d}$$

We then insert the resulting bank-year specific measure of *MC* from (d) into (b). This results in a bank-year specific *Lerner Index* measure.

## Appendix B

### I. Estimating the market value of a bank's total assets

To compute each bank's weekly percentage change in market-valued total assets (*MVA*) we follow prior research and define it as:.

$$X_t = \frac{MVA_t - MVA_{t-1}}{MVA_{t-1}} = \frac{(MTB_t * BVA_t) - (MTB_{t-1} * BVA_{t-1})}{MTB_{t-1} * BVA_{t-1}}$$

$$= \frac{MVE_t}{MVE_{t-1}} * \left[ \frac{BVA_t / BVE_t}{BVA_{t-1} / BVE_{t-1}} \right] - 1 \quad . \tag{8a}$$

*MTB* is the weekly market to book ratio, *BVA* (*BVE*) is the weekly book value of assets (equity), and MVE is market value of equity. Because book value of equity and book value of assets are only reported on a quarterly basis, we linearly interpolate the book value over the quarter on a weekly basis. To compute the weekly percentage change in the banks market value of equity, we use CRSP and compute a weekly stock return for the bank. Note that equity returns can be recovered from (8a) by setting the ratio inside the square bracket equal to one.

### II. Macro state variable vector M used to estimate time varying VaRs

The *M* vector we use follows Adrian and Brunnermeier [2011]. The vector consists of: 1) *VIX,* which captures the implied volatility of the S&P 500 reported by the CBOE; 2) *Liquidity Spread*, defined as the difference between the 3-month general collateral repo rate and the 3-month bill rate *Liquidity Spread* is a proxy for short-term liquidity risk in market. We obtain the repo rates from Bloomberg and the bill rates from the Federal Bank of New York; 3) The change in the 3-

month T-Bill rate (*Δ3T-Bill*), as it predicts the tails of the distribution better in the financial sector than the level; 4) Δ*Yield Curve Slope*, measured as the yield spread between the 10-year Treasury rate and the 3-month rate; 5) *ΔCredit Spread*, defined as change in the spread between BAA-rated bonds and the Treasury rate with the same 10-year maturity; 6) The weekly value weighted equity market return ($Ret_{Mrkt}$); and 7) the weekly real estate (SIC code 65-66) sector return in excess of the market return ($Ret_{Estate}$). The 3-month T-Bill, 10-year Treasury, and spread between BAA-rated bonds and Treasuries are obtained from the Federal Reserve. The market returns are from CRSP.

**Table 1 – Descriptive Statistics**

*BCE* is the number of occurrences of competition-related words per 1,000 total words in the 10-k (Li et al. [2013]). *VaR* is defined as the bank's 1 percentile value-at-risk over the quarter. *ΔCoVaR* is our measure of systemic risk which is computed as the market's value-at risk conditional on the bank's value-at-risk. *LLP* is loan loss provision scaled by lagged total loans. *ΔNPL* is the change in nonperforming loans over the quarter scaled by lagged total loans. *EBLLP* is earnings before tax and loan loss provision scaled by lagged total loans. *LCO* is gross charge-offs scaled by lagged loans. *Loan Growth* is the percentage change in total loans over the quarter. *Commercial* is the percentage of the loan portfolio in commercial loans. *Consumer* is the percentage of consumer loans to total loans. *RealEstate* is the percentage of real estate loans to total loans. *Mismatch* is the maturity mismatch. *Trading* is computed as total trading assets divided by total assets. *RevMix* is the ratio of non-interest income to total interest income. *Deposits* is total deposits scaled by lagged total loans. *Tier1* is the bank's tier 1 capital ratio. *Size* is the natural logarithm of total assets. *Borrower Z-Score* is the Altman z-score (Altman [1977]) of the borrower. *Borrower EDF* is the expected default frequency (Bharath and Shumway [2008]). *Borrower Size* is the natural logarithm of the bank's (firm's) lagged total assets. *Spread* is the basis points over Libor on the loan. *#Covenants* is the number of financial and net worth covenants associated with the package. *Revolver* is an indicator variable equal to 1 if the facility is a revolver and 0 otherwise. *Amount* is the natural log of the facility amount. *Maturity* is the number of months to maturity.

| **Variables** | **Mean** | **Median** | **StdDev** |
|---|---|---|---|
| *BCE* | 0.3524 | 0.3071 | 0.2597 |
| $VaR^A$ | -1.4701 | -1.2699 | 0.8477 |
| $\Delta CoVaR^A$ | -0.2218 | -0.1990 | 0.1595 |
| $VaR^E$ | -1.4737 | -1.2652 | 0.8696 |
| $\Delta CoVaR^E$ | -0.1969 | -0.1752 | 0.1451 |
| *MES* | -0.0122 | -0.0092 | 0.0237 |
| *LLP* | 0.0013 | 0.0007 | 0.0019 |
| *ΔNPL* | 0.0006 | 0.0001 | 0.0042 |
| *EBLLP* | 0.0071 | 0.0068 | 0.0038 |
| *LCO* | 0.0019 | 0.0007 | 0.0031 |
| *Loan Growth* | 0.0341 | 0.0207 | 0.1125 |
| *Commercial* | 0.1209 | 0.1087 | 0.1157 |
| *Consumer* | 0.0243 | 0.0000 | 0.0576 |
| *RealEstate* | 0.4677 | 0.5949 | 0.3520 |
| *Maturity Mismatch* | 0.8442 | 0.8703 | 0.1043 |
| *Trading* | 0.0011 | 0.0000 | 0.0069 |
| *RevenueMix* | 0.1451 | 0.1267 | 0.0947 |
| *Deposits* | 1.2166 | 1.1608 | 0.3085 |
| *Tier 1* | 0.1113 | 0.1061 | 0.0371 |
| *Size* | 7.4284 | 7.0732 | 1.5633 |
| *Borrower Z-Score* | 2.8391 | 2.4628 | 2.0701 |
| *Borrower EDF* | 5.9444 | 0.0000 | 17.9323 |
| *Borrower Size* | 7.2649 | 7.2618 | 1.6741 |
| *Spread* | 152.4018 | 125.0000 | 102.5396 |
| *#Covenants* | 2.5238 | 2.0000 | 1.1128 |
| *Revolver* | 0.8476 | 1.0000 | 0.3594 |
| *Amount* | 5.5502 | 5.6284 | 1.3282 |
| *Maturity* | 47.5580 | 59.0000 | 21.2108 |
| *LI* | 0.9419 | 0.9727 | 0.0665 |

**Table 2 – Measures of Competition (*BCE, LI, and HH*) on Interstate Regulation Index**

The table below presents the results from an OLS regression of *BCE* on *RegIndex.* Where *BCE* is defined as the number of instances the word 'competition' appears in the bank's 10-K divided by the total number of words in the 10-K (Li et al., 2013). *RegIndex* is the Rice and Strahan (2010) branching restrictiveness index, where higher values indicate more restrictions. The regression includes both bank and time fixed effects. Standard errors are clustered by bank and year.

*Panel A.*

| Variable | Dependent Variable | | |
|---|---|---|---|
| | ***BCE*** | ***BCE & Geographic Footprint*** | ***LI*** |
| *RegIndex* | -0.0068** | -0.0069** | 0.0002 |
| | [0.003] | [0.003] | [0.001] |
| *Unemployment* | 0.0031 | 0.0031 | -0.0005* |
| | [0.003] | [0.003] | [0.000] |
| *Leading Index* | 0.0025 | 0.0025 | 0.0004 |
| | [0.002] | [0.002] | [0.001] |
| Year FE | Yes | Yes | Yes |
| Firm FE | Yes | Yes | Yes |
| N | 14,633 | 14,633 | 14,633 |

*Panel B.*

| Variable | Dependent Variable | |
|---|---|---|
| | 1st Stage: *BCE* | 2nd Stage: $BCE^{Resdiual}$ |
| *RegIndex* | | -0.0062** |
| | | [0.002] |
| *Unemployment* | -0.0315*** | |
| | [0.004] | |
| *Leading Index* | 0.0148*** | |
| | [0.004] | |
| *LI* | -0.7352*** | |
| | [0.130] | |
| *HH* | 0.0258 | |
| | [0.078] | |
| Year FE | No | Yes |
| Firm FE | No | Yes |
| N | 14,633 | 14,633 |

*, **, *** Indicates significance at the 0.10, 0.05, and 0.01 level respectively.

**Table 3 – Competition and Contracting**

The below results report pooled OLS regressions. The dependent variable *Z-Score* is the Altman z-score (Altman [1977]) of the borrower. *EDF* is the borrower's expected default frequency (Bharath and Shumway [2008]). *ExtremeZ* is an indicator variable equal to 1 if the borrower's z-score is below 1.81 and 0 otherwise. *Lender BCE* is the number of occurrences of competition-related words per 1,000 total words in the 10-k (Li et al. [2013]). *Lender Tier 1* is the bank's tier 1 capital ratio at the end of the quarter. *Lender (Borrower) Size* is the natural logarithm of the bank's (firm's) lagged total assets. *Revolver* is an indicator variable equal to 1 if the package includes a revolver and 0 otherwise. *Amount* is the natural log of the package amount. *Maturity* is the number of months to maturity. *Spread* is the basis points over Libor on the loan. *#Covenants* is the number of financial and net worth covenants associated with the package. Time, Borrower and Lender fixed effects are included and standard errors are clustered by time and lender.

*Panel A – Portfolio Risk*

| | | Dependent Variables | | |
|---|---|---|---|---|
| **Variable** | **Prediction** | Z-Score | EDF | Extreme Z |
| *Lender BCE*$_{t-1}$ | − (Z-Score)<br>+ (EDF/ExtremeZ) | -0.4334**<br>[0.187] | 5.7253**<br>[2.859] | 1.17863**<br>[0.564] |
| *Lender Tier 1 (%)* | | 0.0380<br>[0.034] | -1.4081***<br>[0.535] | -0.1590*<br>[0.083] |
| *Lender Size* | | -0.0451<br>[0.119] | 1.4272<br>[1.327] | 0.4841<br>[0.301] |
| *Borrower Size* | | -0.6891***<br>[0.088] | -0.7354<br>[1.090] | 1.2158***<br>[0.113] |
| *Revolver* | | -0.0950<br>[0.060] | 3.4371***<br>[1.098] | 0.1828<br>[0.171] |
| *Amount* | | -0.0011<br>[0.047] | 0.2433<br>[0.523] | 0.0271<br>[0.108] |
| *Maturity* | | 0.0034***<br>[0.001] | -0.1123***<br>[0.021] | -0.0071<br>[0.005] |
| *Spread* | | -0.0059***<br>[0.000] | 0.0730***<br>[0.007] | 0.0141***<br>[0.001] |
| *#Covenants* | | -0.0561**<br>[0.027] | -1.5090***<br>[0.400] | -0.0908*<br>[0.055] |
| Estimation | | OLS | OLS | Probit |
| Fixed Effect | | Bank, Borrower, Time | Bank, Borrower, Time | Bank, Borrower, Time |
| Observations | | 6,546 | 6,546 | 1,854 |
| R-squared | | 0.840 | 0.641 | |

***, **, * indicates significance at the 0.01, 0.05, and 010 level respectively.

**Table 3 – Competition and Contracting**

The below results report pooled OLS regressions. The dependent variable *Spread* is the basis points over Libor on the loan. *Lender BCE* is the number of occurrences of competition-related words per 1,000 total words in the 10-k (Li et al. [2013]). *Lender Tier 1* is the bank's tier 1 capital ratio at the end of the quarter. *Lender (Borrower) Size* is the natural logarithm of the bank's (firm's) lagged total assets. *Borrower Z-Score* is the Altman z-score (Altman [1977]) of the borrower. *Borrower EDF* the expected default frequency (Bharath and Shumway [2008]). *ExtremeZ* is an indicator variable equal to 1 if the borrower's z-score is below 1.81 and 0 otherwise. *Revolver* is an indicator variable equal to 1 if the package includes a revolver and 0 otherwise. *Amount* is the natural log of the package amount. *Maturity* is the number of months to maturity. *#Covenants* is the number of financial and net worth covenants associated with the package. Time, Borrower and Lender fixed effects are included and standard errors are clustered by time and lender.

*Panel B – Under Pricing*

| **Variable** | **Prediction** | **Dependent Variable: Spread** | | | |
|---|---|---|---|---|---|
| *Lender $BCE_{t-1}$* Z-Score* | + | 15.0750*** | | 14.6132*** | |
| | | [4.321] | | [3.876] | |
| *Lender $BCE_{t-1}$* EDF* | – | | -0.4430 | -0.0870 | |
| | | | [0.685] | [0.651] | |
| *Lender $BCE_{t-1}$*ExtremeZ* | – | | | | -50.7016*** |
| | | | | | [18.613] |
| *Lender $BCE_{t-1}$* | | -15.9468 | 28.0358** | -20.8043 | 49.5375*** |
| | | [18.818] | [13.736] | [18.864] | [13.696] |
| *Lender Tier 1 (%)* | | 2.3144 | 3.2667 | 3.5663 | 2.6899 |
| | | [2.393] | [2.410] | [2.253] | [2.431] |
| *Lender Size* | | -1.8497 | -2.3409 | -3.1981 | -0.9965 |
| | | [6.214] | [6.421] | [5.941] | [6.340] |
| *Borrower Z-Score* | – | -19.2750*** | | -16.3988*** | |
| | | [1.317] | | [1.244] | |
| *Borrower EDF* | + | | 1.3223*** | 1.0387*** | |
| | | | [0.160] | [0.154] | |
| *Borrower ExtremeZ* | + | | | | 58.4934*** |
| | | | | | [4.369] |
| *Borrower Size* | | -25.0786*** | -12.9323*** | -21.4505*** | -21.3105*** |
| | | [3.902] | [3.944] | [3.958] | [3.850] |
| *Revolver* | | -4.0803 | -6.7814 | -7.1977* | -3.0726 |
| | | [4.283] | [4.535] | [4.226] | [4.580] |
| *Amount* | | -1.3097 | -1.5674 | -1.4820 | -0.8031 |
| | | [2.494] | [2.356] | [2.291] | [2.579] |
| *Maturity* | | 0.1736* | 0.2574*** | 0.2724*** | 0.1353 |
| | | [0.097] | [0.097] | [0.093] | [0.104] |
| *#Covenants* | | 11.0501*** | 14.0856*** | 11.9850*** | 12.7146*** |
| | | [1.607] | [1.585] | [1.553] | [1.617] |
| Fixed Effect | | Bank, Borrower, Time | Bank, Borrower, Time | Bank, Borrower, Time | Bank, Borrower, Time |
| Observations | | 6,546 | 6,546 | 6,546 | 6,546 |
| R-squared | | 0.825 | 0.812 | 0.825 | 0.805 |

***, **, * indicates significance at the 0.01, 0.05, and 010 level respectively.

**Table 3 – Competition and Contracting**

The below results report pooled OLS regressions. The dependent variable *#Covenants* is the number of financial and net worth covenants associated with the package. *Lender BCE* is the number of occurrences of competition-related words per 1,000 total words in the 10-k (Li et al. [2013]). *Lender Tier 1* is the bank's tier 1 capital ratio at the end of the quarter. *Lender (Borrower) Size* is the natural logarithm of the bank's (firm's) lagged total assets. *Borrower Z-Score* is the Altman z-score (Altman [1977]) of the borrower. *Borrower EDF* the expected default frequency (Bharath and Shumway [2008]). *Revolver* is an indicator variable equal to 1 if the package includes a revolver and 0 otherwise. *Amount* is the natural log of the package amount. *Maturity* is the number of months to maturity. *Spread* is the basis points over Libor on the loan. Time, Borrower and Lender fixed effects are included and standard errors are clustered by time and lender.

*Panel C – Relaxed Activity Restrictions*

| **Variable** | **Prediction** | **Dependent Variable: #Covenants** | | |
|---|---|---|---|---|
| *Lender BCE$_{t-1}$* | – | -0.2747** | -0.2420** | -0.2526** |
| | | [0.114] | [0.117] | [0.113] |
| *Lender Tier 1 (%)* | | -0.0445** | -0.0490** | -0.0485** |
| | | [0.021] | [0.022] | [0.022] |
| *Lender Size* | | -0.0079 | -0.0025 | -0.0033 |
| | | [0.045] | [0.044] | [0.044] |
| *Borrower Z-Score* | | -0.0139 | | -0.0209 |
| | | [0.020] | | [0.019] |
| *Borrower EDF* | | | -0.0030** | -0.0033** |
| | | | [0.001] | [0.001] |
| *Borrower Size* | | 0.0511 | 0.0564 | 0.0419 |
| | | [0.044] | [0.045] | [0.042] |
| *Revolver* | | 0.0208 | 0.0328 | 0.0313 |
| | | [0.031] | [0.030] | [0.030] |
| *Amount* | | -0.0129 | -0.0119 | -0.0120 |
| | | [0.018] | [0.018] | [0.018] |
| *Maturity* | | 0.0019* | 0.0015* | 0.0016* |
| | | [0.001] | [0.001] | [0.001] |
| *Spread* | | 0.0016*** | 0.0020*** | 0.0017*** |
| | | [0.000] | [0.000] | [0.000] |
| Fixed Effect | | Bank, Borrower, Time | Bank, Borrower, Time | Bank, Borrower, Time |
| Observations | | 6,546 | 6,546 | 6,546 |
| R-squared | | 0.771 | 0.772 | 0.772 |

***, **, * indicates significance at the 0.01, 0.05, and 010 level respectively.

**Table 4 – Competition and Accrual Choices**

The below results report pooled OLS regressions. The dependent variable *LLP* is defined as the loan loss provision scaled by lagged total loans. *BCE* is the number of occurrences of competition-related words per 1,000 total words in the 10-k (Li et al. [2013]). *ΔNPL* is the change in nonperforming loans over the quarter scaled by lagged total loans. *EBLLP* is earnings before tax and loan loss provision scaled by lagged total loans. *Loan Growth* is the percentage change in total loans over the quarter. *Size* is the natural logarithm of lagged total assets. *Tier 1* is the bank's tier 1 capital ratio at the end of the quarter. *Consumer* is the percentage of consumer loans to total loans. *Commercial* is the percentage of the loan portfolio in commercial loans. *RealEstate* is the percentage of real estate loans to total loans. *Big5* is an indicator variable set equal to 1 if the bank is audited by a big 5 auditor and 0 otherwise. Both time and bank fixed effects are included and the standard errors are clustered by bank and time.

| Variable | Predictions | Dependent Variable: $LLP_t$ |
|---|---|---|
| $BCE_{t-1}*\Delta NPL_{t+1}$ | – | -0.0552*** |
| | | [0.017] |
| $BCE_{t-1}*\Delta NPL_t$ | – | -0.0972*** |
| | | [0.018] |
| $Consumer*\Delta NPL_{t+1}$ | | 0.1298 |
| | | [0.110] |
| $Consumer*\Delta NPL_t$ | | 0.2492* |
| | | [0.140] |
| $Commercial*\Delta NPL_{t+1}$ | | 0.1043** |
| | | [0.042] |
| $Commercial*\Delta NPL_t$ | | 0.2581*** |
| | | [0.059] |
| $Real\ Estate*\Delta NPL_{t+1}$ | | -0.0010 |
| | | [0.016] |
| $Real\ Estate*\Delta NPL_t$ | | -0.0239 |
| | | [0.021] |
| $BCE_{t-1}$ | | 0.0003*** |
| | | [0.000] |
| $\Delta NPL_{t+1}$ | | 0.0308*** |
| | | [0.008] |
| $\Delta NPL_t$ | | 0.0782*** |
| | | [0.012] |
| $\Delta NPL_{t-1}$ | | 0.0575*** |
| | | [0.008] |
| $\Delta NPL_{t-2}$ | | 0.0521*** |
| | | [0.008] |
| *EBLLP* | | -0.0072 |
| | | [0.011] |
| *Loan Growth* | | -0.0001 |
| | | [0.001] |
| *Size* | | 0.0003*** |
| | | [0.000] |
| *Tier1* | | 0.0017 |
| | | [0.002] |
| *Consumer* | | 0.0006 |
| | | [0.001] |
| *Commercial* | | 0.0004 |
| | | [0.001] |
| *RealEstate* | | 0.0001 |
| | | [0.001] |
| Fixed Effect | | Time, Bank |
| Observations | | 17,693 |
| R-squared | | 0.488 |

***, **, * indicates significance at the 0.01, 0.05, and 010 level respectively.

**Table 5 – BCE and Operating Decisions: Revenue Mix and Fee Mix**

The below results report pooled OLS regressions where the dependent variables are *RevMix* defined as non-interest revenue divided by interest revenue. *FeeMix* is defined as the total non-interest income minus deposit service charges and trading revenue divided by interest revenue. *BCE* is the number of occurrences of competition-related words per 1,000 total words in the 10-k (Li et al. [2013]). *NonInt Exp* is non-interest expense divided by interest revenue. *Commercial* is the percentage of the loan portfolio in commercial loans. *Consumer* is the percentage of consumer loans to total loans. *RealEstate* is the percentage of real estate loans to total loans. *Deposits* is the total deposits scaled by lagged total loans. *Mismatch* is the maturity mismatch. *Tier1* is the bank's tier 1 capital ratio. *Size* is the natural logarithm of total assets. *ROA* is defined as net income divided by total assets. Time and bank fixed effects are included in the regression and standard errors are clustered by time and bank.

| | | Dependent Variable | |
|---|---|---|---|
| **Variable** | **Prediction** | **RevMix** | **FeeMix** |
| $BCE_{t-1}$ | + | 0.0153*** | 0.0130*** |
| | | [0.004] | [0.004] |
| *NonInt Exp* | | 0.4429*** | 0.2998*** |
| | | [0.028] | [0.029] |
| *Commercial* | | 0.0229 | 0.0360 |
| | | [0.016] | [0.026] |
| *Consumer* | | 0.0074 | 0.0536** |
| | | [0.024] | [0.025] |
| *RealEstate* | | 0.0434*** | 0.0416*** |
| | | [0.008] | [0.014] |
| *Deposits* | | -0.0084* | -0.0242*** |
| | | [0.005] | [0.007] |
| *Mismatch* | | -0.0457*** | -0.0242 |
| | | [0.013] | [0.017] |
| *Tier1* | | -0.0421 | -0.0951 |
| | | [0.051] | [0.068] |
| *Size* | | 0.0069* | 0.0139** |
| | | [0.004] | [0.006] |
| *ROA* | | 15.5009*** | 12.6299*** |
| | | [1.284] | [1.448] |
| Fixed Effects | | Time, Bank | Time, Bank |
| Observations | | 18,444 | 10,054 |
| $R^2$ | | 0.827 | 0.764 |

***, **, * indicates significance at the 0.01, 0.05, and 010 level respectively.

**Table 6 – Competition and Regulatory Capital**

The below results report pooled OLS regressions where the dependent is *Tier1* defined as the bank's tier 1 capital ratio. *BCE* is the number of occurrences of competition-related words per 1,000 total words in the 10-k (Li et al. [2013]). *Trading* is the percent of trading revenue divided by interest revenue. *Commercial* is the percentage of the loan portfolio in commercial loans. *Consumer* is the percentage of consumer loans to total loans. *RealEstate* is the percentage of real estate loans to total loans. *Mismatch* is the maturity mismatch. *Deposits* is the total deposits scaled by lagged total loans. *ROA* is the bank's return on assets. *Size* is the natural logarithm of total assets. $\beta_{mrkt}$ is defined and the market beta of the bank over the prior period. *MTB* is the bank's market to book ratio. Time and bank fixed effects are included in the regression and standard errors are clustered by time and bank.

| **Variable** | **Prediction** | **Dependent Variable: *Tier1*** |
|---|---|---|
| $BCE_{t-1}$ | – | -0.0032** |
| | | [0.001] |
| *Trading* | | 0.0664** |
| | | [0.032] |
| *Commercial* | | -0.0126* |
| | | [0.007] |
| *Consumer* | | 0.0439*** |
| | | [0.008] |
| *RealEstate* | | -0.0002 |
| | | [0.002] |
| *Mismatch* | | 0.0077** |
| | | [0.003] |
| *Deposits* | | 0.0072*** |
| | | [0.002] |
| *ROA* | | 0.7964*** |
| | | [0.243] |
| *Size* | | -0.0113*** |
| | | [0.002] |
| $\beta_{mrkt}$ | | 0.0027*** |
| | | [0.001] |
| *MTB* | | -0.0003* |
| | | [0.000] |
| Fixed Effect | | Time, Bank |
| Observations | | 15,199 |
| R-squared | | 0.701 |

***, **, * indicates significance at the 0.01, 0.05, and 010 level respectively.

**Table 7 – Competition and Individual Bank Risk – Future Charge-offs**

The below results report pooled OLS regressions. The dependent variable $LCO_{12m}$ ($LCO_{24m}$) is defined as gross charge-offs scaled by lagged total loans over the next 12 (24) months. *BCE* is the number of occurrences of competition-related words per 1,000 total words in the 10-k (Li et al. [2013]). *ΔNPL* is the change in nonperforming loans over the quarter scaled by lagged total loans. *Loan Growth* is the percentage change in total loans over the quarter. *Size* is the natural logarithm of lagged total assets. *Tier 1* is the bank's tier 1 capital ratio at the end of the quarter. *Consumer* is the percentage of consumer loans to total loans. *Commercial* is the percentage of commercial loans to total loans. *Real Estate* is the percentage of real estate loans to total loans. Both time and bank fixed effects are included and the standard errors are clustered by bank and time.

| | | Dependent Variables | |
|---|---|---|---|
| **Variable** | **Prediction** | $LCO_{12m}$ | $LCO_{24m}$ |
| $BCE_{t-1}$*Loan Growth* | + | 0.0109*** | 0.0198** |
| | | [0.004] | [0.008] |
| $BCE_{t-1}$*Consumer* | | -0.0026 | -0.0011 |
| | | [0.013] | [0.032] |
| $BCE_{t-1}$*Commercial* | | 0.0032 | 0.0189 |
| | | [0.009] | [0.018] |
| $BCE_{t-1}$*RealEstate* | | -0.0069 | 0.0087 |
| | | [0.005] | [0.015] |
| $BCE_{t-1}$ | | 0.0018** | 0.0029** |
| | | [0.001] | [0.001] |
| $\Delta NPL_t$ | | 0.5187*** | 0.7869*** |
| | | [0.062] | [0.136] |
| $\Delta NPL_{t-1}$ | | 0.4538*** | 0.5879*** |
| | | [0.056] | [0.111] |
| $\Delta NPL_{t-2}$ | | 0.4289*** | 0.4512*** |
| | | [0.062] | [0.091] |
| *Loan Growth* | | -0.0093** | -0.0284** |
| | | [0.004] | [0.013] |
| *Size* | | 0.0042*** | 0.0113*** |
| | | [0.001] | [0.002] |
| *Tier 1* | | -0.0010 | -0.0524*** |
| | | [0.009] | [0.012] |
| *Consumer* | | -0.0002 | -0.0145 |
| | | [0.004] | [0.011] |
| *Commercial* | | 0.0173*** | 0.0230*** |
| | | [0.002] | [0.005] |
| *RealEstate* | | 0.0024 | -0.0094*** |
| | | [0.002] | [0.003] |
| *ROA* | | -0.1238** | -0.0304 |
| | | [0.051] | [0.235] |
| Fixed Effect | | Time, Bank | Time, Bank |
| Observations | | 12,833 | 11,037 |
| R-squared | | 0.642 | 0.664 |

***, **, * indicates significance at the 0.01, 0.05, and 010 level respectively.

**Table 8 – Competition and Individual Bank Risk – *VaR* and *VaR^E***

The below results report pooled OLS regressions where the dependent variables are $VaR^A$ ($VaR^E$) and is defined as the bank's 1 percentile value-at-risk of market value of assets (equity) over the quarter. *BCE* is the number of occurrences of competition-related words per 1,000 total words in the 10-k (Li et al. [2013]). *Trading* is the percent of trading revenue divided by interest revenue. *Commercial* is the percentage of the loan portfolio in commercial loans. *Consumer* is the percentage of consumer loans to total loans. *RealEstate* is the percentage of real estate loans to total loans. *Mismatch* is the maturity mismatch. *Deposits* is the total deposits scaled by lagged total loans. *ROA* is the bank's return on assets. *Tier1* is the bank's tier 1 capital ratio. *Size* is the natural logarithm of total assets. $\sigma_E$ is the standard deviation of equity returns. $\beta_{mrkt}$ is defined and the market beta of the bank over the prior period. *Illiquid* is the average daily illiquid of the stock over the quarter. *MTB* is the bank's market to book ratio. Time and bank fixed effects are included in the regression and standard errors are clustered by time and bank.

*Panel A. VaR*

| | Dependent Variable | | | |
|---|---|---|---|---|
| **Variable** | $VaR^A_{1\%}$ | $\Delta VaR^A_{Left}$ | $VaR^A_{50\%}$ | $\Delta VaR^A_{Right}$ |
| $BCE_{t-1}$ | -0.0737*** | 0.0750*** | 0.0013 | 0.0496 |
| | [0.021] | [0.020] | [0.002] | [0.054] |
| *Trading* | 0.5162 | -0.6433 | -0.1270 | 6.4303 |
| | [1.991] | [1.995] | [0.130] | [5.259] |
| *Commercial* | -0.1900* | 0.1707 | -0.0193 | 0.4267** |
| | [0.106] | [0.106] | [0.012] | [0.190] |
| *Consumer* | 0.7333** | -0.6868** | 0.0464 | -0.8898 |
| | [0.321] | [0.317] | [0.032] | [0.556] |
| *RealEstate* | -0.1385*** | 0.1524*** | 0.0139*** | 0.0997 |
| | [0.038] | [0.037] | [0.003] | [0.070] |
| *Mismatch* | -0.0261 | 0.0456 | 0.0194* | -0.2226 |
| | [0.071] | [0.070] | [0.010] | [0.155] |
| *Deposits* | 0.0344 | -0.0402 | -0.0058* | 0.0460 |
| | [0.028] | [0.028] | [0.003] | [0.049] |
| *ROA* | 10.0582*** | -10.3364*** | -0.2781 | -13.1805* |
| | [3.566] | [3.618] | [0.194] | [6.915] |
| *Tier1* | -0.0140 | 0.0263 | 0.0123 | 0.3742 |
| | [0.236] | [0.237] | [0.017] | [0.366] |
| *Size* | -0.0291 | 0.0132 | -0.0159*** | -0.0067 |
| | [0.036] | [0.036] | [0.003] | [0.084] |
| $\sigma_E$ | -1.1551*** | 1.1457*** | -0.0094 | 1.6991** |
| | [0.429] | [0.422] | [0.008] | [0.662] |
| $\beta_{mrkt}$ | -0.0205 | 0.0189 | -0.0016 | 0.0211 |
| | [0.029] | [0.028] | [0.002] | [0.046] |
| *Illiquid* | -9.9154 | 40.3437 | 30.4284** | -51.3978 |
| | [290.799] | [285.356] | [13.707] | [459.126] |
| *MTB* | 0.0096 | -0.0062 | 0.0034*** | -0.0521*** |
| | [0.010] | [0.009] | [0.001] | [0.017] |
| Fixed Effects | Time, Bank | Time, Bank | Time, Bank | Time, Bank |
| Observations | 13,730 | 13,730 | 13,730 | 13,730 |
| $R^2$ | 0.667 | 0.666 | 0.318 | 0.791 |

***, **, * indicates significance at the 0.01, 0.05, and 010 level respectively.

**Table 8 – Competition and Individual Bank Risk –*VaR* and *VaR^E* *(Continued)***

The below results report pooled OLS regressions where the dependent variables are *VaR* ($VaR^E$) and is defined as the bank's 1 percentile value-at-risk of market value of assets (equity) over the quarter. *BCE* is the number of occurrences of competition-related words per 1,000 total words in the 10-k (Li et al. [2013]). *Trading* is the percent of trading revenue divided by interest revenue. *Commercial* is the percentage of the loan portfolio in commercial loans. *Consumer* is the percentage of consumer loans to total loans. *RealEstate* is the percentage of real estate loans to total loans. *Mismatch* is the maturity mismatch. *Deposits* is the total deposits scaled by lagged total loans. *ROA* is the bank's return on assets. *Tier1* is the bank's tier 1 capital ratio. *Size* is the natural logarithm of total assets. $\sigma_E$ is the standard deviation of equity returns. $\beta_{mrkt}$ is defined and the market beta of the bank over the prior period. *Illiquid* is the average daily illiquid of the stock over the quarter. *MTB* is the bank's market to book ratio. Time and bank fixed effects are included in the regression and standard errors are clustered by time and bank.

*Panel B. $VaR^E$*

| | Dependent Variable | | | |
|---|---|---|---|---|
| **Variable** | $VaR^E_{1\%}$ | $\Delta VaR^E_{left}$ | $VaR^E_{50\%}$ | $\Delta VaR^E_{Right}$ |
| $BCE_{t-1}$ | -0.0604*** | 0.0580*** | -0.0024 | 0.0590 |
| | [0.021] | [0.021] | [0.002] | [0.052] |
| *Trading* | 0.5262 | -0.6244 | -0.0981 | 6.8116 |
| | [2.124] | [2.136] | [0.112] | [5.204] |
| *Commercial* | -0.0846 | 0.0666 | -0.0180* | 0.4471** |
| | [0.102] | [0.100] | [0.010] | [0.193] |
| *Consumer* | 0.7515** | -0.6955** | 0.0560* | -0.8594 |
| | [0.319] | [0.315] | [0.032] | [0.543] |
| *RealEstate* | -0.1693*** | 0.1747*** | 0.0054 | 0.0837 |
| | [0.039] | [0.037] | [0.004] | [0.069] |
| *Mismatch* | -0.0069 | 0.0248 | 0.0178** | -0.2176 |
| | [0.072] | [0.070] | [0.008] | [0.150] |
| *Deposits* | 0.0326 | -0.0341 | -0.0015 | 0.0325 |
| | [0.027] | [0.027] | [0.002] | [0.051] |
| *ROA* | 10.1769*** | -9.8016*** | 0.3752* | -11.7684* |
| | [3.395] | [3.237] | [0.209] | [6.511] |
| *Tier1* | 0.0377 | -0.0595 | -0.0219 | 0.4304 |
| | [0.240] | [0.242] | [0.013] | [0.359] |
| *Size* | -0.0360 | 0.0235 | -0.0125*** | 0.0213 |
| | [0.038] | [0.038] | [0.003] | [0.081] |
| $\sigma_E$ | -1.1881*** | 1.1668*** | -0.0214** | 1.6382** |
| | [0.431] | [0.422] | [0.009] | [0.638] |
| $\beta_{mrkt}$ | -0.0209 | 0.0188 | -0.0021 | 0.0206 |
| | [0.029] | [0.028] | [0.002] | [0.044] |
| *Illiquid* | 72.3665 | -47.7744 | 24.5921** | 83.1694 |
| | [321.465] | [315.304] | [9.482] | [473.623] |
| *MTB* | 0.0101 | -0.0070 | 0.0031** | -0.0478*** |
| | [0.011] | [0.010] | [0.001] | [0.017] |
| Fixed Effects | Time, Bank | Time, Bank | Time, Bank | Time, Bank |
| Observations | 13,730 | 13,730 | 13,730 | 13,730 |
| $R^2$ | 0.667 | 0.665 | 0.334 | 0.796 |

***, **, * indicates significance at the 0.01, 0.05, and 010 level respectively.

**Table 9 – Competition and Systemic Risk – *ΔCoVaR*, *ΔCoVaR$^E$*, and Marginal Expected Shortfall (*MES*)**

The below results report pooled OLS regressions where the dependent variables are: $\Delta CoVaR^A$ ($\Delta CoVaR^E$) is the bank's contribution to the system's 1 percent $VaR^A(VaR^E)$. *MES* and is defined as the bank's average daily return computed over the trading days where the market return was in the bottom 5% over the quarter. *BCE* is the number of occurrences of competition-related words per 1,000 total words in the 10-k (Li et al. [2013]). *Trading* is the percent of trading revenue divided by interest revenue. *Commercial* is the percentage of the loan portfolio in commercial loans. *Consumer* is the percentage of consumer loans to total loans. *RealEstate* is the percentage of real estate loans to total loans. *Mismatch* is the maturity mismatch. *Deposits* is the total deposits scaled by lagged total loans. *ROA* is the bank's return on assets. *Tier1* is the bank's tier 1 capital ratio. *Size* is the natural logarithm of total assets. $\sigma_E$ is the standard deviation of equity returns. $\beta_{mrkt}$ is defined and the market beta of the bank over the prior period. *Illiquid* is the average daily illiquid of the stock over the quarter. *MTB* is the bank's market to book ratio. Time and bank fixed effects are included in the regression and standard errors are clustered by time and bank.

| | **Dependent Variable** | | |
|---|---|---|---|
| **Variable** | ***ΔCoVaR$^A$*** | ***ΔCoVaR$^E$*** | ***MES*** |
| *$BCE_{t-1}$* | -0.0156*** | -0.0124*** | -0.0025** |
| | [0.004] | [0.003] | [0.001] |
| *Trading* | 0.4568 | 0.3578 | -0.0475 |
| | [0.276] | [0.224] | [0.064] |
| *Commercial* | 0.0051 | -0.0006 | -0.0086 |
| | [0.014] | [0.012] | [0.007] |
| *Consumer* | 0.1118** | 0.0799 | 0.0012 |
| | [0.052] | [0.054] | [0.012] |
| *RealEstate* | -0.0289*** | -0.0215*** | -0.0022 |
| | [0.005] | [0.005] | [0.002] |
| *Mismatch* | 0.0173 | 0.0208* | -0.0015 |
| | [0.013] | [0.011] | [0.003] |
| *Deposits* | 0.0039 | 0.0039 | 0.0030*** |
| | [0.004] | [0.003] | [0.001] |
| *ROA* | 0.2471 | 0.2508 | 0.3102*** |
| | [0.279] | [0.266] | [0.101] |
| *Tier1* | -0.0810* | -0.0728** | -0.0346** |
| | [0.042] | [0.032] | [0.014] |
| *Size* | -0.0060 | -0.0046 | -0.0039** |
| | [0.004] | [0.004] | [0.002] |
| $\sigma_E$ | -0.1021*** | -0.0948*** | -0.0137 |
| | [0.037] | [0.036] | [0.008] |
| $\beta_{mrkt}$ | 0.0002 | 0.0007 | -0.0080*** |
| | [0.003] | [0.003] | [0.001] |
| *Illiquid* | 22.8645 | 60.2791 | 10.0473 |
| | [37.562] | [43.901] | [11.830] |
| *MTB* | 0.0015 | 0.0013 | -0.0006 |
| | [0.001] | [0.001] | [0.000] |
| Fixed Effects | Time, Bank | Time, Bank | Time, Bank |
| N | 13,730 | 13,730 | 14,282 |
| $R^2$ | 0.848 | 0.857 | 0.359 |

***, **, * indicates significance at the 0.01, 0.05, and 010 level respectively.

**Table 10 – Deregulation, Channels and Risk**

The below results present pooled OLS regressions of the paper's primary analyses controlling using the regulation index (*RegIndex*). All of the same controls from the original analyses are included but not reported. Time and bank fixed effects are included in the regression and standard errors are clustered by time and bank.

*Panel A. Channels – Accounting & Revenue Mix*

| | Dependent Variable | |
|---|---|---|
| **Variable** | ***LLP*** | ***RevMix*** |
| $RegIndex_t$ | -0.0001** | -0.0005 |
| | [0.000] | [0.001] |
| $RegIndex_t * \Delta NPL_{t+1}$ | 0.0034* | |
| | [0.002] | |
| $RegIndex_t * \Delta NPL_t$ | 0.0067** | |
| | [0.003] | |
| Controls | Included | Included |
| Fixed Effects | Time, Bank | Time, Bank |
| Observations | 15,905 | 15,117 |
| $R^2$ | 0.84 | 0.48 |

*Panel B. Individual Risk (Charge-offs, $VaR^A$ & $VaR^E$) and Systemic Risk ($\Delta CoVaR^A$, $\Delta CoVaR^E$, & MES)*

| | Dependent Variable | | | | | |
|---|---|---|---|---|---|---|
| **Variable** | **$LCO_{24M}$** | $VaR^A_{1\%}$ | $VaR^E_{1\%}$ | $\Delta CoVaR^A$ | $\Delta CoVaR^E$ | ***MES*** |
| $RegIndex_t$ | -0.0007*** | 0.0292*** | 0.032*** | 0.0038** | 0.0039*** | 0.0007** |
| | [0.000] | [0.009] | [0.009] | [0.001] | [0.001] | [0.000] |
| $RegIndex_t$*LoanGrowth | -0.0075** | | | | | |
| | [0.003] | | | | | |
| Controls | Included | Included | Included | Included | Included | Included |
| Fixed Effects | Time, Bank | Time, Bank | Time, Bank | Time, Bank | Time, Bank | Time, Bank |
| Observations | 10,280 | 11,999 | 11,999 | 11,827 | 11,827 | 11,998 |
| $R^2$ | 0.66 | 0.80 | 0.61 | 0.85 | 0.85 | 0.24 |

***, **, * indicates significance at the 0.01, 0.05, and 010 level respectively.

**Table 11 – Channels and Risk in the Post-Deregulation Period**

The below results present pooled OLS regressions of the paper's primary analyses during the post deregulation period. All of the same controls from the original analyses are included but not reported. Time and bank fixed effects are included in the regression and standard errors are clustered by time and bank.

*Panel A. Channels – Accounting & Revenue Mix*

| | Dependent Variable | |
|---|---|---|
| **Variable** | ***LLP*** | ***RevMix*** |
| $BCE_{t-1}$ | 0.0003*** | 0.0143*** |
| | [0.000] | [0.004] |
| $BCE_{t-1} * \Delta NPL_{t+1}$ | -0.0509*** | |
| | [0.017] | |
| $BCE_{t-1} * \Delta NPL_{t}$ | -0.0902*** | |
| | [0.018] | |
| Controls | Included | Included |
| Fixed Effects | Time, Bank | Time, Bank |
| Observations | 17,803 | 16,806 |
| $R^2$ | 0.81 | 0.49 |

*Panel B. Individual Risk (Charge-offs, $VaR^A$ & $VaR^E$) and Systemic Risk ($\Delta CoVaR^A$, $\Delta CoVaR^E$, & MES)*

| | Dependent Variable | | | | | |
|---|---|---|---|---|---|---|
| **Variable** | **$LCO_{24M}$** | $VaR^A_{1\%}$ | $VaR^E_{1\%}$ | $\Delta CoVaR^A$ | $\Delta CoVaR^E$ | ***MES*** |
| $BCE_{t-1}$ | 0.0034** | -0.0777*** | -0.0672*** | -0.0158*** | -0.0122*** | -0.0025** |
| | [0.001] | [0.020] | [0.019] | [0.004] | [0.003] | [0.001] |
| $BCE_{t-1}*LoanGrowth$ | 0.0191** | | | | | |
| | [0.008] | | | | | |
| Controls | Included | Included | Included | Included | Included | Included |
| Fixed Effects | Time, Bank | Time, Bank | Time, Bank | Time, Bank | Time, Bank | Time, Bank |
| Observations | 10,355 | 13,271 | 13,271 | 12,929 | 12,929 | 13,819 |
| $R^2$ | 0.67 | 0.66 | 0.65 | 0.85 | 0.85 | 0.36 |

***, **, * indicates significance at the 0.01, 0.05, and 010 level respectively.

**Table 12 – Systemic Risk and Channels Mitigation**

The below results report pooled OLS regressions where the dependent variables are: $\Delta CoVaR^{A}$ ($\Delta CoVaR^{E}$) is the bank's contribution to the system's 1 percent $VaR^{A}$($VaR^{E}$). *MES* and is defined as the bank's average daily return computed over the trading days where the market return was in the bottom 5% over the quarter. *BCE* is the number of occurrences of competition-related words per 1,000 total words in the 10-k (Li et al. [2013]). *Timely LLP* is defined as the bank's loan loss allowance dividend by NPL. *RevMix* defined as non-interest revenue divided by interest revenue. Control Variables include: *Trading* is the percent of trading revenue divided by interest revenue. *Commercial* is the percentage of the loan portfolio in commercial loans. *Consumer* is the percentage of consumer loans to total loans. *RealEstate* is the percentage of real estate loans to total loans. *Mismatch* is the maturity mismatch. *Deposits* is the total deposits scaled by lagged total loans. *ROA* is the bank's return on assets. *Tier1* is the bank's tier 1 capital ratio. *Size* is the natural logarithm of total assets. $\sigma_E$ is the standard deviation of equity returns. $\beta_{mrkt}$ is defined and the market beta of the bank over the prior period. *Illiquid* is the average daily illiquid of the stock over the quarter. *MTB* is the bank's market to book ratio. Time and bank fixed effects are included in the regression and standard errors are clustered by time and bank.

| | **Dependent Variables** | | |
|---|---|---|---|
| **Variable** | $\Delta CoVaR^{A}$ | $\Delta CoVaR^{E}$ | ***MES*** |
| *Panel A. Not Controlling for Channels* | | | |
| $BCE_{t-1}$ | -0.0173*** | -0.0138*** | -0.0027** |
| | [0.004] | [0.004] | [0.001] |
| Controls | Included | Included | Included |
| Fixed Effects | Time, Bank | Time, Bank | Time, Bank |
| Observations | 12,383 | 12,383 | 12,383 |
| $R^2$ | 0.848 | 0.857 | 0.367 |
| *Panel B. Controlling for Channels* | | | |
| $BCE_{t-1}$ | -0.0139*** | -0.0111*** | -0.0017** |
| | [0.004] | [0.004] | [0.001] |
| Accounting Channel: | | | |
| *Timely LLP* | 0.0013*** | 0.0011*** | 0.0002*** |
| | [0.000] | [0.000] | [0.000] |
| Operations Channel: | | | |
| *RevMix* | -0.0313** | -0.0313** | -0.0011 |
| | [0.001] | [0.015] | [0.001] |
| Controls | Included | Included | Included |
| Fixed Effects | Time, Bank | Time, Bank | Time, Bank |
| Observations | 12,383 | 12,383 | 12,383 |
| $R^2$ | 0.866 | 0.857 | 0.381 |

***, **, * indicates significance at the 0.01, 0.05, and 010 level respectively.