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Bank Competition: Measurement, Decision-Making, and Risk-Taking

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ABSTRACT

This paper investigates whether greater competition increases or decreases individual bank and banking system risk. Using a new text-based measure of competition, and an instrumental variables analysis that exploits exogenous variation in bank deregulation, we provide robust evidence that greater competition increases both individual bank risk and a bank's contribution to system-wide risk. Specifically, we find that higher competition is associated with lower underwriting standards, less timely loan loss recognition, and a shift toward noninterest 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

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greater contribution by individual banks to downside risk of the banking sector.

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1. *Introduction*

Banks play a central role in the financial system. Of particular concern to bank regulators is excessive risk-taking by individual banks and banking system vulnerabilities due to correlated risk-taking across banks (e.g., Acharya et al. [2010], Hanson, Kashyap, and Stein [2011]). An important unresolved issue is the extent to which bank competition mitigates or exacerbates financial stability. Theory provides competing hypotheses on this issue. At one extreme, the competition–fragility hypothesis posits that downward competitive pressure on bank profits reduces charter value and creates incentives for excessive bank risk-taking (e.g., Keeley [1990], Allen and Gale [2000, chapter 8]). In contrast, the competition–stability hypothesis posits that banks with greater market power charge higher rates, which induces borrowing firms to take on greater risk and increases the risk of banks' loan portfolios. This leads to the hypothesis that banks become less risky as competition increases (Boyd and De Nicolo [2005]). While prior literature explores these hypotheses, the evidence is inconclusive.[1]

Using both a new text-based measure of competition and an instrumental variables analysis that exploits exogenous variation in bank deregulation, this paper investigates whether greater competition increases or decreases individual bank and banking system risk. We provide robust evidence that risk at the individual bank level and a bank's contribution to system-wide risk increase with 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, higher competition is associated with significantly higher co-dependence between downside risk of individual banks and downside risk of the entire banking sector. We also investigate key decision-making channels through which competition can operate to increase the overall riskiness of banks. We find that higher competition is associated with lower underwriting standards, less timely accounting recognition of expected loan losses, and a greater reliance on noninterest sources of income.

As Beck [2008] notes, there is no agreement about how best to measure competition. Two important classes of bank competition measures are (1) measures of industry structure, and (2) measures that infer market power without regard to industry structure (e.g., Berger et al. [2004],

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

Beck [2008], Degryse and Ongena [2008]). Industry structure measures (e.g., Herfindahl–Hirschman indices) require industry membership to be explicitly defined, making it difficult to capture competition deriving from potential entrants and nonbanks. These measures also rely on the restrictive assumption that all industry members are continuously subjected to identical levels of competition.[2] In contrast, measures of market power directly examine relationships between factor input and output prices. For example, the Lerner index is a bank-specific measure that estimates the gap between marginal revenues and costs.[3] Its construction requires estimation of cost function parameters using historical accounting data in a pooled industry regression. Reliance on historical data raises the possibility that Lerner indices are sluggish in capturing recent changes in competition, and pooled industry estimation assumes that all banks in a researcher-defined industry have identical cost function parameters.

In this paper, we do not use either industry structure or market power measures to capture competition. Rather, we capture competition using a bank-specific measure of competition extracted from banks' 10-K filings (Li, Lundholm, and Minnis [2013]) that we show captures exogenous changes in barriers to entry. The premise of this text-based measure, bank's competitive environment (*BCE*), is that it captures managers' current perceptions of competitive pressures deriving from any and all sources, including potential entrants, nonbank competitors, and labor markets. Further, *BCE* 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 a given bank due, for example, to differences in geographic footprints (Dick [2006]), business models (Altunbas, Manganelli, and Marques-Ibanez [2011]), or product-line mixes (Bolt and Humphrey [2012]).[4] Further, it requires no equilibrium assumptions, no definition of market boundaries, and no restrictive assumptions about bank cost functions.

Li, Lundholm, and Minnis [2013] make a case for the validity of this text-based measure for nonfinancial firms. Controlling for industry-level competition, they find that firm profitability mean reverts more quickly for

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

[3] A larger gap implies more market power. Another measure of market power is the Panzar–Rosse H-statistic (e.g., Claessens and Laeven [2004], Bikker, Shaffer, and Spierdijk [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.

[4] 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.

firms with higher values of the measure. While we obtain similar results in the banking industry, we significantly extend the validation process by performing a regional competition analysis and by exploiting branch bank deregulation in the United States to capture exogenous changes in the threat of entry into a state's banking market.[5] Defining regional competition at the state level, we show that an aggregated state-level measure of *BCE* is correlated with state–year level Herfindahl–Hirschman and Panzar–Rosse metrics of regional competition. We also show that *BCE* significantly increases following reductions in barriers to out-of-state branching. This result holds *after* controlling for the Lerner, Herfindahl–Hirschman, and Panzar–Rosse indices. While correlated with our *BCE* measure, the firm-specific Lerner index responds only with a lag to changes in entry threats, suggesting that *BCE* reflects changes in a *BCE* in a more timely fashion than the Lerner index.

The competition construct encompasses the idea that pressure from new and existing rivals diminishes a firm's ability to earn profits. Firms are likely to respond to increased pressure by making strategic operating and investing decisions with real consequences for both future profitability and bank risk. For example, greater competition can increase risk by pressuring banks to relax underwriting standards. Recurring surveys conducted by the Office of the Comptroller of the Currency (OCC) and the Federal Reserve show that banks regularly report that changes in competition are the most prevalent reason for easing underwriting standards.[6] We examine associations between *BCE* and characteristics of subsequent syndicated loan deals for which a bank serves as a lead arranger. We find that as competition increases, the credit quality of borrowers at loan origination decreases, loan interest spreads become less sensitive to borrowers' credit quality, and the number of covenants decreases. The consistency of our findings with the regulatory surveys provides additional evidence that *BCE* captures real competitive pressure. It also highlights one decision-making channel through which competition can operate to influence bank risk, namely, reduced underwriting standards.

We next examine two additional 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

[5] 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.

[6] For example, the 2012 Survey of Credit Underwriting Practices conducted by the 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).

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 [2015]). 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 toward noninterest sources (e.g., investment banking, proprietary trading, and insurance underwriting). As we discuss in section 3.2, a growing literature provides evidence that expanding into such nontraditional banking activities increases the riskiness of individual banks and decreases the stability of the banking system. We extend this literature by showing that the proportion of revenues a bank derives from noninterest sources is significantly increasing in *BCE*.

These results are consistent with competition changing incentives such that managers increase risk by relaxing lending standards, delaying loss recognition, and shifting revenue mix. This situation is potentially exacerbated to the extent that downward competitive pressures on profits squeeze bank capital levels.[7] Banks could potentially counteract this higher risk by increasing their capital buffers. However, they may be reluctant to do so if, for example, banks view equity as expensive (e.g., Hanson et al. [2011]). Banking theory provides no 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 the tier 1 capital finding that capital decreases as competition increases.

We next examine the overall effect of competition on individual bank risk and systemic risk. We first investigate the relation between competition and future loan performance. We predict that reduced lending standards associated with higher competition will negatively impact future loan performance, finding that the loan growth of banks facing higher competition is associated with higher future loan charge-offs relative to banks facing lower competition. We also 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 the co-dependence in downside risk of changes in both banks' equity and asset values using co-dependence measures developed by Adrian and Brunnermeier [2011] and Acharya et al. [2010].[8] We find that higher values of *BCE* are associated with banks contributing

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[7] We discuss profitability further in section 2.1.2.

[8] 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 noninterest revenue, and easing credit standards.

more to the tail risk of the financial system and having increased exposure to downside equity risk during times of system-wide distress.[9]

Similar to other measures created through textual analysis, we acknowledge that *BCE* may be measured with error or reflect managers' strategic disclosure decisions (Loughran and McDonald [2015]). To address these concerns and more convincingly establish a potential causal connection between competition and bank risk, we again exploit exogenous changes in competition that arise from branch bank deregulation. Specifically, we truncate our sample to end after the final deregulation event in the sample. We then re-estimate the risk regressions, measuring competition using the branch bank deregulation index, rather than *BCE*.[10] Consistent with competition increasing bank risk, we find that the inferences from our previous results on the relation between competition and bank risk are unchanged. Further, we also find that these results hold when we use an instrumental variables analysis in which the branch bank deregulation index is used as an instrument for *BCE*.

While we observe similar associations when using either *BCE* or the regulation index, it is important to note that the analyses using the regulation index only use variation in competition that arises from the regulation. Alternatively, *BCE* can capture incremental information by capturing variation in competition from all sources (although potentially with measurement error). Further, *BCE* can potentially be used by researchers to examine the effects of competition during periods when regulation is unchanged. To examine this possibility, we perform a post-deregulation analysis that measures competition with *BCE* and only includes observations *subsequent* to the last deregulation event in each state. All inferences from our main results on the relation between competition and bank risk are unchanged in this post-deregulation analysis. This analysis suggests that *BCE* can be of value to researchers and others seeking to measure competitive pressure at any point in time, regardless of a regulatory event.

The remainder of this paper proceeds as follows. Section 2 describes the construction of our text-based measure of competition and discusses our validation tests of *BCE* using branch banking deregulation. Section 3 investigates whether higher values of *BCE* are associated with more relaxed underwriting standards. Section 4 presents our analyses of the relations between competition and banks' accounting decisions and revenue mix choices, and section 5 presents our analyses of connections between competition and bank stability. Section 6 concludes.

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[9] While these results are consistent with competition having negative implications for bank risk, there are potentially significant positive benefits of competition that we do not address in this paper.

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

2. *Measuring Competition at the Bank Level*

In section 2.1, we detail our construction of firm-level, text-based measure of *BCE*. We then validate the *BCE* measure in section 2.2.

2.1 CONSTRUCTING A BANK-LEVEL MEASURE OF COMPETITION

A growing literature provides evidence that textual analysis techniques can be used to extract valuable information from published financial reports (e.g., Li [2010a, b], Brown and Tucker [2011], Ball, Hoberg, and Maksimovic [2013]). *BCE* is extracted from discussions of competition in banks' 10-K filings. The measure is designed to capture perceptions of competition from the perspective of top management of the overall bank holding company. The 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 multidimensional 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 construct *BCE* from banks' discussion of their competitive situation in 10-K filings, we follow the two-step algorithm developed by Li, Lundholm, and Minnis [2013] in their analysis of competition in nonbanking industries. 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.[11]

We acknowledge the possibility that a "better" measure of competition could be constructed by employing more sophisticated computational linguistic tools designed to capture meaning. However, as noted by Li, Lundholm, and Minnis [2013], capturing competition in a more structured way would require more detailed assumptions about the exact nature of

[11] In section 1.1 of the online appendix, we consider altering the original *BCE* algorithm by also removing all instances where the word competition, or one its variants (*BCE* words), was identified within three or fewer words of the following: "decrease," "decreased," "decreasing," "reduce," "reduced," "reduction," "declining," "declined," or "decline." We find that these words occur within three words of *BCE* words for less than one half of 1% of all *BCE* words. Further, when these words appear in such close proximity, firms are rarely intending to communicate a lower level of competition. Thus, our analysis suggests that incorporating these additional modifiers into the *BCE* algorithm (1) would have a little effect on the *BCE* values calculated using the original algorithm, and (2) could actually introduce additional noise into the variable. We refer the reader to section 1.1 of the online appendix for additional information about this analysis.

competition, and the context and linguistic structure of the references to competition.[12] We do not pursue alternative algorithms in this paper. We envision our main contribution to the textual analysis literature as extending Li, Lundholm, and Minnis [2013] by exploiting branch banking deregulation and other unique features of the banking setting to perform new, discriminating validation tests of *BCE* as a measure of competition.

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 *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* 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 a standard deviation of 0.26.[13] It is likely that to some extent banks use boilerplate language in their 10-K discussions of competition. However, the premise of *BCE* is that deviations from boilerplate language will be informative about changes in the competitive landscape. To mitigate concerns about boilerplate language and to focus on deviations from normal boilerplate language in the 10-K both in the time series and in the cross-section, we incorporate bank and time-fixed effects in all of our regression analysis.

2.2 VALIDATING OUR BANK-LEVEL MEASURE OF COMPETITION

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. In this section, we take up this challenge by examining (1) the relationship between *BCE* and a bank's future profitability, and (2) whether *BCE* maps into a dynamic regional measure of competition that captures the threat of entry.

2.2.1. Competition and Profitability. It is important to consider the relationship between a *BCE* and its profitability. The competition construct, at a fundamental level, encompasses the idea that more intense behavior

[12] On this point, Loughran and McDonald [2015] 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] In section 1.2 of the online appendix (table A1), we provide additional descriptive analyses of the impact that each competition word has on the *BCE* measure. In sections 1.3 and 1.4 of the online appendix, we examine time-series properties of *BCE* and compare the magnitude of banking industry *BCE* with those of nonfinancial firms.

TABLE 1
Descriptive Statistics

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
LoanGrowth	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
MTB	1.6877	1.5678	0.9891
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
Tier1	0.1113	0.1061	0.0371
Size	7.4284	7.0732	1.5633
β_{Mrkt}	0.5498	0.4108	0.6689
σ_e	0.0595	0.2437	0.1699
Z-Score	2.8391	2.4628	2.0701
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	0.1862	0.2275	2.0239

The table reports the descriptive statistics for all of the variables used in the analysis. For the calculations of each of the variables, refer to appendix C for the exact details. The sample period is from 1996 to 2012. Each of the variables is winsorized at the 1st and 99th percentiles.

from new and existing rivals diminishes a firm's ability to earn profits. Future profitability plays an important role in bank theory as profits provide a cushion to absorb future losses and avoid insolvency (e.g., Martínez and Repullo [2006], Wagner [2010], Freixas and Ma [2014]). However, future profitability is not a mechanistic consequence of current competitive pressures. While increased rivalry exerts downward pressure on profitability, banks are likely to respond by making strategic operating and investing decisions to at least partially counter the effects of more intense rivalry. Such operating and investing decisions have real consequences for both future profitability and bank risk.[14]

[14] A central tenet of theories about the relation between bank competition and risk is that banks respond to increased competitive pressure by altering their choices of borrowers,

To examine the extent to which banks are able to counter competitive profit pressure, we examine the speed in mean reversion of banks' return on assets (*ROA*) and return on equity (*ROE*) as a function of *BCE* (see the online appendix, section 1.6, for details). We document that, despite banks' strategic responses, the speed of mean reversion in bank profitability is increasing in *BCE*. Li, Lundholm, and Minnis [2013] find that firm profitability more quickly mean reverts for nonfinancial firms with higher values of the text-based competition measure. Our analysis demonstrates that this important implication of competition also holds in the banking industry using *BCE*.

It is also 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, *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).[15]

2.2.2. Bank-Level and Regional-Level Measures of Competition: A Regional-Level Analysis. Prior literature has used both the Panzar–Rosse H-statistic and the Herfindahl–Hirschman concentration metric to measure competition within a defined geographical area. The H-statistic captures the relationship between factor input prices and revenues for a bank (see appendix A for a detailed description), where an H-statistic of 1 indicates perfect competition and 0 a monopoly. The Herfindahl–Hirschman index captures the concentration of a market for a given year, where higher values are interpreted as less competition.

In addition to these two commonly used measures of regional competition (Herfindahl–Hirschman and H-statistic), we also identify changes in the threat of entry for each region based on interstate variation in both the timing and the extent of adoption by state legislatures of the 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.

lending standards, screening and monitoring efforts, loan contract features (e.g., Wagner [2010]), and leverage (Freixas and Ma [2014]), among other channels.

[15] In section 3 of the online appendix, we also consider controlling for *ROA* in the period prior to the measurement of *BCE* and the results are robust.

However, while the 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. Rice and Strahan [2010] argue that this differential deregulation of interstate branching across states, while shaped by political processes within each state, represents a good instrument to identify the effects of changes in banks' competitive environment.[16]

The IBBEA deregulation occurred at the state level and therefore we begin our validation analysis at the state level. We start by computing a comparable state-level *BCE* measure (*State BCE*). *State BCE* is defined as the average *BCE* for each state and year based on all public banks headquartered in a given state.[17] As a first validation check, we compute the correlations between *State BCE* and both state-year H-statistic (*H-Stat*) and Herfindahl–Hirschman (*HH*) measures. We expect a positive (negative) correlation between the H-statistic (Herfindahl-Hirschman) measure and our *BCE* measure. Table 2, panel A, provides evidence consistent with our predictions and suggests that *State BCE* does capture regional competition. We next examine this in a regression framework. To do this we regress *State BCE* on *H-Stat* and *HH* controlling for state- and year-fixed effects. We report the results in table 2, panel B, column 1. The results indicate that the signs of the predicted correlations are still present while only the coefficient on *H-Stat* is statistically significant. This analysis provides further validation that our *BCE* measure captures aspects of geographic competition.

We next investigate whether *State BCE* captures changes in the threat of entry using the IBBEA deregulation index. The index, denoted *RegIndex,* is 0 for states without entry restrictions (greatest threat of entry) and increases by 1 for each of the four restrictions up to a maximum of four (the least threat of entry). We use a two-step process. First, we regress *State BCE* on our state-level measures of competition (*H-Stat* and *HH*). Next, we regress the residual from this regression on *RegIndex,* the state unemployment rate (*Unemployment*), the state's expected six-month growth rate (*Leading Index*),

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[16] To the extent that state-level characteristics underpinning the political process, such as the structure of industry or the relative bargaining power of large versus small banks, are very persistent, this will be taken out by our inclusion of bank-fixed effects. See Rice and Strahan [2010] for further discussion of this point. Branch banking deregulation has been used in numerous studies to identify the effect of competition on banking markets. See, for example, Dick [2006], Johnson and Rice [2008], and Rice and Strahan [2010].

[17] We acknowledge that, by using the headquarters of the bank, we are ignoring entities that have branches and private subsidiaries in states where the headquarters are not located. To address this potential measurement error, in section 2.2.3, we construct measures of competition that reflect a weighted average of state-level competition measures based on the percentage of a bank's total deposit located in a given state.

TABLE 2

Regional Competition Measures (State BCE, H-Stat, HH) and Interstate Deregulation

Panel A: Spearmen correlation between regional competition measures

Variables	*State BCE*	*State H-Stat*
State H-Stat	0.1634***	
	(<0.01)	
State HH	–0.2741***	–0.0835***
	(<0.01)	(<0.01)

Panel B: Regression analysis

		Dependent Variable		
			Two-Stage Analysis	
Variables	Prediction	*State BCE*	*State BCE*	*State BCE Residual*
State H-Stat	+	0.0029**	0.0076***	
		[0.001]	[0.002]	
State HH	–	–0.0375	–0.1917***	
		[0.031]	[0.020]	
RegIndex	–			–0.0080*
				[0.004]
Unemployment				–0.0041
				[0.003]
Leading Index				–0.0025
				[0.003]
State-fixed effects		Yes	No	Yes
Year-fixed effects		Yes	No	Yes
R-squared		0.699	0.091	0.616
N		635	635	635

Panel A presents the Spearman correlation matrix of state-quarter *BCE*, *H-Stat*, and Herfindahl–Hirschman (p-values in parenthesis). To compute the state-year *BCE*, we first count the number of occurrences of competition-related words per 1,000 total words in the 10-K (Li, Lundholm, and Minnis [2013]) for each firm-year. In Panel B, we take the average *BCE* for each state-year and call it *State BCE. State H-Stat* and *State HH* are both calculated at the state-year level following the methodology reported in appendices A and C. *RegIndex* is the Rice and Strahan [2010] branching restrictiveness index, where higher values indicate more restrictions, and is assigned on a state-year basis. *Unemployment* is the unemployment rate for the state during year *t*. *Lending Index* is a measure of the expected six-month growth rate for the state. For detailed variable descriptions, see appendices A and C. In Panel B, the reported standard errors (in brackets) are clustered by state.

*, **, *** indicate the significance at the 0.10, 0.05, and 0.01 levels, respectively.

and state-, and year-fixed effects. We report the results from the first regression in column 2 of table 2, panel B. Both the *H-Stat* and *HH* coefficients have the expected sign. It is also noteworthy that, in the absence of year- and state-fixed effects, both coefficients are statistically significant. In column 3, we report the results from the second-stage regression. Here we find that the coefficient on *RegIndex* is negative and significant, indicating that the competitive pressure in a state (i.e., *State BCE*) decreases as restrictions on branch banking in the state increase. Taken together, table 2 provides evidence that *BCE* captures changes in state-level competition over and above what is captured by *H-Stat* and *HH*.

2.2.3. Bank-Level and Regional-Level Measures of Competition: A Bank-Level Analysis. To investigate the validation of *BCE* as a firm-level measure of competition, we again use the IBBEA as an exogenous shock to competition within a state. 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 0 for states without entry restrictions (greatest threat of entry) and increases by 1 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) with the necessary data components. We eliminate observations if the bank was involved in an acquisition during a particular quarter. The time period of our data spans 1996–2010.

Table 3, panel A, reports results from ordinary least squares (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. *RegIndex* is assigned according to the state where the bank headquarters are located. We include two control variables that reflect a state's economic performance, the unemployment rate, and the leading index for the state.[18] We also include bank- and year- fixed effects. From panel A, column 1, 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 0 (p-value < 0.05). Thus, a decrease of *RegIndex* from 4 to 0 results in a reduction of *BCE* of 2.8. This represents 8% (9%) of the mean (median) value of *BCE*. This result shows that 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 2 of table 3, 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 10-K reports, it reflects a comprehensive view of competition across all of the geographic regions in which a bank operates. We identify the states where a bank has deposits using the Summary of Deposits report from the Federal Deposit Insurance Corporation (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.

[18] 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.

TABLE 3

Firm Measures of Competition (BCE and LI) and Interstate Deregulation

Panel A

	Dependent Variable		
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-fixed effects	Yes	Yes	Yes
Firm-fixed effects	Yes	Yes	Yes
R-squared	0.606	0.607	0.931
N	14,633	14,633	14,633

Panel B

	Dependent Variable	
Variable	First Stage: *BCE*	Second Stage: $BCE^{Resdiual}$
RegIndex		–0.0027***
		[0.001]
Unemployment		0.0032
		[0.003]
Leading Index		0.0024
		[0.002]
LI	–0.8122***	
	[0.107]	
HH	0.1732	
	[0.354]	
H-Stat	0.8997***	
	[0.285]	
Year-fixed effects	No	Yes
Firm-fixed effects	No	Yes
R-squared	0.021	0.595
N	14,633	14,633

The table presents the results from an OLS regression of *BCE* on *RegIndex* over the sample period 1996–2012, 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, Lundholm, and Minnis [2013]). *RegIndex* is the Rice and Strahan [2010] branching restrictiveness index, where higher values indicate more restrictions, and is assigned on a state-year basis. *Unemployment* is the unemployment rate for the state during year *t*. *Lending Index* is a measure of the expected six-month growth rate for the state. *LI* is the firm-specific Lerner index for year *t*. *HH* is the Herfindahl–Hirschman concentration index for the state-year. *H-Stat* is the H-statistic for the state-year. For the *Geographic Footprint* analysis, we use the summary of deposits from the FDIC and create a new *RegIndex* that is the deposit-weighted average of all the state regulation index scores in which the bank has deposits. Specifically, using the Summary of Deposits from the FDIC, all variable details are described in appendices A and C. The regression includes both bank- and year-fixed effects. The reported standard errors (in brackets) have been clustered by both year and bank.

*, **, *** indicate the significance at the 0.10, 0.05, and 0.01 levels, respectively.

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 3, column 3 (entitled *LI*), we see that the Lerner index does not immediately 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 may be sluggish in capturing changes in the competitive environment relative to the more timely *BCE* measure.[19]

We next perform a two-stage regression analysis to investigate whether *BCE* reflects information incremental to that captured by Lerner state-year-level Herfindahl–Hirschman indices (*HH*) and state-year-level Panzar–Rosse H-statistics (*H-Stat*).[20] In the first stage, we estimate an OLS regression of *BCE* on the Lerner *HH* and *H-Stat* indices. As documented in column 1 of panel B, the coefficient on Lerner is –0.8122 (p-value < 0.01), while the coefficient on *HH* is 0.1732 (p-value > 0.10) and that on *H-Stat* is 0.8997 (p-value < 0.01). 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 *BCE*. Next, we take the *BCE* residual from the first stage and estimate an OLS regression of this residual against *RegIndex, Unemployment,* and *Leading Index*. In column 2 of panel B, we see that the coefficient of –0.0027 on *RegIndex* is significantly different from zero (p-value < 0.01). That is, *BCE* contains information about a *BCE* that is independent of any information reflected in Lerner, *HH*, and *H-Stat* at the firm level.

3. Competition and Changes in Banks' Credit Standards

The competition construct encompasses the idea that the pressure from new and existing rivals diminishes a firm's ability to earn profits. Firms are likely to respond to increased pressure by making strategic operating and investing decisions that can have real consequences for both future profitability and bank risk. For example, greater competition can increase risk by pressuring banks to relax underwriting standards. 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." Accordingly,

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[19] In section 2 of 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).

[20] Note that, because we are focused on only one industry, our inclusion of time-fixed effects controls out the industry-level measures of competition such as Herfindahl–Hirschman indices and H-statistics.

in this section, we investigate whether higher values of *BCE* are associated with more relaxed underwriting standards.

This analysis also provides us with an additional opportunity to provide evidence on the validity of *BCE* as a measure of competition. Specifically, we note that recurring surveys conducted by the OCC and the Federal Reserve inquire about the extent to which banks have recently eased or tightened credit standards, and their reasons for doing so. Responses to these regulatory surveys indicate that changes in competition are the most prevalent reason for easing their underwriting standards.[21] Thus, to the extent that *BCE* is a valid measure of competition, we would expect it to be negatively associated with underwriting standards. A failure to find this result would, at a minimum, cast doubt on the validity of *BCE*.

We focus on 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.[22] We examine characteristics of syndicated loan deals for which the bank serves as a 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 and Roberts [2008], 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.[23]

In addition to a set of appropriate control variables, all empirical specifications in this section and throughout the remainder of this 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).

3.1 COMPETITION 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

[21] 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.

[22] 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 rather than tightening them. Covenants are indicated as the second most frequently relaxed mechanism during these periods.

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

Altman's original weighting factors (Altman [1977]), and the borrower's estimated default frequency (*EDF*) as described by Bharath and 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.[24] We estimate the following pooled regressions, clustering standard errors by both calendar quarter and bank to correct for possible time-series and cross-sectional correlation:

$$\begin{aligned} BorrowerRisk_t = {} & \beta_0 + \beta_1 BCE_{t-1} + \beta_2 Tier1_t + \beta_3 LenderSize_t \\ & + \beta_4 BorrowerSize_t + \beta_5 Revolver_t + \beta_6 Amount_t \\ & + \beta_7 Maturity_t + \beta_8 Spread_t + \beta_9 \#Covenants_t \\ & + BorrowerEffects + BankEffects + TimeEffects + \varepsilon_t, \quad (1) \end{aligned}$$

where *BorrowerRisk* is defined as *Z-Score, EDF,* or *ExtremeZ. Tier1* 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 Size* (*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. *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 dependent variables.

Table 4, panel A, reports the results from the estimation of (1). Columns 1 and 2 in table 4, panel A, indicate that the riskiness of borrowers is increasing in *BCE.* 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.*[25] 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 a more competitive environment increases its 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.

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[24] *Z-Score* lower than 1.81 is considered to be in a "distress" zone, whereas *Z-Score* greater than 2.99 is deemed to be "safe" and *Z-Score* in between 1.81 and 2.99 is said to be in a "gray" zone.

[25] 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 are robust to the use of a linear probability model.

TABLE 4
Competition and Underwriting Standards

Panel A: Credit quality of borrowers

		Dependent Variables		
Variable	Prediction	*Z-Score*	*EDF*	*ExtremeZ*
LenderBCE$_{t-1}$	− (*Z-Score*)	–0.4334**	5.7253**	1.17863**
	+ (*EDF/Extreme Z*)	[0.187]	[2.859]	[0.564]
LenderTier1 (%)		0.0380	–1.4081***	–0.1590*
		[0.034]	[0.535]	[0.083]
LenderSize		–0.0451	1.4272	0.4841
		[0.119]	[1.327]	[0.301]
BorrowerSize		–0.6891***	–0.7354	1.2158***
		[0.088]	[1.090]	[0.113]
Revolver		–0.0950	3.4371***	0.1828
		[0.060]	[1.098]	[0.171]
Amount		–0.0011	0.2433	0.0271
		[0.047]	[0.523]	[0.108]
Maturity		0.0034***	–0.1123***	–0.0071
		[0.001]	[0.021]	[0.005]
Spread		–0.0059***	0.0730***	0.0141***
		[0.000]	[0.007]	[0.001]
#Covenants		–0.0561**	–1.5090***	–0.0908*
		[0.027]	[0.400]	[0.055]
Estimation		OLS	OLS	Probit
Fixed effects		Bank, borrower, quarter	Bank, borrower, quarter	Bank, borrower, quarter
Observations		6,546	6,546	1,854
R-squared		0.840	0.641	

Panel B: Pricing of credit risk

Variable	Prediction	Dependent Variable: *Spread*			
LenderBCE$_{t-1}$* *Z-Score*	+	15.0750***		14.6132***	
		[4.321]		[3.876]	
LenderBCE$_{t-1}$* *EDF*	–		–0.4430	–0.0870	
			[0.685]	[0.651]	
LenderBCE$_{t-1}$**ExtremeZ*	–				–50.7016***
					[18.613]
LenderBCE$_{t-1}$		–15.9468	28.0358**	–20.8043	49.5375***
		[18.818]	[13.736]	[18.864]	[13.696]
LenderTier(%)		2.3144	3.2667	3.5663	2.6899
		[2.393]	[2.410]	[2.253]	[2.431]
LenderSize		–1.8497	–2.3409	–3.1981	–0.9965
		[6.214]	[6.421]	[5.941]	[6.340]
BorrowerZ-Score	–	–19.2750***		–16.3988***	
		[1.317]		[1.244]	
BorrowerEDF	+		1.3223***	1.0387***	
			[0.160]	[0.154]	
BorrowerExtremeZ	+				58.4934***
					[4.369]
BorrowerSize		–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]

(*Continued*)

TABLE 4—*Continued*

Panel B: Pricing of credit risk

Variable	Prediction	Dependent Variable: *Spread*			
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 effects		Bank, borrower, quarter	Bank, borrower, quarter	Bank, borrower, quarter	Bank, borrower, quarter
Observations		6,546	6,546	6,546	6,546
R-squared		0.825	0.812	0.825	0.805

Panel C: Loan covenant intensity

Variable	Prediction	Dependent Variable: *#Covenants*		
$LenderBCE_{t-1}$	–	–0.2747**	–0.2420**	–0.2526**
		[0.114]	[0.117]	[0.113]
LenderTier1 (%)		–0.0445**	–0.0490**	–0.0485**
		[0.021]	[0.022]	[0.022]
LenderSize		–0.0079	–0.0025	–0.0033
		[0.045]	[0.044]	[0.044]
BorrowerZ-Score		–0.0139		–0.0209
		[0.020]		[0.019]
BorrowerEDF			–0.0030**	–0.0033**
			[0.001]	[0.001]
BorrowerSize		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 effects		Bank, borrower, quarter	Bank, borrower, quarter	Bank, borrower, quarter
Observations		6,546	6,546	6,546
R-squared		0.771	0.772	0.772

Using the sample period 1996–2012, the results in Panel A present an OLS regression for the dependent variables *Z-Score* and *EDF*, which are defined in appendix C. The *ExtremeZ* regression is a Probit regression. *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, Lundholm, and Minnis [2013]). All other variables are defined in appendix C. Each regression includes calendar quarter–, borrower-, and lender-fixed effects.

The results in Panel B report pooled OLS regressions over the time period 1996–2012. 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, Lundholm, and Minnis [2013]). All other variables are defined in appendix C. Each regression includes calendar quarter–, borrower-, and lender-fixed effects.

The results in Panel C report pooled OLS regressions over the time period 1996–2012. 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, Lundholm, and Minnis [2013]). All other variables are defined in appendix C. Each regression includes calendar quarter–, borrower-, and lender- fixed effects. The reported standard errors (in brackets) have been clustered by both calendar quarter and bank.

*, **, *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.

TABLE 5
Competition and Accrual Choices

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]
$RealEstate * \Delta NPL_{t+1}$		–0.0010
		[0.016]
$RealEstate * \Delta NPL_t$		–0.0239
		[0.021]
BCE_{t-1}		0.0003***
		[0.000]
ΔNPL_{t+1}		0.0308***
		[0.008]
ΔNPL_t		0.0782***
		[0.012]
ΔNPL_{t-1}		0.0575***
		[0.008]
ΔNPL_{t-2}		0.0521***
		[0.008]
Ebllp		–0.0072
		[0.011]
LoanGrowth		–0.0001
		[0.001]
Size		0.0003***
		[0.000]
Tier 1		0.0017
		[0.002]
Consumer		0.0006
		[0.001]
Commercial		0.0004
		[0.001]
RealEstate		0.0001
		[0.001]
Fixed effects		Quarter, bank
Observations		17,693
R-squared		0.488

The results in the table report pooled OLS regressions over the time period from 1996 to 2012. 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, Lundholm, and Minnis [2013]). All other variables are defined in appendix C. Each regression includes calendar quarter– and bank-fixed effects. The reported standard errors (in brackets) have been clustered by both calendar quarter and bank.

*, **, *** indicate the significance at the 0.10, 0.05, and 0.01 levels, respectively.

3.2 COMPETITION AND THE PRICING OF BORROWER RISK

We next 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 examine this conjecture, we estimate the following OLS pooled regressions, clustering the standard errors by both calendar quarter and bank:

$$\begin{aligned} Spread_t = {} & \beta_0 + \beta_1 BCE_{t-1}{}^* BorrowerRisk_t + \beta_2 BCE_{t-1} + \beta_3 Tier1_t \\ & + \beta_4 LenderSize_t + \beta_5 BorrowerRisk_t + \beta_6 BorrowerSize_t \\ & + \beta_7 Revolver_t + \beta_8 Amount_t + \beta_9 Maturity_t + \beta_{10} \#Covenants_t \\ & + BorrowerEffects + BankEffects + TimeEffects + \varepsilon_t, \end{aligned} \quad (2)$$

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 together with those of table 3, panel A suggest not only that a lender's competitive environment results 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.

3.3 COMPETITION 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 the loan volume. We test this conjecture by estimating the following OLS pooled regression:

$$\begin{aligned} \#Covenants_t = {} & \beta_0 + \beta_1 BCE_{t-1} + \beta_2 Tier1_t + \beta_3 LenderSize_t \\ & + \beta_4 BorrowerRisk_t + \beta_5 BorrowerSize_t + \beta_6 Revolver_t \\ & + \beta_7 Amount_t + \beta_8 Maturity_t + \beta_9 Spread_t \\ & + BorrowerEffects + BankEffects \\ & + TimeEffects + \varepsilon_t, \end{aligned} \quad (3)$$

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 4 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 4 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.

4. Competition and Loan Provisioning, Revenue Mix Decisions, and Bank Capital

In this section, we explore three additional 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 noninterest sources of revenue, and tier 1 capital levels.

4.1 COMPETITION 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, 2015]). 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 calendar quarter:

$$
\begin{aligned}
LLP_t = \beta_0 &+ \beta_1 BCE_{t-1}{}^* \Delta NPL_{t+1} + \beta_2 BCE_{t-1}{}^* \Delta NPL_t \\
&+ \beta_3 Consumer_{t-1}{}^* \Delta NPL_{t+1} + \beta_4 Consumer_{t-1}{}^* \Delta NPL_t \\
&+ \beta_5 Commercial_{t-1}{}^* \Delta NPL_{t+1} + \beta_6 Commercial_{t-1}{}^* \Delta NPL_t \\
&+ \beta_7 RealEstate_{t-1}{}^* \Delta NPL_{t+1} + \beta_8 RealEstate_{t-1}{}^* \Delta NPL_t
\end{aligned}
$$

$$
\begin{aligned}
&+ \beta_9 BCE_{t-1} + \beta_{10} \Delta NPL_{t+1} + \beta_{11} \Delta NPL_t + \beta_{12} \Delta NPL_{t-1} \\
&+ \beta_{13} \Delta NPL_{t-2} + \beta_{14} Ebllp_t + \beta_{15} LoanGrowth_t \\
&+ \beta_{16} Size_t + \beta_{17} Tier1_{t-1} + \beta_{18} Consumer_{t-1} \\
&+ \beta_{19} Commerical_{t-1}{}^{*} \beta_{20} RealEstate_{t-1} + BankEffects \\
&+ TimeEffects + \varepsilon_t, \qquad (4)
\end{aligned}
$$

where *LLP* is defined as loan loss provisions scaled by lagged total loans. ΔNPL is the change in nonperforming loans over the quarter scaled by lagged total loans; *Ebllp* is earnings before loan loss provisions and taxes scaled by lagged total loans; *LoanGrowth* is the percentage change in total loans over the quarter; *Commercial, Consumer,* and *RealEstate* are the percentages 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 the timeliness of expected loan loss recognition, we include ΔNPL measured in four different time periods, $t+1$, t, $t-1$, and $t-2$. The idea is that more timely banks should weight ΔNPL_{t+1} and ΔNPL_t more than less timely banks (i.e., current loan loss provisions are more sensitive to current and future changes in nonperforming loans). Larger coefficients on future and contemporaneous ΔNPL are indicative of timelier provisioning. To test the effect of competition on the timeliness of loss recognition, we examine interactions of *BCE* with ΔNPL_{t+1} and ΔNPL_t (i.e., β_1 and β_2). We conjecture that competitive 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 5. Consistent with our conjectures, we find that banks' accrual choices are a function of competition. Specifically, we find that both β_1 and β_2 are significantly different from 0 (p-value < 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 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 [2015]). This suggests that competition can operate through a bank manager's accounting decisions to generate externalities that extend beyond an individual bank's reported profitability.

4.2 COMPETITION, REVENUE MIX DECISIONS, AND NONINTEREST INCOME

In this section, we examine whether banks respond to competitive pressure in the loan market by aggressively seeking out noninterest sources of revenue. Sources of noninterest 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, Madura, and Weigand [2002] find that noninterest income is associated with more volatile bank returns. DeYoung and Roland [2001] find that fee-based activities are associated with increased revenue and earnings variability. Brunnermeier, Dong, and Palia [2012] find that banks with higher noninterest 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 noninterest income and then increases, and De Jonghe [2010] finds that noninterest income monotonically increases systemic tail risk.

While these prior studies document that increased bank risk is associated with a bank's pursuit of noninterest income, it is not clear why banks choose to pursue these revenue sources. Accordingly, we examine the extent to which competition drives banks to seek out these alternative sources of income. We consider two measures of noninterest revenue: *RevMix*, defined as total noninterest revenue divided by interest revenue, and *FeeMix*, defined as total noninterest 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 calendar quarter and bank:

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

where the dependent variable is either total revenue mix (*RevMix*) or fee revenue mix (*FeeMix*). We include *NonIntExp*, defined as total noninterest 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 noninterest revenue activities. As reported in table 6, 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.

TABLE 6

BCE and Operating Decisions: Revenue Mix and Fee Mix

		Dependent Variable	
Variable	Prediction	*RevMix*	*FeeMix*
BCE_{t-1}	+	0.0153***	0.0130***
		[0.004]	[0.004]
NonIntExp		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		Quarter, bank	Quarter, bank
Observations		18,444	10,054
R-squared		0.827	0.764

The results in the table report pooled OLS regressions over the sample period from 1996 to 2012, where the dependent variables are *RevMix*, defined as noninterest revenue divided by interest revenue, and *FeeMix*, defined as the total noninterest 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, Lundholm, and Minnis [2013]). All other variables are defined in appendix C. Each regression includes calendar quarter– and bank-fixed effects. The reported standard errors (in brackets) have been clustered by both calendar quarter and bank.

*, **, *** indicate the significance at the 0.10, 0.05, and 0.01 levels, respectively.

Given the findings from prior research linking a bank's pursuit of noninterest revenue with increased risk, this finding highlights another important channel through which competition influences bank stability.

4.3 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., Brunnermeir, Dong, and Palia [2012], Bushman and Williams [2015]). This situation is potentially exacerbated to the extent that downward competitive pressures on profits squeeze bank capital levels. Banks could potentially counteract this higher risk by increasing their capital buffers. However, they may be reluctant to do so if, for example, banks view equity as expensive (e.g., Hanson et al. [2012]). 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 show that banks may choose higher or lower leverage depending intricately on the parameters of the model (see also Allen et al. [2011]). Empirical studies provide conflicting results concerning the relation between competition and bank capital. For example, Beck, De Jonghe, and Schepens [2013] and Berger, Klapper, and Turk-Ariss [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 pressures. To do so, we run the following OLS regression:

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

where *Tier1* is the bank's tier 1 capital ratio, and all other variables are as previously defined. Table 7 reports the results from estimating equation (6). 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.[26]

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.

5. *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

[26] 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 a further discussion on this issue, see Mehran and Mollineaux [2012], Mehran, Morrison, and Shapiro [2011], Fahlenbrach and Stulz [2011], and Anginer, Demirguc-Kunt, and Zhu [2014].

TABLE 7
Competition and Regulatory Capital

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]
β_{mrkt}		0.0027***
		[0.001]
MTB		–0.0003*
		[0.000]
Fixed effects		Quarter, bank
Observations		15,199
R-squared		0.701

The results in the table report pooled OLS regressions over the sample period from 1996 to 2012, 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, Lundholm, and Minnis [2013]). All other variables are defined in appendix C. Each regression includes calendar quarter– and bank-fixed effects. The reported standard errors (in brackets) have been clustered by both calendar quarter and bank.

*, **, *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.

risk. In this section, we investigate the possibility that competition, operating through the channels considered earlier and other channels, increases the stand-alone risk of individual banks and systemic risk by increasing codependence in the tails of banks' equity and asset returns. Section 5.1 investigates relations between competition and stand-alone risk of individual banks and section 5.2 examines relations between competition and systemic risk.

5.1 COMPETITION AND STAND-ALONE RISK OF INDIVIDUAL BANKS

We take two approaches to examining the stand-alone 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.

5.1.1. Competition, Loan Growth, and Future Charge-Offs. In section 3, we provide evidence consistent with competition influencing banks to relax their underwriting standards. This finding suggests that competition will negatively impact 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 calendar quarter and bank:

$$\begin{aligned} LCO_{12m/24m} = {} & \beta_0 + \beta_1 LoanGrowth_t + \beta_2 BCE_t + \beta_3 LoanGrowth_t{}^* BCE_t \\ & + \beta_4 LoanGrowth_t{}^* Consumer_t + \beta_5 LoanGrowth_t{}^* Commercial_t \\ & + \beta_6 LoanGrowth_t{}^* RealEstate_t + \beta_7 \Delta NPL_t + \beta_8 \Delta NPL_{t-1} \\ & + \beta_9 \Delta NPL_{t-2} + \beta_{10} Size_t + \beta_{11} Tier1_t + \beta_{12} Consumer_t \\ & + \beta_{13} Commerical_t + \beta_{14} RealEstate_t + \beta_{15} ROA_t + \varepsilon_t, \qquad (7) \end{aligned}$$

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

Table 8 reports the results of estimating (7). Consistent with our prediction, we find that $\beta_3 > 0$ for each specification. Specifically, table 8 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) horizons is increasing in *BCE*. This finding reinforces our earlier results on underwriting standards by revealing future consequences of these decisions. Further, higher future loan write-offs in conjunction with our previous finding that competition reduces the timeliness of banks' loan loss provisions and capital buffers raise the possibility that competition increases the overall downside risk of banks. We examine this possibility next.

5.1.2. Bank-Level 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.[27] 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).

[27] 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.

TABLE 8

Competition and Individual Bank Risk: Future Charge-Offs

		Dependent Variables	
Variable	Prediction	LCO_{12m}	LCO_{24m}
BCE_{t-1}* *LoanGrowth* (× 100)	+	1.0863***	1.9792**
		[0.405]	[0.817]
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]
ΔNPL_t		0.5187***	0.7869***
		[0.062]	[0.136]
ΔNPL_{t-1}		0.4538***	0.5879***
		[0.056]	[0.111]
ΔNPL_{t-2}		0.4289***	0.4512***
		[0.062]	[0.091]
LoanGrowth		–0.0093**	–0.0284**
		[0.004]	[0.013]
Size		0.0042***	0.0113***
		[0.001]	[0.002]
Tier1		–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 effects		Quarter, bank	Quarter, bank
Observations		12,833	11,037
R-squared		0.642	0.664

The results in the table report pooled OLS regressions over the sample period from 1996 to 2012. 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, Lundholm, and Minnis [2013]). For ease of interpreting coefficients, we have multiplied the coefficient and standard error on the *BCE* measure by 100. All other variables are defined in appendix C. Each regression includes calendar quarter– and bank-fixed effects. The reported standard errors (in brackets) have been clustered by both calendar quarter and bank.

*, **, *** indicate the significance at the 0.10, 0.05, and 0.01 levels, respectively.

We capture a bank's stand-alone 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 $probability(X^i \leq VaR_q^i) = q$.[28] 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:

$$X_t^i = \alpha^i + \beta^i M_{t-1} + \varepsilon_t^i. \tag{8a}$$

M in (8a) is a vector of macro state variables.[29] Our conditional weekly time-varying *VaR* at the *q*-percentile is computed as follows, where the coefficients are the estimates from equation (8a):

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

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

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

where σ_E is the standard deviation of the bank's equity returns over the prior quarter. β^{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 the daily absolute value of stock returns divided by the dollar trading volume for the day. All other variables are as defined previously.

---

[28] If the *VaR* of a bank's equity returns is −15% at a one-week, 95% confidence level, there is only a 5% chance that the bank's equity value will drop more than 15% over any given week.

[29] See appendix B for a detailed description of the vector of macro state variables used in this estimation.

Table 9, panels A and B, presents 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 suggest that competition primarily affects the left tail of the distribution. We find that *BCE* is significantly and positively associated with both ΔVaR^{E}_{left} and ΔVaR^{A}_{left}, while it is not significantly associated with either ΔVaR^{E}_{Right} or ΔVaR^{A}_{Right}.

5.2. 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 a bank's equity prices to extract measures of systemic risk. Some papers in this stream use contingent claims analysis (e.g., Gray, Merton, and Bodie [2008], Gray and Jobst [2010]), while others focus on co-dependence 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.

5.2.1. Bank-Level Competition and Δ*CoVaR.* 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 Δ*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 regression equations again using weekly data:

$$X_t^i = \alpha^i + \beta^i M_{t-1} + \varepsilon_t^i, \quad (10a)$$

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

TABLE 9

Competition and Individual Bank Risk: VaR^A and VaR^E

Panel A: *VaR*

Variable	Dependent Variable			
	$VaR^A_{1\%}$	ΔVaR^A_{Left}	$VaR^A_{50\%}$	ΔVaR^A_{Right}
BCE_{t-1} (× 100)	−7.3749***	7.5010***	0.1261	4.9588
	[2.085]	[2.049]	[0.194]	[5.411]
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]
σ_E	−1.1551***	1.1457***	−0.0094	1.6991**
	[0.429]	[0.422]	[0.008]	[0.662]
β_{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	Quarter, bank	Quarter, bank	Quarter, bank	Quarter, bank
Observations	13,730	13,730	13,730	13,730
R-squared	0.667	0.666	0.318	0.791

Panel B: *VaR^E*

Variable	Dependent Variable			
	$VaR^E_{1\%}$	ΔVaR^E_{Left}	$VaR^E_{50\%}$	ΔVaR^E_{Right}
BCE_{t-1} (× 100)	−6.0389***	5.8026***	−0.2362	5.9033
	[2.145]	[2.055]	[0.207]	[5.247]
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]

(*Continued*)

TABLE 9—*Continued*

Panel B: VaR^E

	Dependent Variable			
Variable	$VaR^E_{1\%}$	ΔVaR^E_{Left}	$VaR^E_{50\%}$	ΔVaR^E_{Right}
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]
σ_E	–1.1881***	1.1668***	–0.0214**	1.6382**
	[0.431]	[0.422]	[0.009]	[0.638]
β_{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	Quarter, bank	Quarter, bank	Quarter, bank	Quarter, bank
Observations	13,730	13,730	13,730	13,730
R-squared	0.667	0.665	0.334	0.796

The results in the table report pooled OLS regressions over the time period from 1996 to 2012, where the dependent variables are VaR^A (VaR^E) and are 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, Lundholm, and Minnis [2013]). For ease of interpreting coefficients, we have multiplied the coefficient and standard error on the *BCE* measure by 100. All other variables are defined in appendix C. Each regression includes calendar quarter– and bank-fixed effects. The reported standard errors (in brackets) have been clustered by both calendar quarter and bank.

*, **, *** indicate the significance at the 0.10, 0.05, and 0.01 levels, respectively.

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 variables 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 performance bank *i*. Equation (10a) is estimated at both $q\% = 1\%$ and 50%, and (10b) at $q\% = 1\%$. Using the predicted values from (9a) and (9b), we specify

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

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

$CoVaR_{1\%,t}$, equation (10d), is the system's time *t VaR* at $q\% = 1\%$, *conditional* on the *VaR* of individual bank *i* being at either the 1% or the 50%

quantile. To capture the sensitivity of the system's conditional $VaR_{1\%}$ to bank i's events, we compute

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

We sum weekly $\Delta CoVaR$ to obtain a quarterly measure, where *more negative* values of $\Delta CoVaR_q$ indicate 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 $\Delta CoVaR$, 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 that $\beta_1 < 0$.

We estimate equation (11) and report the results in the first two columns in table 10. 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.

5.2.2. Competition and 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 is *MES*, the lower an individual bank's returns are when the return of the banking sector is low (higher *MES*). We then estimate the following equation:

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

TABLE 10

Competition and Systemic Risk: $\Delta CoVaR$, $\Delta CoVaR^E$, and MES

	Dependent Variable		
Variable	$\Delta CoVaR^A$	$\Delta CoVaR^E$	*MES*
BCE_{t-1} (× 100)	–1.5589***	–1.2426***	–0.2498**
	[0.366]	[0.338]	[0.108]
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]
σ_E	–0.1021***	–0.0948***	–0.0137
	[0.037]	[0.036]	[0.008]
β_{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	Quarter, bank	Quarter, bank	Quarter, bank
N	13,730	13,730	14,282
R-squared	0.848	0.857	0.359

The results in the table report pooled OLS regressions over the time period from 1996 to 2012, where the dependent variables are $\Delta CoVaR^A$ ($\Delta CoVaR^E$) and are defined as the bank's contribution to the system's 1% VaR^A (VaR^E). *MES* is defined as the bank's average daily return computed over the trading days when 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, Lundholm, and Minnis [2013]). For ease of interpreting coefficients, we have multiplied the coefficient and standard error on the *BCE* measure by 100. All other variables are defined in appendix C. Each regression includes calendar quarter– and bank-fixed effects. The reported standard errors have been clustered by both calendar quarter and bank.

*, **, *** indicate the significance at the 0.10, 0.05, and 0.01 levels, respectively.

If competition increases the systemic risk of the bank, we would predict that $\beta_1 < 0$. 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 *MES* 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%.

5.3 DEREGULATION AND POST DEREGULATION ANALYSES

We acknowledge the possibility that *BCE* measures competition with error or reflects strategic disclosure decisions of managers. Therefore, to address these concerns and more convincingly establish connections between competition and bank risk-taking, we extend our previous analysis by incorporating branch bank deregulation directly into our risk analyses. We break the analyses into two parts. First, we perform a deregulation analysis that truncates the sample to end after the final deregulation event in the sample. Using this sample, we run our risk regressions, measuring competition using the branch bank deregulation index, rather than *BCE*, and also by using instrumental variable analyses in which the branch bank deregulation index is used as an instrument for *BCE*.[30] Second, the post deregulation analysis measures competition with *BCE* and only includes observations subsequent to the last deregulation event in a state.

The main *BCE* results reported previously 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 limit the sample to the 1996–2005 period and run risk analyses using the branch bank deregulation index as an instrument for competition. We perform this analysis for *VaR*, *CoVar*, *MES*, revenue mix, loan loss provisioning policy, and future charge-offs.[31] In table 11, panel A, we report results where *RegIndex* is included directly in the analysis, while panel B reports results using *RegIndex* as an instrumental variable for *BCE* (*IV_BCE*) in two-stage least-squares analysis. For the instrumental variable analysis, the exclusion restriction requires that *RegIndex* only influences banks' decision-making and risk through its impact on *BCE* (competition). Although we have no way to directly prove it, this assumption is plausible, given the tight connection between *RegIndex* and changes in competition established in the prior literature. While we do not tabulate the first-stage regression in the draft, we do tabulate the first-stage regressions in the online appendix and note that the *F*-statistic for *RegIndex* is in excess of 13 for each of the specifications, which is well above the single instrument cutoff suggested by Stock, Wright, and Yogo [2002].[32]

Both panels A and B document that using *RegIndex* directly as an instrument for *BCE* produces similar results to those in our previous analyses

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[30] As noted earlier in this paper, the branch bank deregulation index is widely accepted in the banking literature as a good instrument for identifying the effects of changes in a bank's competitive environment. See, for example, Rice and Strahan [2010] and Dou, Ryan, and Zou [2015].

[31] 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.

[32] As noted by Angrist and Pischke [2009, p. 209], just-identified 2SLS is approximately unbiased, implying that weak instrument concerns are minimal. They state: "But with weak instruments, just-identified estimates tend to be too imprecise to mislead you into thinking you have pinned down a useful causal result."

TABLE 11

Deregulation, Channels, and Risk in the Deregulation Time Period

Panel A: *RegIndex*	Dependent Variables							
	Channels		Risk (coefficients multiplied by 100)					
Variable	*LLP*	*RevMix*	LCO_m	$VaR^A_{1\%}$	$VaR^E_{1\%}$	$\Delta CoVaR^A$	$\Delta CoVaR^E$	*MES*
$RegIndex_t$	–0.0044**	–0.0563	–0.0751***	2.9282***	3.1845***	0.3872***	0.3803***	0.0752**
	[0.000]	[0.081]	[0.022]	[0.935]	[0.955]	[0.154]	[0.145]	[0.033]
$RegIndex_t{}^* \Delta NPL_{t+1}$	0.3445*							
	[0.200]							
$RegIndex_t{}^* \Delta NPL_t$	0.6757**							
	[0.307]							
$RegIndex_t{}^* LoanGrowth$			–0.7529**					
			[0.358]					
Controls	Included	Included	Included	Included	Included	Included	Included	Included
Fixed effects	Quarter, bank	Quarter, bank	Quarter, bank	Quarter, bank	Quarter, bank	Quarter, bank	Quarter, bank	Quarter, bank
Observations	15,117	15,905	10,280	11,999	11,999	11,827	11,827	11,998
R-squared	0.84	0.48	0.66	0.80	0.61	0.85	0.85	0.24

Panel B: Instrumental variable approach	Dependent Variables							
	Channels		Risk (coefficients multiplied by 100)					
Variable	*LLP*	*RevMix*	LCO_m	$VaR^A_{1\%}$	$VaR^E_{1\%}$	$\Delta CoVaR^A$	$\Delta CoVaR^E$	*MES*
IV_BCE_{t-1}	0.0141***	0.2001	3.2596***	–5.6385**	–4.7189**	–0.9635**	–0.9022**	–0.1494**
	[0.003]	[0.155]	[0.007]	[2.529]	[2.549]	[0.419]	[0.394]	[0.080]
$IV\_BCE_{t-1}{}^* \Delta NPL_{t+1}$	–0.0870***							
	[0.023]							
$IV\_BCE_{t-1}{}^* \Delta NPL_t$	–0.0469*							

(*Continued*)

TABLE 11—*Continued*

Panel B: Instrumental variable approach	Dependent Variables							
	Channels		Risk (coefficients multiplied by 100)					
Variable	*LLP*	*RevMix*	LCO_{24M}	$VaR^{A}_{1\%}$	$VaR^{E}_{1\%}$	$\Delta CoVaR^{A}$	$\Delta CoVaR^{E}$	*MES*
	[0.029]							
IV_BCE_{t-1}* *LoanGrowth*			4.0338**					
			[1.616]					
Controls	Included	Included	Included	Included	Included	Included	Included	Included
Fixed effects	Quarter, bank	Quarter, bank	Quarter, bank	Quarter, bank	Quarter, bank	Quarter, bank	Quarter, bank	Quarter, bank
Observations	15,117	15,905	10,280	11,999	11,999	11,827	11,827	11,998
R-squared	0.43	0.83	0.66	0.69	0.68	0.89	0.90	0.25

This table presents results from pooled OLS regressions of the paper's primary analyses over the time period 1996–2005 measuring competition with the regulation index (*RegIndex*) in Panel A and in Panel B with *BCE* using an IV approach. The same controls from the original analyses are included but not reported. For ease of interpreting the coefficients on the risk variables, we have multiplied the coefficient and standard error on the *BCE* measure by 100. All other variables are defined in appendix C. Each regression includes calendar quarter– and bank-fixed effects. The reported standard errors (in brackets) have been clustered by both calendar quarter and bank.

*, **, *** indicate the significance at the 0.10, 0.05, and 0.01 levels, respectively.

using only *BCE*. The only exception is our analysis of *RevenueMix*, where the coefficient on *RegIndex* (*IV_BCE*) is not statistically significant in panel A (panel B). These findings provide evidence 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. Assuming that *RegIndex* is a valid instrument for *BCE*, then, by construction, *IV_BCE* is uncorrelated with the error in the second stage. Therefore, measurement error in *BCE* cannot bias the estimates of the coefficient on *IV_BCE*.

For the postderegulation analyses, we 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 12, our main results on the relation between competition and risk-taking continue to hold in this postderegulation analysis.[33] The fact that postderegulation analysis using *BCE* produces results qualitatively similar to 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 the existence of a regulatory event.

5.4 ROBUSTNESS ANALYSES

5.4.1. Controlling for the Average Bank-Level Competition of Other Local Banks. In this section, we add a control for the average *BCE* of other banks located near a given bank, excluding the bank of interest. First, we estimate the correlation between the *BCE* of an individual bank and the average *BCE* (*LocalBCE*) of all other banks headquartered in the same metropolitan statistical area (MSA) to examine the extent to which banks operating in the same geographic region report similar levels of competition. We find that the simple correlation between the firm-specific *BCE* measure and the *LocalBCE* is 0.3684 (p-value < 0.01). This suggests that there is a common component of *BCE* for banks operating in the same MSA. However, it is quite plausible that banks face competitive pressures deriving from sources outside the narrow confines of the MSA in which they are headquartered. This suggests that *LocalBCE* would generally not subsume competitive pressures experienced by a bank as a whole, and that residual variation in *BCE* beyond *LocalBCE* captures meaningful information about competition that extends beyond the local geographic area.

We rerun our analyses after including the average *BCE* of all other banks headquartered in the same MSA as the individual bank (*LocalBCE*) and report the results in the online appendix (table A14). While *LocalBCE* does indeed load in some specifications, the firm-specific *BCE* measure is robust to the inclusion of *LocalBCE* in all specifications. Under the plausible assumption that *BCE* reflects competitive pressures emanating from sources

[33] Note that we also replicate all results if we use *BCE* to measure competition using the deregulation sample period.

TABLE 12

Channels and Risk in the Post-Deregulation Time Period

	Dependent Variable							
	Channel		Risk (coefficients multiplied by 100)					
Variable	*LLP*	*RevMix*	LCO_m	$VaR^A_{1\%}$	$VaR^E_{1\%}$	$\Delta CoVaR^A$	$\Delta CoVaR^E$	*MES*
BCE_{t-1}	0.0003***	0.0143***	0.3469**	–7.7711***	–6.7155***	–1.5842***	–1.2202***	–0.2514**
	[0.000]	[0.004]	[0.137]	[1.969]	[1.988]	[0.375]	[0.340]	[0.115]
$BCE_{t-1} * \Delta NPL_{t+1}$	–0.0509***							
	[0.017]							
$BCE_{t-1} * \Delta NPL_t$	–0.0902***							
	[0.018]							
$BCE_{t-1} * LoanGrowth$			1.9119**					
			[0.849]					
Controls	Included	Included	Included	Included	Included	Included	Included	Included
Fixed effects	Quarter, bank	Quarter, bank	Quarter, bank	Quarter, bank	Quarter, bank	Quarter, bank	Quarter, bank	Quarter, bank
Observations	17,803	16,806	10,355	13,271	13,271	12,929	12,929	13,819
R-squared	0.81	0.49	0.67	0.66	0.65	0.85	0.85	0.36

The results in the table present pooled OLS regressions over the time period 1996–2012 of this paper's primary analyses during the postderegulation period in each of the respective states. The same controls from the original analyses are included but not reported. For ease of interpreting the coefficients on the risk variables, we have multiplied the coefficient and standard error on the *BCE* measure by 100. All other variables are defined in appendix C. Each regression includes calendar quarter– and bank-fixed effects. The reported standard errors (in brackets) have been clustered by both calendar quarter and bank.

*, **, *** indicate the significance at the 0.10, 0.05, and 0.01 levels, respectively.

outside the local market of a bank's headquarters, this result demonstrates the value of constructing a firm-specific measure of competition such as *BCE*. One of the primary benefits of the *BCE* measure is that it does not require the researcher to define the competitive market, but rather allows managers to convey their assessments of a *BCE*. Given the fact that banks compete with nonbanks (e.g., insurance companies, credit unions, and private equity firms), as well as with geographically disperse banks, it is not surprising that *BCE* captures information beyond that reflected in *Local-BCE*.

We also investigate whether our results using *BCE* are robust to the inclusion of the Lerner index (*LI*). We rerun our primary analyses, including both *BCE* and *LI*, and report the results in table A5 of the online appendix. All of our results are robust to including *LI*. This analysis provides additional evidence that *BCE* provides information above and beyond that captured by *LI*.

5.4.2. Channel Attenuation Analysis. The previous analysis indicates that more competition leads to more systemic risk, while section 4 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 working through these specific channels to influence systemic risk, then the inclusion of these channels in our model should reduce the effect that *BCE* has on systemic risk. Accordingly, we use an attenuation analysis approach (Baron and Kenny [1986]) to examine this conjecture. We provide some evidence to support our conjecture that competition influences systemic risk through both *TimelyLLP* (accounting channel) and *RevMix* (operations channel).[34]

5.4.3. Controlling for the Complexity of the Bank. One possible explanation for the results is that *BCE* is capturing bank complexity. To control for this possibility, we create two measures of bank complexity. The first is an indicator variable equal to 1 (0) if the bank's total assets are above (below) $50 billion. We use the $50 billion threshold because this is the regulatory threshold for systemically important financial institutions. Our second measure of complexity in banking is an indicator variable equal to 1 if the bank has trading assets and 0 otherwise. We include each of these proxies for complexity in the regression and rerun our analyses. While not reported in this paper, in tables A8 and A9 in the online appendix, we show that our results are robust to the inclusion of proxies for bank complexity.

6. Summary

In this paper, we use both a new text-based measure of competition and an instrumental variables analysis that exploits exogenous variation in bank

[34] See section 3 in the online appendix for further discussion and tabulated results.

deregulation to investigate whether greater competition increases or decreases individual bank and banking system risk, and influences fundamental operating and accounting decisions of the bank. Evidence providing insight into these issues is important not only for academics, but also for bank regulators, policy makers, financial analysts, credit-rating agencies, and investors as they seek to forecast a bank's future performance. The evidence we find related to these questions makes several contributions to the existing literature.

First, building on Li, Lundholm, and Minnis [2013], we use textual analysis of banks' 10-K filings to construct a comprehensive, time-varying, bank-specific measure of a *BCE*. Using U.S. branch banking deregulation to reflect exogenous variation in competition, we provide evidence 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 examining future bank responses to current shifts in competition.

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 a greater reliance on noninterest sources of income.

Finally, we show that risk at the individual bank level and a bank's contribution to system-wide risk are increasing in competition. We find that competition is associated with a 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., Schaeck, Cihák, and Wolfe [2009], Beck, De Jonghe, and Schepens [2013], Anginer, Demirguc-Kunt, and Zhu [2014]).

Applying a simple word count algorithm to banks' 10-K reports to capture a complex economic construct such as competition raises a number of challenges in regards to endogeneity (e.g., strategic disclosure by managers) and measurement error. We have taken extensive efforts to validate *BCE* as a useful measure of individual banks' competitive environment. To this end, we document that *BCE* is correlated with key measures of regional competition (Herfindahl–Hirschman index and Panzar–Rosse H-statistic) and firm-specific competition (Lerner index), and that *BCE* responds in a timely fashion to reductions in barriers to entry into a state's banking market. While these tests provide evidence that *BCE* reflects information common to these other competition measures, we acknowledge that any variation in *BCE* that is independent of these other measures may represent measurement error or reflect a correlated omitted variable. We have addressed endogeneity and measurement error issues using the branch bank deregulation index to capture competition, rather than *BCE*, and through an instrumental variables analysis using bank deregulation as an instrumental variable for *BCE*. However, we can never fully rule out the concern and thereby caution future research on the use of the variable in other settings.

APPENDIX A

This appendix briefly describes the Lerner index and how we estimate these measures in this paper.

H-Stat

The H-statistic captures the extent to which factor input prices are reflected in the revenues earned by a bank. Under perfect competition, an increase in input prices raises both marginal costs and total revenues by the same amount as the rise in costs. The H-statistic is a measure that is estimated within a defined geographical region to capture the relationship between input prices and revenues for the banks within that defined region. The H-statistic is computed by first estimating the following regression by year and state:

$$\begin{aligned}\ln(P_{it}) &= \alpha + \beta_1 \ln\left(W_{1,it}\right) + \beta_2 \ln\left(W_{2,it}\right) + \beta_3 \ln\left(W_{3,it}\right)\\ &\quad + \gamma_1 \ln\left(Y_{1,it}\right) + \gamma_2 \ln\left(Y_{2,it}\right) + \gamma_3 \ln\left(Y_{3,it}\right) + \varepsilon_{it}, \qquad \text{(A.1)}\end{aligned}$$

where P is defined as the gross interest revenue to total assets for bank i at time t, W_1 is defined as the ratio of interest expenses to total deposits, W_2 is the ratio of wages to total assets, W_3 is the ratio of other operating and administrative expenses to total assets, Y_1 is the ratio of book equity to total assets, Y_2 is the ratio of loans to assets, and Y_3 is the total assets of the bank. Next, we compute *H-Stat* by summing $\hat{\beta}_1,\ \hat{\beta}_2,$ and $\hat{\beta}_3$. The H-statistic equals 1 under perfect competition.

Lerner index (see, e.g., Beck, De Jonghe, and Schepens [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*) is computed as follows:

$$Lerner_{it} = \frac{P_{it} - MC_{it}}{P_{it}}, \qquad \text{(A.2)}$$

where P_{it} is defined as the operating income (interest revenue plus noninterest revenue) to total assets.

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

$$\begin{aligned}\ln(C_{it}) &= \beta_0 + \beta_1 \ln\left(Q_{it}\right) + \frac{\beta_2}{2} \ln\left(Q_{it}^2\right) + \sum_{k=1}^{3} \gamma_{kt} \ln\left(W_{w,it}\right)\\ &\quad + \sum_{k=1}^{3} \phi_k \ln\left(Q_{it}\right) \ln\left(W_{k,it}\right) + \sum_{k=1}^{3}\sum_{j=1}^{3} \ln\left(W_{k,ot}\right) \ln\left(W_{j,it}\right) + \varepsilon_{it}, \qquad \text{(A.3)}\end{aligned}$$

where C_{it} are the bank's total costs (interest expenses plus noninterest operating expenses) scaled by total assets. Q is the bank's 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, and W_3 is the input price of fixed capital and is defined as noninterest expenses divided by total assets.

We estimate (A.3) using all banks with available data in the cross-section each year to attain predicted coefficients for each year. After estimating (A.3) we compute the marginal cost for each bank-year as

$$MC_{it} = \frac{C_{it}}{Q_{jt}} \left[\hat{\beta}_1 + \hat{\beta}_2 \ln\left(Q_{jt}\right) + \sum_{k=1}^{3} \hat{\phi}_k W_{k,it} \right]. \tag{A.4}$$

We then insert the resulting bank-year-specific measure of MC from (A.4) into (A.2). This results in a bank-year-specific LI measure.

APPENDIX B

Estimating the Market Value of a Bank's Total Assets

To compute each bank's weekly percentage change in the market value of total assets (MVA), we follow prior research and define it as

$$\begin{aligned} X_t &= \frac{MVA_t - MVA_{t-1}}{MVA_{t-1}} = \frac{(MTB_t * BVA_t) - (MTB_{t-1} * BVA_{t-1})}{MTB_{t-1} * BVA_{t-1}} \\ &= \frac{MVE_t}{MVE_{t-1}} * \left[\frac{BVA_t / BVE_{t-1}}{BVA_t / BVE_{t-1}} \right] - 1 \,. \end{aligned} \tag{B.1}$$

MTB is the weekly market-to-book ratio, BVA (BVE) is the weekly book value of assets (equity), and MVE is the market value of equity. Because the book value of equity and the 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. It should also be noted that equity returns can be recovered from (B.1) by setting the ratio inside the square bracket equal to 1. The equity return variable used in the estimation of VaR^E is not dependent on market-to-book ratio.

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 three-month general collateral repo rate and the three-month bill rate, (after "rate") is a proxy for short-term liquidity risk in the market (the repo rates obtained from Bloomberg and the bill rates from the

Federal Bank of New York); (3) the change in the three-month T-Bill rate (Δ*3T-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 three-month rate; (5) Δ*Credit Spread*, defined as the 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 three-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.

APPENDIX C

Variable	Description	Source(s)
BCE	The annual estimate of the bank's competitive landscape computed by counting the number of occurrences of the words "competition, competitor, competitive, compete, competing." We remove all cases where the competition words included in *BCE* are preceded by "not, less, few, limited" by three or fewer words. We then divide the count by the total number of words in the 10-K. Finally, the resulting ratio is adjusted to be on a per 1,000 word basis.	Edgar
Dependent Variables		
Underwriting dependent variables		
Z-Score	Altman's [1968] bankruptcy measure, estimated by the following model: $Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 0.999X_5$, where X_1, is defined as working capital (total current asset minus total current liabilities) divided by total assets. X_2 is defined as retained earnings divided by total assets. X_3 is defined as earnings before interest and taxes divided by total assets. X_4 is the market value of equity divided by total liabilities. X_5 is total sales divided by total assets.	Compustat
EDF	The expected default frequency from a Merton [1974] bond-pricing model.	Compustat, CRSP
Spread	The basis points over LIBOR of the loan.	DealScan
#Covenants	The total number of both financial and net worth covenants for the associated loan package.	DealScan
Accounting decision variables		
LLP	Loan loss provisions scaled by lagged total loans.	Compustat
Product mix variables		
Revenue Mix	Noninterest revenue divided by total revenue.	Compustat
FeeMix	Total noninterest revenue minus deposit service charges and trading revenue divided by interest revenue.	Compustat

Variable	Description	Source(s)
Capital Buffers		
Tier 1	The bank's tier 1 capital ratio.	Compustat
Bank-level risk variables		
LCO_T	Loan charge-offs over the time period *T*, where *T* is equal to either 12 months or 24 months.	Compustat
$VaR_q^{A(E)}$	The quarterly estimated conditional value-at-risk of the market value of assets (equity). This is computed using quantile regressions using weekly market value of equity returns regressed on macro state variables and taking the predict value. We then sum the weekly predicted values over the quarter.	Compustat, CRSP, Federal Reserve, CBOE
Systemic risk variables		
$\Delta CoVaR^{A(E)}$	Is the systems market value of assets (equity) VaR conditional on bank *i* moving from the 50 percentile VaR to the 1 percentile VaR.	Compustat, CRSP, Federal Reserve, CBOE
MES	The bank's average equity return on the days in which the market return is in the bottom 5% for the year.	CRSP
Control variables		
Amount	The natural logarithm of the loan amount in U.S. dollars.	DealScan
β_{Mrkt}	The firm's market beta from a single factor CAPM estimated on daily return over the quarter.	CRSP
Commercial	Total commercial loans outstanding divided by total loans outstanding.	Call reports
Consumer	Total consumer loans outstanding divided by total loans outstanding.	Call reports
Deposits	Total deposit scaled by lagged total loans.	Compustat
Ebllp	Earnings before loan loss provisions and taxes scaled by lagged total loans.	Compustat
LI	The Lerner index. Refer to appendix A for the computation.	Compustat
LoanGrowth	Percentage change in loans over the quarter.	Compustat
Maturity	The number of months to maturity.	DealScan
Mismatch	(Current liabilities – cash) total liabilities.	Compustat
MTB	The market-to-book ratio.	CRSP, Compustat
ΔNPL	Change in nonperforming loans scaled by lagged total loans.	Compustat
σ_e	The standard deviation of daily equity returns over the quarter.	CRSP
Real Estate	Total real estate loans outstanding divided by total loans outstanding.	Call Reports
RegIndex	The Rice and Strahan [2010] branching restrictiveness index, where higher values indicate more restrictions. The variable is scaled from 0–5, where 5 indicates pre-deregulation. The variable is assigned by location of the bank's headquarters on a year-by-year basis.	Rice and Strahan [2010]

Variable	Description	Source(s)
Revolver	Noninterest revenue divided by total revenue.	Compustat
Size	Natural logarithm of total assets.	Compustat
Trading	The ratio of trading assets to total assets.	Compustat
Macro state variable		
Δ*Credit Spread*	Change in the spread between the BAA-rated bonds and the Treasury rate with the same 10-year maturity.	Federal Reserve Board's H.15
Liquidity Spread	Difference between the three-month general collateral repo and the three-month bill rate.	Bloomberg, Federal Reserve Bank of New York
VIX	Expected volatility from options on the S&P 500 index	CBOE
Ret_{Mrkt}	The weekly value weight market return.	CRSP
Ret_{Estate}	Weekly real estate (SIC 65–66) sector market adjusted return.	CRSP
Δ*3T-Bill*	Change in the three-month T-Bill rate.	Federal Reserve Board's H.15
Δ*Yield Curve Slope*	Yield spread between the 10-year Treasury rate and the three-month rate.	Federal Reserve Board's H.15
Unemployment	The unemployment rate for a state in a given year.	Federal Reserve
Lending Index	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.	Federal Reserve
Alternative measures of competition		
H-Stat	A measure of the relationship between factor input price to bank revenues. See appendix A for a detail description of the computation.	Call Reports
HH	A Herfindahl–Hirschman concentration ratio using bank deposits, computed for each state-year as: $\sum_{i=1}^{n}[d_i/D]^2$, where d_i is firm *i*'s deposits in year *t* and *D* is the sum of deposits for the banks in the state during year *t*.	Call Reports
LI	The Lerner index is the firm-specific measure of competition that captures the relationship between the marginal costs and marginal revenue of a bank. For a detailed description of how *LI* is calculated, see appendix A.	Call Reports

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