# Does Bank Competition Affect Financial Stability?

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## Abstract

Competition in the banking system has been a focal point of interest among researchers and policymakers. Some researchers argue that the competition in the banking system contributes to adverse shocks in the financial system and others argue it hinders the likelihood that a financial system will be vulnerable to adverse shocks. Theoretical and empirical views on bank competition and financial stability present conflicting views and do not provide clear guidance on the relationship between bank competition and financial stability. This paper examines the relationship between the bank competition and financial stability using quarterly data for the listed banks operating in the US banking system for the period 2000 to 2017. This paper uses two empirical approaches. First, it estimates the H-statistic, Lerner index and Boone indicator, which are common proxy measures of competition. These measures try to capture different aspects of the banking system and it is interesting to see the association between the H-statistic, Lerner index, and Boone indicator. The results confirm that there is a loose association between these competition measures. Second, to estimate the effect of bank competition on financial stability, all the competition measures and bank-specific control variables regress on the bank stability. The results indicate that the competition measured by the H-statistic, Lerner index, and Boone indicator increase financial instability. Thus, this paper does not support the view that competition promotes stability in the US banking system.

Keywords: Bank competition, Stability, USA

## 1. Introduction

Bank competition and financial stability is a highly contesting relationship in the banking literature. Zigraiova and Havranek (2016) find that the selected sample of countries, sample period, proxy measures of competition and stability, and the estimation methods are the main reasons for the conflicting evidence in the literature. This study focuses on combining those reasons and addresses the issue "Does bank competition affect financial stability?"

This study examines the relationship between bank competition and financial stability by using bank-level data in the USA for the period between 2000 and 2017. The proxy measures used to capture competition and stability is the main reason which leads to conflicting results. This study uses three common proxies of bank competition: H-statistic, Lerner index and Boone indicator. The stability of the banks is capturing Z-score, non-performing loan ratio, and distance-to-default.

This study empirically confirms Zigraiova and Havranek (2016) findings. The effect of competition on stability varies with the proxy measures of competition and stability. When the proxy measure of stability is Z-score, all the competition measures are negatively associated with stability. The similar relationship is observable when the proxy measure of stability is distance-to-default with low statistical significance. This effect is not consistent when the stability is measured using non-performing loans. Then, Lerner and Boone are positively associated with stability. In terms of the economic significance, the Boone indicator presents relatively a large economic significance compared to other competition measures.

The remainder of the study is organized into seven sections; section 2 presents a review of related literature. Section 3 explains competition measures and stability measures. Section 4 presents the estimation method. Section 5 presents data and variables of the study. Section 6 discusses the results and findings of the study and section 7 summarizes the conclusions.

## 2. Literature Review

### 2.1 Competition-Fragility Hypothesis

The banking sector in the USA was protected by state laws with the aim of limiting branches, multi-bank holdings, and interstate expansions until the late 1960s. However, these laws were liberalized in the 1970s and 1980s and allow competition in the banking sector. In addition, technological changes and developments in the money market also contribute to increasing the competition. The competition in the banking sector reduces the incentive to undertake prudence banking businesses and increase bank failures (Keeley, 1990). Allen and Gale (2004); Keeley (1990); Marcus (1984) introduce the competition-fragility hypothesis. They find that an increase in competition reduces the charter value of a bank and increases the risk of bank failure.

Many empirical studies find evidence to support the competition-fragility hypothesis (Agoraki, Delis, & Pasiouras, 2011; Beck, De Jonghe, & Schepens, 2013; Berger, Klapper, & Turk-Ariss, 2008; Fernandez & Garza-Garciab, 2012; Fu, Lin, & Molyneux, 2014; Tabak, Fazio, & Cajueiro, 2012; Yeyati & Micco, 2007). These studies present their results based on various proxy measures of stability and competition. A full discussion of measures of competition and stability is relegated to Section 3. Tabak et al. (2012) use Boone index as the competition measure and Z-score as the stability measure. Many studies considered the Lerner index as the competition measure and the Z-score as the stability measure (Agoraki et al., 2011; Beck et al., 2013; Berger et al., 2008; Fernandez & Garza-Garciab, 2012; Fu et al., 2014). Yeyati and Micco (2007) present their evidence based on Z-score and H-statistic. Fungáčová and Weill (2013) present findings from a bank level study in Russia supporting the competition-fragility hypothesis.

### 2.2 Competition-Stability Hypothesis

Boyd and De Nicolo (2005) revisit Keeley’s view and introduce an opposing theoretical explanation known as the competition-stability hypothesis. According to their interpretation, banks compete in both deposits and lending markets. In a less competitive market, banks pay low deposit rates and charge high interest from borrowers. That allows them to make more profits. At the same time, high loan rates increase the cost of borrowings and decline the profit margin of borrowers. There is a high probability to default the loan repayment and it increases the non-performing loan ratio or the credit risk of banks. Boyd and

De Nicolo (2005) explain that in a competitive banking system, banks offer low borrowing rates to their clients and it contributes to reducing the level of credit risk. Their theoretical view suggests that the competition in the banking system promotes financial stability. Caminal and Matutes (2002) also explain that monopolists accept more risk and there are high tendencies go bankrupt compared to competitive banks. Increasing competition reduces the power of individual players and it reduces the risk of bank failure.

Empirical studies support the competition-stability hypothesis by using different proxy measures of competition and stability (Amidu & Wolfe, 2013; Goetz, 2016; Jeon & Lim, 2013; Liu, Molyneux, & Wilson, 2013; Schaeck & Cihak, 2008, 2014; Schaeck, Cihak, & Wolfe, 2009). The estimation results of Schaeck et al. (2009) are based on the H-statistic and a dummy variable to represent the occurrence of a crisis. Results find that there is a positive relationship between competition and stability. They explain that time to crisis increase with an increase in competition. Schaeck and Cihak (2008, 2014) assess the relationship between Boone indicator and Z-score. It supports the view that competitive banks are efficient and stable. Amidu and Wolfe (2013) use both Lerner and H-statistic as competition measures and Z-score, non-performing loans, bank profitability as stability measures. They find more competition is associated with greater stability. Liu and Wilson (2013) find the relationship between competition and stability varies based on the different types of Japanese banks. For regional level banks, increase in competition appears to reduce the stability. On the contrary, for national banks, increase in competition promotes more stability. These studies exemplify that the relationship between bank competition and stability differs based on the country, type of the bank, and proxy measures of stability and competition.

## 3. Measures of Competition and Stability

There is no consensus regarding the best measure to capture the competition effect. Section 2 presents evidence for use of various proxy measures of competition in empirical studies. Bikker and Haaf (2002b) explain two categories of competition measures. The first category uses the structural measure as measures of competition. Bank concentration ratio and Herfindahl-Hirschman index (HHI) are the common structural measures. The bank concentration ratio is the total assets of three or five largest banks as a percentage of total assets of the entire banking system. The HHI is the sum of the squared market share of each bank. However, empirical literature find that the concentration ratio and HHI are poor proxies for bank competition (Claessens & Laeven, 2004; Schaeck et al., 2009). The second category uses non-structural measures of competition. The common non-structural measures are H-statistic, Lerner index, and Boone indicator. These measures capture different characteristics of the banking system (Leon, 2015). Therefore, this study uses all three non-structural measures of competition.

### 3.1 H-statistic

Panzar and Rosse (1987) H-statistic assess the competitiveness of the market based on revenue and costs. It is the sum of the elasticities of a bank's total revenue with respect to its input prices. It is negative for a monopolist, equal to 1 for a competitive price-taking firm and varies from 0 to 1 for monopolistic competition. H-statistic explains to which extent factor prices reflected in revenues or the ability of a bank to pass on increases in factor input prices to customers. As explained by Bikker and Haaf (2002a), under a monopolistic condition, an increase in input prices leads to an increase in the marginal costs, reduce equilibrium output and consequently reduce the revenue of the monopolistic firm. This produces H-statistic <0 for a monopolistic firm. In a perfectly competitive situation, H-statistic=1. A firm's output level remains constant and increases in firm's price in proportion to the increase in both average and marginal cost. Under monopolistic competition, H-statistic is 0 < and < 1. Banks produce more output and price is less than the optimal condition. Revenue of the individual firm depends on the product differentiation among the rival firms within the industry.

Claessens and Laeven (2004) empirically estimate the H-statistic using the following method;

$$\ln(p_{it}) = \alpha + \beta_1 \, ln(W_{1,it}) + \beta_2 \, ln(W_{2,it}) + \beta_3 ln(W_{3,it}) + \gamma_1 \, ln(W_{1,it}) + \gamma_2 \, ln(W_{2,it}) + \gamma_3 \, ln(W_{3,it}) + \varepsilon_{it} \qquad (1)$$

where $P_{it}$ is the ratio of interest revenue to total assets (a proxy for output price), $W_1$, is the ratio of interest expenses to total deposits and money market funding (proxy for the input price of deposits), $W_2$, is the ratio of personnel expense to total assets (proxy for the price of labour), and $W_3$, is the ratio of other operating and administrative expenses to total assets (proxy for price of fixed capital), with *i* denoting bank *i* and *t* denoting time *t*. $Y_1$, it is a control variable for the ratio of equity to total assets, $Y_2$, it controls for the ratio of net loans to total assets, and $Y_3$, it is the log of total assets to capture size effects. All variables enter the equation in natural logarithm. H-statistic is calculated as $\beta_1 + \beta_2 + \beta_3$. The equation (1) is estimated using OLS with time dummies and GLS with fixed effects and time dummies. Then an alternative dependent variable is also used to estimate H-statistic as shown in equation (2).

$$\ln(R_{it}) = \alpha + \beta_1 \, ln(W_{1,it}) + \beta_2 \, ln(W_{2,it}) + \beta_3 ln(W_{3,it}) + \gamma_1 \, ln(W_{1,it}) + \gamma_2 \, ln(W_{2,it}) + \gamma_3 \, ln(W_{3,it}) + \varepsilon_{it} \quad (2)$$

where $R_{it}$ is the ratio of total revenue to total assets (a proxy for output price). All the explanatory variables are same as in equation (1). The equation (2) is also estimated using OLS with time dummies and GLS with fixed effects and time dummies. Then the overall H-statistic is an average of four estimation models.

The interpretation of H-statistic is valid only if the country meets the long-run equilibrium condition. The long run equilibrium condition is estimated by using the equation (3). The equilibrium E-statistic is calculated as $\beta_1 + \beta_2 + \beta_3$. The F-test is used to examine whether E-statistic = 0 (Claessens & Laeven, 2004; Goddard & Wilson, 2009; Schaeck et al., 2009).

$$\ln(ROA_{it}) = \alpha + \beta_1 \, ln(W_{1,it}) + \beta_2 \, ln(W_{2,it}) + \beta_3 ln(W_{3,it}) + \gamma_1 \, ln(W_{1,it}) + \gamma_2 \, ln(W_{2,it}) + \gamma_3 \, ln(W_{3,it}) + \varepsilon_{it} \quad (3)$$

Goddard and Wilson (2009) explain that the static equilibrium condition of Panzar and Rosse (1987) H-statistic is not practical and there are situations where markets are out of the equilibrium position. This is the main drawback of it as a measure of competition (Zigraiova & Havranek, 2016).

### 3.2 Lerner Index

The Lerner index captures the market power of the bank. It compares the bank's output price with its associated marginal costs. The marginal cost of a bank is estimated from a translog cost function (Spierdijk & Zaouras, 2016). This study follows the methodology of Anginer, Demirguc-Kunt, and Zhu (2014); Demirguc-Kunt and Martinez-Peria (2010) to estimate the marginal cost of each bank. The zero value reflects the competitive behaviour of banks and a positive value reflects less competitive behaviour. A larger value indicates a wider gap between output price and marginal costs and greater monopoly power.

$$\ln(C_{it}) = \alpha + \beta_1 ln(Q_{it}) + \beta_2 (ln(Q_{2,it}))^2 + \beta_3 ln(W_{1,it}) + \beta_4 ln(W_{2,it}) + \beta_5 ln(W_{3,it}) + \beta_6 ln(Q_{it}) * ln(W_{1,it}) + \beta_7 ln(Q_{it}) * ln(W_{2,it}) + \beta_8 ln(Q_{it}) * ln(W_{3,it}) + \beta_9 (ln(W_{1,it}))^2 + \beta_{10} (ln(W_{2,it}))^2 + \beta_{11} (ln(W_{3,it}))^2 + \beta_{12} ln(W_{1,it}) * ln(W_{2,it}) + \beta_{13} ln(W_{1,it}) * ln(W_{3,it}) + \beta_{14} ln(W_{2,it}) * ln(W_{3,it}) + \theta D + \varepsilon_{it} \tag{4}$$

where $C_{it}$ is the sum of total costs, $Q_{it}$ is the quantity of total assets in million dollars, $W_{1,it}$ is the ratio of interest expenses to total assets, $W_{2,it}$ is the personnel expenses as a percentage of total assets, $W_{3,it}$ is the administrative and other operating expenses as a percentage of total assets. $D$ indicates time dummies. The subscript $i$ and $t$ denote each bank and quarter respectively. The natural logarithms of all the variables are used for the estimation equation (4) and the ordinary least square estimation impose five restrictions on regression coefficients as shown in equation (5).

$$\beta_3 + \beta_4 + \beta_5 = 1; \beta_6 + \beta_7 + \beta_8 = 0; \beta_9 + \beta_{12} + \beta_{13} = 0; \beta_{10} + \beta_{12} + \beta_{14} = 0;$$

$$\beta_{11} + \beta_{13} + \beta_{14} = 0 \tag{5}$$

$$MC_{it} = \frac{\partial C_{it}}{\partial Q_{it}}$$

$$= \frac{C_{it}}{Q_{it}} \left[\beta_1 + 2\beta_2 lnQ_{it} + \beta_6 \ln(W_{1,it}) + \beta_7 \ln(W_{2,it}) + \beta_8 \ln(W_{3,it})\right] \tag{6}$$

$$Lerner_{it} = (P_{it} - MC_{it})/P_{it} , \tag{7}$$

In equation (6) and (7), $P_{it}$ is the ratio of total revenue to total assets and $MC_{it}$ is the marginal cost. The subscripts $i$ and $t$ denote each bank and quarter respectively.

Lerner index is a flexible measure and it allows the measurement of market power separately for individual banks. More importantly, it can calculate with a limited number of observations, which is particularly important when the data availability is limited. Unlike the H-statistic, the Lerner index does not require a banking system to be in the long-run equilibrium. Conversely, there are limitations of the Lerner index. Lerner index is a static measure base on the price of the bank (Leon, 2015). Oliver, Fumás, and Saurina (2006) point out that the market power differs across loan products and an overall Lerner index does not capture the real market power.

### 3.3 Boone indicator

Boone (2008) introduces a new measure of competition. This measure considers the impact of efficiency on performance. Banks are producing close substitutes and low entry barriers are the main assumptions of Boone (2008). When there is an increase in the product substitution, consumers will obtain the service from the bank that charges less for their service. An efficient bank generates high profits when its marginal cost is low, more negative the Boone indicator will be (Tabak, Fazio and Cajueiro, 2012). The equation (8) shows the estimation of the Boone indicator ($\beta$). Profits increase for the banks with lower marginal cost ($\beta < 0$). Hence, an increase in competition improves the profits of efficient bank relative to the less efficient bank (Schaeck & Cihak, 2010).

$$\ln(\pi_{it}) = \alpha + \beta ln(C_{it}) , \tag{8}$$

where $\pi_{it}$ indicates return on assets of bank *i* at time *t*, $\beta$ is referred as the Boone indicator and C is the cost.

Schaeck and Cihak (2014) use an average cost to estimate the Boone indicator. Tabak et al. (2012); van Leuvensteijn, Bikker, van Rixtel, and Sørensen (2011) use marginal cost to estimate the Boone indicator. This study incorporates both the average cost and the marginal cost. This allows observing the estimation difference based on the average cost and the marginal cost. The marginal cost is calculated by using translog function is given in equation (4). Equations (9) and (10) estimate the competitive condition ($\beta$) of each bank for the full sample period.

$$\ln(ROA_{it}) = \alpha + \beta ln(AC_{it}) + D_t + \varepsilon_{it} , \tag{9}$$

$$\ln(ROA_{it}) = \alpha + \beta ln(MC_{it}) + D_t + \varepsilon_{it} , \tag{10}$$

where $ROA_{it}$ indicates return on assets of bank *i* at time *t*, $\beta$ is referred as the Boone indicator and $AC$ is the average cost and $MC$ is the marginal cost. Time dummies are included to control for the timely changes in the US banking system.

The main advantage of the Boone indicator is it estimates the relationship between costs and profits in a dynamic market. It only requires information about profits (or market shares) and costs and it is a non-price measure. Both Lerner and H-statistic require static price when estimating the competition. However, the efficiency gains of banks are not immediately translated into lower costs or higher profits in the short term (Leon, 2015). It is the problem of the Boone indicator.

### 3.4 Accounting-based Stability Measures

Z-score is widely used accounting-based risk measure and it is computed using the individual bank level data. It compares the capital buffer and returns of the bank with the volatility of returns and interprets it as the inverse probability of default (Boyd, Graham, & Hewitt, 1993; Boyd & Runkle, 1993). A higher Z-score value indicates a lower probability of default and provides more stability. It is estimated as follows;

$$Z - score \ = \frac{ROA_{it} + \frac{Equity_{it}}{Assets_{it}}}{SDROA_{it}}, \tag{11}$$

where $ROA_{it}$ indicates the return on assets of the bank *i* at time *t*, $Equity_{it}$ is the total equity of the bank *i* at time *t*, $Assets_{it}$ is the total assets of the bank *i* at time *t* , and $SDROA_{it}$ is the standard deviation of $ROA$ or the volatility of return.

Lepetit and Strobel (2013) explain different approaches to calculate time-varying Z-score and recommend computing time-varying standard deviation rather than one standard deviation for the full sample period. This study chooses a twelve-quarter rolling time window to calculate the standard deviation of ROA (Beck et al., 2013; Boyd, De Nicolo, & Jalal, 2006; Leroy & Lucotte, 2017). This approach is the most preferred approach for unbalanced panel data.

The ratio of non-performing loans to total loans (NPL) is another accounting-based measure used as a proxy for credit risk of the bank. The higher percentage of non-performing loans indicates an increase in credit risk and less stability (Berger et al., 2008; Jiménez, Lopez, & Saurina, 2013; S. Kasman & A. Kasman, 2015)

### 3.5 Market-based Stability Measures

When concerning the market-based measures, the common measure is Merton (1974) distance-to-default. The distance-to-default model estimates the difference between the current market value of assets of a firm and its estimated default point divided by the volatility of assets. A higher distance-to-default explains less probability of default and the bank is stable. A higher value indicates either increase in bank's assets or decrease the volatility of assets (Kliestik, Misankova, & Kocisova, 2015). Market-based measures are more forward-looking and predictability measures, hence the distance-to-default explains market's perception of the bank's stability in the future (Anginer et al., 2014). This study uses the computation method of distance-to-default outlined by Bharath and Shumway (2008); Fu et al. (2014).

$$DD = N\left(-\frac{\ln\left(\frac{V_A}{D}\right)+\left(u-\delta-\left(\frac{\sigma_A^2}{2}\right)\right)T}{\sigma_A\sqrt{T}}\right) \tag{12}$$

where $DD$ is the distance-to-default, $N$is the cumulative normal distribution function, $V_A$ is the value of total assets, $D$ is the total liabilities as a proxy for the face value of debt, $u$ is the expected return, $\delta$ is the total dividend as a percentage of total value of the bank, $\sigma_A$ is the standard deviation of total assets, and $T$is the time to maturity.

$$V_A = V_E + D \tag{13}$$

$$\sigma_A = \frac{V_E}{V_A}\sigma_E + \frac{D}{V_A}\sigma_D \tag{14}$$

$$\sigma_D = 0.05 + 0.25\sigma_E \tag{15}$$

$$u = r_{i,t-1} \tag{16}$$

where $V_A$ is the total value of assets, $V_E$ is the market value of common equity, $D$ is the total liabilities, $\sigma_A$ is the standard deviation of total assets, $\sigma_E$ is the standard deviation of equity returns, $\sigma_D$ is the standard deviation of total liabilities, $u$ is the expected return, and $r_{i,t-1}$ is the stock returns over the previous quarter[1]. In terms of the calculation of volatility of debt $(\sigma_D)$, Bharath and Shumway (2008) assume that the risk of debt is correlated with the risk of equity. Therefore, they include the five percentage points in the equation (15) to represent

[1] When the stock returns of the previous quarter are negative, replace the expected return with the treasury bill rate (risk-free rate) of the respective quarter (Fu et al., 2014).

term structure volatility and 25 percent of the equity volatility to allow for volatility associated with risk of equity. This study follows the same approximation to calculate the volatility of debt.

## 4. Estimation methods

This study considers fractional logistic estimation and correlated random effects to estimate the effect of competition on financial stability for the US banks. The equation (17) estimated the effect of competition on stability. Estimation equations independently use three stability measures: Z-score, NPL, and distance-to-default.

$$Stability\ measure_{it} = \beta_0 + \beta_1 competition\ measure_{it} + \beta_2 bank\ controls_{it} + \beta_3 time\ dummies + \varepsilon_{it} \tag{17}$$

Z-score, NPL, and distance-to-default are fractional variables. Z-score and distance-to-default are inversed of probabilities of default. The NPL is a ratio of non-performing loans as a percentage of total loans. All three measures are restricted to the interval between 0 and 1. Papke and Wooldridge (1996) developed a fractional logistic estimation method for estimation models with the fractional dependent variable. Therefore, the fractional logistic estimation is used to examine the effect of competition on stability.

There are four competition measures used as the main explanatory variable in each estimation equation: H-statistic, Lerner index, Boone indicator based on marginal costs (Boone MC), and Boone indicator based on average costs (Boone AC). H-statistic and the Boone indicator are the time constant competition measures for each bank $i$. Hence, correlated random effects estimation is also used to estimate the regressions. According to Wooldridge (2013), the correlated random effects provides a way to include time constant explanatory variables and it is effectively fixed effects analysis.

Bank level control variables are the total assets of the bank, non-interest as a percentage of total income, and net loans to total assets. The natural logarithm of total assets is used to control for the size of the bank. Large banks have the advantage of obtaining economies of scale and remain more stable compared to small banks (Liu & Wilson, 2013; Schaeck & Cihak, 2014). The diversification of revenue is measured by the ratio of non-interest income to total income. The expansion into non-traditional financial services is associated with increase in the volatility of revenue generation and it contributes to increasing the operational risk (Kick & Prieto, 2015; Liu & Wilson, 2013) Banks with relatively high loans to assets ratio are more illiquid banks (Chronopoulos, Liu, McMillan and Wilson, 2015). On the one hand, literature present evidence on the decrease in loans to assets contributes to more stability (Leroy & Lucotte, 2017; Liu & Wilson, 2013) and on the other hand increase in loans to assets ratio contributes to more stability. High-quality assets promote more stability (Amidu, 2013; Soedarmono, Machrouh, & Tarazi, 2013; Turk-Ariss, 2010). Time dummy is included to capture the unobserved factors that change over time and that is common across all the banks of the sample.

## 5. Data

This study collects data from multiple sources. Quarterly accounting data of the US banks are obtained from the Standard and Poor Global Market Intelligence platform SNL for the sample period of 2000 to 2017. The bank level competition measures calculate from accounting data and winsorize to reduce the influence of outliers. Market-based data collect from the Center for Research in Security Prices (CRSP). Quarterly average of the 3 month T-bill rates are obtained from the Federal Reserve Bank of St. Louis.

## 6. Results

### 6.1 Pairwise Correlations

H-statistic, Lerner index, Boone MC, and Boone AC are the four measures of competition. Tables 1A, 1B and 1C report pairwise correlations. Tables 1A and B use Boone MC and 1C use Boone AC. In Table 1A, there are different numbers of observations for each pair of correlations. Tables 1B and 1C set a common number of observations for all pairwise correlations. All three tables report small values of pairwise correlations while they are statistically significant at the 1 percent level. These results highlight that these measures have the intention of measuring the same thing, though they are picking up different aspects of competition (Leon, 2015).

As expected, the Lerner is negatively correlated with the H-statistic in all three tables. A large value of Lerner explains decreasing in the degree of competition, while H-statistic explains the increase in competition. Boone indicator is also expected to report a negative correlation with the H-statistic. But, it seems to be positive. The pairwise correlations using Boone AC are relatively small compared to Boone MC. Lerner index and Boone indicator expected to present a positive correlation. Tables 1A and 1B show 0.24 correlations between Lerner and Boone MC. The correlation between Lerner and Boone AC drops to 0.1307 in Table 1C. The higher value from the former correlation is mainly due to the incorporation of the marginal cost in the computation by both Lerner and Boone MC.

Table 1A: *Pairwise Correlations*

| | H-statistic | Lerner | Boone MC |
|---|---|---|---|
| H-statistic | -<br>-<br>obs=63866 | | |
| Lerner | -0.0626<br>p-value=0.000<br>obs=45975 | -<br>-<br>Obs=46040 | |
| Boone MC | 0.1537<br>p-value=0.000<br>obs=46123 | 0.2420<br>p-value=0.000<br>obs=45953 | -<br>-<br>Obs=46187 |

*Note.* This table considers the H-statistic, Lerner index and Boone MC as the competition measures. H-statistic, Lerner, and Boone MC are described in the text. Number of pairwise observations differ because the availability of data.

Table 1B: *Pairwise correlations with common observations*

| | H-statistic | Lerner | Boone MC |
|---|---|---|---|
| H-statistic | -<br>-<br>obs=41030 | | |
| Lerner | -0.0600<br>p-value=0.000<br>obs=41030 | -<br>-<br>Obs=41030 | |
| Boone MC | 0.1537<br>p-value=0.000<br>obs=41030 | 0.2482<br>p-value=0.000<br>obs=41030 | -<br>-<br>Obs=41030 |

*Note.* This table considers the H-statistic, Lerner index and Boone MC as the competition measures. H-statistic, Lerner, and Boone MC are described in the text.

Table 1C: *Pairwise correlation with common observations*

| | H-statistic | Lerner | Boone AC |
|---|---|---|---|
| H-statistic | -<br>-<br>obs=41019 | | |
| Lerner | -0.0602<br>p-value=0.000<br>obs=41019 | -<br>-<br>Obs=41019 | |
| Boone AC | 0.0389<br>p-value=0.000<br>obs=41019 | 0.1307<br>p-value=0.000<br>obs=41019 | -<br>-<br>Obs=41019 |

*Note.* This table considers the H-statistic, Lerner index and Boone AC as the competition measures. H-statistic, Lerner, and Boone AC are described in the text.

### 6.2 Evaluating the effect of competition on stability

This section employs both the fractional logistic estimation and the correlated random effects estimation approaches. Tables 2 to 7 report results by using Z-score, NPL ratio, and distance-to-default as the stability measures.

#### 6.2.1 Z-score as the stability measure

Table 2 reports the results of each competition variable separately in columns (1) to (4). Columns (5) and (6) use H-statistic, Lerner, and Boone in one specification. Column (5) uses Boone MC as the Boone indicator and column (6) uses Boone AC as the Boone indicator. Column (1) reports the H-statistic is statistically insignificant. While the sign of the respective estimate suggests a negative association between competition and stability, and the t-statistic is -0.63 (P-value of 0.5290) thus, produce a weak results and the hypothesis test is inconclusive. For Lerner, Boone MC, and Boone AC, positive coefficients indicate that variables are negatively associated with financial stability and the results are statistically significant at the 1 percent level. The results are consistent across all the proxy measures of competition and in line with the previous findings of Agoraki et al. (2011); A. Kasman and S. Kasman (2015). Bank size is represented by the natural logarithm of total assets and it is positively associated with bank stability. This confirms that large banks tends to experience lesser earnings volatility (Beck et al., 2013). Income diversification presents a negative association with the Z-score and confirms the previous evidence. When the bank expand into non-traditional financial services, it is associated with an increase in the volatility of revenue generation and it contributes to increase the instability (Kick & Prieto, 2015; Liu & Wilson, 2013). A negative coefficient of loans to total assets indicates liquidity level of the bank positively related with the stability. Liu and Wilson (2013) report a similar finding in the Japanese banking sector and they explained that a higher proportion of loans to assets increases default risk of the bank.

Table 2: *Effect of competition on stability (Z-score as the stability measure)*

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| H-statistic | -0.0478 | | | | -0.0841 | -0.0264 |
| | (0.0758) | | | | (0.0760) | (0.0758) |
| Lerner | | 0.4391*** | | | 0.2513** | 0.3697*** |
| | | (0.1135) | | | (0.1122) | (0.1082) |
| Boone MC | | | 0.1105*** | | 0.1071*** | |
| | | | (0.0125) | | (0.0131) | |
| Boone AC | | | | 4.4317*** | | 4.3143*** |
| | | | | (0.6600) | | (0.6739) |
| Assets | 0.0913*** | 0.0843*** | 0.0777*** | 0.0752*** | 0.0768*** | 0.0710*** |
| | (0.0119) | (0.0117) | (0.0116) | (0.0115) | (0.0120) | (0.0119) |
| Non-interest | -0.7594*** | -0.7804*** | -0.9259*** | -0.7385*** | -0.9305*** | -0.7563*** |
| | (0.1520) | (0.1524) | (0.1514) | (0.1547) | (0.1530) | (0.1569) |
| Loans | -0.4809*** | -0.4513*** | -0.4188*** | -0.4580*** | -0.3826*** | -0.4194*** |
| | (0.1460) | (0.1459) | (0.1410) | (0.1454) | (0.1415) | (0.1454) |
| Time dummies | Yes | Yes | Yes | Yes | Yes | Yes |
| Obs | 41,525 | 41,094 | 41,315 | 41,315 | 41,030 | 41,030 |
| Banks | 880 | 874 | 882 | 882 | 871 | 871 |

*Note.* The table reports estimation results from the fractional logistic estimation. The standard errors are reported in parentheses below their coefficient estimates. Column (1) uses H-statistic; column (2) uses Lerner index; column (3) uses Boone MC; and column (4) uses Boone AC as competition variable in the respective specifications. Columns (5) and (6) estimate the regression with all the competition measures. *, **, and ***, indicate significance at the 10-, 5-, and 1-percent significance levels.

Table 3: *Effect of competition on stability (Z-score as the stability measure)*

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| H-statistic | -0.0009* | | | | -0.0011** | -0.0007 |
| | (0.0005) | | | | (0.0005) | (0.0005) |
| Lerner | | 0.0022*** | | | 0.0016** | 0.0019** |
| | | (0.0008) | | | (0.0008) | (0.0008) |
| Boone MC | | | 0.0004*** | | 0.0004*** | |
| | | | (0.0007) | | (0.0007) | |
| Boone AC | | | | 0.0237*** | | 0.0232*** |
| | | | | (0.0039) | | (0.0039) |
| Assets | 0.0007*** | 0.0007*** | 0.0006*** | 0.0006*** | 0.0006*** | 0.0006*** |
| | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) |
| Non-interest | -0.0020*** | -0.0021*** | -0.0022*** | -0.0021*** | -0.0022*** | -0.0021*** |
| | (0.0007) | (0.0007) | (0.0007) | (0.0007) | (0.0007) | (0.0007) |
| Loans | 0.0038*** | 0.0038*** | 0.0038*** | 0.0038*** | 0.0038*** | 0.0038*** |
| | (0.0007) | (0.0008) | (0.0008) | (0.0008) | (0.0008) | (0.0008) |
| Time dummies | Yes | Yes | Yes | Yes | Yes | Yes |
| Obs | 41,525 | 41,094 | 41,315 | 41,315 | 41,030 | 41,030 |
| Banks | 880 | 874 | 882 | 882 | 871 | 871 |

*Note.* The table reports estimation results from the correlated random effects estimation. The standard errors are reported in parentheses below their coefficient estimates. Column (1) uses H-statistic; column (2) uses Lerner index; column (3) uses Boone MC; and column (4) uses Boone AC as competition variable in the respective specifications. Columns (5) and (6) estimate the regression with all the competition measures. *, **, and ***, indicate significance at the 10-, 5-, and 1-percent significance levels.

Table 3 follows the same specifications as Table 2. But, it employs the correlated random effects estimation. All the competition measures report statistically significant results and they are negatively associated with stability. The H-statistic is barely significant the 10 percent level in column (1) and all other proxy measures of competition are highly significant at the 1 percent level. The size of the bank and income diversification reports similar results as in Table 2. A positive coefficient of loans to total assets indicates illiquidity positively related with the stability. It supports the previous finding that the bank's loan portfolio contains high-quality loans and an increase in high-quality loans promotes more stability (Amidu, 2013; Soedarmono et al., 2013; Turk-Ariss, 2010).

According to the results of Tables 2 and 3, when the Z-score is used as the stability measure, competition measures are negatively related with the stability and support the competition-fragility hypothesis.

### 6.2.2 NPL as the stability measure

Tables 4 and 5 repeat the same estimation procedure as Tables 2 and 3 with the NPL ratio as the dependent variable. In Table 4, the H-statistic is marginally significant at the 10 percent level. A positive coefficient of the H-statistic suggests that increase in competition is negatively associated with stability. Both the Lerner index and Boone MC present an opposing association with stability and results are at least significant at the 5 percent level. These two variables support the competition-stability hypothesis and in line with the empirical findings of Berger et al. (2008). A negative coefficient of the bank size represent that the large banks have a negative association with the NPL. Large banks are able to maintain stable loan portfolio (Agoraki et al., 2011). In Table 5, a positive coefficient of the H-statistic indicates that the competition is negatively associated with the stability. Boone MC supports the positive link between competition and stability. These two proxy measures show similar results as in Table 4. The coefficients of Lerner and Boone AC are not statistically significant. The size of the bank and loans to assets ratio positively linked with stability and confirms that the large banks and banks with large loan portfolio support bank stability.

The effect of competition on stability is different using the NPL ratio compared to the results of Z-score. This confirms Zigraiova and Havranek (2016) finding that the definition of the proxy measure of stability decides the effect of competition on stability.

Table 4: *Effect of competition on stability (NPL as the stability measure)*

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| H-statistic | 0.2037* | | | | 0.1354 | 0.1892* |
| | (0.1074) | | | | (0.1032) | (0.1051) |
| Lerner | | 0.3354** | | | 0.2214 | 0.3742** |
| | | (0.1437) | | | (0.1489) | (0.1469) |
| Boone MC | | | 0.0931*** | | 0.0771*** | |
| | | | (0.0252) | | (0.0258) | |
| Boone AC | | | | -0.4862 | | -0.5781 |
| | | | | (1.2971) | | (1.3044) |
| Assets | -0.0404** | -0.0364** | -0.0481** | -0.0310 | -0.0521*** | -0.0416** |
| | (0.0186) | (0.0180) | (0.0193) | (0.0193) | (0.0195) | (1.3044) |
| Non-interest | -0.0294 | 0.0087 | -0.1703 | 0.0075 | -0.1701 | -0.0323 |
| | (0.2241) | (0.2299) | (0.2237) | (0.2274) | (0.2233) | (0.2260) |
| Loans | -0.1009 | -0.0616 | 0.0051 | -0.0978 | 0.0016 | -0.0755 |
| | (0.2035) | (0.2081) | (0.2077) | (0.2074) | (0.2072) | (0.2069) |
| Time dummies | Yes | Yes | Yes | Yes | Yes | Yes |
| Obs | 44,008 | 43,876 | 44,072 | 44,072 | 43,811 | 43,811 |
| Banks | 877 | 872 | 879 | 879 | 869 | 869 |

*Note.* The table reports estimation results from the fractional logistic estimation. The standard errors are reported in parentheses below their coefficient estimates. Column (1) uses H-statistic; column (2) uses Lerner index; column (3) uses Boone MC; and column (4) uses Boone AC as competition variable in the respective specifications. Columns (5) and (6) estimate the regression with all the competition measures. *, **, and ***, indicate significance at the 10-, 5-, and 1-percent significance levels.

Table 5: *Effect of competition on stability (NPL as the stability measure)*

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| H-statistic | 0.0055** | | | | 0.0030 | 0.0047** |
| | (0.0021) | | | | (0.0020) | (0.0021) |
| Lerner | | -0.0015 | | | -0.0032 | -0.0013 |
| | | (0.0031) | | | (0.0032) | (0.0032) |
| Boone MC | | | 0.0018*** | | 0.0017*** | |
| | | | (0.0005) | | (0.0005) | |
| Boone AC | | | | 0.0076 | | 0.0113 |
| | | | | (0.0259) | | (0.0264) |
| Assets | -0.0025*** | -0.0023*** | -0.0026*** | -0.0024*** | -0.0025*** | -0.0024*** |
| | (0.0006) | (0.0006) | (0.0006) | (0.0006) | (0.0006) | (0.0006) |
| Non-interest | -0.0024 | -0.0027 | -0.0026 | -0.0021 | -0.0033 | -0.0029 |
| | (0.0042) | (0.0042) | (0.0042) | (0.0042) | (0.0066) | (0.0042) |
| Loans | -0.0143*** | 0.0143*** | -0.0141*** | -0.0143*** | -0.0142*** | -0.0144*** |
| | (0.0040) | (0.0040) | (0.0040) | (0.0040) | (0.0040) | (0.0041) |
| Time dummies | Yes | Yes | Yes | Yes | Yes | Yes |
| Obs | 44,008 | 43,876 | 44,072 | 44,072 | 43,811 | 43,811 |
| Banks | 877 | 872 | 879 | 879 | 869 | 869 |

*Note.* The table reports estimation results from the correlated random effects estimation. The standard errors are reported in parentheses below their coefficient estimates. Column (1) uses H-statistic; column (2) uses Lerner index; column (3) uses Boone MC; and column (4) uses Boone AC as competition variable in the respective specifications. Columns (5) and (6) estimate the regression with all the competition measures. *, **, and ***, indicate significance at the 10-, 5-, and 1-percent significance levels.

### 6.2.3 Distance-to-default as the stability measure

Tables 6 and 7 use the distance to default as the stability measure. These two tables follow the same estimation specifications and the estimation methods as previous tables. The distance to default is a market level measure and the data availability restricted the sample to 359 banks. A higher distance-to-default explains less probability of default and more stability. A positive coefficient of the H-statistic implies competition increases fragility at the 5 percent significance level and a positive coefficient of Boone MC implies that the competition increases stability. Lerner and Boone AC are statistically insignificant. Columns (5) and (6) report only Boone MC and H-statistic with a statistically significant coefficient in each column respectively. From the bank level control variables, the size of the bank is the only significant variable in all six columns and it shows an increase in assets positively associate with the stability. In Table 7, the reported results in most cases are not statistically significant in all columns. H-statistic and Boone MC report competition negatively associated with stability and coefficients are marginally significant at the 10 percent level. The results using the distance to default as the proxy measure of stability presents similar findings to the results using Z-score with lower statistical significance.

Table 6: *Effect of competition on stability (Distance-to-default as the stability measure)*

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| H-statistic | -0.0904* | | | | -0.0878* | -0.0878* |
| | (0.0494) | | | | (0.0493) | (0.0493) |
| Lerner | | 0.0577 | | | 0.0262 | 0.0380 |
| | | (0.0928) | | | (0.0955) | (0.0955) |
| Boone MC | | | 0.0079 | | 0.0073 | |
| | | | (0.0054) | | (0.0056) | |
| Boone AC | | | | 0.0717 | | 0.0491 |
| | | | | (0.2017) | | (0.1929) |
| Assets | 0.0215** | 0.0192* | 0.0109* | 0.0193* | 0.0218** | 0.0211** |
| | (0.0108) | (0.0107) | (0.0107) | (0.0107) | (0.0108) | (0.0108) |
| Non-interest | -0.1051 | -0.1163 | -0.1325 | -0.1147 | -0.1211 | -0.1051 |
| | (0.1536) | (0.1554) | (0.1551) | (0.1549) | (0.1533) | (0.1533) |
| Loans | -0.1248 | -0.1318 | -0.1333 | -0.1369 | -0.1180 | -0.1202 |
| | (0.1484) | (0.1536) | (0.1527) | (0.1530) | (0.1487) | (0.1490) |
| Time dummies | Yes | Yes | Yes | Yes | Yes | Yes |
| Obs | 10,032 | 10,032 | 10,032 | 10,032 | 10,032 | 10,032 |
| Banks | 359 | 359 | 359 | 359 | 359 | 359 |

*Note.* The table reports estimation results from the fractional logistic estimation. The standard errors are reported in parentheses below their coefficient estimates. Column (1) uses H-statistic; column (2) uses Lerner index; column (3) uses Boone MC; and column (4) uses Boone AC as competition variable in the respective specifications. Columns (5) and (6) estimate the regression with all the competition measures. *, **, and ***, indicate significance at the 10-, 5-, and 1-percent significance levels.

Table 7: *Effect of competition on stability (Distance-to-default as the stability measure)*

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| H-statistic | -0.0174* | | | | -0.0160 | -0.0160 |
| | (0.0098) | | | | (0.0098) | (0.0098) |
| Lerner | | 0.0240 | | | 0.0179 | 0.0208 |
| | | (0.0174) | | | (0.0176) | (0.0177) |
| Boone MC | | | 0.0014* | | 0.0012 | |
| | | | (0.0008) | | (0.0008) | |
| Boone AC | | | | 0.0064 | | 0.0012 |
| | | | | (0.0338) | | (0.0326) |
| Assets | 0.0012 | 0.0007 | 0.0009 | 0.0111 | 0.0012 | 0.0010 |
| | (0.0023) | (0.0023) | (0.0023) | (0.0287) | (0.0023) | (0.0023) |
| Non-interest | 0.0129 | 0.1024 | 0.0093 | 0.0111 | 0.0108 | 0.0122 |
| | (0.0286) | (0.0286) | (0.0287) | (0.0310) | (0.0286) | (0.0286) |
| Loans | 0.0010 | 0.0018 | 0.0007 | 0.0003 | 0.0025 | 0.0024 |
| | (0.0306) | (0.0310) | (0.0309) | (0.0310) | (0.0307) | (0.0307) |
| Time dummies | Yes | Yes | Yes | Yes | Yes | Yes |
| Obs | 10,032 | 10,032 | 10,032 | 10,032 | 10,032 | 10,032 |
| Banks | 359 | 359 | 359 | 359 | 359 | 359 |

*Note.* The table reports estimation results from the correlated random effects estimation. The standard errors are reported in parentheses below their coefficient estimates. Column (1) uses H-statistic; column (2) uses Lerner index; column (3) uses Boone MC; and column (4) uses Boone AC as competition variable in the respective specifications. Columns (5) and (6) estimate the regression with all the competition measures. *, **, and ***, indicate significance at the 10-, 5-, and 1-percent significance levels.

### 6.3 Estimation of the effect size

This section translates the estimation results of the previous section into economically meaningful numbers. Table 8 reports the results of a comparable exercise of all competition variables for the fractional logistic regression model.

In Panel A, an increase in the H-statistic from its 25$^{th}$ percentile to 75$^{th}$ percentile reduces the inverse probability of default by a 0.01 percent. In Panel B, the similar size change in H-statistic is associated with an increase of NPL ratio by 0.13 percent and in Panel C, the inverse probability of default reduces by 0.66 percent. The estimated effect for H-statistic is large in Panel B and C. However, the Section 6.2 reports that the impact of H-statistic on stability is hardly significant. Table 8 reveals the change in the size of the Lerner index creates negligible economic impact for any stability measure. The change in Boone MC from its 25$^{th}$ percentile to 75$^{th}$ percentile is associated with increase in inverse probability of default by 0.07 percent in Panel A. similarly it is associated with 0.18 percent increase in probability of non-performing loans in Panel B. the same size change in the Boone MC is associated with 0.14 percent increase in the inverse probability of default in Panel C. The results confirm that the impact of Boone MC on stability is statistically and economically significant. In contrast, the estimated effects for Boone AC are much smaller compared to Boone MC. The change in Boone AC from its 25$^{th}$ percentile to 75$^{th}$ percentile is associated with increase in inverse probability of default by 0.06 percent in Panel A, decrease in probability of occurring non-performing loans by 0.02 in Panel B and again an increase in inverse default probability by 0.04 percent in Panel C. However, the Boone AC is statistically insignificant in the respective regression estimates other than the Z-score.

Table 8: *Effect Size Estimates at the 25th, 50th, and 75th Percentile Values of H-statistic, Lerner, Boone MC and Boone AC*

| | H-statistic | Lerner | Boone MC | Boone AC |
|---|---|---|---|---|
| | | Panel A: Z-score | | |
| $25^{th}$ percentile | 0.0058 | 0.0059 | 0.0055 | 0.0054 |
| $50^{th}$ percentile | 0.0057 | 0.0059 | 0.0059 | 0.0057 |
| $75^{th}$ percentile | 0.0057 | 0.0059 | 0.0062 | 0.0060 |
| ***Δ 75^th^ - 25^th^*** | ***-0.0001*** | ***0.0000*** | ***+0.0007*** | ***+0.0006*** |
| Obs | 41,252 | 41,094 | 41,315 | 41,315 |
| | | Panel B: NPL | | |
| $25^{th}$ percentile | 0.0176 | 0.0185 | 0.0179 | 0.0183 |
| $50^{th}$ percentile | 0.0182 | 0.0185 | 0.0188 | 0.0182 |
| $75^{th}$ percentile | 0.0189 | 0.0185 | 0.0197 | 0.0181 |
| ***Δ 75^th^ - 25^th^*** | ***+0.0013*** | ***0.0000*** | ***+0.0018*** | ***-0.0002*** |
| Obs | 44,008 | 43,876 | 44,072 | 44,072 |

| | | | | |
|---|---|---|---|---|
| Panel C: Distance-to-default | | | | |
| $25^{th}$ percentile | 0.7311 | 0.7283 | 0.7274 | 0.7275 |
| $50^{th}$ percentile | 0.7282 | 0.7283 | 0.7281 | 0.7278 |
| $75^{th}$ percentile | 0.7245 | 0.7283 | 0.7288 | 0.7279 |
| ***Δ $75^{th}$ - $25^{th}$*** | ***-0.0066*** | ***0.0000*** | ***+0.0014*** | ***+0.0004*** |
| Obs | 10,032 | 10,032 | 10,032 | 10,032 |

*Note*. The predicted probabilities are derived from the fractional logistic model of Table 2, 4, and 6. The dependent variable in Panels A, B, and C are Z-score, NPL and the distant to default. All probabilities are calculated at the mean values of the regression covariates, except for the variable of interest (*H-statistic*, Lerner, Boone MC, or Boone AC) which are evaluated at their 25th, 50th, and 75th percentile values.

## 7. Conclusion

This study examines the relationship between bank competition and financial stability by using bank-level data in the USA for the period between 2000 and 2017. The proxy measures used to capture competition and stability is another aspect which leads to conflicting results.

The findings of the study confirm that the three competition measures have low pairwise correlations and they capture different aspects of competition. The effect of competition on stability varies with the proxy measure of stability. When the Z-score is used as the stability measure, H-statistic, Lerner, and Boone find competition promotes financial instability. The results of Tables 2 and 3 explain competition measures are negatively related to the stability and support the competition-fragility hypothesis. The results using distance-to-default also in line with the competition-fragility hypothesis with relatively small statistical significance compared to the Z-score. However, these findings are not consistent with the other stability measure. When the proxy measure of stability is NPL ratio, the H-statistic suggests that increase in competition is negatively associated with stability. Both Lerner and Boone indicate a positive link between competition and stability.

Bank size is positively associated with stability and findings are consistent irrespective of the proxy measure of stability. Income diversification is statistically significant only when the Z-score is used as the proxy measure of stability. There is a negative association with the Z-score and confirms that the increase in volatility of revenue generation contributes to reducing the stability. The loans to assets ratio positively associated with stability in most of the estimations. However, it shows a negative association with stability using the fractional logistic estimation.

The estimated results of H-statistic are statistically insignificant in most of the regressions. The economic significance of the H-statistic varies based on the proxy measure of competition. Increases in the degree of competition from its $25^{th}$ percentile to $75^{th}$ percentile are associated with a reduction in the Z-score by a 0.01 percent. The similar size change in H-statistic is associated with an increase of NPL ratio by 0.13 percent and with the distance-to-default it is associated with a reduction of 0.66 percent. The change in Boone MC from its $25^{th}$ percentile to $75^{th}$ percentile implies decreases in the competition and it is associated with the increase in Z-score by 0.07 percent. Similarly, it is associated with 0.18

percent increase in the probability of NPL ratio and 0.14 percent increase in the distance-to-default. These results confirm that the impact of Boone MC on stability is statistically and economically significant. There is an infinitesimal economic significance from the Lerner index. The impact of Boone AC on stability is statistically and economically insignificant.

This study fails to find evidence that competition is positively related to financial stability is an important contribution. It prevents policymakers from relaxing state laws to promote competition in the US banking sector when these are not likely to produce positive results.

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