“Competition, bank fragility, and financial crisis”

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COMPETITION, BANK FRAGILITY AND FINANCIAL CRISIS

Abstract

This paper examines how competition affects bank fragility and how this relation varies in normal times and during a financial crisis using the data from Indonesian commercial banking industry. The author finds significant evidence, both statistically and economically, that more competition reduces bank fragility. In particular, the author finds that a decrease in Herfindahl – Hirschman Index (HHI) of deposits by 100 points leads to an increase in bank Z-score by 14.22 percent from its mean. Similarly, a decrease in HHI of loans by 100 points leads to an increase in Z36 by 20.44 percent. This finding is consistent across different kinds of robustness tests, including endogeneity, as well as alternative bank fragility and competition measures. However, this competition-stability nexus holds only in normal times and is reversed during a financial crisis. This suggests that the impact of competition on bank fragility is conditional on the economic condition.

Keywords banking, competition, bank fragility, financial crisis, Indonesia

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INTRODUCTION

As in other industries, most policy makers and academicians believe that more competition in the banking industry will benefit the economy. For example, President Obama (2010) in one of his speeches asserts, "The American people will not be served by a financial system that comprises just a few massive firms. That's not good for consumers; it's not good for the economy". Meanwhile, previous research has shown that more competition in the banking industry increases per capita income growth (Jayaratne & Strahan, 1996), reduces loan rate (Rice & Strahan, 2010), improves income distribution (Beck et al., 2010), and promotes innovation (Chava et al., 2013). However, the nexus between competition and bank fragility has still been a controversial debate. On the one hand, more competition shrinks a bank's ability to reap profit and results in lower charter value, which induces the bank to compensate it by taking higher risk (e.g., Keeley, 1990; Hellmann et al., 2000; Repullo, 2004). On the other hand, more competition makes bank loans cheaper, which lessens moral hazard incentives of borrowers to shift into riskier projects and draws a safer set of borrowers (e.g., Boyd & De Nicolo, 2005; Boyd et al., 2006; Akins et al., 2016). Moreover, more competition might promote a less concentrated banking system with fewer too-big-to-fail (TBTF) banks that benefit most from the government's implicit or explicit bailout program (Berger et al., 2009).

The recent global financial crisis has shown once more how disruptive a financial crisis to the economy. Laeven and Valencia (2013) show that during 1970–2011, the world's median output loss and fiscal cost caused by banking crises are 23.2 and 6.8 percent of GDP, respectively[1]. Financial economists have studied financial crises extensively. However, the literature on how competition affects bank fragility in normal times and during a financial crisis is still relatively sparse. This gap in the literature is surprising considering that competition is one of the main determinants of bank fragility.

This paper aims to fill the gap by providing novel evidence from the Indonesian commercial banks industry. Mulyaningsih and Daly (2011) show that Indonesia has experienced material changes in its banking structure after the 1997 Asian financial crisis, which results in more consolidated banking industry. This makes Indonesia a good laboratory to test the relation between competition and bank fragility. Moreover, focusing on a single country dataset ensures greater homogeneity that mitigates the omitted variables bias.

The sample covers monthly observations of all commercial banks in the Indonesian banking industry from 2002 to 2011, which includes the recent 2008 global financial crisis (2007:Q3–2009:Q4) (Berger & Bouwman, 2013). Therefore, the sample covers longer period than the previous studies (e.g., Akins et al., 2016) and includes both crisis and normal times. Finally, I also perform instrumental variable (IV) techniques to ensure that the reverse causality problem does not bias my findings, as well as other robustness checks.

In summary, for the overall sample and during normal times, I find that banks in a more competitive market are less fragile to insolvency, consistent with the competition-stability hypothesis. Meanwhile, during a financial crisis, my findings suggest that less competition promotes higher bank stability, consistent with the competition-fragility hypothesis.

The remainder of this paper is structured as follows. Section 1 provides literature review and hypotheses development. Section 2 describes the methodology, variables, and data. Section 3 presents the empirical results and robustness checks. Final section concludes the paper.

1. LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

The traditional "competition-fragility hypothesis" suggests that tougher bank competition decreases franchise value and results in higher risk taking (Marcus, 1984; Keeley, 1990; Demsetz et al., 1996; Carletti & Hartmann, 2003; Craig & Dinger, 2013). On the other hand, the "competition-stability hypothesis" contends that lower competition in the loan market may induce banks to charge higher interest rates to their borrowers and results in higher banks' risk-taking either via moral hazard or adverse selection channel (Boyd & De Nicolo, 2005; Boyd et al., 2006; De Nicolo & Loukoianova, 2007; Schaeck et al., 2009). Accordingly, the first two hypotheses to test in this paper are:

H1: *More competition is associated with higher bank fragility (the traditional competition-fragility hypothesis).*

H2: *More competition is associated with lower bank fragility (the competition-stability hypothesis).*

Despite the debate over the competition-fragility versus competition-stability hypotheses, most of the previous research has ignored the notion that competition might affect bank fragility differently during normal time and financial crisis. One notable exception is a paper by Akins et al. (2016), which examines the competition-fragility nexus in the banking industry before and during the recent 2008 financial crisis. However, as the crisis starts from the third quarter of 2007 through 2009 (Berger & Bouwman, 2013), Akins et al.'s sample covers only a short non-crisis period. This might

1 Laeven and Valencia calculate the output losses of a crisis as the cumulative losses in GDP relative to a precrisis trend, and the fiscal costs as the direct fiscal outlays to rescue financial sector from the crisis.

explain why they find competition affecting bank risk in the same way before and during the crisis. Moreover, the paper does not address the potential reverse causality problem between competition and bank fragility. I address all of these concerns in this paper.

Why does competition may affect bank fragility differently in normal times and financial crises? A financial crisis usually involves significant losses in banking industry due to high nonperforming loans or fire sales of assets in response to bank runs (e.g., Laeven & Valencia, 2013). In this harsh time, a bank might benefit from a substantial market power, since it may attract deposits with lower rate due to flight-to-safety. This will mitigate the decline on the bank's profit, preserve its charter value, and lessen the incentives to take high risks. Accordingly, I hypothesize that during a financial crisis, less competition is associated with less bank fragility (competition-fragility hypothesis). Since loan prices are typically high during a financial crisis due to a contraction in credit supply (e.g., Ivashina & Scharfstein, 2010; Cornett et al., 2011; Puri et al., 2011), it is unlikely that banks will use their market power to increase loan prices further. However, in normal times, either competition-fragility or competition-stability can still occur. Accordingly, the third hypothesis to test in this paper is:

H3: The relationship between competition and bank fragility is different in normal times and during a financial crisis.

2. METHODOLOGY, VARIABLES, AND DATA

Following Berger et al. (2017), I use Z-score as the main proxy of overall (inverse) bank fragility. The Z-score measures the number of standard deviations below the mean by which a bank's profits would have to fall to exhaust its capital. Higher Z-score shows less bank fragility and vice versa. As the baseline, I compute the Z-score over three years or 36 months (Z36), from time $t-35$ to time *t*. I also use the Z-score over two years (Z24) and five years period (Z60) as robustness checks. Other measures of bank fragility that I use as additional robustness checks are nonperforming loans ratio (NPL/TL) and allowance for loans losses to total loans ratio (ALL/TL). While the NPL ratio is a historical risk measure, the ALL ratio is more forward-looking measure of a bank's loans portfolio[2]. A bank with higher NPL/TL or ALL/TL is more fragile to insolvency.

Following the U.S. Department of Justice and Federal Trade Commission (2010), I use the Herfindahl – Hirschman Index (HHI) as the main proxy of bank competition. In order to capture (inverse) bank competition in both deposit and loan markets, I calculate HHI of deposits (HHID) and loans (HHIL) to use in the baseline regressions. In robustness checks, I use the 4-firms concentration ratio in deposits (CR4D) and loans markets (CR4L) as alternative measures of bank competition (e.g., Mirzaei et al., 2013).

In order to ensure that other factors do not confound the impact of competition to bank fragility, I control for a number of bank-level characteristics and macroeconomic environments[3]. Moreover, I control for bank fixed effects to mitigate the potential omitted variable bias caused by any time invariant bank-specific factor. Table 1 provides detailed definitions of all variables used in this paper.

The baseline model specification to test the impact of competition on bank fragility in a multivariate setting is as follows:

$$Z_{i,t-k+1,t} = \alpha + \beta \cdot HHI_{t-k} + \\ +\gamma \cdot Controls_{t-k} + \delta_i + \varepsilon_{i,t-k+1,t}, \quad (1)$$

where Z denotes the main measure of (inverse) bank fragility, *HHI* is the main measure of (inverse) bank competition, $Controls$ is the vector of bank characteristics and macroeconomic controls, δ is the bank fixed effect, and ε is the error term. I estimate the OLS regression in Equation 1 with robust standard errors clustered at the bank level to correct possible heteroscedasticity and

2 The purpose of the allowance is to cover credit losses that are probable and estimable on the date of financial reporting (Office of the Comptroller of the Currency, 1996).

3 The deposit insurance cap rate data are from the Indonesian Deposit Insurance Corporation (IDIC)'s website (www.lps.go.id) and the Indonesian Financial Statistics published by the Bank of Indonesia. The monthly inflation rates are from the Indonesian Statistical Bureau (www.bps.go.id).

Table 1. Variable definition

Variable	Definition
Main dependent variable (bank fragility measure)	
Z-score36 (Z36)	An inverse measure of bank fragility or overall financial risk, calculated as $\left(mean\left(ROA\right)+mean\left(Equity\ /\ GTA\right)\right)/\ \sigma\left(ROA\right).$ Higher value indicates lower bank fragility. The mean and standard deviation (σ) are calculated over 3 years (36 months) from time to time t. ROA is the bank's return on assets, calculated as the ratio of net income to Gross Total Assets (GTA). $Equity\ /\ GTA$ is the bank's capitalization ratio.
Alternative bank fragility measures	
Z-score24 (Z24)	An alternative measure of Z-score with the mean and standard deviation calculated over 2 years (24 months). Higher value indicates lower financial risk.
Z-score60 (Z60)	An alternative measure of Z-score with the mean and standard deviation calculated over 5 years (60 months). Higher value indicates lower financial risk.
NPL ratio (NPL/TL)	A measure of credit risk calculated as the ratio of nonperforming loans (past due at least 90 days or in nonaccrual status) to total loans. Higher value indicates riskier loan portfolio.
All ratio (ALL/TL)	An alternative measure of risk on a bank's loans portfolio calculated as the ratio of allowance for loans losses to total loans.
Main independent variables (competition measures)	
HHI of deposits (HHID)	A proxy of bank competition calculated as the sum of squared deposit shares of all banks in the market. This measure takes values between zero and 10,000 with higher values indicating less competition. HHI close to zero means that a market is perfect competition, while HHI equal to 10,000 belongs to a monopoly market.
HHI of loans (HHIL)	An alternative proxy of bank competition calculated as the sum of squared loan shares of all banks in the market. This measure takes values between zero and 10,000 with higher values indicating less competition. HHI close to zero means that a market is perfect competition, while HHI equal to 10,000 belongs to a monopoly market.
Alternative competition measures	
CR4 of deposits (CR4D)	An alternative proxy of bank competition calculated as the sum of deposit shares of four largest banks in the market. This measure takes values between zero and 100% with higher values indicating less competition.
CR4 of loans (CR4L)	An alternative proxy of bank competition calculated as the sum of loan shares of four largest banks in the market. This measure takes values between zero and 100% with higher values indicating less competition.
Control variables	
Log of gross total assets (LGTA)	The natural logarithm of Gross Total Assets (GTA). GTA is defined as total assets + allowance for loan losses, following Berger and Bouwman (2013).
Asset diversification ratio (ADR)	A measure of earning assets composition in a bank's balance sheet calculated as $1-\left\lvert\frac{Net\ loans-Other\ earning\ assets}{Total\ earning\ assets}\right\rvert$ following Laeven and Levine (2007). This measure takes values between zero and one with higher values indicating greater diversification.
Overhead costs ratio (OHR)	A proxy for the bank's overhead cost structure calculated as the ratio of overhead expenses to GTA.
Listed dummy (LB)	A dummy variable equals 1 if the bank is listed on a stock exchange or is part of a bank holding company that is listed on a stock exchange, and 0 otherwise.
BHC dummy (BHC)	A dummy variable equals 1 if the bank is part of a bank holding company, and 0 otherwise.
Deposit insurance cap rate (DICR)	The ceiling rate for interest on bank deposits that is set by Indonesia Deposit Insurance Corporation (IDIC) on a monthly basis.
Inflation (INF)	Monthly inflation rate.
Crisis dummy (CRISIS)	A dummy variable equals 1 for the financial crisis period, and 0 otherwise.
Bank FE	Bank fixed effects represented by a dummy variable for each bank.
Instrumental variables	
Age (AGE)	Bank age calculated as year – year of establishment.
Age squared (AGESQ)	The squared term of bank age.

Table 2. Summary statistics

Variables	Abbr.	Mean	St. Dev	P25	P50	P75
Z-score36 (36 months)	Z36	11.251	9.457	4.981	8.398	14.368
Z-score24 (24 months)	Z24	12.053	11.125	4.902	8.524	15.639
Z-score60 (60 months)	Z60	10.601	7.707	5.488	8.953	13.185
NPL ratio (%)	NPL/TL	4.437	5.930	1.084	2.592	4.855
ALL ratio (%)	ALL/TL	3.867	4.201	1.446	2.297	4.187
HHI of deposits	HHID	745.797	95.290	673	709	797
HHI of loans	HHIL	592.871	32.174	572	592	620
CR4 of deposits (%)	CR4D	49.513	2.580	47	48	52
CR4 of loans (%)	CR4L	42.451	1.330	41	42	43
Log of gross total assets	LGTA	7.254	1.781	5.963	7.146	8.481
Gross total assets (billion IDR)	GTA	7,378.6	20,822.7	388.8	1,269.2	4,820.9
Assets diversification ratio	ADR	0.216	0.276	0.000	0.079	0.358
Overhead cost ratio (%)	OHR	4.736	2.898	2.973	4.233	5.906
Listed banks	LB	0.371	0.483	0.000	0.000	1.000
Bank holding company	BHC	0.080	0.272	0.000	0.000	0.000
Deposit insurance cap rate (%)	DICR	9.505	3.006	7	8	12
Inflation, monthly (%)	INF	0.631	0.921	0	1	1
Bank age (year)	AGE	37.393	35.985	16	35	46
Bank age squared	AGESQ	2,693.1	8,229.7	256	1,225	2,116

within-bank serial correlation problems (Rogers, 1993). I make sure that all right-hand side variables are predetermined to the dependent variable, because some researchers argue that this can mitigate the reverse causality problem to some extent (e.g., Duchin et al., 2010). The coefficient of interest in Equation 1 is β, which will be positive if the competition-fragility hypothesis is true, and negative if the competition-stability hypothesis is true.

To test the impact of competition on bank fragility during a financial crisis, I estimate the following regression specification:

$$Z_{i,t-k+1,t} = \alpha + \beta_1 \cdot HHI_{t-k} + \beta_2 \cdot HHI_{t-k} \cdot CRISIS_{t-k} + \beta_3 \cdot CRISIS_{t-k} + \gamma \cdot Controls_{t-k} + \delta_i + \varepsilon_{i,t-k+1,t}, \quad (2)$$

where *CRISIS* is a dummy variable equal to one for the financial crisis period, and zero otherwise. The 2008 global financial crisis is from 2007:Q3–2009:Q4, following Berger and Bouwman (2013). The variable of interest in Equation 2 is β_2.

My main datasets are from the monthly financial reports submitted by commercial banks to the Otoritas Jasa Keuangan (OJK) or Financial Service Authority (FSA), which covers the period of January 2002 to December 2011[4]. OJK is the current bank regulator in Indonesia since 2011, in place of the Bank of Indonesia (BI) which is now focusing on monetary policies and payment system. Due to the lag structure of Z36, the observations start from 2004:M12. To ensure the comparability of level variables over time, I deflate all variables expressed in Indonesian Rupiah (IDR) using the year 2000 implicit GDP price deflator[5]. Further, I exclude Sharia (Islamic) commercial banks from the sample due to material differences in banking practices with the conventionally operated commercial banks[6]. I end the sample period in December 2011, because the bank regulator imposes a new IFRS-based-accounting rule for allowance for loans losses (ALLs) starting in January 2012[7]. This rule makes ALLs prior and after January 2012 not comparable.

My initial sample comprises of 7,772 bank-month observations. After removing Sharia banks and observations with zero gross total assets (GTA)[8],

4 The data are available to download from http://www.ojk.go.id/en/kanal/perbankan/data-dan-statistik/laporan-keuangan-perbankan/Default.aspx or http://www.bi.go.id/en/publikasi/laporan-keuangan/bank/umum-konvensi-onal/Default.aspx

5 http://www.bi.go.id/seki/tabel/TABEL7_5.xls

6 Islamic banks practice non-usury banking, in contrast to the conventional banks that operate usury banking practices.

7 See the Bank of Indonesia's circular letter No. 11/4/DPNP (January 27, 2009).

8 Gross total assets are total assets plus ALLL. Berger and Bouwman (2013) suggest this measure rather than total assets in order to capture the full value of assets financed.

total deposits, total loans, or total assets, the sample available for multivariate analyses has 7,597 bank-month observations. Finally, I winsorize all unbounded financial variables at 3 percent level on the top and bottom of their distributions in order to mitigate the impact of outliers, following Berger and Bouwman (2013)[9].

Table 2 presents summary statistics for all variables used in this paper. Moreover, there seems to be no serious pairwise correlations between the main independent variables and other control variables that can potentially lead to a multicollinearity problem[10].

3. EMPIRICAL RESULTS AND ROBUSTNESS CHECKS

3.1. Main regression results

Table 3 presents the main OLS regression estimates of the inverse measure of bank fragility (Z36) on competition, as specified in Equation 1. Models 1-3 use HHID as the proxy of bank competition, while Models 4-6 use HHIL. Models 1 and 4 include no control variables, Models 2 and 5 control for bank-specific variables, and Models 3 and 6 control for bank-specific, as well as macroeconomic variables. All estimates include bank fixed effects and standard errors are clustered at bank level. I find that the coefficient of bank competition is negative and statistically significant in each of the model specifications. This result is also economically material. In particular, holding all bank-specific and macroeconomic variables at their means, a decrease in HHID by 100 points leads to an increase in Z36 by 14.22 percent from its mean. Similarly, a decrease in HHIL by 100 points leads to an increase in Z36 by 20.44 percent[11]. This suggests that more competition is associated with less bank fragility, supporting the competition-stability hypothesis (hypothesis 2).

In terms of control variables, the coefficients of bank size (LGTA) and its squared term (LGTA SQ) are statistically significant in all regression specifications that control them. The inflection point of the bank size varies between 6.35 and 7.03 (real GTA between IDR 572.49 billion and IDR 1.13 trillion). These values are between the 25th percentile and the median, which means that there is a "U-shaped" relation between bank size and fragility. Next, overhead cost ratio (OHR) has negative and statistically significant coefficients in most of the regression specifications, consistent with the notion that cost inefficient banks tend to be riskier (Demirguc-Kunt & Huizinga, 2010). Meanwhile, none of the asset diversification ratio (ADR), listed dummy (LB), and Bank Holding Company dummy (BHC) is statistically significant. In terms of macroeconomic controls, I find some evidence that higher deposit insurance cap rate (DICR) leads to higher bank fragility. However, I find no evidence the monthly inflation rate (INF) is related to bank fragility.

3.2. Endogeneity

An endogeneity problem might arise from a reverse causality between bank fragility and competition. For example, a financially stable bank might have sufficient resources to increase its market power (reduce bank competition) by acquiring other banks. Alternatively, a bank might increase its risk in order to increase returns and grow larger, which results in more market power (e.g., Berger et al., 2009). In order to address this potential problem, I run Instrumental Variable (IV) regressions with a Generalized Method of Moments (GMM) estimator. This estimation technique, which was introduced by Hansen (1982), does not require distributional assumptions on the error terms and is more efficient than 2SLS to address heteroscedasticity (Hall, 2005). Moreover, since bank fragility measures might be serially correlated, I cluster the standard errors at the bank level using a formula-

9 Unbounded financial variables can take any value between $(-\infty,+\infty)$ and, therefore, might suffer from outlier problem.

10 I follow a rule-of-thumb in Gujarati (2004, p. 359) who suggests that there might be a serious multicollinearity problem between two regressors if the pairwise correlation between them exceeds 0.80. The pairwise correlation table is not shown in this paper for brevity, but it is available by request as an Appendix.

11 The coefficient of HHID in Model 3 is –0.016. This means that holding all regressors at their means, a decrease in HHID by 100 points will translate to an increase in Z36 by 1.60 from its mean (11.251). In other words, Z36 will increase by 14.22% from its mean when the HHID decreases by 100 points. By the same logic, the coefficient of HHIL in Model 6 (–0.023) implies that Z36 will increase by 20.44% from its mean when the HHIL decreases by 100 points. I use an incremental of HHID and HHIL of 100 points to examine the economic significance of the main findings following the approach in the Horizontal Merger Guidelines (U.S. Department of Justice and Federal Trade Commission, 2010) to assess whether a bank merger will increase the local market concentration materially.

Table 3. Competition and bank fragility

Independent variables	Dependent variables: Z-score36 (36 months)					
	(1)	(2)	(3)	(4)	(5)	(6)
HHID	–0.012***	–0.014***	–0.016***			
	(–3.332)	(–3.443)	(–3.300)			
HHIL				–0.019**	–0.019*	–0.023**
				(–1.996)	(–1.946)	(–2.106)
LGTA		8.731***	8.919***		8.199***	8.129***
		(3.068)	(3.121)		(2.749)	(2.795)
LGTA SQ		–0.686***	–0.702***		–0.583**	–0.611***
		(–3.064)	(–3.131)		(–2.460)	(–2.632)
ADR		–0.214	–0.006		0.254	–0.143
		(–0.143)	(–0.004)		(0.156)	(–0.094)
OHR		–0.093**	–0.084*		–0.038	–0.077*
		(–2.050)	(–1.863)		(–0.803)	(–1.700)
LB		1.148	1.158		2.757	1.857
		(0.538)	(0.528)		(0.903)	(0.685)
BHC		0.506	0.435		1.452	1.033
		(0.263)	(0.226)		(0.721)	(0.515)
DICR			0.096			–0.236***
			(1.409)			(–2.915)
INF			0.075			0.065
			(1.589)			(1.036)
Constant	20.892***	–2.826	–3.020	22.436***	–5.237	2.442
	(7.259)	(–0.278)	(–0.297)	(4.023)	(–0.512)	(0.211)
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
N	7,664	7,597	7,597	7,664	7,597	7,597
N-clusters (bank)	131	130	130	131	130	130
R-squared	0.711	0.716	0.717	0.698	0.702	0.708

tion proposed by Arellano (1987). I employ bank age (AGE) and its squared term (AGESQ) as instruments for bank competition in the IV-GMM regressions. The economic theory predicts that as a bank becomes more mature and earns positive economic profits, new entrants will be attracted to enter the industry (e.g., Baumol et al., 1988; Baumol & Lee, 1991). Consequently, competition tends to get tougher as the bank matured.

Table 4 presents the first-stage and second-stage results of the IV-GMM regressions. In the first-stage, AGE and AGESQ have statistically significant coefficients at least at 5 percent level for all models specified in the table[12]. Moreover, the first-stage regressions have very high F-statistics and Kleibergen-Paap Wald rk F statistics. Following the rule-of-thumb in Staiger and Stock (1997), the null hypothesis that the instruments are weak can be rejected if the F-statistic is greater than 10. Similarly, the Kleibergen-Paap Wald rk F statistics are all greater than Stock-Yogo critical values[13]. These indicate that both of the instruments satisfy the relevance criterion for good instruments. Next, the first-stage results show that Hansen-J-statistics in all specified models are not statistically significant. This suggests that both instruments have also met the exogeneity criterion (overidentifying restriction) for good instruments[14].

The second-stage results are qualitatively similar with the main findings using OLS in Table 3. In terms of magnitude, HHID coefficients are very close between the OLS and IV-GMM, while the HHIL IV-GMM coefficients are larger than the OLS' counterpart. The latter might suggest that OLS underestimate the causal effect between HHIL and bank risk.

12 Coefficients are not shown in the table for brevity.

13 For the sake of brevity in Table 4, the associated Stock-Yogo critical values are not shown and are available by request.

14 See, for example, Stock and Watson (2011, pp. 419-422) for further details about the relevance and exogeneity criteria for instruments used in an IV regression.

Table 4. Endogeneity – IV regression

Independent variables	Dependent variables: Z-score36 (36 months)					
	(1)	(2)	(3)	(4)	(5)	(6)
Second-stage IV regression						
HHID	–0.0121***	–0.0133***	–0.0153***			
	(–3.01)	(–3.08)	(–2.80)			
HHIL				–0.0636***	–0.0728***	–0.0472***
				(–2.90)	(–2.98)	(–2.76)
Bank controls	No	Yes	Yes	No	Yes	Yes
Macroeconomic controls	No	No	Yes	No	No	Yes
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
N	7620	7553	7553	7620	7553	7553
RMSE	5.163	5.125	5.119	5.444	5.476	5.247
First-stage IV regression						
F-statistic	9678.8	2294.4	5454.5	747.3	239.7	2656.6
Kleibergen-Paap Wald rk F statistic	9678.8	5770.4	6258.2	747.3	365.1	2822.7
Hansen-J-statistic	0.580	0.476	0.498	1.192	1.064	0.782
P-value of Hansen-J-statistic	0.446	0.490	0.480	0.275	0.302	0.376
First-stage R-squared	0.853	0.855	0.875	0.296	0.317	0.592

3.3. Other robustness checks: alternative measures of risk and competition

As additional robustness checks, firstly, I use different alternative measures of bank fragility other than Z36: 24 months – Z-score (Z24), 60 months – Z-score (Z60), NPL/TL, and ALL/TL. Next, I use four-bank concentration ratios of deposits (CR4D) and loans (CR4L) as alternative measures of bank competition. Following Carlson and Mitchener (2006), I calculate the CR4 as the sum of deposit or loan shares of four largest banks in the market for each time period. The results from all of these robustness checks are consistent with the main findings, in which more competition decreases bank fragility[15].

3.4. Competition and financial crisis

Table 5 presents the OLS regression estimates of the inverse measure of bank fragility (Z36) on competition and its interaction with financial crisis, as specified in Equation 2. Models 1-4 use different measures of bank competition – HHIL, HHID, CR4D, and CR4L, respectively – and all of them control for bank-specific, as well as macroeconomic variables and bank fixed effects. The re-

15 These results are available upon request as an Appendix.

Table 5. Competition and bank fragility in normal times and financial crisis

Independent variables	Dependent variables: Z–score36 (36 months)			
	(1)	(2)	(3)	(4)
	HHID	**HHIL**	**CR4D**	**CR4L**
COMPETITION	–0.017***	–0.031***	–0.481***	–0.723**
	(–3.561)	(–2.696)	(–3.558)	(–2.527)
COMPETITION X CRISIS	0.017***	0.050***	0.543***	1.037***
	(3.866)	(3.127)	(4.173)	(2.832)
Bank controls	Yes	Yes	Yes	Yes
Macroeconomic controls	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes
N	7,597	7,597	7,597	7,597
N-clusters (bank)	130	130	130	130
R-squared	0.718	0.708	0.715	0.707

sults show that competition is statistically significant and negatively associated with Z36 in all of the specified models. On the contrary, the interaction term between bank competition and crisis has positive and statistically significant coefficients in all of the specified models. These findings imply that market power helps to reduce bank fragility during a financial crisis. Therefore, whether competition affects bank fragility positively or negatively is conditional on the economic condition. In normal times, as shown by the main findings, more competition increases bank stability, but in a financial crisis, the impact is reversed. This finding provides strong evidence on hypothesis 3.

CONCLUSION

This paper contributes to the strand of literature about the impact of competition on bank fragility. In particular, this paper sheds light that the relation between competition and bank fragility can be different in normal time and financial crisis. Using the data from the Indonesian banking industry, I document significant evidence that more competition leads to lower bank fragility in the overall sample period, supporting the competition-stability hypothesis. This finding is robust to endogeneity as well as to different bank fragility and competition measures. Interestingly, during a financial crisis, I find that less competition helps to lower bank fragility. The policy implication of these findings is essential, especially for the government. In particular, the government should design different policies in normal times and during a financial crisis. Bank regulation that supports bank competition should be nurtured in normal times. However, such bank regulation that intensifies competition should be relaxed during a financial crisis.

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APPENDIX

Table 1. Correlations among key variables

Variabbles	Z36	HHID	HHIL	LGTA	ADR	OHR	LB	BHC	DICR	INF
Z36	1									
HHID	–0.160***	1								
HHIL	–0.068***	0.429***	1							
LGTA	–0.132***	–0.093***	–0.036***	1						
ADR	–0.119***	–0.029**	0.040***	0.527***	1					
OHR	–0.147***	–0.031***	0.032***	–0.202***	–0.153***	1				
LB	–0.120***	–0.028**	–0.001	0.541***	0.468***	–0.104***	1			
BHC	–0.139***	–0.084***	–0.069***	0.312***	0.223***	–0.006	0.313***	1		
DICR	–0.087***	0.643***	–0.130***	–0.074***	–0.066***	–0.062***	–0.027**	–0.033***	1	
INF	0.013	–0.059***	–0.167***	0.007	0.011	0.021*	0.004	0.003	0.017	1

Notes: ***, **, * indicate significance at the 1%, 5%, and 10% level, respectively. This table shows pairwise correlations among the key variables used throughout the paper. Bank-specific data are from monthly financial reports submitted by banks to Financial Service Authority (FSA), the bank regulator in Indonesia. The full sample contains unbalanced panel of 131 commercial banks in Indonesia from 2002:M1 to 2011:M12. The sample observations are monthly and exclude Sharia (Islamic) banks. Inflation rate data are from the Indonesia Central Bureau of Statistics' publications, while deposit insurance cap rates are from Indonesia Deposit Insurance Corporation (IDIC). All variables in Indonesian Rupiah (IDR) are in real term using the year 2000 implicit GDP price deflator. Financial variables with extreme outliers are winsorized at 3% level on top and bottom of the distribution.

Table 2. Endogeneity – IV regression

Panel A. First-stage IV regression estimates

Independent variables	Dependent variables					
	HHID			HHIL		
	(1)	(2)	(3)	(4)	(5)	(6)
AGE	–49.79***	–49.83***	–44.44***	–7.950***	–7.714***	–13.26***
	(–85.56)	(–77.17)	(–84.73)	(–24.85)	(–17.05)	(–53.26)
AGESQ	0.0188**	0.0181**	0.0137**	–0.00975***	–0.00958***	–0.00528***
	(2.49)	(2.60)	(2.46)	(–3.00)	(–2.89)	(–2.70)
Inflection point of AGE	1,324.202	1,376.519	1,621.898	–407.692	–402.610	–1,295.455
LGTA		23.02*	30.03***		8.998	0.548
		(1.86)	(3.81)		(0.72)	(0.12)
LGTA SQ		–1.569*	–2.179***		–0.934	–0.237
		(–1.85)	(–3.72)		(–1.06)	(–0.68)
Inflection point of LGTA		7.331	6.907		4.820	0.957
ADR		–27.16***	–12.04*		21.26***	5.689*
		(–3.37)	(–1.90)		(3.61)	(1.76)
OHR		–0.600**	0.0649		0.961***	0.330***
		(–2.02)	(0.28)		(4.40)	(2.88)
LB		7.847	7.708		–3.229	–3.739
		(0.46)	(0.66)		(–0.19)	(–0.34)
BHC		10.10	5.403		–6.018**	–1.030
		(0.99)	(0.61)		(–2.09)	(–0.41)
DICR			5.488***			–5.843***
			(48.69)			(–76.53)
INF			–2.326***			–3.580***
			(–13.00)			(–31.34)
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
N	762	7553	7553	7620	7553	7553
F-statistic	9678.8	2294.4	5454.5	747.3	239.7	2656.6
Kleibergen-Paap Wald rk F statistic	9678.8	5770.4	6258.2	747.3	365.1	2822.7
Hansen-J-statistic	0.580	0.476	0.498	1.192	1.064	0.782
P-value of Hansen-J-statistic	0.446	0.490	0.480	0.275	0.302	0.376
R-squared	0.853	0.855	0.875	0.296	0.317	0.592

Table 2 (cont.). Endogeneity – IV regression

Panel B. Second-stage IV regression estimates

Independent variables	Dependent variables: Z-score36 (36 months)					
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
HHID	–0.0121***	–0.0133***	–0.0153***			
	(–3.01)	(–3.08)	(–2.80)			
HHIL				–0.0636***	–0.0728***	–0.0472***
				(–2.90)	(–2.98)	(–2.76)
LGTA		8.898***	9.093***		9.213***	8.644***
		(3.16)	(3.21)		(3.12)	(3.07)
LGTA SQ		–0.686***	–0.701***		–0.722***	–0.673***
		(–3.07)	(–3.12)		(–3.11)	(–3.00)
Inflection point of LGTA		6.485	6.486		6.380	6.422
ADR		–0.225	0.0151		1.749	0.480
		(–0.15)	(0.01)		(1.09)	(0.33)
OHR		–0.0948**	–0.0845*		–0.0198	–0.0723*
		(–2.09)	(–1.89)		(–0.42)	(–1.65)
LB		1.015	1.039		0.717	0.744
		(0.49)	(0.48)		(0.19)	(0.26)
BHC		0.477	0.413		0.0501	0.357
		(0.25)	(0.22)		(0.02)	(0.17)
DICR			0.107			–0.254***
			(1.27)			(–3.06)
INF			0.0678			–0.0662
			(1.31)			(–0.79)
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
N	7620	7553	7553	7620	7553	7553
RMSE	5.163	5.125	5.119	5.444	5.476	5.247

Notes: ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively. This table shows instrumental variable (IV) GMM regression estimates of the relation between competition and (inverse) bank fragility with robust standard errors clustered at bank level to correct for heteroscedasticity and within-bank serial correlation. Panel A reports IV-GMM first-stage regression estimates. The endogenous variable estimated is bank competition that is proxied by Herfindahl-Hirschman Index (HHI): columns (1) to (3) use HHI of deposits, while columns (4) to (6) use HHI of loans. The exogenous instruments are bank age (AGE) and its squared term (AGESQ). Panel B reports IV-GMM second-stage regression estimates. The dependent variable is (inverse) bank fragility that is proxied by Z-score36. The key endogenous explanatory variable is bank competition that is proxied by Herfindahl-Hirschman Index (HHI): columns (1) to (3) use HHI of deposits, while columns (4) to (6) use HHI of loans. In terms of control variables used in Panels A and B, columns (1) and (4) control for bank fixed effects only. Columns (2) and (5) control for bank-specific variables and bank fixed effects. And finally, columns (3) and (6) control for bank-specific and macroeconomic variables, as well as bank fixed effects. The full sample contains unbalanced panel of all commercial banks in Indonesia from 2002:M1 to 2011:M12. The sample observations are monthly and Sharia (Islamic) banks are excluded. All variables in Indonesian Rupiah (IDR) are expressed in real term using the year 2000 implicit GDP price deflator. Financial variables with extreme outliers are winsorized at 3% level on top and bottom of the distribution. Numbers in parentheses are t-statistics.

Table 3. Other robustness checks

Panel A. Alternative bank fragility measures

Independent variables	Alternative dependent variables							
	Z-score24	Z-score60	NPL ratio	ALL ratio	Z-score24	Z-score60	NPL ratio	ALL ratio
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
HHID	–0.018***	–0.009**	0.012***	0.012***				
	(–3.460)	(–2.468)	(4.187)	(5.862)				
HHIL					–0.024**	–0.015	0.013***	0.017***
					(–2.445)	(–1.630)	(3.181)	(6.042)
LGTA	9.632***	4.710	–2.510	–1.397	8.936***	4.099	–2.315	–1.226
	(3.219)	(1.443)	(–1.158)	(–0.660)	(2.952)	(1.158)	(–1.008)	(–0.577)
LGTA SQ	–0.735***	–0.349	0.134	0.043	–0.636***	–0.274	0.092	0.005
	(–3.212)	(–1.558)	(0.745)	(0.255)	(–2.710)	(–1.144)	(0.491)	(0.028)
Inflection point of LGTA	6.552	6.748	9.366	16.244	7.025	7.480	12.582	122.600
ADR	–1.068	–1.129	0.856	0.566	–1.400	–1.218	0.982	0.672
	(–0.631)	(–0.681)	(0.772)	(0.767)	(–0.782)	(–0.716)	(0.858)	(0.855)
OHR	–0.096*	–0.010	0.003	–0.026	–0.088	–0.008	0.003	–0.029
	(–1.676)	(–0.273)	(0.061)	(–0.587)	(–1.550)	(–0.217)	(0.055)	(–0.651)
LB	3.419**	3.017***	–3.173	–3.355	3.805*	4.172***	–3.156	–3.330
	(2.163)	(2.903)	(–1.069)	(–1.272)	(1.897)	(4.758)	(–1.125)	(–1.341)
BHC	0.682	0.988	0.461	0.790	1.462	1.582	0.161	0.490
	(0.320)	(0.519)	(0.467)	(0.907)	(0.694)	(0.859)	(0.165)	(0.579)
DICR	0.109	–0.029	0.134***	–0.021	–0.285***	–0.220**	0.387***	0.241***
	(1.339)	(–0.605)	(3.076)	(–0.676)	(–3.202)	(–2.429)	(5.191)	(4.895)
INF	–0.075	0.002	0.012	–0.033	–0.116	–0.007	0.008	–0.014
	(–1.257)	(0.046)	(0.337)	(–1.363)	(–1.567)	(–0.242)	(0.244)	(–0.578)
Constant	–4.363	3.211	5.985	4.258	–0.735	6.396	5.825	1.504
	(–0.395)	(0.293)	(0.803)	(0.622)	(–0.063)	(0.526)	(0.729)	(0.224)
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	9,650	4,319	14,269	14,268	9,650	4,319	14,269	14,268
N-clusters (bank)	135	97	139	139	135	97	139	139
R-squared	0.627	0.821	0.408	0.479	0.617	0.815	0.392	0.455

Table 3 (cont.). Other robustness checks

Panel B. Alternative competition measures

Independent variables	Dependent variables: Z-score36 (36 months)					
	(1)	(2)	(3)	(4)	(5)	(6)
CR4D (%)	–0.431***	–0.468***	–0.450***			
	(–3.323)	(–3.421)	(–3.282)			
CR4L (%)				–0.275	–0.265	–0.556*
				(–1.357)	(–1.274)	(–1.939)
LGTA		8.759***	8.727***		8.079***	8.111***
		(3.058)	(3.035)		(2.665)	(2.772)
LGTA SQ		–0.674***	–0.672***		–0.557**	–0.604**
		(–2.996)	(–2.982)		(–2.320)	(–2.584)
Inflection point of LGTA		6.498	6.493		7.252	6.714
ADR		–0.070	–0.145		0.065	–0.182
		(–0.046)	(–0.096)		(0.039)	(–0.118)
OHR		–0.069	–0.075		–0.036	–0.072
		(–1.536)	(–1.641)		(–0.724)	(–1.585)
LB		1.472	1.453		3.133	1.968
		(0.645)	(0.640)		(1.039)	(0.732)
BHC		0.694	0.697		1.742	1.167
		(0.361)	(0.362)		(0.868)	(0.582)
DICR			–0.028			–0.282***
			(–0.541)			(–2.834)
INF			0.097**			0.092
			(2.077)			(1.544)
Constant	33.011***	8.938	8.435	22.911***	–6.034	12.309
	(5.053)	(0.770)	(0.733)	(2.678)	(–0.545)	(0.811)
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
N	7,664	7,597	7,597	7,664	7,597	7,597
N-clusters (bank)	131	130	130	131	130	130
R-squared	0.709	0.714	0.714	0.695	0.700	0.707

Notes: ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively. This table shows the relation between competition and bank fragility using several different alternative measures. The regressions are OLS with robust standard errors clustered at bank level to correct for heteroscedasticity and within-bank serial correlation. Panel A reports the regression estimates using several alternative measures of bank fragility: Z-score24, Z-score60, NPL ratio, and ALL ratio. The key explanatory variable is bank competition that is proxied by Herfindahl-Hirschman Index (HHI): columns (1) to (4) use HHI of deposits, while columns (5) to (6) use HHI of loans. All columns control for bank-specific and macroeconomic variables, as well as bank fixed effects. Panel B reports the regression estimates using several alternative measures of bank competition: columns (1) to (3) use CR4 of deposits, while columns (4) to (6) use CR4 of loans. The dependent variable is (inverse) bank fragility that is proxied by Z-score36. In terms of control variables used, columns (1) and (4) control for bank fixed effects only. Columns (2) and (5) control for bank-specific variables and bank fixed effects. Finally, columns (3) and (6) control for bank-specific and macroeconomic variables, as well as bank fixed effects. The full sample contains unbalanced panel of all commercial banks in Indonesia from 2002:M1 to 2011:M12. The sample observations are monthly and exclude Sharia (Islamic) banks. All variables in Indonesian Rupiah (IDR) are in real term using the year 2000 implicit GDP price deflator. Financial variables with extreme outliers are winsorized at 3% level on top and bottom of the distribution. Numbers in parentheses are t-statistics.