Bank Size, Market Concentration, and US Bank Earnings Volatility in the Wake of the Global Financial Crisis

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Motivation

- "The real issue is size. … A complex but small business is no threat to systemic stability; neither is a highly international but small business. Size is the core of the problem; the other dimensions (interconnectedness, complexity and international linkages) only matter (and indeed worsen the instability problem) if the institution in question is big. ….Large banks can be broken up in a variety of ways ….. The crisis and contraction are delivering the opposite outcome. There are fewer banks and market concentration is increasing everywhere." (Willem Buiter)

Research questions

- In this paper we address the following questions:
- (i) are there any significant differences between earnings volatility of large and small banks?
- (ii) is the effect of bank size on bank earnings volatility conditioned by the degree of concentration in the banking sector?
- (iii) has the recent global financial crisis affected the relationship between bank size, market concentration, and earnings volatility?

Why earnings volatility?

- Volatile earnings may lead to uncertainty about the level of equity capital and can result in a deterioration of banks' soundness (Couto, 2002).
- Previous studies (e.g., Albertazzi and Gamabacorta, 2009) suggest that excess volatility in bank earnings can result in unstable capital structures.
- As market concentration is also a potentially important determinant of profitability (Berger et al., 2005; Beck et al., 2006), we investigate whether the impact of the crisis is conditioned by bank size and market concentration.

Main findings

- Quarterly data on all commercial, savings, and cooperative banks in the US for 2004Q1-2009Q4.
- We find that bank size has a negative effect on return volatility, while market concentration has a positive effect.
- Financial crisis has increased volatility, but negative effect of size remains.
- The negative impact of bank size on bank earnings volatility decreases with market concentration.

Previous studies: bank size and returns

- Carter and McNulty (2005) find an inverse relationship between bank size and the net return on small business lending, suggesting that smaller banks are better at making these types of loans.
- Berger et al. (2005) report similar results.
- Stever (2007) reports that small banks have fewer opportunities to diversify, which forces them to either pick borrowers whose assets have relatively low credit risk or to make loans that are backed by more collateral.

Previous studies: bank size and volatility

- Boyd and Runkle (1993) report an inverse and significant relationship between size and the standard deviation of the rate of return on assets (ROA).
- Hannan and Prager (2009) have estimated profit models for small banks operating in only 1 market, distinguishing between rural and urban banking markets. The authors find that effect of size differs across both markets.

Previous studies: diversification and volatility

- There is a related line of literature examining whether banks' increasing dependence on non-interest income has affected earnings volatility. E.g.: Stiroh (2004) finds that non-interest income growth is much more volatile than net interest income growth, largely due to very volatile trading revenue. Stiroh (2004) also reports that the standard deviation of the return on equity (ROE) is not related to bank size.
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Previous studies: concentration and fragility

- Most empirical evidence lends support to the view that concentration increases banking sector fragility.
- De Nicolo et al. (2004), which is based on data for some 100 banks over the period 1993-2000 and z-scores as proxy for riskiness, suggests that more concentrated banking sectors are more fragile.
- Beck et al. (2006) use data for 69 countries from 1980 to 1997 and find that banking crises are less likely in economies with more concentrated banking systems.

Our study differs:

- We use data for **all** commercial, savings, and cooperative banks in the United States for the period Q1.2004-Q4.2009.
- We focus on the impact of size on earnings volatility.
- We examine whether concentration affects earnings volatility of U.S. banks.
- We examine whether crisis has affected these relationships.

Model (I)

$$Volatility_{i,s,t} = \alpha_{i,s,t} + \beta_1 Crisis_t + \beta_2 Concentration_{s,t} + \beta_3 Size_{i,s,t} + \gamma_1 X_{s,t} + \varepsilon_{i,s,t} \ ,$$

where *Crisis* is the financial crisis variable; *Concentration* is our proxy for bank concentration in state *s* in year *t*; *Size* indicates a proxy for bank size of bank *i* in state *s* at time *t*; *X* is a vector of bank-specific control variables. The model also includes state fixed effects and time fixed effects to control for systemic factors affecting all states simultaneously.

Model (II)

› To identify the individual and collective impact of bank size, market concentration, and the financial crisis on earnings volatility, we introduce interaction terms with these variables:

$$Volatility_{i,s,t} = \alpha_{i,s,t} + \beta_1 Crisis_t + \beta_2 Concentration_{s,t} + \beta_3 Size_{i,s,t} +$$
$$\beta_4 Crisis_t * Size_{i,s,t} + \beta_5 Crisis_t * Concentration_{s,t} + \beta_6 Size_{i,s,t} * Concentration_{s,t} +$$
$$\beta_7 Crisis_t * Size_{i,s,t} * Concentration_{s,t} + \gamma_1 X_{s,t} + \varepsilon_{i,s,t}$$

Model (III)

› Our key hypothesis relates to the significance of the marginal effect of bank size on our dependent variable. Therefore, we test the following hypothesis:

$$H_0: \beta_3 + \beta_4 (Crisis) + \beta_6 (Concentration_{s,t}) + \beta_7 (Crisis * Concentration_{s,t}) = 0$$

$$H_1: \beta_3 + \beta_4 (Crisis) + \beta_6 (Concentration_{s,t}) + \beta_7 (Crisis * Concentration_{s,t}) \neq 0$$

Variables

- Bank balance sheet and income statement data are taken from the Reports on Condition and Income (the "Call Report") collected by federal bank regulators.
- Regressors:
- 1. *Financial crisis:* dummy that takes the value of one after the collapse of Lehman Brothers.
- 2. *Bank size*: number of standard deviations the log total assets of bank *i* located in state *s* at time period *t* deviates from the mean log assets of all banks located in state *s* at time *t*.

Cont.

- 3. *Market concentration:* Herfindahl-Hirshman index of market concentration.
- 4. *Cost-to-income ratio:* total costs to total revenues to proxy the efficiency of bank operations.
- 5. *Leverage:* ratio of bank total assets to total equity to proxy risk taken by individual banks.
- 6. *Bank type:* dummy variables for commercial, savings, and cooperative banks.

Table A2. Data sources and expected signs			
Variable	Definition	Expected Sign	Data Source
Dependent Variables			
ROA Volatility	4 or 8 quarter standard deviation of Return on Equity		Call Reports
ROE Volatility	4 or 8 quarter standard deviation of Return on Equity		Call Reports
Explanatory Variables			
Global Financial Crisis	Dummy variable that takes the value of one after the Lehman Brothers collapse in September 2008, and zero otherwise.	Positive	Own assumption
Bank Size	The number of standard deviations above or below mean logarithmic bank size in a state	Negative/Positive	Call Reports
Bank Concentration	Herfindahl index at state level based on bank assets	Negative/Positive	Call Reports
Cost/Income	Cost as a share in bank income	Positive	Call Reports
Leverage	Total Assets/ Equity Ratio	Negative	Call Reports
Savings Bank	Dummy which takes a value of 1 for savings banks and zero otherwise	Negative/Positive	Call Reports
Cooperative Bank	Dummy which takes a value of 1 for investment banks and zero otherwise	Negative/Positive	Call Reports
Commercial Bank	Dummy which takes a value of 1 for commercial banks and zero otherwise	Negative/Positive	Call Reports

Results

- The estimations are performed using the fixed effects panel estimator, which was found to be superior to the random effects estimator based on the Hausman test. Table 2 shows the main results. Columns (1) and (2) refer to ROE volatility measured over a four-quarters and eight-quarters period, respectively, while columns (3) and (4) measure ROA volatility over a four-quarters and eight-quarter period, respectively.

Table 2. Empirical results

		ROE		ROA	
		[1]	[2]	[3]	[4]
		Four quarters	Eight quarters	Four quarters	Eight quarters
er of st. dev. above or mean log bank size	Coefficient	-0.0159***	-0.0175***	-0.0011***	-0.0013***
	Standard Error (Robust)	(0.002)	(0.001)	(0.000)	(0.000)
ıge: total assets/capital	Coefficient	0.0044***	0.0031***	0.0001***	0.0001***
	Standard Error (Robust)	(0.000)	(0.000)	(0.000)	(0.000)
› income ratio	Coefficient	0.0673***	0.0666***	0.0067***	0.0062***
	Standard Error (Robust)	(0.002)	(0.002)	(0.000)	(0.000)
t concentration	Coefficient	0.0063	0.0063*	0.0004***	0.0004***
	Standard Error (Robust)	(0.004)	(0.004)	(0.000)	(0.000)
	Coefficient	0.0107***	0.0088***	0.0007***	0.0005***
	Standard Error (Robust)	(0.001)	(0.000)	(0.000)	(0.000)
ction: Concentration-	Coefficient	0.0141***	0.0105**	0.0005***	0.0002*
	Standard Error (Robust)	(0.005)	(0.004)	(0.000)	(0.000)
ction: Size-Crisis	Coefficient	0.0041***	0.0034***	0.0003***	0.0003***
	Standard Error (Robust)	(0.001)	(0.001)	(0.000)	(0.000)
ction: Concentration-	Coefficient	0.0006	0.0012	0.0002**	0.0003***
	Standard Error (Robust)	(0.003)	(0.002)	(0.000)	(0.000)
ction: Concentration-risis	Coefficient	0.0086**	0.0100***	0.0006***	0.0008***
	Standard Error (Robust)	(0.004)	(0.003)	(0.000)	(0.000)
ant	Coefficient	-0.0733***	-0.0756***	-0.0014***	-0.0046***
	Standard Error (Robust)	(0.017)	(0.007)	(0.001)	(0.000)
ixed effects		Yes	Yes	Yes	Yes
ixed effects		Yes	Yes	Yes	Yes
ype fixed effects		Yes	Yes	Yes	Yes
er of Observations		137297	134681	137297	134681
er of Banks		8426	8310	8426	8310
ared		0.022	0.023	0.111	0.117

*Estimations are performed using the fixed effects estimator. ***, **, and * denote significance at 10, 5, and 1 percent ence levels, respectively.*

Cont.

- Main findings:
- 1. relative bank size reduces return volatility (diversification or too-big-to-fail?)
- 2. a high degree of market concentration leads to higher bank earnings volatility
- 3. higher leveraged banks face higher return volatility
- 4. the global financial crisis has significantly increased the return volatility of banks, where larger banks were more affected.

Interactions effects of concentration

- We follow Brambor et al. (2006) and show the impact of size on return volatility, conditional on market concentration. Figure 1 shows the impact of bank size on ROA volatility. The graphs in the upper part show the marginal effect of bank size at different levels of market concentration before the crisis and the graphs in the upper part show the marginal effect of bank size at different levels of market concentration during the crisis. The dashed lines present the 95 percent confidence intervals.

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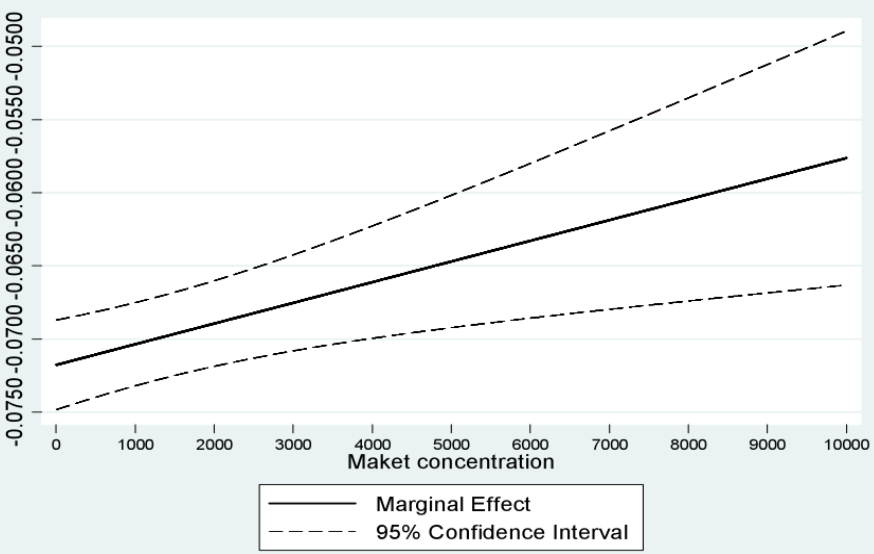

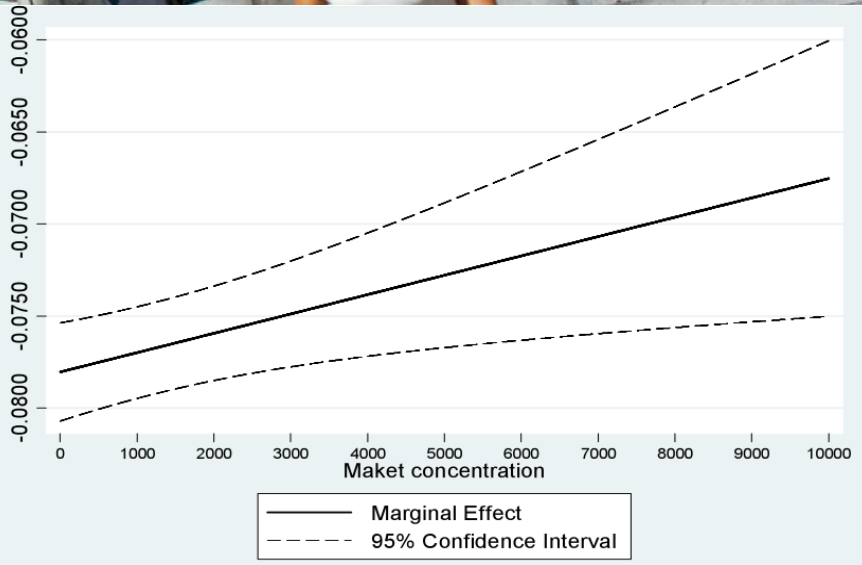

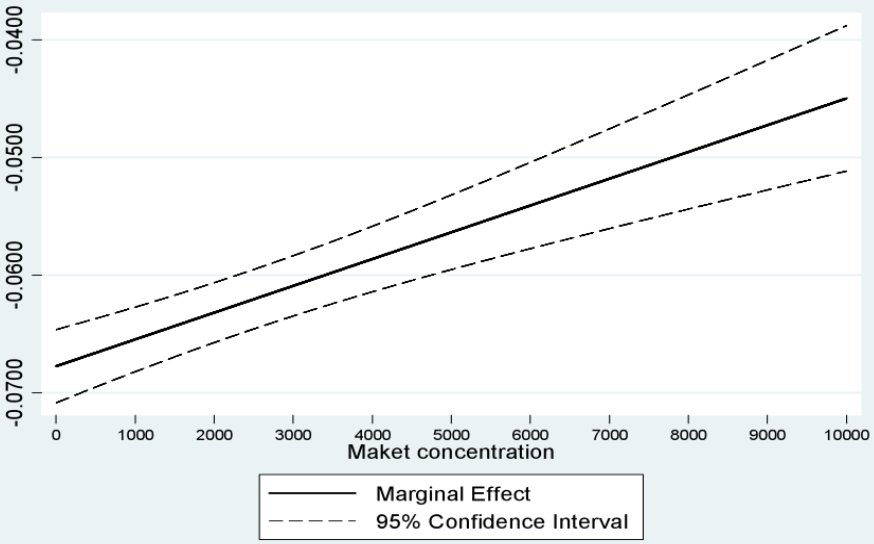

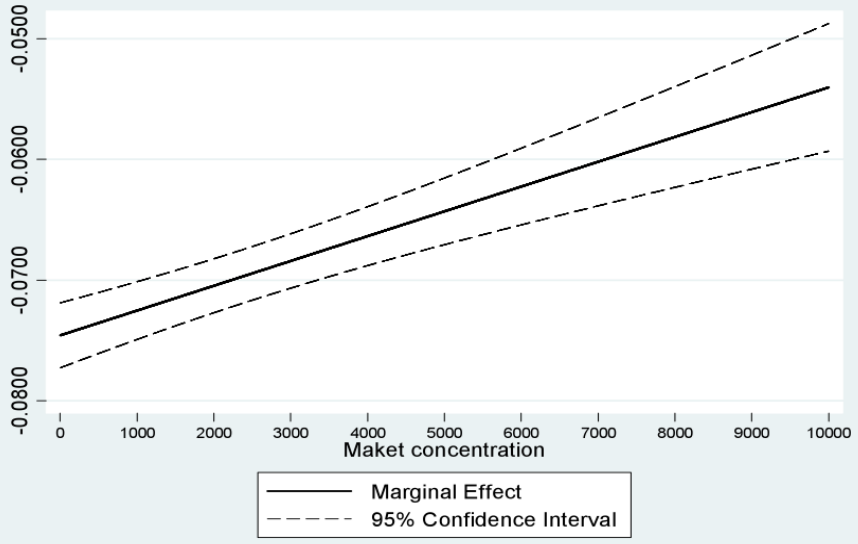

Cont.

- Figure 2 presents the impact on ROE volatility conditional on concentration. The graphs in the first column pertain to the four-quarters measures of return volatility and the graphs in the second column pertain to the eight-quarters measures of return volatility. The dashed lines present the 95 percent confidence intervals.

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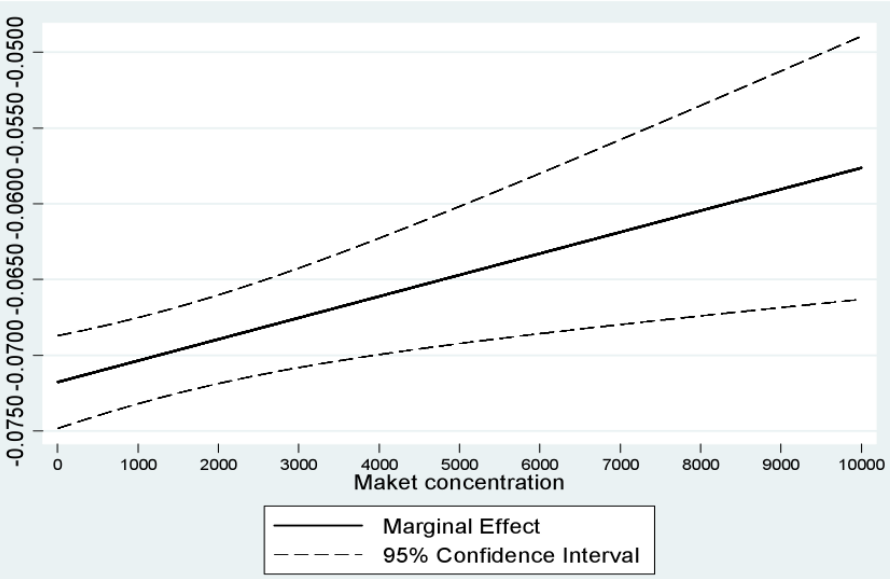

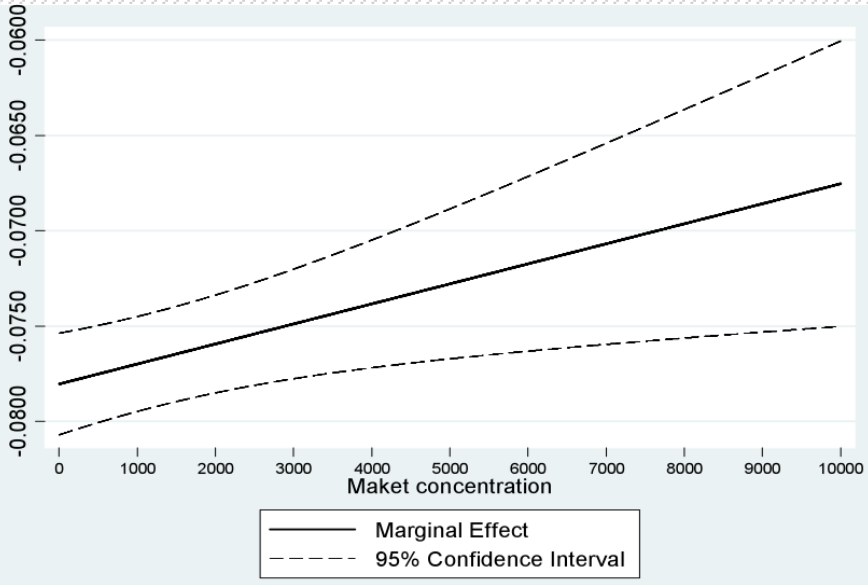

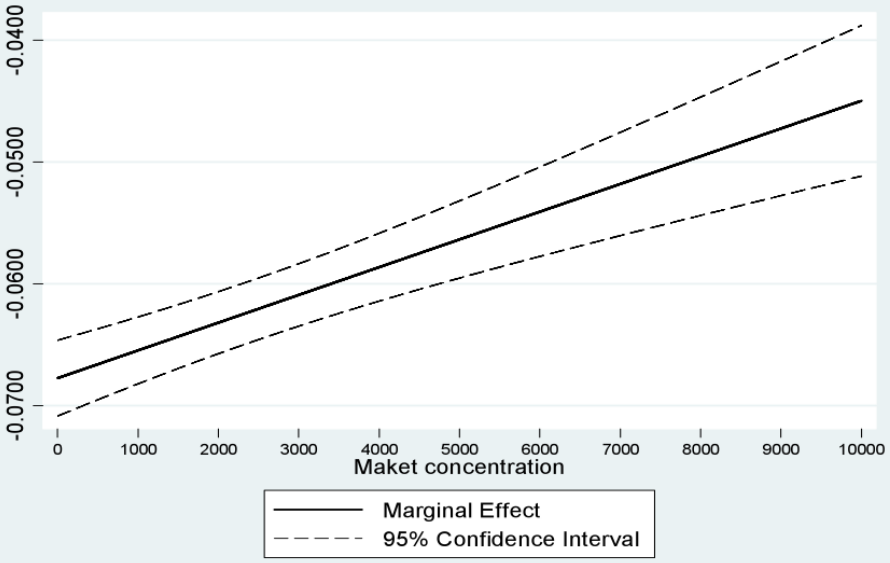

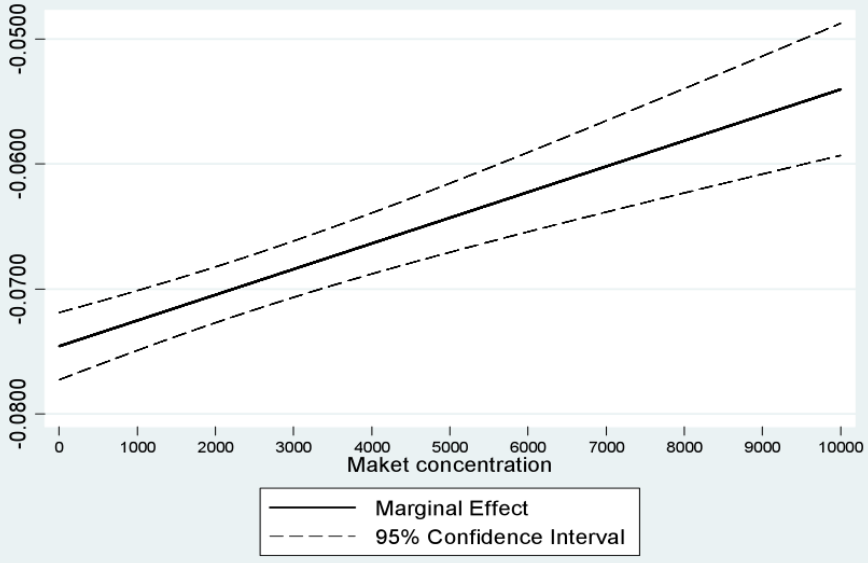

Main findings

- Smaller banks faced higher earnings volatility before the financial crisis, since the confidence interval falls in the negative quadrant.
- The upward sloping marginal effect lines suggest that the negative impact of bank size on bank earnings volatility decreases with market concentration. This relationship has become more pronounced during the crisis.
- Smaller banks face more earnings volatility during the financial crisis, since both upper and lower lines of the confidence interval are negative.

Robustness tests

- First, we have redefined our financial crisis variable. Instead of using the demise of Lehman as the starting point of the crisis, we presume that the crisis started in the third quarter of 2007. The results reported in Table 3 suggest that not only the crisis variable remains positive and significant, but also the impact of other variables hardly changes.

Table 3. Robustness check: Alternative crisis variable

		ROE		ROA	
		[1]	[2]	[3]	[4]
		Four quarters	Eight quarters	Four quarters	Eight quarters
er of st. dev. above or mean log bank size	Coefficient	-0.0164***	-0.0179***	-0.0012***	-0.0014***
	Standard Error (Robust)	(0.002)	(0.001)	(0.000)	(0.000)
ge: total assets/capital	Coefficient	0.0044***	0.0031***	0.0001***	0.0001***
	Standard Error (Robust)	(0.000)	(0.000)	(0.000)	(0.000)
income ratio	Coefficient	0.0660***	0.0656***	0.0066***	0.0061***
	Standard Error (Robust)	(0.002)	(0.002)	(0.000)	(0.000)
t concentration	Coefficient	0.0011	0.0019	0.0001	0.0002
	Standard Error (Robust)	(0.004)	(0.004)	(0.000)	(0.000)
	Coefficient	0.0091***	0.0073***	0.0006***	0.0005***
	Standard Error (Robust)	(0.000)	(0.000)	(0.000)	(0.000)
ction: Concentration-	Coefficient	0.0130***	0.0099**	0.0004**	0.0002
	Standard Error (Robust)	(0.005)	(0.004)	(0.000)	(0.000)
ction: Size-Crisis	Coefficient	0.0041***	0.0035***	0.0003***	0.0003***
	Standard Error (Robust)	(0.001)	(0.001)	(0.000)	(0.000)
ction: Concentration-	Coefficient	0.0091***	0.0086***	0.0007***	0.0007***
	Standard Error (Robust)	(0.003)	(0.002)	(0.000)	(0.000)
ction: Concentration-risis	Coefficient	0.0092**	0.0103***	0.0006***	0.0008***
	Standard Error (Robust)	(0.004)	(0.003)	(0.000)	(0.000)
unt	Coefficient	-0.0907***	-0.0728***	-0.0058***	-0.0043***
	Standard Error (Robust)	(0.009)	(0.007)	(0.000)	(0.000)
ixed effects		Yes	Yes	Yes	Yes
ixed effects		Yes	Yes	Yes	Yes
ype fixed effects		Yes	Yes	Yes	Yes
er of Observations		137297	134681	137297	134681
er of Banks		8426	8310	8426	8310
ured		0.022	0.023	0.111	0.117

*Estimations are performed using the fixed effects estimator. ***, **, and * denote significance at 10, 5, percent confidence levels, respectively.*

Cont.

- Second, we use the logarithm of total assets to measure of bank size. The estimation results reported in Table 4 confirm that our results are robust to this alternative definition of bank size. The impact of bank size remains negative and significant across different specifications. The impact of other variables is also very similar compared to the results reported in Table 2.

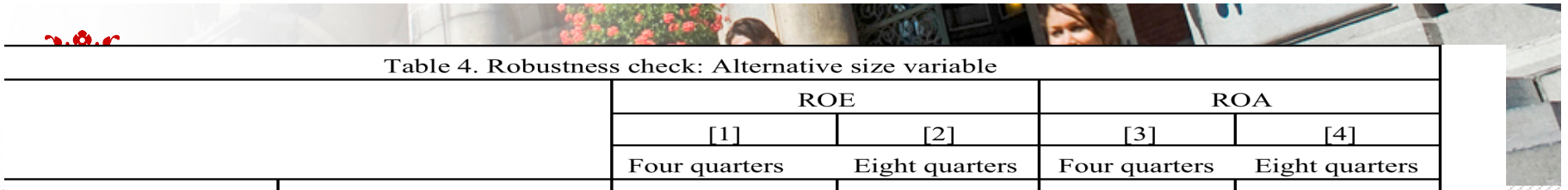

Table 4. Robustness check: Alternative size variable

		ROE		ROA	
		[1]	[2]	[3]	[4]
		Four quarters	Eight quarters	Four quarters	Eight quarters
of total assets	Coefficient	-0.0123***	-0.0150***	-0.0010***	-0.0012***
	Standard Error (Robust)	(0.001)	(0.001)	(0.000)	(0.000)
erage: total ts/capital	Coefficient	0.0044***	0.0031***	0.0001***	0.0001***
	Standard Error (Robust)	(0.000)	(0.000)	(0.000)	(0.000)
t to income ratio	Coefficient	0.0693***	0.0698***	0.0068***	0.0064***
	Standard Error (Robust)	(0.002)	(0.002)	(0.000)	(0.000)
ket concentration	Coefficient	0.0083**	0.0086**	0.0006***	0.0006***
	Standard Error (Robust)	(0.004)	(0.004)	(0.000)	(0.000)
is	Coefficient	0.0125***	0.0109***	0.0009***	0.0007***
	Standard Error (Robust)	(0.001)	(0.000)	(0.000)	(0.000)
raction: centration-Size	Coefficient	0.0125***	0.0099**	0.0005***	0.0003**
	Standard Error (Robust)	(0.005)	(0.004)	(0.000)	(0.000)
raction: Size-Crisis	Coefficient	0.0039***	0.0034***	0.0003***	0.0003***
	Standard Error (Robust)	(0.001)	(0.001)	(0.000)	(0.000)
raction: centration-Crisis	Coefficient	0.0001	0.0005	0.0002*	0.0002***
	Standard Error (Robust)	(0.003)	(0.002)	(0.000)	(0.000)
raction: centration-Size- is	Coefficient	0.0080**	0.0092***	0.0005***	0.0007***
	Standard Error (Robust)	(0.004)	(0.003)	(0.000)	(0.000)
stant	Coefficient	0.0735***	0.0977***	0.0102***	0.0095***
	Standard Error (Robust)	(0.022)	(0.014)	(0.001)	(0.000)
e fixed effects		Yes	Yes	Yes	Yes
e fixed effects		Yes	Yes	Yes	Yes
k type fixed effects		Yes	Yes	Yes	Yes
nber of Observations		137297	134681	137297	134681
nber of Banks		8426	8310	8426	8310
quared		0.022	0.023	0.112	0.120

*es: Estimations are performed using the fixed effects estimator. ***, **, and * denote significance at 10, 5, and 1 percent fidence levels, respectively.*

Cont.

- Finally, following Stiroh (2004), we include the share of non-interest income in total income of banks as additional explanatory variable to control for diversification. Table 5 suggests that banks having a higher share of non-interest revenues in total revenues have less volatile earnings, providing support for the diversification hypothesis. However, even after controlling for the diversification effect, all our previous findings still hold. In particular, larger banks have less volatile earnings and the financial crisis increased earnings volatility.

Table 5. Robustness check: Controlling for diversification

		ROE		ROA	
		[1]	[2]	[3]	[4]
		Four quarters	Eight quarters	Four quarters	Eight quarters
ber of st. dev. above or v mean log bank size	Coefficient	-0.0160***	-0.0176***	-0.0012***	-0.0013***
	Standard Error (Robust)	(0.002)	(0.001)	(0.000)	(0.000)
rage: total assets/capital	Coefficient	0.0044***	0.0031***	0.0001***	0.0001***
	Standard Error (Robust)	(0.000)	(0.000)	(0.000)	(0.000)
to income ratio	Coefficient	0.0671***	0.0665***	0.0067***	0.0062***
	Standard Error (Robust)	(0.002)	(0.002)	(0.000)	(0.000)
e of non-interest income al income	Coefficient	-0.0024*	-0.0015	-0.0001***	-0.0001**
	Standard Error (Robust)	(0.001)	(0.001)	(0.000)	(0.000)
et concentration	Coefficient	0.0063	0.0063*	0.0004***	0.0004***
	Standard Error (Robust)	(0.004)	(0.004)	(0.000)	(0.000)
s	Coefficient	0.0107***	0.0088***	0.0007***	0.0005***
	Standard Error (Robust)	(0.001)	(0.000)	(0.000)	(0.000)
action: Concentration-	Coefficient	0.0141***	0.0105**	0.0005***	0.0002*
	Standard Error (Robust)	(0.005)	(0.004)	(0.000)	(0.000)
action: Size-Crisis	Coefficient	0.0041***	0.0035***	0.0003***	0.0003***
	Standard Error (Robust)	(0.001)	(0.001)	(0.000)	(0.000)
action: Concentration-s	Coefficient	0.0006	0.0012	0.0002**	0.0003***
	Standard Error (Robust)	(0.003)	(0.002)	(0.000)	(0.000)
action: Concentration-Crisis	Coefficient	0.0086**	0.0100***	0.0006***	0.0008***
	Standard Error (Robust)	(0.004)	(0.003)	(0.000)	(0.000)
tant	Coefficient	-0.0723***	-0.0740***	-0.0014***	-0.0044***
	Standard Error (Robust)	(0.017)	(0.007)	(0.001)	(0.000)
fixed effects		Yes	Yes	Yes	Yes
fixed effects		Yes	Yes	Yes	Yes
type fixed effects		Yes	Yes	Yes	Yes
ber of Observations		137297	134681	137297	134681
ber of Banks		8426	8310	8426	8310
uared		0.022	0.023	0.111	0.117

*s: Estimations are performed using the fixed effects estimator. ***, **, and * denote significance at 10, 5, and 1 percent dence levels, respectively.*

Conclusions

- Larger banks have lower earnings volatility compared to smaller banks.
- This inverse relationship has become stronger during the global financial crisis.
- The relationship between bank size and earnings volatility is positively conditioned by the level of market concentration in the U.S. states.

Cont.

- "Diversification" hypothesis is supported by our estimations but it does not fully explain the negative relationship between bank size and earnings volatility as the inverse relationship between bank size and earnings volatility remains intact when diversification of bank earnings is taken into account. Hence, the "too-big-to-fail" hypothesis also seems to contribute to the inverse relationship between size and earnings volatility, supporting the need for the current regulatory reforms aimed at tackling the "too-big-to-fail" issue.

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Thank you for your attention