

Bank Consolidation and Systemic Risk: M&A During the 2008 Financial Crisis

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Abstract

In this paper, we analyze the relationship between US bank consolidation and systemic risk before, during, and after the 2008 financial crisis. We find that mergers during the crisis decreased market-adjusted systemic risk. This effect was more pronounced for mergers with smaller acquirers of larger targets. Meanwhile, mergers of larger banks increased the aggregate systemic risk. In the years following the crisis, we find that banks that merged during the crisis had lower return volatility and fewer nonperforming loans than non-merged banks. Comparing pre- and post-crisis mergers, we do not find a significant difference with respect to their effect on systemic risk.

Keywords: Banks; M&A; Systemic Risk; Financial Crises

JEL Codes: G01, G21, G28, G32, G34

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"The actions taken by central banks and other authorities to stabilize a panic in the short run can work against stability in the long run if investors and firms infer from those actions that they will never bear the full consequences of excessive risk-taking."

Ben Bernanke, Chairman of the Federal Reserve (2006-2014)

1. Introduction

The recent 2008 financial crisis was the worst economic disaster since the Great Depression in the history of the United States. The banking industry, in particular, experienced a severe downturn that resulted in the failure of nearly 200 banks for a total of more than 3 trillion dollars in losses.¹ At the same time, there were approximately 740 mergers and acquisitions (M&A) that took place during the 2008 financial crisis, of which some were supported by the US government. The largest and best-known examples of mergers during this period were JP Morgan Chase's acquisition of Bear Stearns, Bank of America's purchase of Merrill Lynch, and Wells Fargo's merger with Wachovia. While the use of bank consolidation to mitigate a crisis has merits, it also prompts the criticism that if the initial problem was that the distressed banks were too-big-to-fail (TBTF), then the solution of a merger could only result in an even larger bank. In other words, a merger could potentially pose an even greater risk to the stability of the aggregate financial system.

Therefore, the events of the 2008 financial crisis present a truly striking tension between the possible destabilizing or stabilizing effect that bank M&A can have on the financial system and have revitalized the broader debate surrounding the relationship between bank consolidation and financial stability. In this debate, there are two main competing hypotheses. The concentration-stability hypothesis argues that consolidation in banking results in an overall decrease in risk at the individual bank level primarily through an increased amount of diversification as well as enhanced profitability. The consequent reduction in the idiosyncratic risk of a consolidated bank is then theorized to improve the overall stability of the financial system (Diamond 1984; Allen and Gale 2003; Beck et al. 2007). On the other hand, the concentration-fragility hypothesis contends that although consolidation may increase the diversification of individual banks, consolidated banks, in general, are similar in structure and are more interconnected than ever before, resulting in a more homogenous and thus vulnerable financial system (De Nicolo and Kwast 2002). Overall, the relationship between bank consolidation and the stability of the financial system is rather unclear in the literature on systemic risk and consequently is a topic that warrants additional research.

Accordingly, in this study, we analyze the relationship between bank consolidation and systemic risk within the United States through the use of several different risk measures that are common to the literature on systemic risk.² In particular, given the recent crisis, we aim to

¹Statistics refer to the years 2007-2009 and are obtained from the Federal Deposit Insurance Corporation (FDIC), accessed through the Federal Reserve Economic Data (FRED) on the website of the Federal Reserve Bank of St. Louis.

²Up until this point, we have implied the term systemic risk refers to the stability of the overall financial system but have not explicitly defined it as such. In 2001, the Group of Ten (G-10) formally defined systemic risk as "the risk that an event will trigger a loss of economic value or confidence in, and attendant increases in

reconcile the tension between the bank mergers that contribute to a more vulnerable financial system and the bank mergers that improve financial stability through the reduction of an individual bank's risk. We also explore how economic conditions may affect this issue by comparing the M&A of banks during the 2008 financial crisis with those that occurred during stable periods. Thereby, we seek to determine whether the effects of bank consolidation on the systemic risk of the individual acquirers and the broader banking sector differ depending on the financial conditions.

In our paper, we use several risk measures. We focus on the marginal expected shortfall (MES) that was developed by Acharya et al. (2017), and in supplementary analyses in the online appendix, we use the SRISK that was created by Brownlees and Engle (2017) and the delta conditional value at risk (ΔCoVaR) that was constructed by Adrian and Brunnermeier (2016).

In the first part of our paper, we explore the effect of the 2008 financial crisis on the merged banks' systemic risk through a difference-in-differences (DiD) analysis. Using the MES, we find that banks that merged during the 2008 financial crisis experienced a reduction in their market-adjusted systemic risk.³ Moreover, we show that the reduction in systemic risk is particularly significant for mergers where the acquirer has less than \$10,000 million in assets and the relative target size is greater than 0.05. Meanwhile, the systemic risk for larger banks increased during both the crisis period and the stable periods.

In the second part of our analysis, we explore the effect of the bank mergers on the risk of the broader banking sector by isolating the merged banks' marginal effect on aggregate risk. Our results show that the aggregate exposure to systemic risk increased primarily due to an increase in large banks' risk. Meanwhile, smaller banks significantly reduced the aggregate exposure to systemic risk. Based on these analyses, we find evidence for small banks that is consistent with the concentration-stability hypothesis with respect to aggregate exposure to systemic risk. On the other hand, we find evidence for large banks that is consistent with the concentration-fragility hypothesis with respect to the aggregate exposure to systemic risk.

In the third part, we conduct a 2-stage Heckman analysis that confirms the findings of the DiD analysis. After controlling for the selection bias and balance-sheet variables, the crisis dummy stays negative and significant, indicating that the post-merger market-adjusted systemic risk is distinctly lower for the banks that merged during the crisis. Considering the effects of the control variables on the systemic risk, we find that the interaction variable of the crisis dummy and bank size is significant. This result indicates that the larger banks that merged during the crisis experienced a larger increase in their market-adjusted risk.

In the last part, we focus on the years following the crisis. We first study the ex-post differences in performance of the banks that merged during the crisis with those that did not. We find that banks that merged during the 2008 financial crisis have lower return volatility and fewer nonperforming loans in the following years. The latter indicates that they were more successful with regard to their loan performance which is in line with the reduction in their

uncertainty about, a substantial portion of the financial system that is serious enough to quite probably have significant adverse effects on the real economy." This is the official definition used by Weiss et al. (2014) as well as De Nicolo and Kwast (2002) and which this paper adopts.

³The results are similar for the NSRISK and ΔCoVaR risk measures.

return volatility. We also compare the mergers of the pre-crisis years with the post-crisis years and find that even though the merger-related systemic risk went down for smaller banks and went up for larger banks, the difference is not significant.

Even though there is a substantial amount of literature on bank mergers and their effects on systemic risk, to the best of our knowledge, this is the first paper to explicitly examine the merger-related changes in systemic risk with respect to the economic climate within the United States while also taking into account the characteristics of both the acquirer and the target.⁴ Of this literature on mergers and risk, our paper is closest to Weiss et al. (2014). In Weiss et al. (2014), the authors investigate the systemic risk of merging banks and find that after controlling for the market trends in the banking sector, the change in the systemic risk is insignificant. Weiss et al. (2014) attribute this insignificant change to an increase in the systemic risk of the overall banking sector and claim that mergers increase the systemic risk of the non-merged banks as well. We replicate their analysis in the online appendix and find a similar insignificant change in the market-adjusted systemic risk measure.⁵ However, when we exclude banks that merged during the 2008 financial crisis, we find a different result. Specifically, we find that banks that merged during the stable periods experienced a significant post-merger increase (rather than an insignificant one) in their market-adjusted systemic risk. Meanwhile, for the banks that merged during the crisis, we find a reduction in their post-merger market-adjusted systemic risk. This finding means that the insignificant coefficient found in Weiss et al. (2014) may be due to the inclusion of the banks that merged during the crisis and that these mergers have a distinctly negative effect on banks' systemic risk. In our sample, the significance of the results depends heavily on whether we exclude the subsample that merged during the crisis or not.

The remainder of this paper proceeds as follows: In Section 2, we outline our hypotheses and the construction of our sample. In Section 3, we use a DiD analysis to investigate whether there is a dissimilarity between mergers that occurred during the 2008 financial crisis and those that took place during regular times in terms of the change in the merged banks' systemic risk. In this section, we also consider the change in the aggregate systemic risk. In Section 4, we extend these analyses using a Heckman selection model. In Section 5, we compare the post-crisis risk performance and balance-sheet characteristics. In Section 6, we summarize our findings and conclusions.

⁴See Amihud et al. (1981), Furfine and Rosen (2006), and Vallascas and Hagedorff (2011) for a discussion of mergers and risk. Moreover, see Berger et al. (2019), Ivashina and Scharfstein (2010), Kowalik et al. (2015), and DeYoung and Torna (2013) for a discussion of 2008 financial crisis.

⁵Referred as "competitive-adjusted" in Weiss et al. (2014)

2. Hypotheses and Data Construction

2.1. Hypotheses

We test the following hypotheses in our paper (corresponding sections in parentheses):

- *H1: Mergers during the 2008 financial crisis differed with respect to their market-adjusted exposure and contribution to systemic risk from their counterparts that took place during stable periods.* (Section 3.2 and Section 4.3) The 2008 financial crisis was a period of extreme financial distress for the banking sector. Mergers that occurred during that period may have had different motivations and effects on a merged bank's systemic risk. Possibly, markets undervalued the targets during the crisis, and merged banks benefited from these fire sales.
 - *H1a: Merged banks' market-adjusted systemic risk differs with respect to the size of the acquirer and the target.* (Section 3.2 and Section 4.3) The size of the acquirer and the target are critical factors that underpin the concentration-stability and concentration-fragility debate. Specifically, a larger bank may have a broader effect on the financial system that could be destabilizing if there is an increase in the systemic risk of the bank. On the other hand, a larger bank is often more diversified that may reduce the systemic risk.
- *H2: The effect of mergers on aggregate systemic risk is different in the crisis period and the stable periods.* (Section 3.3) This difference follows from H1. If the systemic risk of the merged bank is different in the crisis period from that in the stable periods, then this difference could also have an effect on aggregate risk.
 - *H2a: The effect of a merger on aggregate risk differs with respect to the size of the acquirer and the target.* (Section 3.3) This difference follows from H1a. If the systemic risk of an acquirer or a target is dependent on size, their effect on the aggregate risk could also be affected by that factor.
- *H3: The ex-ante balance-sheet characteristics are different in the crisis period and the stable periods both for the acquirer and the target.* (Section 4.1) Due to differences in the financial conditions, banks that merged during the 2008 financial crisis may be distinct in their balance-sheet characteristics.
- *H4: The banks that merged during the 2008 financial crisis have different ex-post performance than the banks that did not.* (Section 5.1) Due to changes in their risk exposure and balance-sheet characteristics following a merger, banks that merged during the crisis may display differences in their performance after the crisis.
- *H5: The banks that merged before and those that merged after the 2008 financial crisis had different exposures and made different contributions to systemic risk after the merger.* (Section 5.2) Due to changes in the regulations of the banking system, banks that merged after the crisis may differ from their pre-crisis counterparts with respect to their exposure and contribution to systemic risk.

2.2. Data

In the main body of the paper, we use the MES to capture a bank’s exposure to systemic risk. In the online appendix, we complement our primary analysis with NSRISK and ΔCoVaR to further quantify a bank’s exposure and contribution to systemic risk, respectively. Description of these risk measures together with their data sources are also provided in the online appendix.

Regarding the construction of the merged bank sample, we use the Thomson One database and collect all domestic merger transactions that occurred within the United States between acquirers with the Standard Industrial Classification (SIC) codes ranging from 6021-6036 and 6712 and targets with the SIC codes ranging from 6000-6162. In other words, the composition of the sample involves acquiring firms that are either depository institutions or bank holding companies that merged with target firms that were either depository or non-depository credit institutions. Furthermore, although important during the 2008 financial crisis, we make a simplifying restriction and exclude any brokers, dealers, exchanges, and services of securities and commodities in our sample since the focus of this paper is bank consolidation.

Moreover, M&A deals are further restricted by requiring that the acquirer purchases at least 50% of the target firm and that the deal value is at least 10 million dollars. Additional constraints regarding the mergers’ absolute size and relative size (the ratio of the acquirer’s assets to the target’s assets) are explored alongside the overall sample. In these ways, we only consider the mergers where the acquisition would reasonably have an effect on the risk level of the acquirer.⁶

Likewise, mergers that involve the same acquirer and that occurred within the short period of a single month are entirely excluded, while we only keep the transactions at the maximum deal value for acquisitions that took place within six months of one another. This is done to capture the transactions that most likely will have the clearest effect on the acquirer.

Furthermore, all of the mergers considered in this paper were announced and completed between the years 1995 and 2016. This time frame was selected in part to extend the findings in the literature on M&A (Weiss et al. 2014). The periods of stability and crisis follow the official dates for business cycles that the National Bureau of Economic Research (NBER) provides. Moreover, in order to account for significant lags of bank failures that persisted in the system even after contractions technically ended according to the NBER dates, we gather complementary data from the Federal Deposit Insurance Corporation (FDIC) regarding the annual number of bank failures and those by total assets. A more detailed account of the time periods occurs in the online appendix. The following are the windows that we construct:

Stable Periods:	Crisis Period:
1995 – 2006	2007 – 2010
2011 – 2016	

Last, all acquiring banks in the sample are listed with share price data from the CRSP/Compustat Merged database. Accounting data for both acquirers and targets are primarily gathered from

⁶For specific relative size thresholds, see Furfine and Rosen (2006) and Minnick et al. (2011).

the CRSP/Compustat Merged database. A complete account of the construction of the sample is discussed in the online appendix. Furthermore, we omit the transactions where there is only partial or a complete lack of either accounting or share price data. Therefore, the sample used in our analysis consists of mergers that transpired from 1995 to 2016 when complete share price and accounting data were available in the CRSP/Compustat Merged database.

3. Difference-in-Differences Analysis

The main aim of the difference-in-differences (DiD) analysis is to compare the bank mergers that occurred during the 2008 financial crisis with those that took place during stable periods. Specifically, to test H1, we consider the effect on the merged bank’s risk using the MES. In our analysis, we focus on two variants of MES, which are marked as bold segments in Table 1. We start by examining the difference in the merged banks’ pre- and post-merger levels of systemic risk and denote them with ΔMES . The pre-merger values are calculated over a [-11, -180] day window before the merger announcement, and post-merger values are calculated over a [+11, +180] day window after the merger completion.

In order to investigate whether a merger affects the risk of the financial system, it is important to incorporate the effect of the target on systemic risk. To this end, we redefine the pre-merger MES to be a function of both the acquirer and the target. Specifically, we define:

$$\text{Pre-merger MES of the Acquirer}_{\text{target-adjusted}} = \text{Cap-weighted Average of the Acquirer and the Target Pre-merger MES}$$

Accordingly, the $\Delta\text{MES}_{\text{target-adjusted}}$ can be defined as :

$$\Delta\text{MES}_{\text{target-adjusted}} = \text{Post-merger MES of the Acquirer} - \text{Pre-merger MES of the Acquirer}_{\text{target-adjusted}}$$

From this point on, whenever we mention *MES*, it is in reference to the target-adjusted version of the risk measure (unless otherwise noted).⁷

Moreover, in order to determine whether this change in systemic risk is truly caused by a merger as opposed to a general trend in the banking sector, a comparison between merged and non-merged banks is necessary.⁸ We construct a control group and use it to adjust for the changes in the non-merged banks’ systemic risk. To construct our control group, we calculate the systemic risk for each bank available in the CRSP database. Next, for each merger, we create a broad cap-weighted index of non-merged banks by excluding the corresponding acquirer and target from the sample and weighting each bank’s systemic risk according to its market capitalization for the MES risk measure. We name these cap-weighted non-merged control

⁷While capturing the target effect on the systemic risk is important, it also reduces the sample size significantly and can lead to potential sample selection bias. For instance, it may be the case that only larger targets may have price data that are publicly available that would affect the MES results in the subsample.

⁸A key underlying assumption implicit in the DiD analysis is that the treatment group and the control group have parallel trends. Please refer to the online appendix for a visual examination of the trends prior to the mergers during stable and crisis periods.

groups as CapES and calculate the change in this measure around each merger by deducting the average pre-merger value from the post-merger average and denote it as ΔCapES . Next, we control for the aggregate risk by deducting the change in risk of the cap-weighted non-merged bank index from the change in the merged bank’s risk and name it the market-adjusted change in risk that is shown in the last row of [Table 1](#) and denoted as $\Delta\text{CapMAES}$.

Table 1: DEFINITIONS OF RISK MEASURES

Risk Measure	MES
Change in Acquirer Risk (Post Merger-Pre Merger)	ΔMES
Cap-weighted Non-merged Banking Sector Risk	CapES
Change in Cap-weighted Non-merged Banking Sector Risk (Post Merger-Pre Merger)	ΔCapES
Market-Adjusted Change in Risk Controlled for Cap-weighted Non-merged Banking Sector Risk (Post Merger-Pre Merger)	$\Delta\text{CapMAES}$ $=\Delta\text{MES}-\Delta\text{CapES}$

3.1. Summary Statistics

We start our analysis with the change in the merged bank’s risk after the merger that is illustrated in the third row of [Table 2](#). The results show that the risk has increased for the merged bank following a merger in the overall sample.

The sixth row illustrates the change in risk for the cap-weighted bank index. The results show that the constructed cap-weighted index experienced a rise in its exposure to systemic risk on average.

The ninth row illustrates the change in the market-adjusted risk, in which case we calculate the change in the merged banks’ risk after controlling for the change in risk for the cap-weighted index of non-merged banks. The results show that in the overall sample, merged banks’ exposure to systemic risk went up even after controlling for the changes in the banking sector with the help of the cap-weighted index.

Table 2: SUMMARY STATISTICS

	Mean	p25	Median	p75	Std.Dev.	Min	Max	Obs
Pre-merger MES	1.34	0.63	1.20	1.87	1.23	-3.40	9.02	579
Post-merger MES	1.76	0.78	1.50	2.29	1.84	-2.09	16.69	579
Δ MES	0.43	-0.49	0.27	1.16	1.70	-5.51	13.95	579
Pre-merger CapES	2.16	1.48	1.96	2.67	0.96	0.67	8.63	566
Post-merger CapES	2.58	1.55	2.28	2.80	1.82	0.57	13.04	566
Δ CapES	0.43	-0.40	0.13	1.06	1.70	-4.28	10.30	566
Pre-merger CapMAES	-0.85	-1.51	-0.64	-0.09	1.13	-5.96	2.40	566
Post-merger CapMAES	-0.83	-1.45	-0.63	-0.01	1.36	-9.63	3.65	566
Δ CapMAES	0.02	-0.67	0.05	0.74	1.30	-6.08	4.62	566

3.2. The results for Difference-in-Differences Analysis

In this section, we focus on the mergers during the 2008 financial crisis and explore whether these merged banks experienced an increase or a decrease in their exposure to systemic risk compared to the mergers during stable periods. To analyze the crisis's effect on the merged banks' systemic risk, we split the sample into a crisis period (defined as 2007 to 2010) and stable periods (1995-2006 & 2011-2016) and conduct the DiD analysis. In order to capture the size effects on the systemic risk, we also consider different subsamples with respect to acquirer size and relative size (target assets/acquirer assets) and test H1a. We provide more details regarding the construction of these subsamples in the online appendix.

Table 3 shows the DiD results for the MES. For each subsample grouping, the first line gives the change in the risk measure without using a control group, while the second line presents the market-adjusted version of the risk measure when using the cap-weighted control.

In the overall sample shown in the first line of Table 3, Δ MES is positive for both the crisis period and stable periods that indicates the risk increased after the merger regardless of the period. Moreover, Δ MES is higher for the mergers that occurred during the crisis that at first glance may be interpreted as those mergers creating a riskier environment. However, this analysis is incomplete without considering the risk level of the overall banking sector, which necessitates the usage of a control variable to calculate the market-adjusted version of this risk measure. When we introduce the cap-weighted non-merged control group to our analysis and calculate the market-adjusted MES, the sign of the risk difference between the crisis period and the stable periods reverses and is significant. Specifically, the effect of mergers during the crisis is on the average negative that indicates a merged bank's exposure to systemic risk diminished after the merger. Meanwhile, for stable periods, the merged banks' market-adjusted exposure to systemic risk, in general, increased. This reversal demonstrates that it is indeed important to detrend the sample through the use of a control group.

Furthermore, in our subsequent analysis, we focus on mergers where the relative target asset size is greater than 5 percent of the acquirer. We impose this restriction in order to exclude mergers where the target would reasonably have little to no effect on the systemic risk of the merged bank. When we consider the subgroups with respect to the acquirer size (when acquirer assets are less than \$10,000 million), they represent a large share of our merged sample, espe-

cially for the crisis. Moreover, the reduction in the acquiring banks' market-adjusted risk after the merger is larger and more significant. Mergers with acquirers whose asset size is greater than \$10,000 million also show a decrease in market-adjusted systemic risk, but this value is smaller and not significant.

Overall, using the market-adjusted MES measure, the findings of this section show that for the entire sample and most of the subsamples, mergers during the crisis had a greater reduction in their market-adjusted systemic risk than their counterparts in stable periods.⁹

Table 3: DIFFERENCE-IN-DIFFERENCES ANALYSIS (TARGET-ADJUSTED CAPWEIGHTED PRE-MERGER RISK)

	Stable Obs.	Stable	Crisis Obs.	Crisis	Risk Difference	p-value
MES						
<u>No Restriction</u>						
Δ MES	525	0.258	54	2.071	-1.814***	(0.000)
Δ CapMAES	519	0.0946	47	-0.790	0.885***	(0.008)
<u>Relative Target Assets\geq0.05</u>						
Δ MES	441	0.295	45	1.668	-1.373***	(0.006)
Δ CapMAES	436	0.108	38	-0.925	1.034***	(0.006)
<u>Acquirer Assets\leq10000 & Relative Target Assets\geq0.05</u>						
Δ MES	345	0.270	36	1.205	-0.934**	(0.035)
Δ CapMAES	340	0.164	31	-1.094	1.259***	(0.004)
<u>Acquirer Assets$>$10000 & Relative Target Assets\geq0.05</u>						
Δ MES	96	0.383	9	3.519	-3.136*	(0.087)
Δ CapMAES	96	-0.0919	7	-0.178	0.0863	(0.906)

This table shows the changes in the merged banks' target-adjusted systemic risk. The crisis period consists of observations for the years 2007-2010. The p-values are reported with respect to unequal variance (Welch) t-test. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

3.2.1. Robustness Checks

To show that these results are valid and only apply to the mergers that took place during the 2008 financial crisis, we conduct placebo tests where we alter the years of the crisis period. Specifically, we change the years of the crisis period from 2007-2010 to 2002-2005. These years do not coincide with other historical crisis periods that might be present in our sample. The results are reported in the online appendix. For the placebo period, the coefficients either become reversed or lose their significance. This finding confirms that the relationship between bank mergers and systemic risk during the crisis is different from other periods. As an additional robustness check, we exclude non-bank targets and repeat our DiD analysis. For all three risk measures, we find that the magnitudes and significance of the coefficients are similar to the overall sample that indicates robustness, and these results can be found in the online appendix.

⁹The findings for the other risk measures are in line with these results. Namely, for both NSRISK and Δ CoVaR, the market-adjusted systemic risk is significantly lower during the crisis as compared to the stable periods.

3.3. Effects of Bank Mergers on Aggregate Risk

In addition to analyzing individual acquirers, we explore how bank mergers affect the aggregate risk of the financial system to test H2. In our analysis, we examine the marginal effect of each merger on the aggregate risk. First, we calculate the aggregate risk that includes and excludes the individual acquirer-target pair using market capitalization weights. Next, we calculate the change between pre- and post-merger periods as previously defined for these two variants of aggregate risk. Then, we isolate the merger effect by deducting the change in aggregate risk excluding the acquirer-target pair from the change in aggregate risk including the acquirer-target pair.¹⁰ The equations are as follows:

$$\begin{aligned} \Delta \text{Aggregate Risk incl. the Acquirer and the Target} = \\ (\text{Post-merger Aggregate Risk incl. the Acquirer} \\ - \text{Pre-merger Aggregate Risk incl. the Acquirer and the Target}) \end{aligned}$$

$$\begin{aligned} \Delta \text{Aggregate Risk excl. the Acquirer and the Target} = \\ (\text{Post-merger Aggregate Risk excl. the Acquirer} \\ - \text{Pre-merger Aggregate Risk excl. the Acquirer and the Target}) \end{aligned}$$

$$\begin{aligned} \text{Acquirer and Target Effect} = \\ (\Delta \text{Aggregate Risk incl. the Acquirer and the Target} \\ - \Delta \text{Aggregate Risk excl. the Acquirer and the Target}) \end{aligned}$$

In [Table 4](#), we calculate the magnitude of this effect by summing the marginal effects across each of the stable periods and the crisis period. The first row shows that in line with our previous analysis, the total increase in the aggregate risk is larger for the crisis period that overall, indicates the bank mergers increased the aggregate systemic risk during the crisis. The table shows that the difference between stable periods and the crisis period is approximately equal to 0.16 that corresponds to the pre-merger MES of a merged bank with approximately \$5,000 million in assets. In relative terms, 0.16 value corresponds to 8 percent of the pre-merger cap-weighted aggregate risk. Comparing the subsamples in the third and fourth row, we find that mergers with large acquirers drive the increase in aggregate risk. Moreover, in the fourth row, there are 96 mergers during the stable periods and 9 mergers during the crisis. Therefore, the increase in the aggregate risk during the crisis is mainly driven by these nine banks. When we exclude these mergers in the third row, we find that banks during the crisis reduced aggregate systemic risk.

¹⁰We assume *ceteris paribus* that other banks are not directly affected by this merger.

Table 4: DIFFERENCE-IN-DIFFERENCES ANALYSIS FOR AGGREGATE RISK

	Stable Obs.	Stable	Crisis Obs.	Crisis	Risk Difference
MES					
<u>No Restriction</u>					
Σ Acquirer Effect (Cap-weighted)	525	0.10	54	0.26	-0.16
<u>Relative size ≥ 0.05</u>					
Σ Acquirer Effect (Cap-weighted)	441	0.11	45	0.29	-0.18
<u>Acquirer Assets ≤ 10000 & Relative size ≥ 0.05</u>					
Σ Acquirer Effect (Cap-weighted)	345	0.07	36	0.02	0.05
<u>Acquirer Assets > 10000 & Relative size ≥ 0.05</u>					
Σ Acquirer Effect (Cap-weighted)	96	0.09	9	0.27	-0.18

This table shows the sum of the merged banks' marginal effects on the change in the aggregate systemic risk. The crisis period consists of observations for the years 2007-2010. The p-values are reported with respect to unequal variance (Welch) t-test. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Overall, the DiD analyses show that mergers that took place during the 2008 financial crisis experienced a significant decrease in their market-adjusted MES. Moreover, regarding the mergers that took place during the stable periods, we find that on average, these merged banks had an increase in their risk.

Considering the effect of the mergers on the aggregate risk, we find that they significantly increased the market-adjusted aggregate exposure to risk during the crisis in the overall sample. However, this result is mainly driven by a few large banks whose risk had increased during the crisis. When we consider mergers with small acquirers, we find that these mergers reduced the aggregate market-adjusted systemic risk during the crisis.

Concerning the initial competing hypotheses of concentration-stability and concentration-fragility, we find evidence consistent with the concentration-stability hypothesis with respect to aggregate exposure to systemic risk for mergers of small banks. Further, mergers by larger banks are consistent with the concentration-fragility hypothesis with respect to aggregate exposure to systemic risk. Such results call into question the absolute nature of the effect that bank consolidation has on financial stability and demonstrate that market conditions are indeed an important factor.¹¹

4. Multivariate Regression Analyses

In this section, we extend our analysis to control for balance-sheet variables that have the potential to affect the post-merger systemic risk of a bank. We use the Heckman selection model in order to account for the potential self-selection bias since the acquirers choose to participate

¹¹Similarly, Acemoglu et al. (2015) recognize that the effect of interconnectedness varies depending on the economic conditions.

in M&A.¹² We specify the following regression model to examine the effect of the crisis on the change in the market-adjusted systemic risk of a bank:

$$\Delta CapMAES = \beta_0 + \beta_1 Crisis + \beta_2 (Control\ Variables_{i,t-1}) + \epsilon_{i,t} \quad (1)$$

where $\Delta CapMAES$ is the difference between post- and pre-merger values of the MES that are adjusted for the cap-weighted non-merged control group over the same period. *Crisis* is the dummy variable that equals one if the merger is announced between 2007-2010 and zero otherwise.

The control variables that are used in this specification are described in detail in [Table 5](#).

Table 5: DEFINITIONS OF CONTROL VARIABLES

Variable	Definition
Asset Growth	Percentage change in the total assets.
Stock Price Growth	Percentage change in the stock price.
Bank Size	The natural log of a bank's total assets (in millions). The natural log is used for magnitude purposes since the value of total assets is very large.
Return on assets (ROA)	Net income divided by total assets multiplied by 100 (ratio).
Liquidity	Cash and short-term investments divided by total assets multiplied by 100 (ratio).
Tangibility	Property, plant, and equipment divided by total assets multiplied by 100 (ratio).
Loans Ratio	Loans-net of the total allowance for loan losses (balance sheet variable approximately equivalent to total loans) divided by total assets multiplied by 100 (ratio).
Nonperforming Loans	Nonperforming assets divided by total assets multiplied by 100 (ratio).
Tobin's Q	The market value of assets divided by the book value of assets multiplied by 100 (ratio). The market value of assets is defined as total assets plus the price per share times the number of common shares outstanding less common equity. The book value of assets is equal to total assets.
Tier-1 Capital	The risk-adjusted capital ratio-tier-1 (multiplied by 100).

4.1. Comparison of Acquirer and Target Characteristics

[Table 6](#) compares the acquirers and targets with respect to their balance-sheet characteristics to test H3. As for acquirers, banks that merged during the crisis had less asset growth, stock price growth, and liquidity, Tobin's Q, tier 1 capital as well as lower ROA. At the same time these banks had larger asset size, carried more tangible assets, had a higher loan ratio, and had a higher share of nonperforming loans than their counterparts in stable periods. As for targets, banks that were acquired during the crisis had less asset growth, stock price growth, and liquidity, Tobin's Q, tier 1 capital as well as lower ROA. Moreover, these banks were larger in size, carried more tangible assets, had a higher loan ratio, and had a slightly higher ratio of nonperforming loans as compared to their counterparts in stable periods.

¹²Further, even though OLS cannot establish causality, we replicate our results using the OLS analysis in the online appendix.

Table 6: BALANCE-SHEET CHARACTERISTICS OF ACQUIRERS AND TARGETS

	Whole Sample		Acquirer Assets <=10000		Acquirer Assets>10000	
	(Stable)	(Crisis)	(Stable)	(Crisis)	(Stable)	(Crisis)
Acquirer						
Asset Growth	16.20	12.81	16.95	12.75	13.68	11.47
Stock Price Growth	12.55	-18.76	12.88	-17.67	11.49	-23.14
Bank Size	7.77	8.09	7.25	7.58	10.29	10.57
Assets	9187.42	13421.89	2321.63	3022.93	41961.89	63416.89
ROA	1.00	0.79	0.97	0.75	1.13	0.92
Liquidity	5.31	4.52	5.22	4.52	5.38	3.98
Tangibility	1.58	1.63	1.64	1.74	1.38	1.19
Loans Ratio	63.70	68.60	64.19	69.89	62.78	64.90
Non-performing Loans	0.78	0.86	0.79	0.87	0.71	0.92
Tobin's Q	106.31	105.15	105.97	105.11	107.72	105.06
Tier 1 Capital	11.66	11.26	12.11	11.68	9.82	9.75
Target						
Asset Growth	6.58	2.96	6.38	2.01	7.48	5.83
Stock Price Growth	41.12	8.04	43.98	15.71	38.29	-16.63
Bank Size	6.82	7.15	6.31	6.73	7.99	8.18
Assets	3585.50	4935.42	875.12	1398.99	7740.72	15125.21
ROA	0.80	0.41	0.75	0.17	0.93	0.78
Liquidity	5.17	4.36	4.99	5.13	5.26	2.67
Tangibility	1.43	1.63	1.49	1.72	1.26	1.48
Loans Ratio	63.44	69.98	63.68	70.97	62.39	67.91
Non-performing Loans	0.95	1.04	1.06	1.33	0.67	0.42
Tobin's Q	103.72	102.53	103.00	101.00	105.33	105.78
Tier 1 Capital	11.33	10.75	11.63	10.86	10.55	10.30

This table shows the balance-sheet characteristics of acquirers and targets. The balance-sheet characteristics of particular interest are in bold.

4.2. First-stage Analysis

The first stage of the analysis is a probit model with the following specification:

$$\begin{aligned}
 Acq_{i,t} = & \beta_0 + \beta_1(\text{Asset Growth}_{i,t}) + \beta_2(\text{Stock Price Growth}_{i,t}) + \beta_3(\text{Bank Size}_{i,t}) + \\
 & \beta_4(\text{Return on Assets}_{i,t}) + \beta_5(\text{Liquidity}_{i,t}) + \beta_6(\text{Tangibility}_{i,t}) + \beta_7(\text{Loans Ratio}_{i,t}) \\
 & + \beta_8(\text{Non-performing Loans}_{i,t}) + \beta_9(\text{Tobin's Q}_{i,t}) + \beta_{10}(\text{Tier-1 Capital}_{i,t}) + \mu_i
 \end{aligned}$$

In this specification, $Acq_{i,t}$ equals one for the acquirers that merged in a given year and zero otherwise. Similar to Srivastav et al. (2018), we use the historical asset growth as an instrument only in the first stage. We calculate the asset growth rate for the two years prior to the merger.¹³ Based on the findings presented in Table 7, larger bank size, stock price growth, asset growth, return on assets, tangible assets, Tobin's Q, and tier-1 capital are all associated with a high probability of being an acquirer. On the other hand, liquidity and nonperforming loans are associated with a lower likelihood of being an acquirer.

¹³Srivastav et al. (2018) use asset growth for the three years prior to the merger. Due to constraints in data availability, we use two years prior to the merger.

Table 7: HECKMAN SELECTION MODEL FIRST STAGE RESULTS
(PROBIT)

	(1)	(2)	(3)
Asset Growth	2.625*** (0.184)		2.447*** (0.152)
Stock Price Growth	0.001*** (0.000)	0.001*** (0.000)	
Bank Size	0.247*** (0.016)	0.228*** (0.016)	
ROA	0.292*** (0.063)	0.220*** (0.048)	
Liquidity	-0.013** (0.006)	-0.008 (0.006)	
Tangibility	0.099*** (0.029)	0.107*** (0.029)	
Loans Ratio	-0.001 (0.002)	0.000 (0.002)	
Non-performing Loans	0.015 (0.022)	-0.039* (0.023)	
Tobin's Q	0.014*** (0.005)	0.025*** (0.004)	
Tier 1 Capital	0.021*** (0.007)	0.012* (0.007)	
Constant	-5.326*** (0.490)	-5.965*** (0.473)	-1.445*** (0.034)
Bank Fixed Effects	Yes	Yes	Yes
N	8917	9508	10711
Pseudo R^2	0.135	0.097	0.046

This table shows the first-stage probit estimation results of the Heckman selection model.

4.3. Second-stage Analysis

In the second stage, we estimate an OLS and add the inverse Mills ratio denoted by λ that is obtained from the first-stage analysis and controls for the potential selection bias.¹⁴ Table 8 presents the regression results for the market-adjusted change in MES that is denoted by $\Delta\text{CapMAES}$. We use bank fixed effects in all columns, while the results with year fixed effects are in the second column.

First, the coefficient for λ is insignificant that indicates the endogenous sample selection does not play a role in the MES.¹⁵ Moreover, in Column 1, we control for the selection bias and balance-sheet variables, and the crisis dummy stays negative and significant that indicates the post-merger systemic risk is distinctly lower for the banks that merged during the 2008

¹⁴We use bootstrapping with 500 replications in order to estimate the asymptotic standard errors.

¹⁵In the online appendix, we change the assumption of normally distributed errors and repeat the analysis of the Heckman selection model with a logit distribution. The results are in line with the probit specification.

financial crisis. In Columns 2 and 3, we add interaction variables and find that the interaction variable of the crisis dummy and bank size is significant that indicates the larger banks that merged during the crisis experienced a larger increase in their market-adjusted risk. Further, none of the other balance-sheet variables are significant except for bank size, ROA, and Tobin's Q. The positive coefficients for bank size and Tobin's Q show that larger banks and banks with higher market values experienced an increase in risk, while the negative coefficient for ROA shows that more profitable banks experienced a reduction in their risk following the merger. Together with the univariate case, these results confirm that banks that merged during the crisis experienced a reduction in their exposure to market-adjusted systemic risk.

Table 8: $\Delta\text{CapMAES}$ (HECKMAN'S 2-STEP ESTIMATION (PROBIT))

	(1)	(2)	(3)
Crisis	-0.921** (0.418)	-7.298** (3.240)	-11.109* (6.192)
Pre-merger CapMAES	-0.866*** (0.072)	-0.827*** (0.068)	-0.780*** (0.070)
Bank Size	0.226** (0.095)	0.168** (0.080)	0.208*** (0.080)
Stock Price Growth	0.000 (0.003)	0.000 (0.003)	-0.000 (0.003)
ROA	-0.318 (0.231)	-0.407* (0.242)	-0.537** (0.231)
Liquidity	0.023 (0.023)	0.026 (0.023)	0.010 (0.026)
Tangibility	-0.133 (0.118)	-0.121 (0.124)	-0.083 (0.123)
Loans Ratio	-0.013 (0.008)	-0.009 (0.008)	-0.005 (0.008)
Non-performing Loans	-0.051 (0.131)	-0.047 (0.135)	-0.185* (0.106)
Tobin's Q	0.032* (0.019)	0.042** (0.020)	0.047** (0.021)
Tier 1 Capital	-0.006 (0.024)	-0.002 (0.024)	0.021 (0.027)
λ	0.076 (0.373)	0.125 (0.329)	0.213 (0.316)
Crisis x Pre-merger CapMAES		-0.152 (0.201)	-0.261 (0.213)
Crisis x Bank Size		0.738** (0.362)	0.742** (0.357)
Bank Size / Target Size			-0.417 (0.476)
Crisis x Relative Size			3.137 (3.634)
Constant	-4.481* (2.567)	-5.312** (2.608)	-6.126** (2.493)
Year Fixed Effects	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes
N	11907	11907	11907
R^2	0.521	0.548	0.568

This table shows the multivariate regression results of $\Delta\text{CapMAES}$. We control for selection bias using Heckman's selection model with the inverse Mills ratio obtained from the first-stage probit regression. Year fixed effects are included. Robust standard errors are clustered by bank and are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

5. Additional Tests

In this section, we analyze the years following the crisis. We first study the ex-post differences in performance of the banks that merged during the crisis with those that did not. Subsequently, we compare the mergers of pre-crisis years with the post-crisis years.

5.1. Post-merger Analysis

In this subsection, we study the effects of mergers on the acquiring banks' post-crisis performance in the years following the 2008 financial crisis to test H4. Specifically, we compare the balance sheet and equity market performance of the banks that merged during the crisis with the ones that did not. In order to do that, we calculate the pre-crisis and post-crisis averages of these variables for the years 2005-2006 and 2011-2012, respectively. Then we construct a Δ measure for these variables by deducting the pre-crisis from the post-crisis average:

$$\Delta variable = Post-crisis variable - Pre-crisis variable$$

The variables of interest are as follows: Δ Asset Growth, Δ Stock Price Growth, Δ Bank Size, Δ Return Volatility, Δ Liquidity, Δ Non-performing Loans, Δ ROA, Δ Tangibility, Δ Loans Ratio, Δ Tobin's Q and Δ Tier-1 Capital Ratio.

For the pre-crisis values of the banks that merged during the 2008 financial crisis, we incorporate the effect of the target by redefining the pre-crisis values to be the asset-weighted average of the variable with respect to the acquirer and the target. Specifically, we define:

$$Pre-crisis variable = \\ Asset-weighted Average of the Acquirer and the Target Variable$$

Next, we conduct a t-test with unequal variances where we compare banks that merged during the crisis with those that did not. In [Table 9](#), the first two columns correspond to the banks that did not merge during the crisis, while columns 3 and 4 contain information relevant to banks that merged during the crisis. Columns 5 and 6 lay out the t-test results and the p-values, respectively.

Before examining the differences between the banks that merged during the crisis and those that did not, we examine the sign of the Δ values in columns 2 and 4 to compare the post-merger balance sheet and equity characteristics with the pre-merger levels. The positive sign of these Δ values for both groups indicates that following the crisis, the banking sector on average experienced an increase in its stock price, size, return volatility, liquidity, nonperforming loans, and tier-1 capital. Conversely, the banking sector on average had lower asset growth, ROA, loans ratio, and Tobin's Q after the crisis. The reduction in profitability and lending as well as the market value of these banks means that the effect of the crisis may have continued to influence the banking system in the ensuing years. Despite the banks' weaker performance in the years following the crisis, the increase in their tier-1 capital ratios is likely reflective of more stringent capital requirements implemented by regulators as a direct response to the crisis.

Comparing the banks that merged during the crisis with those that did not, the DiD results in column 5 show that those that merged experienced a greater increase in their size, and a smaller increase in their stock price, return volatility, liquidity, and nonperforming loans as compared to their non-merged counterparts. The increase in size relative to other banks is expected as these banks increased the amount of their assets by obtaining the assets of the targets. Considering the other performance characteristics, we find that the banks that merged during the crisis performed better and were more stable in the long term as they displayed lower return volatility. This lower volatility may be due to merger-related diversification benefits or to differences in the types of mergers across the two periods. Furthermore, these banks had a lower ratio of nonperforming loans that indicates they had more stable income streams but also had less liquid assets and lower stock price growth. We find no significant difference with respect to asset growth, ROA, tangibility, loan ratio, Tobin’s Q, and the tier-1 capital ratio. Overall, these results show that banks that merged during the crisis performed better after the crisis with respect to their return volatility and loan performance.¹⁶

Table 9: EX-POST DIFFERENCE-IN-DIFFERENCES ANALYSIS FOR THE MERGED BANKS

	Obs.	Crisis Non-merged	Obs.	Crisis Merged	Difference	p-value
Δ Asset Growth	193	-0.0779	41	-0.0463	-0.0316	(0.232)
Δ Stock Price Growth	191	16.70	37	6.263	10.44**	(0.045)
Δ Bank Size	225	0.294	42	0.779	-0.485***	(0.000)
Δ ROA	225	-0.326	42	-0.581	0.255	(0.249)
Δ Return Volatility	230	0.215	42	0.158	0.0574*	(0.089)
Δ Liquidity	225	2.326	42	0.678	1.647***	(0.000)
Δ Tangibility	225	-0.0122	42	0.0359	-0.0481	(0.529)
Δ Loans Ratio	225	-4.656	42	-3.364	-1.292	(0.319)
Δ Non-performing Loans	221	2.562	42	1.850	0.712*	(0.077)
Δ Tobin’s Q	225	-8.613	42	-8.602	-0.0113	(0.986)
Δ Tier 1 Capital	198	1.466	42	1.821	-0.355	(0.505)

This table shows the comparison of the performance of the mergers that took place during the 2008 financial crisis with those that did not. For each variable reported below, the $\Delta variable$ is calculated by subtracting the pre-crisis values from the post-crisis values, where post-crisis values are calculated by the average of the years 2011 and 2012 and pre-crisis values are calculated by the average of the years 2005 and 2006. The Crisis Non-merged group is defined as the banks that did not merge between the years 2007 and 2010, whereas the Crisis Merged group is defined as the banks that merged during those years. The p-values are reported with respect to unequal variance (Welch) t-test. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

5.2. Comparison of Pre-Crisis and Post-Crisis Risk

In this section, we divide the stable periods in our sample into two subgroups. Specifically, we compare the pre-crisis mergers between 1995 and 2006 with the post-crisis mergers between

¹⁶It is important to acknowledge that our results may be affected by the policy changes as the banking system itself underwent significant changes after the 2008 financial crisis, including becoming subject to more stringent regulations such as higher capital requirements and living wills. Moreover, whenever a time horizon is expanded, there is more room for unaccounted variation that makes it harder to assign the merger as the specific cause.

years 2011 and 2016, excluding the mergers in 2000 due to the dot-com bubble. This exercise helps us to test H5 on whether mergers that took place after the crisis differed from their pre-crisis counterparts with respect to their post-merger risk.

Table 10 shows the target-adjusted change in risk with respect to the MES measure. The first row shows that the Δ MES values for the pre- and post-crisis are positive that indicates an increase in the merged banks' risk following the merger. Moreover, in the second row, the market-adjusted risk difference is insignificant between pre- and post-crisis. Considering the size restrictions, we find that in all of the scenarios, the difference between pre- and post-crisis market-adjusted risk is insignificant. These findings show that there is not a consistently significant difference in terms of the change in risk between pre- and post-crisis mergers.

Table 10: DIFFERENCE-IN-DIFFERENCES ANALYSIS

	Pre-Crisis Obs.	Pre-Crisis	Post-Crisis Obs.	Post-Crisis	Risk Difference	p-value
MES						
<u>No Restriction</u>						
Δ MES	397	0.291	86	0.148	0.143	(0.347)
Δ CapMAES	388	0.0990	85	0.147	-0.0480	(0.736)
<u>Relative Target Assets\geq0.05</u>						
Δ MES	324	0.343	83	0.160	0.183	(0.252)
Δ CapMAES	316	0.111	82	0.151	-0.0404	(0.789)
<u>Acquirer Assets\leq10000 & Relative Target Assets\geq0.05</u>						
Δ MES	249	0.329	68	0.0652	0.264	(0.111)
Δ CapMAES	241	0.167	67	0.163	0.00446	(0.981)
<u>Acquirer Assets$>$10000 & Relative Target Assets\geq0.05</u>						
Δ MES	75	0.390	15	0.589	-0.200	(0.675)
Δ CapMAES	75	-0.0706	15	0.0994	-0.170	(0.319)

This table shows the changes in the merged banks' systemic risk during the pre-crisis and post-crisis periods. The pre-crisis period consists of observations for the years 1995-2006 but excludes the year 2000. The post-crisis period consists of observations for the years 2011-2016. The p-values are reported with respect to unequal variance (Welch) t-test. * p < 0.1, ** p < 0.05, *** p < 0.01.

6. Conclusion

In this paper, we analyzed the relationship between bank consolidation and systemic risk within the US financial system. Specifically, we compared the mergers and acquisitions of US banks during the 2008 financial crisis to those that occurred during stable periods to determine whether the effects of bank consolidation on systemic risk differed due to the financial conditions. We calculated the MES both before and after a merger so as to capture the consequent merger-related change in a merged bank's exposure to systemic risk. We started our analysis with a DiD model and continued with a Heckman selection model in order to control for potential selection bias. Following this start, we focused on the effect of the mergers on the aggregate systemic risk of the banking sector. Last, we examined the banks in the years following the

2008 financial crisis.

Regarding the DiD analysis, we found that mergers during the crisis led to a significant reduction in market-adjusted systemic risk after the merger. Meanwhile, we found that mergers during the stable periods on average led to an increase in market-adjusted systemic risk. In addition, we found that this reduction was more pronounced for the mergers with smaller acquirers and relatively larger targets.

We continued our analysis by exploring the effect of the mergers on the aggregate risk. We analyzed the merger effect on a cap-weighted index of aggregate risk. For the MES, the aggregate exposure to systemic risk increased primarily due to an increase in large banks' risk. Meanwhile, smaller banks reduced the aggregate exposure to systemic risk.

In the last part of our paper, we focused on the years following the crisis. We first studied the ex-post differences in performance of the banks that merged during the crisis with those that did not and found that the banks that merged during the crisis had lower return volatility in the following years. In addition, the banks that merged during the crisis had lower nonperforming loans that indicated they were more successful with regards to their loan performance which is in line with the reduction in their return volatility. We also compared the mergers of pre-crisis years with the post-crisis years and found that even though the risk went down, there was not a significant difference with respect to the merged banks' market-adjusted risk.

Overall, the findings of this paper show that the market-adjusted systemic risk decreased for mergers during the crisis. This result is most pronounced for the mergers involving smaller acquirers with relatively larger targets. Considering the aggregate effect of mergers on the aggregate risk, we found evidence consistent with the concentration-stability hypothesis for small bank mergers. On the other hand, larger banks' mergers are more consistent with the concentration-fragility hypothesis. Last, the post-crisis analysis showed that these merged banks had lower return volatility and better loan performance in the years following the crisis and that banks that merged during the pre-crisis years did not have a significantly different effect on systemic risk versus those that merged after the crisis period.

Declarations

We have no relevant or financial interests related to this project to disclose.

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