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

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Abstract

This paper analyzes the relationship between bank consolidation and systemic risk within the U.S. financial system. Specifically, we compare mergers and acquisitions of U.S. banks during the 2008 financial crisis with those that occurred during stable market conditions to determine whether the effects of bank consolidation on the systemic risk at all differ depending upon the macroeconomic climate. We consider the systemic risk measures of MES, NSRISK, and ΔCoVaR and find that the market-adjusted systemic risk decreased for the acquirers that merged during the 2008 financial crisis. This result is most pronounced for the mergers involving smaller acquirers with relatively larger targets. Moreover, during the 2008 financial crisis, the systemic risk for government-assisted mergers was not significantly different from that of the private mergers. We also consider the effects of acquirers on the systemic risk of the aggregate banking sector and find that for MES and NSRISK the aggregate exposure to systemic risk increased due to an increase in large banks' risk and their disproportionate effect on the weighted indices. Meanwhile, smaller banks significantly reduced the aggregate exposure to systemic risk, alleviating the impact of the larger mergers. For ΔCoVaR, we find that the aggregate risk decreased for both the overall sample and smaller bank subsamples, implying that large banks played a significant role in reducing the aggregate contribution to systemic risk. When we examine the underlying characteristics of the mergers during the 2008 financial crisis, we find that banks with more liquidity acquired target banks with good loan performance. Lastly, we find that these acquirers exhibited lower return volatility in the years following the crisis.

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 in the history of the United States since the Great Depression. In particular, the banking industry experienced a severe downturn, resulting in the failure of nearly 200 banks, totaling more than 3 trillion dollars in losses.[1] During this critical period, federal regulators deemed certain banks as systemically important. The survival of such institutions was prioritized due to their interconnected nature and essential role in the everyday functioning of the economy. These banks were labeled too-big-to-fail (TBTF), as their collapse would create significant disruptions and impose serious negative externalities on the broader banking sector, greatly exacerbating the downturn in the overall economy.[2]

In order to protect the banking sector from the failure of these systemically important banks, the U.S. government emphasized the use of mergers and acquisitions (M&A) as the primary and preferred means of bank resolution during the 2008 financial crisis.[3] The basic idea was that through a merger, a healthy bank would acquire a failing bank, saving the economy from experiencing the full cost of the distressed bank's collapse. This private-sector solution was preferred in the sense that the government was not then forced to use federal funds to bail out the failing institution, which would have been more costly and highly unpopular with the general public (White & Yorulmazer (2014)). Furthermore, even though the distressed bank may have been approaching insolvency, it still was an attractive target for other banks primarily due to its franchise value, which stemmed from its customer base and established relationships (White & Yorulmazer (2014)). During the 2008 financial crisis, there were approximately 740 M&As that took place, and some of the largest and best-known examples of such mergers include JP Morgan Chase's acquisition of Bear Stearns, Bank of America's purchase of Merrill Lynch, and Wells Fargo's merger with Wachovia.

Even though the use of bank consolidation during the financial crisis certainly has merits, it also prompts the criticism that if the initial problem was that the distressed banks were TBTF, then the solution of a merger would only result in an even larger bank. In other words, the answer of 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 as well as stabilizing impact that bank M&A can have on financial stability.[4]

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

[2] Please refer to Boyd & Runkle (1993), Flannery (1989), and Demirgüç-Kunt & Detragiache (2002) for further analysis of bank protection and its relevance to bank size.

[3] Please see Bennett & Unal (2015) for an analysis of resolution costs during earlier periods (before the 2008 financial crisis).

[4] A more detailed account of the 2008 financial crisis as well as its impact on financial stability can be found in Bullard et al. (2009).

Altogether, the 2008 financial crisis has revitalized the broader debate surrounding the relationship between bank consolidation and the stability of the financial system. In this debate, there are two main competing hypotheses. The concentration-stability hypothesis argues that consolidation in banking results in an overall decrease in the individual acquiring bank's risk 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), Beck et al. (2007), Allen & Gale (2003)). Meanwhile, the concentration-fragility hypothesis contends that although consolidation may increase the extent of diversification at the individual level, in general, consolidated banks are indeed more similar in structure and more interconnected than ever before, resulting in a more homogenous and thus vulnerable financial system (De Nicolo & Kwast (2002), Boyd & De Nicolo (2005), Brewer & Jagtiani (2013)). Therefore, the relationship between bank consolidation and the stability of the financial system is rather unclear in the existing literature and consequently is a topic that warrants additional research.[5]

With these opposing hypotheses in mind, 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 in the literature.[6] In particular, given the recent crisis, we aim to reconcile the tension between bank mergers contributing to a more vulnerable financial system and bank mergers improving financial stability through the reduction of an individual bank's risk. We also explore how economic conditions may affect this issue by comparing mergers and acquisitions of banks during the 2008 financial crisis with those that occurred during stable market 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 at all differ depending upon the macroeconomic climate.

We use three systemic risk measures, which are the Marginal Expected Shortfall (MES) developed by Acharya et al. (2017), the SRISK measure created by Brownlees & Engle (2017), and the Delta Conditional Value at Risk (ΔCoVaR) constructed by Adrian & Brunnermeier (2016).[7] The MES and the SRISK are two different measures that quantify a firm's exposure to systemic risk while ΔCoVaR captures a firm's contribution to systemic risk.[8] Moreover, MES and ΔCoVaR are calculated using market return data, while SRISK requires market returns and balance sheet characteristics. This means that SRISK is prone to size effects, and therefore, we also calculate a version of SRISK normalized with respect to a bank's market capitalization referred to as NSRISK.

[5]For a comprehensive survey of the literature, please see Berger et al. (2004).

[6]Up until this point, we have implied the term systemic risk by discussing the stability of the overall financial system, but have not explicitly used the phrase. 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 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 & Kwast (2002) and will also be adopted here. Moreover, the risk measures used in this paper will expand upon this initial definition by considering different aspects of systemic risk.

[7]Estimating systemic risk is a research area in its own right. For examples of measures that are not considered in this paper, please see Billio et al. (2012).

[8]It is important to differentiate between a bank's exposure and contribution to systemic risk. A bank's exposure to systemic risk is defined as the likelihood of a bank being in distress conditional on the financial market experiencing downward movements. Meanwhile, a bank's contribution to systemic risk is the extent to which an individual bank adds to the overall risk in the financial system.

In the first part of our analysis, we explore the effect of the 2008 financial crisis on the acquirers' systemic risk. Using MES, NSRISK, and ΔCoVaR measures, we find that banks that merged during the 2008 financial crisis experienced a reduction in their market-adjusted systemic risk. This finding is robust in the difference-in-differences (DiD) and multivariate regression analysis as well as the Heckman selection model. Moreover, we show that the reduction in systemic risk is particularly significant for banks with less than $10,000 million in assets.[9] Meanwhile, the systemic risk for larger banks increased both during the crisis and stable periods.

In the second part of our analysis, we explore the impact of different government policies on the systemic risk of the acquirers. Specifically, we analyze whether acquirers that received the Troubled Asset Relief Program (TARP) funds or any Federal Deposit Insurance Corporation (FDIC) assistance during the 2008 financial crisis experienced a reduction in risk. The results show that, on average, FDIC-assisted acquirers and TARP recipient acquirers experienced a reduction in their market-adjusted systemic risk, no different than the other banks that merged during the 2008 financial crisis. With these findings in mind, we conclude the second part of our analysis by examining the effect of the bank mergers on the risk of the aggregate banking sector using two methods. In the first method, we aggregate the change in the market-adjusted risk of the acquirers and find a negative value for the crisis, whereas this value is positive for the stable periods. This finding implies that acquirers in total reduced the risk in the financial system. In the second method, we calculate the acquirers' effect on a cap-weighted and an asset-weighted aggregate index. For MES and NSRISK, we find that during the crisis the aggregate exposure to systemic risk increased due to an increase in large banks' risk and their disproportionate effect on the weighted indices. Meanwhile, smaller banks significantly reduced the aggregate exposure to systemic risk, alleviating the impact of the larger mergers. For ΔCoVaR, we find that the aggregate risk decreased for both the overall sample and smaller bank subsamples, implying that large banks played a significant role in reducing the aggregate contribution to systemic risk. Based on these results, we find evidence that smaller banks support the concentration-stability hypothesis with respect to both aggregate exposure and contribution to systemic risk. On the other hand, the results for larger banks are mixed. Namely, we find evidence that larger banks support the concentration-stability hypothesis with respect to aggregate contribution to systemic risk, but contribute to the concentration-fragility argument with respect to aggregate exposure to systemic risk.

In the third part, we explore the differences in the balance sheet characteristics of the banks that merged during the 2008 crisis. As an ex-ante analysis, we employ a logit model and examine which characteristics make some banks more likely to become acquirers and targets. We find that mergers during the 2008 financial crisis tended to involve acquirers that possessed more liquidity than their stable market counterparts. Moreover, banks that were acquired during the 2008 crisis tended to have lower non-performing loans implying that they had higher loan quality. Lastly, we study the ex-post differences in performance of the banks that merged during the 2008 crisis with those that did not, and find that banks that merged during the 2008 financial crisis exhibited lower return volatility in the following years. In addition, the

[9] In our sample, banks of this size comprise the majority (75 percent) of the overall sample.

banks that merged during the 2008 crisis had lower non-performing loans, implying that they were more successful with regards to their loan performance which is line with the reduction in their return volatility. Overall, the findings of this paper suggest that during the 2008 financial crisis, banks with more liquidity acquired target banks with good loan performance, potentially driving the observed reduction in systemic risk and ex-post return volatility.

1.1. Relation to the Literature

Even though there is a substantial amount of literature on bank mergers and the resulting impacts on systemic risk, to 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.[10] Of the existing literature on mergers and risk, our paper is closest to Weiss et al. (2014). In Weiss et al. (2014), authors investigate the systemic risk of the merging banks and find that, after controlling for the market trends in the banking sector, the change in the systemic risk is insignificant.[11] 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-merging banks as well. We replicate their analysis and find a similar insignificant change in the market-adjusted[12] systemic risk measure. 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 implies that the insignificant coefficient found in Weiss et al. (2014) is due to the inclusion of the banks that merged during the 2008 financial crisis, and that these mergers have a distinctly negative impact on bank systemic risk. Therefore, the significance of the results depends heavily on whether we exclude the subsample that merged during the 2008 financial crisis or not.

The remainder of this paper proceeds as follows. Section 2 outlines our hypotheses and the construction of our sample. Section 3 uses DiD analysis to investigate whether there exists a dissimilarity between mergers that occurred during the 2008 financial crisis and those that took place during regular times in terms of their impact on the acquirer's risk. In this section, we also consider the changes in the systemic risk of the acquirers that received government assistance, as well as the changes in the aggregate risk. Section 4 extends these analyses using multivariate regressions and a Heckman selection model. Section 5 includes additional tests that shed light on the pre-merger characteristics that would make a bank more likely to become an acquirer or

[10] For examples of research focused on mergers and risk see Amihud et al. (1981), Furfine & Rosen(2006), and Vallascas & Hagendorff (2011).

[11] Weiss et al. (2004) analyze the systemic risk measures Marginal Expected Shortfall (MES) and Lower Tail Dependence (LTD) for years 1991-2009, while in our analysis we utilize MES, NSRISK, and ΔCoVaR for years 1995-2013 in order to explore the changes in the exposure and contribution to systemic risk while including the whole crisis period and more recent data. Moreover, we support these analyses with balance sheet data as well as the post-merger analysis.

[12] Referred as "competitive-adjusted" in Weiss et al. (2014)

a target. In Section 5, we compare the post-crisis performance of the banks that merged during the crisis with those that did not. Lastly, Section 6 summarizes our findings and concludes.

2. Hypotheses and Data Construction

2.1. Hypotheses

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

- H1: Banks that merge during the 2008 financial crisis differ with respect to their market-adjusted exposure and contribution to systemic risk from their counterparts that merged during stable periods. (Section 3 and Section 4)
  - H1a: Acquirers' market-adjusted systemic risk differs with respect to the size of the acquirer and the target. (Section 3.2)
  - H1b: TARP payments and FDIC assistance impact the change in the acquirers' market-adjusted systemic risk. (Section 3.3)
- H2: The effect of mergers on aggregate systemic risk differs between crisis and stable periods. (Section 3.4)
  - H2a: The effect of a merger on aggregate risk differs with respect to the size of the acquirer and the target. (Section 3.4)
- H3: The ex-ante balance sheet characteristics affect the likelihood of being an acquirer and being a target. (Section 5.1)
- H4: Acquirers that merged during the 2008 financial crisis differ in their ex-post performance compared to the banks that did not. (Section 5.2)

2.2. Data

This paper utilizes the MES, SRISK, and NSRISK measures to capture a firm's exposure to systemic risk while the ΔCoVaR metric is used to quantify a firm's contribution to systemic risk. The explanation of these risk measures and the relevant data sources can be found in Online Appendix A.

Regarding the construction of the merging 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 6021-6036, 6712 and targets with the SIC codes 6000-6162. In other words, the composition of the sample involves acquiring firms that are either depository institutions or bank holding companies merging with target firms that are either depository or non-depository credit institutions. Furthermore, although important during the 2008 financial crisis, since the focus of this paper is bank consolidation, we make a simplifying restriction and do not include any security and commodity brokers, dealers, exchanges, and services in our sample.

Moreover, M&A deals were further restricted by requiring that the acquirer purchase at least 50% of the target firm and the deal value is at least 10 million dollars. Additional constraints focusing on the absolute size of the acquisition as well as the relative size, for instance the ratio of target assets to acquirer assets, are explored alongside the overall sample.[13] In these ways only mergers where the acquisition would reasonably have an impact on the risk level of the acquirer are considered.

Likewise, mergers involving the same acquirer that occurred within the short period of a single month are entirely excluded while for acquisitions that took place within 6 months of one another, only the transaction with the maximum deal value is kept. This is done to capture the transactions that most likely will have the clearest impact on the acquirer and the risk measures that are calculated using equity prices.[14]

Furthermore, all of the mergers considered in this paper were announced and completed between the years 1995 and 2013. This time frame was selected in part to remain consistent with the previous literature (Weiss et al. (2014), Bostandzic (2014)); however, this decision also takes into account considerations regarding window definitions. Namely, since our analysis concerns comparing bank mergers that occurred during the 2008 financial crisis with those that transpired during stable market conditions, it is first necessary to define these periods. The periods of stability and crisis on the official business cycle dates provided by the National Bureau of Economic Research (NBER) is unable to account for significant lags of bank failures that persisted in the system even after contractions technically ended according to the NBER dates. Therefore, we gather complementary data from the Federal Deposit Insurance Corporation (FDIC) regarding annual number of bank failures and bank failures by total assets.[15] In this way, we determine the following windows in which mergers have been announced:[16]

Stable Periods:	Crisis Period:
$1995 - 2006$	$2007 - 2010$
$2011 - 2013$	

Lastly, 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 is primarily gathered from the CRSP/Compustat Merged database.[17] 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 2013 where complete share price and accounting data was available in the CRSP/Compustat Merged database.

[13] For specific relative size thresholds, see Furfine & Rosen (2006) and by Minnick et al. (2011).

[14] While it can be argued that taking only the first merger is preferable in the sense that the acquirer stock prices are entirely unaffected by other transactions, this method is neglectful of the size of the transaction and has the capacity to remove deals that are of significant interest to this paper.

[15] A full account of the considerations and the construction of the time periods used in this paper are discussed in Online Appendix B.

[16] The announcement date of the merger is used because the announcement is a conscious decision on the part of the acquirer to participate in a merger taking the economic climate into account.

[17] A complete account of the construction of the sample is discussed in Online Appendix D.

3. Difference-in-Differences Analysis

The main aim of the DiD analysis is to compare the bank mergers that occurred during the 2008 financial crisis with those that took place during stable periods in terms of their impact on the acquirer's risk using the MES, NSRISK, and ΔCoVaR risk measures.[18] In our analysis, we focus on the three variants of these systemic risk measures, which are marked as bold segments in Table 1. We start by examining the difference in the acquirers' pre- and post-merger levels of systemic risk and denote them with ΔMES, ΔNSRISK, and Change in ΔCoVaR.[19,20]

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 merging and non-merging banks is necessary.[21] We construct two control groups and use them to adjust for the changes in the non-merging banks' systemic risk. To construct our first 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 non-merging banking sector index by excluding the corresponding acquirer from the sample and weighting each bank's systemic risk according to its market capitalization for MES, NSRISK, and ΔCoVaR risk measures. We name these cap-weighted non-merging control groups as CapES, CapNSRISK, and CapΔCoVaR, respectively, and calculate the change in those measures around each merger by deducting the average pre-merger values from the post-merger averages and denote them with ΔCapES, ΔCapNSRISK, and Change in CapΔCoVaR. Next, we control for the aggregate risk by deducting the change in the cap-weighted non-merging aggregate risk measures from the change in the acquirer risk and name it Market-Adjusted change in risk (controlled for aggregate risk), which is shown in the fifth row of Table 1 and denoted by ΔCapMAES, ΔCapMANSRISK, and Change in CapMAΔCoVaR, respectively.

For our second control group, we utilize propensity score matching to pair a merging bank with a particular non-merging bank based upon similar balance sheet characteristics.[22] By comparing merging and non-merging samples, we seek to avoid inappropriately capturing market-related as opposed to merger-related changes of these risk measures in our analysis. We calculate the MES, NSRISK, and ΔCoVaR values for the individual non-merging banks and calculate the change in their risk around the merger of the bank that they are matched with and denote these values as ΔMatchES, ΔMatchNSRISK, and Change in MatchΔCoVaR, respectively. Lastly, we deduct these values from the change in the acquirer's risk, namely ΔMES, ΔNSRISK, and Change in ΔCoVaR values so that we obtain the Market-Adjusted change in risk (controlled

[18] This corresponds to testing hypothesis H1 discussed in Section 2.1

[19] It should be noted that our risk measure is ΔCoVaR and when we consider the change in this measure we use "Change in ΔCoVaR" rather than "ΔΔCoVaR".

[20] Since the results of SRISK are asymmetrically impacted by mergers involving larger banks, we exclude the results of the SRISK measure from our main analysis. These results are available upon request.

[21] A key underlying assumption implicit in the DiD analysis is that the treatment group and the control group have parallel trends. In this case, that would mean that the trend of the systemic risk of merging banks and non-merging banks would be the same in the absence of a merger, proving the validity of the counterfactual. Please refer to Online Appendix C for visual examination of the trends prior to the mergers during stable and crisis periods.

[22] For each merging bank, the corresponding propensity score-matched non-merging bank is selected from the non-merging bank sample, which consists of all banks that did not merge in the same merger year. The procedure we use to match the banks with respect to their propensity scores is explained in Online Appendix D.3.

for PSM-matched non-merging bank risk), which is shown in the eighth row of Table 1, and denoted by ΔMatchMAES, ΔMatchMANSRISK, and Change in MatchMAΔCoVaR, respectively.

Table 1: Definitions of Risk Measures

Risk Measure	MES	NSRISK	ΔCoVaR
Change in Acquirer Risk (Post Merger-Pre Merger)	**ΔMES**	**ΔNSRISK**	**Change in ΔCoVaR**
Cap-weighted Non-merging Banking Sector Risk	CapES	CapNSRISK	CapΔCoVaR
Change in Cap-weighted Non-merging Banking Sector Risk (Post Merger-Pre Merger)	ΔCapES	ΔCapNSRISK	Change in CapΔCoVaR
Market-Adjusted Change in Risk Controlled for Cap-weighted Non-merging Banking Sector Risk (Post Merger-Pre Merger)	**ΔCapMAES =ΔMES-ΔCapES**	**ΔCapMANSRISK =ΔNSRISK-ΔCapNSRISK**	**Change in CapMAΔCoVaR =ΔCoVaR-Change in CapΔCoVaR**
PSM-Matched Non-merging Bank Risk	MatchES	MatchNSRISK	MatchΔCoVaR
Change in PSM-Matched Non-merging Bank Risk (Post Merger-Pre Merger)	ΔMatchES	ΔMatchNSRISK	Change in MatchΔCoVaR
Market-Adjusted Change in Risk Controlled for PSM-Matched Non-merging Bank Risk (Post Merger-Pre Merger)	**ΔMatchMAES =ΔMES-ΔMatchES**	**ΔMatchMANSRISK =ΔNSRISK-ΔCapNSRISK**	**Change in MatchMAΔCoVaR =ΔCoVaR-Change in MatchΔCoVaR**

3.1. Summary Statistics

We start our analysis with the change in the acquirer risk after the merger illustrated on the third row of Panel A, Panel B, and Panel C of Table 2 for MES, NSRISK, and ΔCoVaR measures, respectively. The results show that the risk has increased for the acquirer following a merger in the overall sample. There is only one exception, where the NSRISK measure is negative for both pre- and post-merger periods, even though the change is positive. This finding indicates that, on average, acquirers possessed a capital surplus before they merged, and after a merger, they experienced a reduction in their capital levels but still maintained a surplus.

The sixth and ninth rows of Panel A, Panel B, and Panel C illustrate the change in risk for the cap-weighted bank index and the propensity score-matched (PSM) non-merging banks, respectively. The results reveal that both the constructed cap-weighted index and the PSM-matched non-merging banks experienced a rise in their exposure and contribution to systemic risk on average. However, a noticeable dissimilarity between the two controls is that the pre- and post-merger levels are larger for the cap-weighted index for the MES and ΔCoVaR measures.

The twelfth and fifteenth rows of Panel A, Panel B, and Panel C illustrate the change in the market-adjusted risk, in which case we calculate the change in the acquirers' risk after controlling for the risk changes in the cap-weighted non-merging bank index and the propensity score-matched (PSM) non-merging banks, respectively. The results show that in the overall sample, acquirers' exposure and contribution to systemic risk went up even after controlling for the changes in the banking sector with the help of cap-weighted bank index and the PSM-matched non-merging banks. There are two exceptions, ΔCapMAES and the change in CapMAΔCoVaR indicate that an acquirer's exposure and contribution to systemic risk went down relative to the market and increased relative to its PSM-matched control.

Table 2: Summary Statistics

	Mean	p25	Median	p75	Std.Dev.	Min	Max	Obs
Panel A: MES								
Pre-merger MES	1.29	0.40	1.15	1.96	1.57	-8.65	14.11	1551
Post-merger MES	1.54	0.54	1.30	2.20	1.87	-9.90	16.69	1551
ΔMES	0.25	-0.65	0.17	1.10	1.86	-11.82	13.96	1551
Pre-merger CapES	2.25	1.41	2.06	2.69	1.32	0.64	12.77	1536
Post-merger CapES	2.54	1.52	2.17	2.80	1.80	0.57	13.70	1536
ΔCapES	0.29	-0.48	0.11	1.02	1.82	-8.92	10.59	1536
Pre-merger MatchES	1.35	0.42	1.16	2.06	1.36	-1.36	11.82	1102
Post-merger MatchES	1.52	0.47	1.29	2.18	1.72	-5.25	15.47	1102
ΔMatchES	0.17	-0.75	0.11	1.01	1.73	-7.51	15.16	1102
Pre-merger CapMAES	-0.97	-1.81	-0.84	-0.05	1.40	-13.03	3.24	1525
Post-merger CapMAES	-0.99	-1.74	-0.79	-0.01	1.79	-23.60	9.43	1525
ΔCapMAES	-0.02	-0.86	0.04	0.90	1.75	-19.91	9.80	1525
Pre-merger MatchMAES	-0.05	-0.73	-0.00	0.67	1.26	-6.44	8.57	1102
Post-merger MatchMAES	0.04	-0.75	0.03	0.82	1.63	-15.00	10.92	1102
ΔMatchMAES	0.09	-0.90	-0.01	1.06	1.89	-16.40	12.63	1102
Panel B: NSRISK								
Pre-merger NSRISK	-0.16	-0.36	-0.22	-0.03	0.33	-0.68	3.51	1430
Post-merger NSRISK	-0.14	-0.33	-0.20	-0.03	0.33	-0.68	3.72	1430
ΔNSRISK	0.02	-0.09	0.01	0.10	0.23	-1.41	1.85	1430
Pre-merger CapNSRISK	-0.11	-0.23	-0.19	-0.04	0.20	-0.29	1.05	1423
Post-merger CapNSRISK	-0.11	-0.23	-0.19	-0.08	0.22	-0.30	1.16	1423
ΔCapNSRISK	-0.00	-0.09	-0.03	0.05	0.17	-0.74	1.19	1423
Pre-merger MatchNSRISK	-0.12	-0.33	-0.16	0.03	0.30	-0.66	1.85	987
Post-merger MatchNSRISK	-0.11	-0.33	-0.17	0.00	0.39	-0.67	3.90	987
ΔMatchNSRISK	0.01	-0.11	-0.01	0.09	0.28	-0.86	3.24	987
Pre-merger CapMANSRISK	-0.06	-0.22	-0.08	0.08	0.28	-1.09	1.65	1403
Post-merger CapMANSRISK	-0.04	-0.19	-0.06	0.09	0.29	-1.20	2.09	1403
ΔCapMANSRISK	0.02	-0.07	0.02	0.11	0.20	-1.13	1.83	1403
Pre-merger MatchMANSRISK	-0.03	-0.19	-0.03	0.13	0.34	-1.31	3.43	987
Post-merger MatchMANSRISK	-0.03	-0.17	-0.01	0.14	0.41	-3.25	3.65	987
ΔMatchMANSRISK	0.00	-0.09	0.02	0.12	0.29	-2.78	1.81	987
Panel C: ΔCoVaR								
Pre-merger ΔCoVaR	1.75	0.87	1.63	2.40	1.12	-0.21	5.36	1322
Post-merger ΔCoVaR	1.79	0.91	1.67	2.41	1.16	-0.21	5.36	1322
Change in ΔCoVaR	0.05	-0.14	0.00	0.20	0.51	-2.28	3.15	1322
Pre-merger CapΔCoVaR	3.12	2.35	3.21	3.84	0.81	1.87	5.12	1298
Post-merger CapΔCoVaR	3.18	2.32	3.37	3.89	0.86	1.72	5.13	1298
Change in CapΔCoVaR	0.06	-0.36	0.02	0.48	0.74	-2.27	2.61	1298
Pre-merger MatchΔCoVaR	1.57	0.80	1.43	2.10	0.99	0.04	5.14	765
Post-merger MatchΔCoVaR	1.59	0.83	1.39	2.13	1.05	0.04	5.26	765
Change in MatchΔCoVaR	0.03	-0.16	-0.01	0.15	0.53	-2.26	3.05	765
Pre-merger CapMAΔCoVaR	-1.37	-2.12	-1.32	-0.56	1.15	-4.76	1.50	1295
Post-merger CapMAΔCoVaR	-1.38	-2.21	-1.31	-0.55	1.18	-5.29	1.59	1295
Change in CapMAΔCoVaR	-0.01	-0.25	0.01	0.25	0.50	-2.46	2.00	1295
Pre-merger MatchMAΔCoVaR	0.14	-0.37	0.13	0.65	0.89	-2.39	3.90	765
Post-merger MatchMAΔCoVaR	0.16	-0.41	0.13	0.72	0.93	-2.85	3.36	765
Change in MatchMAΔCoVaR	0.02	-0.13	0.00	0.15	0.33	-1.76	1.53	765

3.2. Results for Difference-in-Differences Analysis

In this section, we focus on the mergers during the 2008 financial crisis and explore whether the acquirers of these mergers experienced an increase or a decrease in their exposure and contribution to systemic risk compared to the mergers during the stable periods. To analyze the 2008 financial crisis's impact on the acquirers' systemic risk, we split the sample between the crisis (defined as 2007 to 2010) and the stable periods (1995- 2006 & 2011-2013) and conduct DiD analysis.[23,24] In order to capture the bank size effects on the systemic risk, we also consider different subsamples with respect to acquirer and target size.[25,26] Table 3 shows the DiD results for MES, NSRISK and ΔCoVaR risk measures. For each subsample grouping, the first line reports the change in the risk measure without the use of a control group. The second line reports the market-adjusted version of the risk measure using the cap-weighted control while as a robustness check, the third line reports the market-adjusted version of the risk measure using the propensity score matched control group. For each risk measure we consider subgroups where the acquirer assets are less than \$10,000 million and target asset size larger than \$100 million.[27]

[23]Note that the crisis period contains fewer observations due to it simply being a smaller time window than the stable periods as well as the fact that the total number of bank mergers decreased during the crisis (Kowalik et al. (2015)).

[24]Relatedly, the F-test for equal variance, which can be found in Online Appendix D.6 indicates that the two samples (stable and crisis) possess different variances for all of the risk measures calculated. Considering this, a Welch test rather than a Student's t-test is required to compare the sample means.

[25]Please refer to Online Appendix D.1 for details regarding the construction of the different subsamples.

[26]This corresponds to testing hypothesis H1a discussed in Section 2.1

[27]For a more detailed breakdown of the sample, please see Online Appendix E.1.

Table 3: Difference-in-Differences Analysis

	Stable Obs.	Stable	Crisis Obs.	Crisis	Risk Difference	p-value
Panel A: MES						
No Restriction						
ΔMES	1389	0.163	162	1.008	-0.845***	(0.004)
ΔCapMAES	1372	0.101	153	-1.092	1.193***	(0.000)
ΔMatchMAES	973	0.118	129	-0.129	0.247	(0.386)
Acquirer Assets≤10000						
ΔMES	1041	0.165	126	0.555	-0.391	(0.177)
ΔCapMAES	1028	0.143	118	-1.509	1.653***	(0.000)
ΔMatchMAES	793	0.156	107	-0.304	0.459	(0.153)
Acquirer Assets≤10000 & ***Target Assets≥100***						
ΔMES	578	0.209	76	0.657	-0.448	(0.176)
ΔCapMAES	570	0.135	71	-1.767	1.902***	(0.000)
ΔMatchMAES	437	0.151	63	-0.521	0.672**	(0.038)
Panel B: NSRISK						
No Restriction						
ΔNSRISK	1282	-0.00187	148	0.186	-0.188***	(0.000)
ΔCapMANSRISK	1266	0.0315	137	-0.0943	0.126***	(0.000)
ΔMatchMANSRISK	876	0.0175	111	-0.134	0.151**	(0.016)
Acquirer Assets≤10000						
ΔNSRISK	974	0.00816	116	0.145	-0.137***	(0.000)
ΔCapMANSRISK	961	0.0448	107	-0.130	0.175***	(0.000)
ΔMatchMANSRISK	701	0.0280	90	-0.147	0.175**	(0.013)
Acquirer Assets≤10000 & ***Target Assets≥100***						
ΔNSRISK	535	-0.00217	72	0.155	-0.157***	(0.001)
ΔCapMANSRISK	530	0.0401	66	-0.150	0.190***	(0.000)
ΔMatchMANSRISK	388	0.0213	55	-0.176	0.197**	(0.028)
Panel C: ΔCoVaR						
No Restriction						
Change in ΔCoVaR	1181	-0.00120	141	0.446	-0.447***	(0.000)
Change in CapMAΔCoVaR	1174	0.0326	121	-0.458	0.491***	(0.000)
Change in MatchMAΔCoVaR	663	0.0262	102	-0.0406	0.0667	(0.204)
Acquirer Assets≤10000						
Change in ΔCoVaR	871	-0.0131	108	0.299	-0.312***	(0.000)
Change in CapMAΔCoVaR	865	0.0460	94	-0.614	0.660***	(0.000)
Change in MatchMAΔCoVaR	532	0.0149	84	-0.0960	0.111**	(0.036)
Acquirer Assets≤10000 & ***Target Assets≥100***						
Change in ΔCoVaR	483	-0.000992	66	0.292	-0.293***	(0.002)
Change in CapMAΔCoVaR	480	0.0421	59	-0.516	0.558***	(0.000)
Change in MatchMAΔCoVaR	277	0.0227	49	-0.122	0.145**	(0.041)

This table shows the changes in the acquirers' systemic risk. Crisis period consists of observations between 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. MES

Panel A of Table 3 reports the DiD results for MES with restrictions on acquirer and target size.[28] ΔMES is positive for both crisis and stable periods implying that the risk increased after the merger regardless of the period that we consider. Moreover, ΔMES is higher for the mergers that occurred during the crisis, which at first sight may be interpreted as those mergers created a riskier environment during the crisis. However, this analysis is incomplete without considering the risk level of the overall banking sector, which necessitates the usage of control variables to calculate the market-adjusted versions of this risk measure. When we introduce the cap-weighted and propensity score-matched non-merging control groups into our analysis and calculate the market-adjusted MES risk measure, the sign of the risk difference between stable and crisis periods is reversed, and is significant for the market-adjusted change in risk using the cap-weighted control. More specifically, for both controls, the impact of mergers during the crisis period is on average negative, indicating that a bank's exposure to systemic risk actually diminished after the merger. Meanwhile, for stable periods, acquiring banks' market-adjusted exposure to systemic risk, in general, appears to have increased while it decreased for the acquirers during the crisis. This reversal demonstrates that it is indeed important to detrend the sample through the use of a control group.[29]

Furthermore, considering the subgroups with respect to the acquirer size (when acquirer assets are less than $10,000 million), we see that we retain a large share of our merging sample, especially for the crisis. Moreover, the reduction in the acquiring banks' exposure to risk after the merger is larger and more significant, especially when we use the cap-weighted non-merging banking sector index as the control group. In addition, when we impose size restrictions on the targets, the coefficients become more significant for smaller banks (with acquirer assets less than $10,000 million) with larger targets (with target assets greater than $100 million), implying that smaller banks with larger targets benefit more in terms of reduction in risk exposure after the merger.

Overall, using the market-adjusted MES measure, the findings of this section show that for the entire sample and the subsamples, acquirers that merged during the crisis experienced a significant reduction in their exposure to systemic risk as compared to the stable market counterparts.

3.2.2. NSRISK

Panel B of Table 3 reports the DiD results for NSRISK with restrictions on acquirer and target size. As can be seen in the first row of Panel B, ΔNSRISK is negative in the stable period merger subsample and positive in the crisis subsample leading to a significant negative difference. In particular, banks that merged during the crisis experienced a greater capital shortage than their stable market counterparts.[30] However, if we consider the market conditions

[28] We also conduct the same analysis using restrictions based on the deal value and find similar results. These results are available upon request.

[29] Besides, as shown in Figure 3 in Online Appendix C, the market-adjusted MES for the banks that merged during the crisis versus those that merged during the stable periods exhibit a similar stable trend prior to the merger announcement.

[30] Note that with NSRISK any change in a bank's capital levels (surplus or shortfall) is relative to the bank's market capitalization.

by analyzing CapMANSRISK and MatchMANSRISK, the sign of the relationship reverses but remains significant. This indicates that if we control for the overall increase in risk in the system, banks that merged during the crisis actually exhibited a reduction in risk. This decrease in exposure to systemic risk is attributed to a capital surplus after the merger for the banks that merged during the crisis. Moreover, comparing the two control groups among each other, we see that the reduction in risk is more pronounced when we use the PSM-matched control group.[31]

Additionally, restrictions of the sample with respect to the acquirers' absolute size reveal that the values of ΔMatchMANSRISK and ΔCapMANSRISK are more significant and larger for acquirers smaller than $10,000 million. Further analysis concerning the target size grouping reveals that the magnitude of the risk reduction becomes even larger as the target asset size increases. Altogether, using the market-adjusted NSRISK measure, we find that acquirers that merged during the crisis experienced a significant reduction in their exposure to systemic risk compared to the stable market counterparts. This reduction was especially significant when the deal involved larger targets relative to the acquirer's size.

3.2.3. ΔCoVaR

Panel C of Table 3 reports the DiD results for ΔCoVaR with restrictions on acquirer and target size. In the first row of Panel C, the risk difference is negative and significant when there is no size restriction or control group. Moreover, the sign of the change in ΔCoVaR is positive for the crisis and negative for the stable periods. This indicates that acquirers contribute to the systemic risk only during the crisis. However, this result needs to be confirmed with the market-adjusted ΔCoVaR. When we adjust for the market through the use of control groups, the signs are reversed yet remain significant. The negative coefficient for the mergers during the crisis period indicates that at this time, an acquiring bank's contribution to market-adjusted systemic risk actually diminished after the merger. Moreover, focusing on the various size groupings, the signs are consistent, and the difference between these two periods is significant, particularly for the mergers that involved smaller acquirers with larger targets in terms of their absolute size.[32]

3.2.4. 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 that are considered the crisis period. Specifically, we change the years of the crisis from 2007-2010 to 2002-2005.

[31]Besides, as shown in Figure 4 in Online Appendix C, the market-adjusted NSRISK for the banks that merged during the crisis versus those that merged during the stable periods exhibit a similar trend prior to the merger announcement. In line with the DiD results, compared to the banks that merged during the stable periods, the banks that merged during the crisis exhibit a significant decline in their systemic risk when the risk is adjusted with respect to the PSM-matched control group. Meanwhile, for banks that merged during the crisis, even though the market adjusted NSRISK using the cap-weighted index also declines immediately after the merger, it eventually increases to a level higher than the stable group.

[32]Furthermore, as shown in Figure 5 in Online Appendix C, the market-adjusted ΔCoVaR for the banks that merged during the crisis versus those that merged during the stable periods exhibit a similar trend prior to the merger announcement, especially in the case of PSM-matched control group. In line with the DiD results, as compared to the banks that merged during the stable periods, the banks that merged during the crisis exhibit a significant decline in their market-adjusted systemic risk using both control groups. Moreover, the decline in the market adjusted ΔCoVaR using the PSM-matched control is less significant as compared to the cap-weighted index.

These years do not coincide with other historical crisis periods that might be present in our sample. The results are reported in Online Appendix E.2. For all three risk measures considered, the coefficients either become reversed or lose their significance as the observations for years 2007-2010 are now included in the stable period. This robustness check confirms the relationship between bank mergers and systemic risk during the crisis is different than that of other periods.

3.2.5. Comparison of MES Analysis with Weiss et al. (2014)

This section compares our findings with the existing literature, of which the closest study to our analysis is Weiss et al. (2014). Following the same procedure outlined in Weiss et al. (2014), we replicate the analysis on MES captured in Table 3 of that paper using data available from 1995 to 2013. In Weiss et al. (2014), Table 3 calculates the change in the acquirers' systemic risk after the merger using the MES measure for different regions of the world, including North America. Weiss et. al (2014) find that the change in MES is positive for the different regions, implying that there is an increase in the exposure to systemic risk after the merger. However, when Weiss et al. control for the change in the systemic risk of competitors, defined as region-specific non-merging banking sector indices, they find that the competitor-adjusted (aka market-adjusted) risk is insignificant. Weiss et al. (2014) interpret the insignificant market-adjusted change in risk as an increase in the overall risk of the system due to mergers. We revisit this finding and observe that when the sample is broken up into crisis and stable periods, the results are different. Specifically, we find that there is a significant increase in the market-adjusted risk during the stable periods and a significant decrease in the market-adjusted risk during the crisis, which in the overall sample cancel each other out.

In Table 4, column 2 to column 4 shows the pre- and post-merger MES values as well as the change in the MES for the acquirers. Column 5 to column 7 show the pre- and post-merger MES for the competitors (denoted by ES) and the change in their systemic risk during the same time periods (denoted by ΔES).[33] Column 8 to column 10 illustrate the competitor-adjusted systemic risk in order to eliminate any market-related trend. In Panel A, the competitor is defined as the cap-weighted non-merging market index, while in Panel B, the competitor is defined as the propensity score matched (PSM) non-merging bank. The first row illustrates the results for our overall sample, which corresponds to North America in Weiss et al. (2014). The second row excludes the banks that merged during the crisis, and the third row only includes the banks that merged during the 2008 financial crisis.[34]

Similar to Weiss et al. (2014), in the first row of Panel A, we find that systemic risk increased for both acquirers and competitors. Moreover, in line with the findings of Weiss et al. (2014), the competitor-adjusted systemic risk is insignificant. Weiss et al. (2014) explain this finding by saying that mergers increase the systemic risk of the banking system as a whole.[35] However, when we repeat the same analysis excluding the mergers that took place during the 2008

[33]For the sake of comparison, we use the same terminology as Weiss et al. (2014).

[34]In these analyses, we use our overall sample between 1995 to 2013. We also conduct the same analyses applying the same periods used in Weiss et al. (2014), i.e., 1995-2009, and find similar results.

[35]Specifically, Weiss et al. (2014) assert that: "ΔMAES between the bidders' MES and the regional bank sectors' ES show that both acquiring banks and their competitors suffer to the same extent from an increase in systemic risk due to consolidation."

financial crisis, we find that the competitor-adjusted systemic risk is positive and significant, implying that these acquirers experienced an increase in their risk relative to their competitors. By the same token, when we only include the mergers that took place during the 2008 financial crisis, we find that the competitor-adjusted systemic risk is negative and significant, indicating that the systemic risk of the acquirers decreased. Therefore, the insignificant result in the overall sample is due to these opposing effects canceling each other. As a robustness test, in Panel B, we replicate this analysis with our PSM-matched control group and find similar results.

Table 4: Replication of Weiss et al. (2014)

Panel A: Replication of Weiss et al. (2014) for MES (Cap-weighted)

		Acquirers' systemic risk			Competitors' systemic risk			Competitor-adjusted systemic risk		
	N	MES_{pre}	MES_{post}	ΔMES	ES_{pre}	ES_{post}	ΔES	$MAES_{pre}$	$MAES_{post}$	ΔMAES
Whole Sample	1525	1.285	1.550	0.265***	2.254	2.537	0.284***	-0.968	-0.987	-0.019
Crisis Excluded	1372	1.135	1.300	0.165***	2.113	2.177	0.064*	-0.978	-0.877	0.101**
Crisis Only	153	2.633	3.795	1.162***	3.516	5.770	2.255***	-0.883	-1.975	-1.092***

Panel B: Replication of Weiss et al. (2014) for MES (PSM)

		Acquirers' systemic risk			Competitors' systemic risk			Competitor-adjusted systemic risk		
	N	MES_{pre}	MES_{post}	ΔMES	ES_{pre}	ES_{post}	ΔES	$MAES_{pre}$	$MAES_{post}$	ΔMAES
Whole Sample	1102	1.298	1.558	0.260***	1.346	1.517	0.171***	-0.047	0.042	0.089
Crisis Excluded	973	1.127	1.302	0.174***	1.186	1.243	0.056	-0.059	0.059	0.118**
Crisis Only	129	2.588	3.493	0.905**	2.547	3.581	1.034***	0.041	-0.088	-0.129

This table shows the replication results for Table 3 in Weiss et al. (2014) using the data available from 1995 to 2013. Column 2 to column 4 show the pre- and post-merger MES values and the ΔMES for the acquirers. Column 5 to column 7 show the pre- and post-merger MES for the competitors and the change in their systemic risk during the same time periods. Column 8 to column 10 illustrate the competitor-adjusted systemic risk in order to eliminate any market-related trend. The first row illustrates the results for our overall sample, corresponding to North America in Weiss et al. (2014). The second row excludes the banks that merged during the crisis, and the third row only includes the banks that merged during the 2008 financial crisis. The p-values are reported with respect to unequal variance (Welch) t-test. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

3.3. TARP Banks and FDIC-Assisted Mergers

We continue the DiD analysis by examining acquirers that received government assistance. Specifically, we focus on the acquirers that received TARP funds or FDIC assistance and explore whether there are any risk differences between these mergers and the other mergers that took place during the 2008 financial crisis.[36]

Table 5 and Table 6 show the DiD results for the banks that received TARP funds. In Table 5, we include all TARP banks while in Table 6, we only include the banks that received the TARP payment within in a one year window before the announcement date. Since the criteria applied in Table 6 is more restrictive, there is a smaller number of banks that received TARP funds prior to their merger.

Considering the first row of each panel in Table 5, TARP banks experienced a larger increase in risk post-merger as compared to the no TARP cohort. However, the first row of each panel in Table 6 shows that if we focus on the banks that received the TARP payments before the merger, we see that they experienced a reduction in risk post-merger. This implies that even though TARP funds were associated with financial hardship, the acquirers' risk went down

[36]This corresponds to testing hypothesis H1b discussed in Section 2.1

after the merger if these funds were available before the merger.

Considering the second and third row of each panel, overall, we observe that the market-adjusted risk is positive and larger for the TARP banks but is insignificant. This implies that TARP funds did not have a direct impact on the acquirer's systemic risk.[37]

Table 5: Difference-in-Differences Analysis for TARP Banks
(TARP Funds Received during the 2008 Financial Crisis)

	No TARP Obs.	No TARP	TARP Obs.	TARP	Risk Difference	p-value
Panel A: MES						
ΔMES	64	0.840	98	1.118	-0.278	(0.619)
ΔCapMAES	64	-0.426	98	-0.786	0.360	(0.592)
ΔMatchMAES	54	0.232	78	-0.373	0.605	(0.288)
Panel B: NSRISK						
ΔNSRISK	60	0.121	88	0.230	-0.109	(0.108)
ΔCapMANSRISK	60	-0.0422	88	-0.0502	0.00800	(0.911)
ΔMatchMANSRISK	47	-0.0297	68	-0.147	0.117	(0.329)
Panel C: ΔCoVaR						
Change in ΔCoVaR	49	0.418	92	0.460	-0.0419	(0.766)
Change in CapMAΔCoVaR	49	-0.442	92	-0.430	-0.0122	(0.945)
Change in MatchMAΔCoVaR	40	-0.0736	65	-0.0131	-0.0605	(0.592)

This table shows the changes in the systemic risk of the acquirers that merged during the 2008 financial crisis. TARP subsample consists of banks that received TARP funds during the 2008 financial crisis. The p-values are reported with respect to unequal variance (Welch) t-test. * p < 0.1, ** p < 0.05, *** p < 0.01.

Table 6: Difference-in-Differences Analysis for TARP Banks
(TARP Funds received within one year prior to merger during the 2008 financial crisis)

	No TARP Obs.	No TARP	TARP Obs.	TARP	Risk Difference	p-value
Panel A: MES						
ΔMES	149	1.460	13	-4.166	5.625***	(0.000)
ΔCapMAES	149	-0.791	13	1.049	-1.840	(0.137)
ΔMatchMAES	122	-0.0110	10	-1.519	1.508	(0.141)
Panel B: NSRISK						
ΔNSRISK	136	0.208	12	-0.0682	0.277	(0.244)
ΔCapMANSRISK	136	-0.0787	12	0.312	-0.391*	(0.069)
ΔMatchMANSRISK	106	-0.112	9	0.0563	-0.168	(0.615)
Panel C: ΔCoVaR						
Change in ΔCoVaR	129	0.561	12	-0.796	1.357***	(0.000)
Change in CapMAΔCoVaR	129	-0.475	12	0.00884	-0.484**	(0.021)
Change in MatchMAΔCoVaR	97	-0.0411	8	0.0239	-0.0650	(0.755)

This table shows the changes in the systemic risk of the acquirers that merged during the 2008 financial crisis. TARP subsample consists of banks that received TARP funds during financial crisis within a year prior to the merger. The p-values are reported with respect to unequal variance (Welch) t-test. * p < 0.1, ** p < 0.05, *** p < 0.01.

Lastly, in Table 7, we consider the mergers that received FDIC assistance, which are mainly failed bank acquisitions through FDIC bank auctions. The first row of each panel shows that as compared to the non-FDIC assisted mergers, these acquirers experienced a reduction in

[37]Only for the ΔCapMANSRISK and Change in CapMAΔCoVaR measures, the market-adjusted risk is significantly less negative, implying that the risk reduction is larger for the non-TARP acquirers.

their risk, although the difference is insignificant for the MES risk measure. Moreover, when we consider the market-adjusted risk, in general, the difference becomes insignificant implying that FDIC-assisted mergers were not different from the other mergers that took place during the crisis.[38]

Table 7: Difference-in-Differences Analysis for FDIC-Assisted Bank Mergers

	No FDIC Obs.	No FDIC	FDIC Obs.	FDIC	Risk Difference	p-value
Panel A: MES						
ΔMES	149	1.194	14	-0.292	1.486	(0.353)
ΔCapMAES	149	-0.715	14	0.322	-1.037	(0.102)
ΔMatchMAES	121	-0.108	12	-0.366	0.258	(0.633)
Panel B: NSRISK						
ΔNSRISK	135	0.225	14	-0.137	0.362**	(0.038)
ΔCapMANSRISK	135	-0.0482	14	0.00906	-0.0572	(0.646)
ΔMatchMANSRISK	104	-0.0983	12	-0.0771	-0.0211	(0.895)
Panel C: ΔCoVaR						
Change in ΔCoVaR	131	0.505	11	-0.187	0.692**	(0.043)
Change in CapMAΔCoVaR	131	-0.456	11	-0.0863	-0.370**	(0.013)
Change in MatchMAΔCoVaR	97	-0.0269	9	-0.153	0.127	(0.243)

This table shows the changes in the systemic risk of the acquirers that merged during the 2008 financial crisis. FDIC subsample consists of FDIC-assisted mergers during the 2008 financial crisis. The p-values are reported with respect to unequal variance (Welch) t-test. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

3.4. Effects of Bank Mergers on Aggregate Risk

In this section, we explore how bank mergers affect the aggregate risk in the financial system to complement the earlier analysis on the change in risk of the acquirer.[39] We start our analysis with a simple method where we aggregate the change in the market-adjusted risk of the acquirers in the crisis and stable periods using the cap-weighted non-merging bank index as the control group. This method allows us to explore the total effect of the acquirers relative to the aggregate risk in the banking sector represented by the cap-weighted non-merging banking sector index. Table 8 shows that the market-adjusted risk is negative for all risk measures in the crisis period while it is positive in the stable period. This finding implies that in total, mergers during the crisis had a negative effect on the aggregate exposure and contribution to systemic risk, while the mergers during stable periods had a positive effect.

Table 8: Aggregate Change in the Market-Adjusted Risk

Crisis	$\sum$ ΔCapMAES	$\sum$ ΔCapMANSRISK	$\sum$ Change in CapMAΔCoVaR
0	127.78	39.92	37.86
1	-104.27	-6.95	-61.22

This table shows the aggregate change in the acquirers' market-adjusted systemic risk.

[38] Only for the Change in CapMAΔCoVaR measure, the market-adjusted risk is significantly less negative, implying that the market-adjusted risk reduction is larger for the non-FDIC assisted acquirers.

[39] This corresponds to testing hypothesis H2 discussed in Section 2.1

In the second method, we calculate two aggregate risk measures during the pre- and post-merger periods. The first measure is created by weighting each bank's systemic risk with respect to its market capitalization, while the second measure is created by weighting each bank's systemic risk with respect to its total assets. In order to isolate the acquirer's effect on the aggregate risk, we calculate the aggregate risk including and excluding the individual acquirer. Following this, we calculate the acquirer effect by deducting the aggregate risk excluding the acquirer from the aggregate risk including the acquirer:[40]

$$\Delta \text{ Aggregate Risk incl. the Acquirer} =$$
$$(\textit{Post-merger Aggregate Risk incl. the Acquirer} - \textit{Pre-merger Aggregate Risk incl. the Acquirer})$$

$$\Delta \text{ Aggregate Risk excl. the Acquirer} =$$
$$(\textit{Post-merger Aggregate Risk excl. the Acquirer} - \textit{Pre-merger Aggregate Risk excl. the Acquirer})$$

$$\textit{Acquirer Effect} =$$
$$(\Delta \text{ Aggregate Risk incl. the Acquirer} - \Delta \text{ Aggregate Risk excl. the Acquirer})$$

Table 9 shows the acquirers' direct effect on the aggregate exposure and contribution to systemic risk. We start our analysis focusing on the risk differences between stable and crisis periods presented in column 5. For MES, the negative and significant risk difference of overall sample presented in the first two rows of Panel A implies that the acquirers that merged during the crisis periods increased the aggregate risk relative to the stable period counterparts. However, when we restrict our sample to the acquirers with assets smaller than \$10,000 million, the sign of the risk difference is reversed, which indicates that the aggregate risk was reduced by the acquirers that merged during the crisis periods. In the first two rows of Panel B and Panel C, for NSRISK and ΔCoVaR measures, the insignificant risk difference between stable and crisis periods implies that the acquirer effect on the aggregate risk is similar in the overall sample. When we consider the acquirers with assets smaller than \$10,000 million, the sign of the risk difference is reversed and significant, which indicates that the aggregate risk was reduced by the acquirers that merged during the crisis periods. Moreover, these results are more pronounced when targets are larger relative to their acquirers.

Focusing on the signs of the acquirer effects for the crisis period, in column 4, the first two rows of Panel A illustrate that for the MES risk measure, acquirers increased the aggregate exposure to systemic risk during the crisis in the overall sample with no restriction. However, when we consider the mergers that have acquirers with assets smaller than \$10,000 million, we see that the cap-weighted and asset-weighted aggregate risk went down as a result of a decrease in the risk of the acquirer. For NSRISK, we see a similar pattern where the acquirers increased the aggregate exposure to risk in the overall sample, while mergers with smaller asset size and larger targets reduced the aggregate exposure to systemic risk. Considering ΔCoVaR,

[40] We assume *ceteris paribus*, implying that other banks are not directly affected by this merger.

we find that mergers during the crisis reduce the aggregate contribution to systemic risk, both in the overall sample as well as the smaller bank subsamples, implying that large banks reduced the aggregate contribution to systemic risk. These findings show that during the crisis, banks with assets greater than $10,000 million, which corresponds to approximately 30 observations in our sample, had a significant impact on the overall system. Specifically, due to their larger size and market presence, they disproportionately increased the aggregate exposure to risk and decreased the aggregate contribution to risk in the overall sample. On the contrary, despite their large number, smaller acquirers constitute a smaller asset and market share of the total banking sector, and even though they decreased both the aggregate exposure and contribution to risk, their effect on the overall sample is less pronounced.

Table 9: Difference-in-Differences Analysis for Aggregate Risk

	Stable Obs.	Stable	Crisis Obs.	Crisis	Risk Difference	p-value
Panel A: MES						
No Restriction						
Acquirer Effect (Cap-weighted)	1498	-0.000239	172	0.00650	-0.00674**	(0.023)
Acquirer Effect (Asset-weighted)	1498	0.000106	172	0.00625	-0.00614*	(0.065)
Acquirer Assets≤10000						
Acquirer Effect (Cap-weighted)	1155	0.0000528	135	-0.0000980	0.000151	(0.347)
Acquirer Effect (Asset-weighted)	1155	0.0000532	135	-0.000181	0.000234*	(0.075)
Acquirer Assets≤10000 & ***Target Assets≥100***						
Acquirer Effect (Cap-weighted)	580	0.0000617	79	-0.000155	0.000217	(0.396)
Acquirer Effect (Asset-weighted)	580	0.0000648	79	-0.000249	0.000314	(0.116)
Panel B: NSRISK						
	Stable Obs.	Stable	Crisis Obs.	Crisis	Risk Difference	p-value
No Restriction						
Acquirer Effect (Cap-weighted)	1345	-0.0000643	154	0.000599	-0.000664	(0.156)
Acquirer Effect (Asset-weighted)	1345	-0.0000737	154	-0.000259	0.000185	(0.757)
Acquirer Assets≤10000						
Acquirer Effect (Cap-weighted)	1051	0.0000181	123	-0.0000531	0.0000712**	(0.016)
Acquirer Effect (Asset-weighted)	1051	0.0000176	123	-0.0000573	0.0000749***	(0.001)
Acquirer Assets≤10000 & ***Target Assets≥100***						
Acquirer Effect (Cap-weighted)	528	0.0000193	73	-0.0000786	0.0000978**	(0.038)
Acquirer Effect (Asset-weighted)	528	0.0000157	73	-0.0000804	0.0000960***	(0.007)
Panel C: ΔCoVaR						
	Stable Obs.	Stable	Crisis Obs.	Crisis	Risk Difference	p-value
No Restriction						
Acquirer Effect (Cap-weighted)	1146	-0.0000668	149	-0.000751	0.000684	(0.380)
Acquirer Effect (Asset-weighted)	1146	-0.0000882	149	-0.000683	0.000595	(0.441)
Acquirer Assets≤10000						
Acquirer Effect (Cap-weighted)	854	0.0000119	115	-0.000140	0.000152***	(0.000)
Acquirer Effect (Asset-weighted)	854	0.0000131	115	-0.000195	0.000208***	(0.000)
Acquirer Assets≤10000 & ***Target Assets≥100***						
Acquirer Effect (Cap-weighted)	440	0.0000255	69	-0.000134	0.000160***	(0.003)
Acquirer Effect (Asset-weighted)	440	0.0000284	69	-0.000182	0.000211***	(0.000)

This table shows the acquirers' effect on the change in the aggregate systemic risk. Crisis period consists of observations between 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 acquirers that merged during the crisis experienced a significant decrease in their market-adjusted systemic risk for all measures tested, regardless of the control group. Moreover, regarding the acquirers that merged during the stable periods, we find that on average, these banks underwent an increase in their risk.

With regards to the government assistance, the results show that, on average, FDIC-assisted acquirers and TARP recipient acquirers experienced a reduction in their market-adjusted systemic risk, no different than the other banks that merged during the 2008 financial crisis.

Considering the effect of the mergers on the aggregate risk, using MES and NSRISK risk measures, we find that mergers increased the market-adjusted aggregate exposure to risk significantly during the crisis. This is mainly due to disproportionate effect of the large acquirers on the aggregate risk. However, when we consider the acquirers with smaller size and larger targets, we see that these mergers reduced the aggregate market-adjusted systemic risk during the crisis. Considering the effect of mergers on the contribution to systemic risk, ΔCoVaR measures shows that the aggregate contribution to systemic risk went down both in the overall sample and the smaller bank subsamples during the crisis, implying that large banks reduced the aggregate contribution to systemic risk.

Consequently, concerning the initial competing hypotheses, we find evidence that smaller banks support the concentration-stability hypothesis with respect to aggregate exposure and contribution to systemic risk. Meanwhile, larger banks support the concentration-stability hypothesis with respect to aggregate contribution to systemic risk, but contribute to the concentration-fragility argument with respect to aggregate exposure to systemic risk. Such results call into question the absolute nature of the impact that bank consolidation has upon financial stability and demonstrates that market conditions are indeed an important factor.[41] In the following section, we extend our analysis and control for the other bank-specific factors that may potentially affect the systemic risk of the merging banks.

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 using OLS regression analysis. In addition, we utilize the Heckman selection model in order to deal with the self-selection problem. We specify the following regression model to examine the effect of the crisis on the post-merger systemic risk of a bank:

$$\Delta\ Market\text{-}Adjusted\ Risk = \beta_0 + \beta_1 Crisis + \beta_2(Control\ Variables_{i,t-1}) + \epsilon_{i,t} \qquad (1)$$

$$\begin{aligned}\Delta\ &Market\text{-}Adjusted\ Risk \\ &= Post\text{-}merger\ Market\text{-}Adjusted\ Risk - Pre\text{-}merger\ Market\text{-}Adjusted\ Risk \\ &= \Delta\ Acquirer's\ Risk - \Delta\ Cap\text{-}weighted\ Control\ Risk\end{aligned}$$

[41] Similarly, Acemoglu et al. (2015) recognize that the role that interconnectedness plays varies depending upon the economic conditions.

Δ *Market-Adjusted Risk* is the difference between post- and pre-merger values for MES, NSRISK and ΔCoVaR adjusted for the cap-weighted non-merging control group over the same period. Post-merger values are calculated over the [+11, +180] day window and pre-merger values are calculated over the [-11, -180] day window and the difference is adjusted for the change in the risk of the cap-weighted control group over the same period. By the same token, it can be defined as the difference between the change in the actual risk of the merging bank and the change in the risk of the cap-weighted non-merging control group. *Crisis* is the dummy variable that takes the value of 1 if the merger is announced between 2007-2010 and 0 otherwise.

Control variables that are used in this specification are described in detail in Table 10.[42,43]

Table 10: Definitions of Control Variables

Variable	**Definition**
Stock Price Growth	Percentage change in the stock price.
Return on Assets	Return on assets (ROA) is 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 total allowance for loan losses (balance sheet variable approximately equivalent to total loans) divided by total assets multiplied by 100 (ratio).
Non-performing Loans	Non-performing assets divided by total assets multiplied by 100 (ratio).
Tobin's Q	Market value of assets divided by the book value of assets multiplied by 100 (ratio). Market value of assets is defined as total assets plus the price per share times the number of common shares outstanding less common equity. Book value of assets is equal to total assets.
Tier-1 Capital	The risk-adjusted capital ratio-tier-1 (multiplied by 100).
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.

4.1. OLS Regression Results

4.1.1. MES

The first two columns of Table 11 present the regression results for ΔCapMAES, with the second column accounting for year fixed effects.[44] In these models, after controlling for other balance sheet variables, the crisis dummy stays negative and significant implying that the post-merger systemic risk is distinctly lower for the banks that merged during the 2008 financial crisis. Considering the effects of control variables on the systemic risk, we find that none of these variables except for bank size and Tobin's Q is significant. In these analyses, when we control for the year-fixed effects, the positive coefficient of bank size implies that larger banks were associated with higher post-merger risk which is in line with our findings in the previous section. Lastly, if we do not control for the year-fixed effects, the positive coefficient of Tobin's

[42]Summary statistics for these variables can be found in Online Appendix D.2

[43]The OLS regression in Section 4.1 only requires acquirer-specific data whereas in Section 4.2 the subsequent Heckman selection model also includes non-merging bank related balance sheet data in the first (selection) stage.

[44]We use year dummies except for the years between 2007 and 2010, where "Crisis" dummy captures the time variation during this time period.

Q implies that the banks with higher market value tended to have higher post-merger risk, but it should be noted that the significance of this relationship is weak.

4.1.2. NSRISK

Column 3 and column 4 of Table 11 present the regression results for ΔCapMANSRISK, with the fourth column accounting for year fixed effects. In these models, the crisis dummy stays negative and significant. Considering the effects of control variables on the systemic risk, in column 3, Tobin's Q is associated with a lower exposure to systemic risk, while in the next column with year fixed effects, loans ratio is associated with higher exposure to the systemic risk. Moreover, in both specifications, the stock price growth is associated with a lower exposure to systemic risk, while higher tier-1 capital is associated with higher market-adjusted exposure to risk.[45] Lastly, Table 11 shows that bank size has a negative significant effect on the systemic risk. This may be due to the definition of NSRISK since NSRISK is defined as SRISK divided by the market capitalization, which is positively correlated with bank size. Therefore, when the bank size goes up, NSRISK tends to fall.

4.1.3. ΔCoVaR

Column 5 and column 6 of Table 11 present the regression results for the change in CapMAΔCoVaR, with the sixth column accounting for year fixed effects. In these models, the crisis dummy stays significantly negative. Considering the effects of control variables on the systemic risk, we find that bank size and non-performing loans are associated with higher market-adjusted systemic risk.

Consequently, the negative and significant coefficient for crisis dummy in all our regressions imply that the mergers that took place during the 2008 financial crisis experienced a reduction in their exposure and contribution to market-adjusted systemic risk, which is consistent across different systemic risk measures and regression models. Moreover, in Online Appendix E.4, we show that the results still hold when we also control for the target balance sheet data.[46]

[45] At first, this may look counter-intuitive as tier-1 capital would act as a cushion and would be expected to reduce the risk. In order to explain this, using the equation ΔCapMANSRISK=ΔNSRISK-ΔCapNSRISK, we run two regressions using ΔNSRISK and ΔCapNSRISK as dependent variables. In the first two columns of Table 31 in Online Appendix E.3, ΔNSRISK is the dependent variable. In the next two columns of Table 31, ΔCapNSRISK is the dependent variable, whereas the last two columns of Table 31 repeats our results in column 3 and column 4 of Table 11 for ΔCapMANSRISK. These columns reveal that while ΔCapNSRISK is negatively associated with tier-1 capital with a significant coefficient, the coefficient of tier-1 capital on ΔNSRISK is insignificant (except for the OLS regression with year fixed effects). Therefore, when we deduct ΔCapNSRISK from ΔNSRISK to obtain our actual measure ΔCapMANSRISK, the coefficient for tier-1 capital becomes significant and positive.

[46] However, regressions with target data is susceptible to sample selection bias as target data is available only for one fourth of the initial merging sample, implying that we may be including the data only for larger targets.

Table 11: OLS Regressions

	ΔCapMAES		ΔCapMANSRISK		Change in CapMAΔCoVar	
	(1)	(2)	(3)	(4)	(5)	(6)
Crisis x Pre-merger CapMAES	-0.551***	-0.547***				
	(0.058)	(0.153)				
Crisis x Pre-merger CapMANSRISK			-0.403***	-0.420***		
			(0.045)	(0.084)		
Crisis x Pre-merger CapMACoVaR					-0.278***	-0.271***
					(0.039)	(0.053)
Crisis	-1.689***	-1.192***	-0.201***	-0.285***	-0.976***	-0.723***
	(0.197)	(0.315)	(0.021)	(0.036)	(0.082)	(0.129)
Stock Price Growth	0.001	0.000	-0.002***	-0.002***	0.001	0.000
	(0.002)	(0.002)	(0.000)	(0.000)	(0.001)	(0.001)
Bank Size	0.061	0.078*	-0.009*	-0.003	0.043***	0.042***
	(0.042)	(0.042)	(0.005)	(0.005)	(0.012)	(0.010)
ROA	-0.128	-0.104	-0.005	-0.033*	0.031	0.002
	(0.151)	(0.207)	(0.017)	(0.019)	(0.043)	(0.036)
Liquidity	0.003	0.011	0.001	-0.001	-0.003	0.007*
	(0.017)	(0.018)	(0.002)	(0.002)	(0.005)	(0.004)
Tangibility	-0.015	-0.016	0.003	0.004	-0.004	-0.006
	(0.084)	(0.089)	(0.009)	(0.012)	(0.025)	(0.019)
Loans Ratio	-0.005	-0.005	0.001	0.002***	-0.001	-0.000
	(0.006)	(0.005)	(0.001)	(0.001)	(0.002)	(0.001)
Non-performing Loans	0.112	0.051	-0.001	0.004	0.074***	0.050**
	(0.070)	(0.077)	(0.008)	(0.017)	(0.020)	(0.024)
Tobin's Q	0.024**	0.012	-0.003**	-0.002	-0.003	-0.004
	(0.012)	(0.015)	(0.001)	(0.002)	(0.004)	(0.003)
Tier 1 Capital	0.002	0.007	0.005**	0.008***	0.002	0.002
	(0.019)	(0.018)	(0.002)	(0.002)	(0.006)	(0.005)
Constant	-2.528*	-2.011	0.343**	0.235	0.005	-0.187
	(1.329)	(1.582)	(0.149)	(0.191)	(0.394)	(0.337)
Year Fixed Effects	No	Yes	No	Yes	No	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
N	1151	1151	1096	1096	988	988
R^2	0.107	0.153	0.163	0.241	0.171	0.389

This table shows the multivariate regression results for ΔCapMAES, ΔCapMANSRISK, and the change in CapMAΔCoVaR. Year fixed effects are included. Robust standard errors clustered by bank are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

4.2. Heckman Selection Model

It is important to recognize the limitations of the multivariate regression analysis in the previous section. Specifically, the multivariate regression approach cannot technically establish causality since the acquirers choose to participate in M&A and therefore are self-selecting. In order to take this endogenous selection problem into account, in this section, we employ the Heckman selection model.

4.2.1. 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, $Acq_{i.t}$ is equal to 1 for the acquirers that merged in a given year and 0 otherwise. Similar to Srivastav et al. (2018), we use the historical asset growth as an instrument used only in the first stage. We calculate the asset growth rate for the two years prior to the merger.[47] Based on the findings presented in Table 34 in Online Appendix E.5, higher bank size, stock price growth, asset growth, return on assets, tangible assets, Tobin's Q, and tier-1 capital are all associated with higher probability of being an acquirer. On the contrary, liquidity is associated with a lower likelihood of being an acquirer.

4.2.2. Second Stage Analysis

In the second stage, we estimate an OLS regression with an additional term, the inverse Mills ratio denoted by λ, which controls for the potential selection bias.[48] Table 12 presents the regression results for the second stage of each risk measure. For MES and ΔCoVaR, λ coefficient is insignificant while for NSRISK, the coefficient is negative and significant. This indicates that endogenous sample selection does not play a role for the risk measures MES and ΔCoVaR, but does impact NSRISK negatively meaning that banks that are more likely to become acquirers are inherently exposed to less systemic risk as represented by the NSRISK measure[49]

Regarding the second stage of the Heckman selection model, for MES, the results are very similar to the OLS regression. In this case, the only major differences are that the coefficients for the bank size and Tobin's Q are no longer significant. For NSRISK, the coefficients for the banks size and Tobin's Q are more significant in the time-fixed effect regressions, but otherwise the results hold. Lastly, for ΔCoVaR, there are no major differences between the

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

[48] We use bootstrapping with 500 replications in order to estimate the asymptotic standard errors.

[49] In the literature, the Heckman selection model is used with a probit model due to its assumption of normally distributed errors. We change this assumption to logit distribution and repeat the analysis of the Heckman Selection model. The results are inline with the probit specification and can be found in Online Appendix E.6.

OLS estimates and the second stage of the Heckman Model. These results imply that for all risk measures, the coefficient for the crisis dummy is negative and significant, which is a robust finding. Together with the univariate case, these results confirm that banks that merged during the crisis experienced a reduction in their exposure as well their contribution to market-adjusted systemic risk.

Table 12: Heckman's 2-step Estimation (Probit)

	ΔCapMAES		ΔCapMANSRISK		Change in CapMAΔCoVar	
	(1)	(2)	(3)	(4)	(5)	(6)
Crisis x Pre-merger CapMAES	-0.505***	-0.503***				
	(0.186)	(0.186)				
Crisis x Pre-merger CapMANSRISK			-0.367***	-0.386***		
			(0.090)	(0.089)		
Crisis x Pre-merger CapMACoVaR					-0.278***	-0.269***
					(0.053)	(0.053)
Crisis	-1.687***	-1.253***	-0.192***	-0.265***	-0.958***	-0.711***
	(0.281)	(0.325)	(0.031)	(0.037)	(0.116)	(0.123)
Stock Price Growth	0.000	-0.001	-0.002***	-0.002***	0.001	0.000
	(0.002)	(0.003)	(0.000)	(0.000)	(0.001)	(0.001)
Bank Size	0.009	0.028	-0.020***	-0.013*	0.045***	0.041***
	(0.055)	(0.056)	(0.007)	(0.007)	(0.014)	(0.015)
ROA	-0.068	-0.049	-0.011	-0.035*	0.048	0.014
	(0.192)	(0.202)	(0.019)	(0.021)	(0.040)	(0.039)
Liquidity	0.006	0.013	0.000	-0.002	-0.005	0.006
	(0.018)	(0.019)	(0.002)	(0.003)	(0.005)	(0.005)
Tangibility	-0.046	-0.035	-0.003	-0.000	-0.020	-0.013
	(0.101)	(0.101)	(0.014)	(0.014)	(0.026)	(0.023)
Loans Ratio	-0.004	-0.003	0.001	0.002**	-0.000	0.000
	(0.006)	(0.006)	(0.001)	(0.001)	(0.002)	(0.001)
Non-performing Loans	0.129*	0.069	0.004	0.009	0.070***	0.053**
	(0.075)	(0.085)	(0.017)	(0.018)	(0.026)	(0.026)
Tobin's Q	0.011	0.001	-0.004**	-0.004*	-0.004	-0.005
	(0.016)	(0.018)	(0.002)	(0.002)	(0.004)	(0.004)
Tier 1 Capital	-0.003	-0.001	0.003	0.006***	0.004	0.004
	(0.019)	(0.021)	(0.002)	(0.002)	(0.006)	(0.005)
λ	-0.250	-0.249	-0.084***	-0.071**	0.017	-0.004
	(0.260)	(0.260)	(0.029)	(0.029)	(0.060)	(0.053)
Constant	-0.479	-0.109	0.723***	0.568**	0.039	-0.088
	(2.179)	(2.309)	(0.264)	(0.284)	(0.503)	(0.475)
Year Fixed Effects	No	Yes	No	Yes	No	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
N	11933	11933	11933	11933	11933	11933
R^2	0.099	0.143	0.163	0.236	0.170	0.380

This table shows the multivariate regression results of ΔCapMAES, ΔCapMANSRISK, and the change in CapMAΔCoVaR. We control for selection bias using Heckman's Selection Model by including the inverse Mills ratio obtained from the first-stage probit regression. Year fixed effects are included. Robust standard errors clustered by bank are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

5. Additional Tests

In this section, we conduct additional tests aimed at understanding the underlying characteristics that separate the banks that merged during the 2008 financial crisis with those of the stable periods. Specifically, in Section 5.1 we focus on the ex-ante differences that make some banks more likely to become acquirers and targets during the 2008 financial crisis. Then, in Section 5.2 we compare the ex-post performance of banks after the 2008 financial crisis based on whether they merged during the 2008 financial crisis or not.

5.1. Logit Regression Analysis

In Section 4.2.1 we examined a bank's propensity to acquire as a first stage estimation to be used in the second stage of the Heckman selection model. In this section, we extend this analysis by examining the probability that a bank will be involved in a merger as an acquirer or as a target.[50] In addition to using a firm's pre-merger balance sheet data as an explanatory variable, we interact this data with a dummy variable for the crisis period in order to investigate whether there are any ex-ante differences between the balance sheets of the banks that merged during the crisis and those of the stable periods. In this way, we analyze how the ex-ante conditions of a bank impact the likelihood of its involvement in a merger and whether there are specific factors that play an additional role specifically for the mergers that took place during the 2008 financial crisis.

5.1.1. Procedure

We estimate two sets of logit regressions, one for acquirers and the other for targets. A comparison of the coefficients and significance levels of these two models will permit us to determine whether there are specific characteristics that make a bank more likely to be an acquirer or a target dependent on the economic conditions at the time of the merger. In our analysis, the coefficients of the regression outputs are in terms of the odds ratio.

The first set of logit regressions focus on the likelihood that a bank will participate in a merger as an acquirer while the second set focuses on the probability that a bank will be a target. In both cases, the dependent variable in the regressions is discrete, and is equal to 1 for an acquirer or a target during the year of the merger and a 0 otherwise.[51] We use the same explanatory variables used in the first stage of Heckman selection model.[52] In order to control for the economic environment during the merger, we use a dummy variable called "Crisis", which takes a value of 1 for the crisis period and 0 otherwise. The interaction of the discrete crisis variable with the balance sheet data captures whether there exists any balance sheet

[50] This corresponds to testing hypothesis H3 discussed in Section 2.1

[51] In our analysis the non-merging bank sample is merger-specific and consists of all banks that have not merged within a year of the respective merger. Note that for the acquirer regression, targets are included with the non-merging banks as non-acquirers for the years the merger didn't take place. In other words, only the target observation for the year it is acquired is removed. Similarly, for the target regression, acquirers are included with the non-merging banks as non-targets. Here, only the acquirer observation for the year of the merger is dropped.

[52] These variables are commonly used in the literature. See Hannan & Pilloff (2009), Wheelock & Wilson (2004), and Kose et al. (2016).

characteristics of the banks that were asymmetrically important for the mergers during the crisis. The specifications of the full model are below.
Model Specification: Acquirer

$$\left(\frac{\Pr(\text{A Bank Being An Acquirer})}{1-\Pr(\text{A Bank Being An Acquirer})}\right) = \beta_0 + \beta_1(\text{Asset Growth}_{i,t}) + \beta_2(\text{ Crisis x Asset Growth}_{i,t})$$
$$+ \beta_3(\text{Stock Price Growth}_{i,t}) + \beta_4(\text{ Crisis x Stock Price Growth}_{i,t}) + \beta_5(\text{Bank Size}_{i,t})$$
$$+ \beta_6(\text{Crisis x Bank Size}_{i,t}) + \beta_7(\text{Return on Assets}_{i,t}) + \beta_8(\text{Crisis x Return on Assets}_{i,t})$$
$$+ \beta_9(\text{Liquidity}_{i,t}) + \beta_{10}(\text{ Crisis x Liquidity}_{i,t}) + \beta_{11}(\text{Tangibility}_{i,t})$$
$$+ \beta_{12}(\text{Crisis x Tangibility}_{i,t}) + \beta_{13}(\text{Loans Ratio}_{i,t}) + \beta_{14}(\text{Crisis x Loans Ratio}_{i,t})$$
$$+ \beta_{15}(\text{Non-performing Loans}_{i,t}) + \beta_{16}(\text{Crisis x Non-performing Loans}_{i,t}) + \beta_{17}(\text{Tobin's Q}_{i,t})$$
$$+ \beta_{18}(\text{Crisis x Tobin's Q}_{i,t}) + \beta_{19}(\text{Tier-1 Capital}_{i,t}) + \beta_{20}(\text{Crisis x Tier-1 Capital}_{i,t}) + \mu_{i,t}$$

Model Specification: Target

$$\left(\frac{\Pr(\text{A Bank Being A Target})}{1-\Pr(\text{A Bank Being A Target})}\right) = \beta_0 + \beta_1(\text{Asset Growth}_{i,t}) + \beta_2(\text{ Crisis x Asset Growth}_{i,t})$$
$$+ \beta_3(\text{Stock Price Growth}_{i,t}) + \beta_4(\text{ Crisis x Stock Price Growth}_{i,t}) + \beta_5(\text{Bank Size}_{i,t})$$
$$+ \beta_6(\text{Crisis x Bank Size}_{i,t}) + \beta_7(\text{Return on Assets}_{i,t}) + \beta_8(\text{Crisis x Return on Assets}_{i,t})$$
$$+ \beta_9(\text{Liquidity}_{i,t}) + \beta_{10}(\text{ Crisis x Liquidity}_{i,t}) + \beta_{11}(\text{Tangibility}_{i,t})$$
$$+ \beta_{12}(\text{Crisis x Tangibility}_{i,t}) + \beta_{13}(\text{Loans Ratio}_{i,t}) + \beta_{14}(\text{Crisis x Loans Ratio}_{i,t})$$
$$+ \beta_{15}(\text{Non-performing Loans}_{i,t}) + \beta_{16}(\text{Crisis x Non-performing Loans}_{i,t}) + \beta_{17}(\text{Tobin's Q}_{i,t})$$
$$+ \beta_{18}(\text{Crisis x Tobin's Q}_{i,t}) + \beta_{19}(\text{Tier-1 Capital}_{i,t}) + \beta_{20}(\text{Crisis x Tier-1 Capital}_{i,t}) + \mu_{i,t}$$

Table 16, Table 17, and Table 18 in Online Appendix D.2 show the summary statistics for the acquirers, targets, and non-merging banks respectively. Comparing these different samples, we find that acquirers on average tend to be larger, more profitable as measured by ROA, have higher asset growth rate, higher Tobin's Q and less non-performing loans than the non-merging banks. Meanwhile, targets on average have lower asset growth rate, less liquidity, less relative tangible assets, and are smaller in size than the acquirers, signaling that subpar performance may be an important characteristic in merger targets. On the contrary, targets have a higher stock price growth which may reflect the positive effect of the merger announcement on the target stock price.

In order to analyze the composition of the targets, we also present the distribution of target data broken down by the size of the acquirer and whether the merger took place during the crisis or not in Table 20, in Online Appendix D.4. Briefly, comparing the third and fifth rows of each panel, we see that during the crisis, targets of the smaller acquirers experienced a higher growth in their stock prices, and had higher liquidity, tangibility and tier-1 capital ratios compared to the targets of larger acquirers. Moreover, comparing the crisis with stable periods for the targets with smaller acquirers on the third and fourth rows of each panel, we see that mergers during the crisis involved larger targets with higher tangibility ratios. These positive characteristics of the targets during the crisis possibly explain the observed reduction in the risk of smaller

acquirers.[53]

5.1.2. Logistic Model Results

Table 13 reports the results of a logit regression with different sets of independent variables. The first column regression utilizes the full set of explanatory variables where in the following two columns we drop the non-performing loans ratio and the tier-1 capital ratio respectively in order to test the sensitivity of our results. In the last three columns, we repeat these analyses while excluding the asset growth and stock price growth to see how results change when we include more observations in the regression while having a smaller number of independent variables. As the regression output indicates, asset growth, bank size, ROA, tangibility, Tobin's Q, and tier-1 capital significantly increase the likelihood that a bank will be an acquirer for the overall sample. Conversely, liquidity significantly decreases the probability of a bank being an acquirer for the overall sample. Moreover, the coefficient of the interaction term for liquidity is positive and significant indicating that liquidity had a distinct positive impact on the probability that a bank would be an acquirer only during the crisis. Comparing the first three columns with the rest, we see that the results are the same except for the non-performing loans. In the fourth and sixth columns, the coefficient of non-performing loans is significant and less than one implying that the likelihood of being an acquirer goes down when the bank has more loan losses.

Table 14 reports the results of a logit regression of the odds of being a target with different sets of independent variables presented in each column. As the regression output indicates, in the first three columns, asset growth, tangibility, and Tobin's Q decrease the likelihood that a bank is a target, while in the following columns, tangibility and tier-1 capital reduces this likelihood. A higher percentage of tangible assets and a higher asset growth rate indicate that a bank is generally healthier, and therefore has less likelihood to be acquired. A higher Tobin's Q corresponds to a larger bank with respect to market capitalization, which reduces the likelihood of being acquired. The negative relationship between tier-1 capital and the prospects for being acquired is quite a common finding in the literature with a bank's proportion of capitalization generally interpreted as a reflection of past performance and itself an index of managerial ability or efficiency (Wheelock & Wilson (2000)). Considering the factors that increase the likelihood of being a target, we find that stock price growth is the only factor that significantly increases the prospects of being a target. This finding may be due to the change in the target's stock price as a reaction to the merger announcement. Regarding the interaction variables, in the first three columns, none of the variables affect the likelihood of being a target during the crisis.[54] In the following columns, non-performing loans further reduce the probability that a bank is acquired, implying that banks acquired during the crisis had better loan performance, making them attractive for the acquirers.

[53]To check the multicollinearity problem, we report piece-wise correlation coefficients in Online Appendix D.4. Table 23 and Table 24 show that the absolute values of the correlation coefficients between explanatory variables are less than 0.5 except for the Tobin's Q and ROA of the acquirer and the non-performing loans and ROA of the target, where the correlation coefficients are 0.51 and -0.51, respectively.

[54]One exception is the interaction variable with liquidity in the third column, which has a positive significant coefficient.

Table 13: Logit Regression Results (Odds Ratio) for the Acquirer

	All Variables	NPL Excl.	Tier1 Cap Excl.	Asset Growth Excl. Stock Price Growth Excl.	Asset Growth Excl. Stock Price Growth Excl. NPL Excl.	Asset Growth Excl. Stock Price Growth Excl. Tier1 Cap Excl.
Crisis	0.0475	0.0334	0.0322	0.120	0.0682	0.117
	(0.220)	(0.161)	(0.155)	(0.346)	(0.222)	(0.333)
Asset Growth	1.041***	1.041***	1.041***			
	(0.000)	(0.000)	(0.000)			
Crisis x Asset Growth	1.010	1.011	1.010			
	(0.316)	(0.252)	(0.281)			
Stock Price Growth	0.999	0.999	0.999			
	(0.288)	(0.281)	(0.211)			
Crisis x Stock Price Growth	1.001	1.001	1.002			
	(0.738)	(0.743)	(0.567)			
Bank Size	1.493***	1.496***	1.453***	1.457***	1.461***	1.419***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Crisis x Bank Size	1.041	1.024	1.052	1.090	1.058	1.089
	(0.568)	(0.737)	(0.430)	(0.191)	(0.382)	(0.156)
ROA	1.315**	1.287**	1.484***	1.084	1.131	1.218**
	(0.019)	(0.028)	(0.001)	(0.336)	(0.112)	(0.019)
Crisis x ROA	1.004	1.079	0.895	1.324	1.468**	1.196
	(0.987)	(0.738)	(0.638)	(0.152)	(0.035)	(0.361)
Liquidity	0.967***	0.968***	0.975**	0.972***	0.970***	0.979**
	(0.002)	(0.002)	(0.015)	(0.005)	(0.003)	(0.034)
Crisis x Liquidity	1.068**	1.068**	1.064**	1.062**	1.061**	1.059**
	(0.029)	(0.031)	(0.040)	(0.030)	(0.033)	(0.039)
Tangibility	1.168***	1.166***	1.177***	1.165***	1.162***	1.174***
	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Crisis x Tangibility	1.017	1.006	1.006	1.029	1.023	1.020
	(0.887)	(0.958)	(0.959)	(0.796)	(0.840)	(0.862)
Loans Ratio	1.005	1.005	1.002	1.006*	1.005	1.003
	(0.202)	(0.228)	(0.600)	(0.095)	(0.173)	(0.336)
Crisis x Loans Ratio	1.002	1.001	1.003	1.010	1.008	1.009
	(0.807)	(0.877)	(0.742)	(0.273)	(0.376)	(0.297)
Non-performing Loans	0.988		0.978	0.889**		0.890**
	(0.823)		(0.671)	(0.020)		(0.018)
Crisis x Non-performing Loans	0.916		0.943	0.912		0.930
	(0.455)		(0.611)	(0.438)		(0.533)
Tobin's Q	1.018*	1.018*	1.018*	1.033***	1.034***	1.034***
	(0.082)	(0.074)	(0.077)	(0.000)	(0.000)	(0.000)
Crisis x Tobin's Q	1.012	1.016	1.013	0.990	0.999	0.992
	(0.588)	(0.433)	(0.538)	(0.607)	(0.939)	(0.673)
Tier 1 Capital	1.054***	1.054***		1.051***	1.049***	
	(0.000)	(0.000)		(0.000)	(0.000)	
Crisis x Tier 1 Capital	0.977	0.971		0.992	0.984	
	(0.545)	(0.449)		(0.823)	(0.648)	
Constant	0.000557***	0.000525***	0.00122***	0.000284***	0.000232***	0.000547***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
N	8220	8313	8655	9419	9558	9974
Pseudo R^2	0.125	0.125	0.123	0.094	0.093	0.091

This table shows the logistic regression results for the acquirers in terms of the odds ratio. The dependent variable is equal to 1 if the banks is an acquirer for the given year and is equal 0 otherwise. Crisis dummy is equal to 1 if the merger has taken place between years 2007 and 2010. Year fixed effects are included. Coefficients are exponentiated. Robust standard errors clustered by bank are in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.01.

Table 14: Logit Regression Results (Odds Ratio) for the Target

	All Variables	NPL Excl.	Tier1 Cap Excl.	Asset Growth Excl. Stock Price Growth Excl.	Asset Growth Excl. Stock Price Growth Excl. NPL Excl.	Asset Growth Excl. Stock Price Growth Excl. Tier1 Cap Excl.
Crisis	63.73	9.971	11.32	1.641	0.371	0.201
	(0.547)	(0.731)	(0.700)	(0.882)	(0.758)	(0.611)
Asset Growth	0.962***	0.969***	0.968***			
	(0.000)	(0.001)	(0.001)			
Crisis x Asset Growth	0.971	0.980	0.962			
	(0.379)	(0.521)	(0.249)			
Stock Price Growth	1.007*	1.007*	1.008**			
	(0.066)	(0.076)	(0.042)			
Crisis x Stock Price Growth	1.000	1.000	1.000			
	(0.949)	(0.982)	(0.994)			
Bank Size	0.895	0.884	0.917	0.995	0.985	1.015
	(0.261)	(0.209)	(0.328)	(0.918)	(0.743)	(0.741)
Crisis x Bank Size	1.175	1.116	1.165	0.972	0.934	1.004
	(0.371)	(0.575)	(0.366)	(0.828)	(0.612)	(0.972)
ROA	0.981	1.018	0.960	0.881	0.891	0.877
	(0.923)	(0.923)	(0.830)	(0.265)	(0.244)	(0.191)
Crisis x ROA	1.028	1.340	1.037	0.937	1.192	0.935
	(0.935)	(0.415)	(0.912)	(0.720)	(0.322)	(0.697)
Liquidity	0.947	0.936*	0.933**	0.980	0.978	0.973*
	(0.114)	(0.050)	(0.027)	(0.187)	(0.156)	(0.063)
Crisis x Liquidity	1.098	1.104	1.112*	1.024	1.013	1.028
	(0.130)	(0.118)	(0.073)	(0.595)	(0.777)	(0.518)
Tangibility	0.648***	0.661**	0.646***	0.816**	0.825**	0.803***
	(0.009)	(0.010)	(0.004)	(0.012)	(0.016)	(0.005)
Crisis x Tangibility	0.919	0.885	0.924	1.167	1.147	1.250
	(0.823)	(0.740)	(0.830)	(0.426)	(0.478)	(0.242)
Loans Ratio	1.005	1.002	1.001	0.996	0.995	0.996
	(0.537)	(0.831)	(0.833)	(0.333)	(0.245)	(0.395)
Crisis x Loans Ratio	1.002	0.994	1.008	1.010	1.004	1.015
	(0.899)	(0.710)	(0.607)	(0.420)	(0.706)	(0.178)
Non-performing Loans	0.858		0.866	1.001		1.017
	(0.337)		(0.319)	(0.991)		(0.799)
Crisis x Non-performing Loans	0.742		0.727	0.718**		0.704**
	(0.274)		(0.235)	(0.048)		(0.037)
Tobin's Q	0.951*	0.952*	0.935**	0.992	0.993	0.985
	(0.093)	(0.091)	(0.015)	(0.522)	(0.559)	(0.198)
Crisis x Tobin's Q	0.950	0.974	0.964	0.991	1.008	0.999
	(0.366)	(0.623)	(0.519)	(0.764)	(0.786)	(0.975)
Tier 1 Capital	0.964	0.969		0.967*	0.964**	
	(0.299)	(0.358)		(0.065)	(0.039)	
Crisis x Tier 1 Capital	1.000	0.977		0.948	0.945	
	(0.999)	(0.814)		(0.343)	(0.334)	
Constant	16.84	16.63	59.12	0.411	0.455	0.505
	(0.302)	(0.287)	(0.114)	(0.468)	(0.511)	(0.562)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
N	7154	7245	7561	8495	8637	9030
Pseudo R^2	0.101	0.096	0.097	0.024	0.023	0.023

This table shows the logistic regression results for the targets in terms of the odds ratio. The dependent variable is equal to 1 if the banks is a target for the given year and is equal 0 otherwise. Crisis dummy is equal to 1 if the merger has taken place between years 2007 and 2010. Year fixed effects are included. Coefficients are exponentiated. Robust standard errors clustered by bank are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

5.2. Post-merger Analysis

In this section, we study the effects of mergers on the acquiring banks' post-crisis performance in the years following the 2008 financial crisis.[55] Specifically, we compare the balance sheet and equity market performance of the banks that merged during the 2008 financial crisis with the ones that did not.[56] In our analysis, we control for the pre-crisis performance of the banks by subtracting the pre-crisis values from post-crisis values to obtain the variables: $\Delta Asset\ Growth$, $\Delta Stock\ Price\ Growth$, $\Delta Bank\ Size$, $\Delta Return\ Volatility$, $\Delta Liquidity$, $\Delta Non\text{-}performing\ Loans$, ΔROA, $\Delta Tangibility$, $\Delta Loans\ Ratio$, $\Delta Tobin's\ Q$ and $\Delta Tier\text{-}1\ CapitalRatio$. Δ measure for these variables are calculated as:

$$\Delta variable = Post_{crisis}\ variable - Pre_{crisis}\ variable$$

Next, we conduct a t-test with unequal variances where we compare banks that merged during the 2008 financial crisis with those that did not. In Table 15, Δ values are calculated by deducting the averages of these variables for the years 2005-2006 from the averages for the years 2011-2012.[57] The first two columns of this table correspond to the banks that did not merge during the 2008 financial crisis, while column 3 and column 4 contain information relevant to banks that merged during the 2008 financial crisis. Column 5 and column 6 lay out the t-test results and the p-values, respectively.

Before examining differences between banks that merged during the 2008 financial crisis and those that did not, we examine the sign of the Δ values in column 2 and column 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 implies that following the crisis, the banking sector on average experienced an increase in its stock price growth, size, return volatility, liquidity, and ratios of non-performing loans and tier-1 capital. Conversely, the banking sector on average tended to have lower asset growth rate, ROA, tangibility, loans ratio,[58] and Tobin's Q after the crisis. The reduction in profitability and lending as well as the market value of these banks implies that the effect of the 2008 crisis continued to impact the banking system in the ensuing years. Lastly, despite 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 events of the crisis.

Comparing the banks that merged during the crisis with those that did not, the DiD results in column 5 show that the banks that merged during the 2008 financial crisis experienced a smaller reduction in their asset growth rate, an increase in their sizes, a smaller increase in their return volatility, liquidity, and non-performing loans ratio as compared to their non-merging counterparts. The increase in size relative to other banks is expected as these banks

[55] This corresponds to testing hypothesis H4 discussed in Section 2.1

[56] The subsample that did not merge during the 2008 financial crisis consists of the banks that did not merge between years 2007 and 2010.

[57] In Table 37 in Online Appendix E.7, we exclude 2006 and 2011 from our analysis and calculate the Δ values by deducting observations of 2005 from those of 2012 in order to eliminate the initial pre- and post- crisis effects.

[58] Ivashina and Scharfstein (2010) report a substantial reduction in lending during the financial crisis. This result implies that the decreased lending practices of banks persisted several years after the 2008 financial crisis.

increased the amount of their assets by obtaining the assets of the targets. Considering the other performance characteristics, interestingly, 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 may be due to merger-related diversification benefits. Furthermore, these banks had lower non-performing loans ratio implying that they had more stable income streams, but also tended to have less liquid assets. We find no significant difference with respect to stock price growth, ROA, tangibility, loans ratio, Tobin's Q and tier-1 capital ratio. Overall, these results imply that banks that merged during the 2008 financial crisis seem to have performed better after the crisis with respect to their return volatility and loan performance.[59]

Table 15: Ex-post Difference-in-Differences Analysis for the Acquirers

	Obs.	Crisis Non-merging	Obs.	Crisis Merging	Difference	p-value
Δ Asset Growth	217	-0.0885	87	-0.0575	-0.0310*	(0.053)
Δ Stock Price Growth	214	17.19	87	11.96	5.229	(0.391)
Δ Bank Size	248	0.244	94	0.495	-0.251***	(0.000)
Δ ROA	234	-0.462	96	-0.454	-0.00796	(0.926)
Δ Return Volatility	259	0.229	99	0.150	0.0787***	(0.002)
Δ Liquidity	237	2.215	96	0.934	1.280***	(0.005)
Δ Tangibility	236	-0.00734	96	-0.0428	0.0355	(0.531)
Δ Loans Ratio	239	-4.798	97	-5.524	0.726	(0.488)
Δ Non-performing Loans	236	2.060	94	1.523	0.537***	(0.003)
Δ Tobin's Q	237	-8.235	92	-8.915	0.680	(0.155)
Δ Tier 1 Capital	208	1.916	90	1.865	0.0516	(0.901)

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

6. Conclusion

This paper analyzes the relationship between bank consolidation and systemic risk within the U.S. financial system. Specifically, we compare mergers and acquisitions of U.S. banks during the 2008 financial crisis with those that occurred during stable market conditions to determine whether the effects of bank consolidation on the systemic risk at all differ depending upon the macroeconomic climate. We calculate the risk measures of MES, NSRISK, and ΔCoVaR both before and after a merger so as to capture the consequent merger-related change in an acquirer's exposure as well as contribution to systemic risk. We start our analysis with a DiD model and complement it with multivariate regression analyses and Heckman selection model in order to control for other factors (including selection bias). Next, we explore the effect of

[59]It 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, making it harder to assign the merger as the specific cause.

different government policies on the systemic risk of the acquirers. Following this, we focus on the effect of the mergers on the aggregate systemic risk of the banking sector, Lastly, we examine the ex-ante and ex-post differences between banks that merged during the 2008 crisis and those that merged during the stable periods.

Regarding the DiD analysis, we find that acquirers that merged during the crisis experienced a significant reduction in their market-adjusted systemic risk after the merger measured by MES, NSRISK, and ΔCoVaR. Meanwhile, we find that acquirers that merged during the stable periods on average experienced an increase in their market-adjusted systemic risk. This robust result implies that an acquirer's exposure as well as its contribution to market-adjusted systemic risk actually diminished after the merger. In addition, we find that this reduction was more pronounced for the mergers with smaller acquirers and relatively larger targets.

We continue our analysis by exploring whether FDIC-assisted mergers and acquirers that received TARP payments differ in their systemic risk from the other mergers during the 2008 financial crisis. Our results show that overall, the difference in systemic risk between these banks and the other acquirers that merged during the 2008 financial crisis is insignificant. We then examine the effect of these mergers on the aggregate risk using two methods. In the first method, we aggregate the change in the acquirers' market-adjusted risk and find a negative value for the crisis, whereas this value is positive for the stable periods. This finding implies that acquirers in total reduced the risk in the financial system. In the second method, we calculate the acquirers' effect on a cap-weighted and an asset-weighted aggregate index. For MES and NSRISK, we find that during the crisis the aggregate exposure to systemic risk increased due to an increase in large banks' risk and their disproportionate effect on the weighted indices. Meanwhile, smaller banks significantly reduced the aggregate exposure to systemic risk, alleviating the impact of the larger mergers. For ΔCoVaR, we find that the aggregate risk decreased for both the overall sample and smaller bank subsamples, implying that large banks played a significant role in reducing the aggregate contribution to systemic risk.

In the last part, in order to explain these findings, we explore the differences in the balance sheet characteristics of the banks that merged during the 2008 crisis. For the ex-ante analysis, we employ a logit model and examine which characteristics make some banks more likely to become acquirers and targets. We find that mergers during the 2008 financial crisis tended to involve acquirers that possessed more liquidity than their stable market counterparts. Moreover, banks that were acquired during the 2008 crisis tended to have lower non-performing loans implying that they had higher loan quality. Lastly, we study the ex-post differences in performance of the banks that merged during the 2008 crisis with those that did not, and find that banks that merged during the 2008 financial crisis exhibited lower return volatility. Furthermore, the banks that merged during the 2008 crisis had lower non-performing loans, implying that they were more successful with regards to their loan performance, which is in line with the reduction in their return volatility.

Overall, the findings of this paper suggest that the market-adjusted systemic risk decreased for the acquirer whereas this result is most pronounced for the mergers involving smaller acquirers with relatively larger targets. Moreover, during the 2008 financial crisis, the systemic risk for the government-assisted mergers was not significantly different from that of the pri-

vate mergers, and the number of those government-assisted mergers was small. Considering the aggregate effect of mergers on the aggregate risk, we find that smaller acquirers reduce both aggregate exposure and contribution to systemic risk, while the larger acquirers increase the aggregate exposure, but reduce the aggregate contribution to systemic risk. Based on these results, we find evidence that smaller banks support the concentration-stability hypothesis with respect to both aggregate exposure and contribution to systemic risk. On the other hand, the results for larger banks are mixed. Namely, we find evidence that larger banks support the concentration-stability hypothesis with respect to aggregate contribution to systemic risk, but contribute to the concentration-fragility argument with respect to aggregate exposure to systemic risk. Lastly, during the 2008 financial crisis, we find that acquirers with more liquidity acquired target banks with good loan performance, potentially driving the observed reduction in ex-post return volatility.

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