The Effects of Mergers and Acquisitions on Acquiring Banks' Contribution to Systemic Risk

van Dellen, S., Benamraoui, A., Ngo, H. and Salaber, Julie

A paper presented at the 27th Edition of International Rome Conference on Money, Banking & Finance, Rome, Italy, 10 - 11 Dec 2018.

The Effects of Mergers and Acquisitions on Acquiring Banks' Contribution to Systemic Risk

Keywords: mergers and acquisitions, systemic risk, bank, consolidation, marginal expected shortfall, conditional Value-at-risk

Abstract

This paper is the first to examine the effects of international bank mergers and acquisitions on acquirers' contribution to systemic risk covering the period from 1998 to 2015. Our sample consists of 608 international bank mergers, involved domestic and cross-border deals as well as conglomerate and non-conglomerate mergers. Using the Marginal Expected Shortfall (as in Acharya et al., 2017) as well as Conditional Value-at-Risk (as in Adrian and Brunnermeier, 2016) as systemic risk measurements, we find that on average, mergers do not impact on the acquiring banks' contribution to systemic risk regardless of the increased potential for risk diversification exhibited by cross-border and cross-industry bank mergers. Determinants that contributes to the decrease in acquirers' systemic risk include product diversifying deals, deals conducted in a more concentrated banking system and a stable political environment. Whereas, for deals financed by cash only and much smaller compared to acquirers as well as involved private targets, acquirers' contribution to systemic risk increase after the merger.

1. Introduction

A crucial regulatory lesson from the 2007-09 global financial crisis has been the prerequisite to devote greater attention to the financial stability because of the systemic risk faced by banks. Dilemmas with portfolios of subprime mortgages grew into a systemic crisis that deteriorated financial firms and markets all over the globe, triggering a severe economic recession. Consequently, building better protection against systemic risk has arisen as a regulatory priority, as has the goal of strengthening the macroprudential orientation of financial stability frameworks. The sub-prime mortgage lending in the US and the 2007-09 global financial crisis have also revived the enthusiasm of academics on these issues. It leads to the generation of a wide range of papers focusing on systemic risk measurement and its threats to the stability of the banking sector (see Acharya et al., 2017; Black et al., 2016; Maria et al., 2016; Ellis et al., 2014). For instance, De Jonghe (2010) notices substantial heterogeneity in banks' contributions to the overall stability of banking industry. This finding is not surprising given the significant developments over the last three decades. Significant banking mergers and acquisitions, the abolition of the legal barriers to the unification of financial services, and technological advancement all affected the organisational design of banking institutions. These developments result in the emergence of very large and complex banking firms (the too-big-to-fail) and financial conglomerates. De Nicolo and Kwast (2002) and De Nicolo, et al. (2004) argue that consolidation and conglomeration activities that create very large financial firms are important factors that increase systemic risk. Indeed, empirical studies that examine systemic risk issues related to bank or insurance M&A activities either by looking at firm's expected short fall in undercapitalized market or information on firm's stock and market index, indicate that systemic risk has increased in recent years due to consolidation trends (Lim et al., 2015; Mühlnickel and Weiß, 2015; Weiß et al., 2014).

Extensive research about the effect of bank M&A on acquirers' contribution to systemic risk leads to mixed findings due to different samples, time frame, methodologies as well as parameters employed. Before the financial crisis, the so-called "concentration-stability" hypothesis which predicts that banking system concentration diminishes fragility has received supports theoretically by Diamond (1984), Allen & Gale (2000b, 2004a) and empirically by Beck et al., (2006). Based on this hypothesis, large banks with high concentration are found to be less volatile because they might be more fruitful, easier to oversee, well-diversified and accordingly more flexible to market shocks. Promoters of the hypothesis also assert that bank M&A harmonises with a reduction in the bidders' default risk; hence systemic risk decreases, and the financial soundness of the whole banking system is enhanced. In contrast, Winton (1999), Caminal and Matutes (2002) and De Nicolo et al., (2004) defend the "concentration-fragility" hypothesis and regard bank M&A as a probable cause for the increase in systemic risk. It is because the hypothesis anticipates more volatility associated with a concentrated banking structure with several large corporations. These corporations might take the excessive risk as a result of implicit "too big to fail" schemes or preferences with risk-expected return trade-off (Berger, 2000; Mishkin, 1999). Specifically, Mishkin (1999) proposes that with a high concentration degree, the few large banking institutions will obtain greater subsidies; thus likely escalating their risk-taking activities; hence resulting in higher insolvency risk.

After the global financial crisis, substantial evidence was found for the significant increase in acquiring banks' contribution to systemic risk as a result of M&A (Weiß et al., 2014). Similarly, Wagner (2010) asserts that diversification cause systemic crises more likely as financial institutions become more co-dependent because of similar business lines, common exposures and portfolios of investment following a merger. Also, bank mergers could be motivated by regulatory incentives to become too big to fail, thus increasing their contribution to systemic risk (see, e.g., Berger, 2000).

These research controversies serve as motivations for this paper to investigate the effects of mergers and acquisitions on bidding banks' contribution to systemic risk post-merger. Employing a global sample of 608 bank M&A deals from 1998 to 2015, this paper applies two reliable, well-known and strong approaches: Marginal Expected Shortfall as in Brownlees and Engle (2012) and ∆CoVaR as in Girardi and Tolga Ergün (2013) to measure the contribution to systemic risk of bank mergers. Furthermore, it provides original evidence on the determinants of merger-related changes in bidding banks' contribution to systemic risk.

This paper provides three main contributions to the M&A literature. First, to the best of our knowledge, this paper is the first to examine the effects of bank mergers on bidders' contribution to systemic risk covering the period between 1998 and 2015. While other papers examining the relationship between bank mergers and stability tend to employ sample only until the end of the 2007-09 global financial crisis, we argue that the motives for bank mergers and the effects of M&A activity might be different after the global financial crisis. Therefore, it might generate different results compared to what has been found in the existing literature. Indeed, we find that mergers and acquisitions, on average, do not impact on the acquiring banks' contribution to systemic risk regardless of the increased potential for risk diversification exhibited by cross-border and cross-industry bank mergers. This result interestingly contradicts various papers in the existing literature as they find that mergers increase bidders’ contribution to systemic risk (Molyneux et al., 2014; Mühlnickel and Weiß, 2015; Uhde and Heimeshoff, 2009). As noted above, this sample period extends beyond the 2007-09 global financial crisis; hence banks may no longer merge to become too-big-to-fail and engage in excessive risk-taking. Instead, they may pursue M&A for healthy growth, expansion of business lines and locations or acquisitions of new customer bases; thereby increase business profit and enhance the stability of the banking system. Therefore, the result from this sample is at best risk neutral.

Second, this is the first paper to shed lights on the risk effects of product diversifications on acquirers’ contribution to systemic risk. Previous studies tend to investigate the influence of specific types of bank mergers on the bidder’s contribution to systemic risk such as bank consolidation as in Weiß et al., (2014), insurance consolidation as in Mühlnickel and Weiß (2015). By including mergers among banks and other non-bank institutions such as insurance companies, securities, brokerages and credit institutions, this sample may offer potentially large diversification benefits. These diversification benefits are further underpinned by many policy initiatives in many countries across the globe, aiming at promoting conglomerates which have substantially lowered the entry barriers for banks when engaging in product diversification. This paper hypothesises that product-diversifying mergers contribute more to the reduction in systemic risk than focusing deals because of the large potential of risk diversification benefits. We find that there is evidence that product-diversifying deals result in the reduction in acquirers’ contribution to systemic risk for non-US acquirers only. Therefore, the second hypothesis of this paper cannot be rejected.

Third, this paper provides original evidence for the underlying factors that influence the changes in bidders' contribution to systemic risk. Specifically, we uncover that payment method, the status of target, relative size, HHI and political stability are all found to play important roles. However, payment method and relative size play bigger roles than the others. First, for deals financed by cash only, the acquirers’ contribution to systemic risk will increase. The results are consistent with the notion that deals which are fully paid for in cash are expected to raise acquiring banks' default risk as acquirers are replacing safe liquid assets (cash) with a riskier balance sheet of the target; thereby increasing acquirers' contribution to systemic risk (Furfine and Rosen, 2011). Second, the smaller the deal size in comparison with acquirers' market value, mergers will increase acquirers' contribution to systemic risk. This effect may be explained as small banks are motivated to engage in M&A with larger banks to gain an implicit bailout guarantee from the government which in turn increases overall systemic risk (Acharya and Yorulmazer, 2007). Regarding target's status, private targets prevent acquirers in realising the systemic risk-reduction effect. In this concern, the literature supports the notion that merger deals involved in private targets are expected to generate risk-increasing effect for acquirers because private firms are subject to lower disclosure requirements; thus, it limits the acquirers' capabilities to evaluate the risks associated with private targets themselves as well as making bidders' due diligence ineffective. With regards to the macroeconomic environment of bidders, the more stable a political environment in an acquirer' country before a merger, the greater the reduction of bidders' contribution to systemic risk will be. Finally, the bank concentration index HHI has a negative and statistically significant coefficient. It implies that the more concentrated a banking system is, the more acquirers' contribution to systemic risk will decrease, which is an initial signal of the 'concentration-stability hypothesis' as seen in Beck et al. (2006).

The remaining paper will be organised as follow. The second section discusses the existing literature of the systemic risk's implications of bank mergers theoretically and empirically. The third section describes two robust and reliable models to compute bidders' contribution to systemic risk in this paper. We describe merger sample and data in section 3. A detailed analysis of the results is included in section 4 and follows a conclusion and study implications in section 5.

2. Related literature

The banking industry plays a significant role in every economy and is a principally significant segment for the stability of financial systems. Consequently, banking supervisors and regulators aim at providing the strength of the financial system and reducing the frequency and severity of potential financial vulnerability in the future. Trustworthy indicators of banking system welfare are of great importance. The academic literature so far has been debated with respect to the risk implications of bank mergers on acquirers' contribution to systemic risk and the determinants of the changes in bidders' systemic risk (see Bierth et al., 2015; Molyneux et al., 2014; Raffestin, 2014; Weiß et al., 2014).

On the one hand, it is believed that M&A might have broadened the scope of diversification at individual firms; thus, reduce each institution's idiosyncratic risk which results in the reduction of the probability of default for individual firm and promote the financial soundness (De Nicolo and Kwast, 2002). Besides these advantages of functional diversification, Méon and Weill (2005) argue that large banks undertaking cross-border M&A might gain more scale and scope economies via the geographical diversification of risk. Third, M&A activity makes banks gain more market power, thereby increase their franchise value.

As franchise value presents intangible asset that will only be secured if banking firms stay in business, such banks experience high opportunity costs when they fail and thereby becoming more hesitant to conduct risky transactions. Moreover, banks have the tendency to hold more capital, less risky portfolios and initiating smaller loan portfolio (Berger et al., 2009). By behaving more prudently, banks reduce their chance of getting into trouble and hence increase the stability of the whole banking system. Finally, by merging with many targets, an acquirer can become significantly larger, possess more complex business model and thus become more interconnected with more substantial number of counterparts in the banking system. Accordingly, banks have better coordination and higher motivation to provide liquidity to other troubled banks; hence lowering the risk of financial contagion in interbank markets and enhance banking stability (see Allen and Gale, 2000; Northcott, 2004).

Empirical evidence from Berger et al. (2009) suggests that banks are more likely to hold higher capital buffers since the global financial crisis (2007-09) or use other mechanisms to reduce risks to possess safer portfolios; thereby implies that recent bank M&A may produce safer banks overall. Chu (2015) investigates banking mergers and stability in Canada from the early period 1867 and 1935 and support the concentration-stability view. Employing numerous empirical methodology and procedures, they show that only one out of 27 bankruptcies during this period was acquirers, while other acquiring banks grew significantly in market share and size. More specifically, geographic diversification is one of the primary factors that reduce the risk for a bank and contribute to banking stability, as two-thirds of 33 consolidations were cross-province deals. Besides, other institutional factors such as barriers to entry produced by the legal requirements for banks' paid-up capital, double-liability provision of bank shareholders, the absence of both central bank and an explicit deposit insurance scheme are factors that enhance banking system stability. All those determinants operate collectively to encourage banks to protect their charter values by restricting from excessive risk-taking, although how they interact and ensure banking stability still benefits future research. The author, therefore, sees the merger waves in Canada as the emergence of a highly concentrated but stable banking system.

On the other hand, bank M&As is one of the critical causes of the increase in acquirers' contribution to systemic risk, which is defended by a number of recent empirical studies (see, e.g., Campa and Hernando, 2008; Kane, 2000; Uhde and Heimeshoff, 2009; Weiß et al., 2014). The first argument in support of this view is that a bank may pursue M&As to become "too big to fail" and thereby, is often more probable to obtain government's safety net or subsidies. The presence of these public guarantees can also result in moral hazard problem that stimulates larger banks' managers to engage in high-risk investments which, in turn, may destabilise the whole banking system (Uhde and Heimeshoff, 2009). More importantly, bank M&As may make joint collapses of borrowers more probable, this can lead to the vulnerability of the whole banking system (Boyd and De Nicoló, 2006). Third, Cetorelli et al. (2007) point out that larger banks via M&As with a higher level of risk diversification might lead to lower managerial efficiency, less effective internal company monitoring, higher control problems concerning customer base as well as increasing operational risk. These supervisory failures may increase the likelihood of individual banks' collapse as well as the increase in the contribution to systemic risk of acquirers. Under cross-border bank mergers, these problems are even more severe, mainly when it involves regulatory arbitrage. Banking firms can relocate their activities geographically, thereby shifting their poorly controlled risk to the taxpayers in other nations which can destabilise the entire banking system (Weiß et al., 2014).

Empirical studies looking into international bank mergers tend to confirm the concentration fragility hypothesis. To start with, De Nicolo et al. (2004) highlight the positive connection between banking sector vulnerability and market concentration employing the Z-core methodology in their sample of 500 largest banks and financial corporations globally in 90 countries. More specifically, more significant and conglomerates corporations did not obtain substantially higher levels of profitability than smaller and more specialised companies. Also, larger corporations with a broader range of financial activities were more leveraged and did not obtain lower return volatility than smaller and more specialised companies. Therefore, it proposes that the determinants creating motivations for banks to take on more risk tend to outweigh the risk reductions expected from geographic and product diversification as well as attained via economies of scale or scope. In a more recent empirical study by Weiß et al. (2014), the concentration-fragility hypothesis is further confirmed by examining their sample of international bank mergers (excluding securities, insurance companies) between 1991 and 2009. They find that after mergers, the combined entities' and their competitors' contribution to systemic risk increase. They support their hypotheses that the existence of banks owned by governments, the explicit deposit insurance as well as the hubris of bank managements are the primary determinants for the destabilising effect of bank M&As on the financial industry.

Empirical evidence from European sample reports the same consensus. Uhde and Heimeshoff (2009) study the consolidated balance sheet data over the EU-25 between 1997 and 2005 to investigate the relationship between consolidation in banking and financial stability in Europe. The results show that the national banking market concentration poses negative effect on European financial stability as estimated by the Z-score method while controlling for bank-specific, regulatory, institutional and macroeconomic factors. The negative connection between concentration and stability is driven by higher return volatility of larger banks in concentrated markets. Molyneux et al., (2014), on the other hand, study the systemic risk implications of banking institutions that are considered too-big-to-fail to capture safety net subsidy effects and evaluate their impact on systemic risk. Employing a sample of European bank mergers in 9 countries from 1997 to 2007, they reveal that safety net advantages obtained from merger activity have a significantly positive connection with governmental rescue probability, implying moral hazard in the banking systems. Besides, substantial evidence is obtained that merger premiums are paid to achieve safety net subsidies that have detrimental systemic risk implications. Lastly, they estimate traditional measures of systemic risk by investigating the connection between safety net subsidy effects and interdependency between too big to fail banks post-merger. Unexpectedly, no significant connection has been found which indicates that safety net subsidies are not associated with stock price return correlations for too big to fail banks. This finding cast doubts on the competency of using stock-return correlations as an appropriate indicator of systemic risk in the banking industry. To conclude, cross-border M&As within the EU may also complicate issues further as uncertainties regarding the jurisdiction of national safety net arrangements and coordination problems between regulators may arise (Hagendorff et al., 2012).

In conclusion, because economic theory and empirical evidence are inconclusive about the impact of bank mergers on banking stability, it motivates this paper to bring the debates to an end and therefore offers advice to banking regulators and supervisors regarding the implications of bank M&A on the stability of the whole banking system.

3. Data

The following section outlines the data used in the empirical study. We first present the data on bank mergers and then discuss in detail on the data used in our cross-sectional regressions based on deal characteristics, acquirer characteristics and macroeconomic factors.

3.1 Mergers

The selected sample of bank mergers and acquisitions is gathered from Bloomberg Terminal and contains merger announcement date falling between 1998 and 2015. The reason for gathering merger deals from 1998 is to capture the effects of product diversification on the sample fully because the Financial Services Modernisation Acts of 1999 in the US voided the barriers on commercial and investment banks consolidating with securities companies and insurance firms written in sections 20 and 32 of Glass-Steagall Act. Since US acquirers constitute a significant number in the sample, large diversification effects on bank risk may be observed. The sample is extended to mergers announced in 2015 to study the most up to date merger deals which predicts to generate exciting results because the sample extends the literature by examining deals in a period long after the 2007-09 global financial crisis. Acquiring banks are located worldwide. Acquirers can be bank holding companies, commercial banks and credit institutions, meanwhile, target banks might also be life and accident insurance companies, mortgage banks, investment companies and securities companies. Acquiring banks are listed with equity returns and accounting data available on Bloomberg. The method of payments can be cash or stock or both cash and stock. Deals that contain default bank as a failing bank will be omitted, and it will be verified via Bloomberg or press coverage around the deal.

Based on these criteria above, the initial sample contains 3,130 deal observations. Besides, it is essential that the acquisition is completed and is not categorized as private acquisitions, liquidation, bankruptcy, restructuring, privatisation, reverse takeover, repurchase, leveraged buyout and minority stock purchase. As a result, the sample reduces to 2,940 deals. Additional criteria are required to ensure that all deals in the sample have a potential impact on acquirers' probability of default. For instance, only deals with the time elapsed between the date of announcement and the completion date less than one year will be selected (Vallascas and Hagendorff, 2011). As a result, the sample reduces to 2,863 deals. Also, deals where acquirers purchase at least 50% of the target banks and the acquiring banks' ownership of target banks following mergers exceeds 90% will be chosen (Koerniadi et al., 2015). Hence, 204 acquisitions are omitted as a consequence of this criterion. Furthermore, it is expected that only target with a substantial size in comparison with acquirer size may have an impact on the default risk of acquiring banks. Therefore, the ratio of deal size to acquirer's total assets is at least 1% but no more than 150% as suggested by Furfine & Rosen (2011). This criterion eliminates a substantial amount of deals, leaving only 887 deals in the sample. The confounding events will be bypassed by choosing deals with at least 180 trading days between two separate deal announcements by the same banking firm and not more than one deal pending until 180 days following completion of a deal by the same bank (Vallascas and Hagendorff, 2011). The sample is left with 766 deals after this category. Minimum size requirement of the deal is $10 million because minor deals are not expected to impact acquirers' default risk, thereby only 24 deals are omitted in this category. Finally, the sample consists of 608 deal observations after excluding deals for which data on share prices is only available less than the estimation period (six months before merger announcement and six months after deal completion) or deals which data on share prices is only available in an infrequent basis and illiquid. The resulting dataset is described in Table 1 as follow.

Table 1: Overview of M&A sample

Overview of M&A sample.					
Panel A: Mergers and acquisitions distribution by year					
Year	Number of mergers	%	Total deal value (million US$)	%	Average deal value (million US$)
1998	48	7.89	161104.86	14.50	3356.35
1999	43	7.07	84977.83	7.65	1976.23
2000	49	8.06	140399.1	12.64	2865.29
2001	44	7.24	49579.35	4.46	1126.80
2002	26	4.28	38792.47	3.49	1492.02
2003	42	6.91	68607	6.17	1633.50
2004	50	8.22	70097.91	6.31	1401.96
2005	44	7.24	88520.18	7.97	2011.82
2006	42	6.91	119508.57	10.76	2845.44
2007	37	6.09	95405.37	8.59	2578.52
2008	20	3.29	101698.78	9.15	5084.94
2009	13	2.14	5243.91	0.47	403.38
2010	14	2.30	23252.54	2.09	1660.90
2011	13	2.14	7162.99	0.64	551.00
2012	18	2.96	8948.96	0.81	497.16
2013	27	4.44	9781.25	0.88	362.27
2014	46	7.57	17620.88	1.59	383.06
2015	32	5.26	20446.26	1.84	638.95
Total	**608**	**100.00**	**1111148.21**	**100.00**	

Table 1 provides an overview of the M&A sample by year. As can be, the total deal value has decreased sharply over the sample period, from US$ 161,104 million in 1998 to about US$ 20,446 million in 2015, except for a peak between 2006 and 2008. Additionally, the majority of sample mergers was announced between 1998 and 2006. This figure continues to fall sharply to only 13 deals in 2009 and 2011; this could be explained by the effects of the post-global financial crisis. It is worth noting that there are only a few deals where acquirers engage in acquisitions with public-listed targets in the sample. It is because private firms experience increasing pressures to merge due to the decrease in government ownership or the phasing out of public guarantees of their liabilities.

Table 2: Merger sample by region of acquirers

Acquirer	Target									
	Africa	Asia	Central Asia	Europe	South America	Central America	North America	Oceania	Western Europe	Sum
Africa	5									
Asia		52		1						
Central America						1				
Europe		2		53			6			
North America		1		2	1		459			
Oceania								9		
South America					9		2		1	
Western Europe			1						3	
Sum										608

Table 2 breaks down the final sample of bank mergers according to the region of acquirers. The final sample consists of mergers with bidding banks predominantly located in the United States and the European Union, Norway and Switzerland. Moreover, it is analysed the risk effects of transactions in Asia (Japan, China, Malaysia, Philippines, Singapore, Taiwan, Thailand) and South America (Argentina, Brazil, Mexico, Peru). There occurred 463 mergers in North America and 65 in entire Europe. In Asia, 53 transactions were completed, while the remaining deals were completed in other regions (South America, Central America, Oceania and Africa). Thus, in 558 of 608 cases (91.77%), the acquiring bank's and the target's domicile are in the same country. For 591 transactions (97.2%) both the bidding bank and the target originate in the same region.

Table 3: Merger sample by different categories

	Target status		Payment method		Deal geography		Product diversification	
	Private	Listed	Cash only	Cash and stock, stock	Cross-border	Domestic	Focusing	Activity diversifying
Full sample (608 deals)	598	10	157	451	50	558	543	65
US sample (451 deals)	450	1	86	365	4	447	423	28
Non-US sample (157 deals)	148	9	71	86	46	111	120	37

Table 3 demonstrates the final sample divided based on different categories such as target status, payment method, the geography of the deal and product diversification. Regarding target status, private targets account for the most prominent number in all cases including US sample and non-US sample. For the payment method, deals financed by cash only in non-US sample constitute up to 45% out of 157 deals in total whereas it is only 19% of US sample. For the geographical region of the deals, it is observed that US acquirers tend to engage in domestic mergers (99%) meanwhile non-US acquirers are interested in cross-border deals more than US acquirers (29%). Regarding product diversification, both US and non-US acquirers show more interest in focusing deals than activity diversifying deals although the balance is more on the non-US acquirers' side.

The definitions of the variables used in the cross-sectional analyses are given in Appendix C. Summary statistics for the independent variables are presented in table 4 below.

Table 4: Variables descriptive statistics

Summary Statistics. This table reports summary statistics for the measures of systemic risk by Marginal Expected Shortfall and ΔCoVaR, deal characteristics, acquirer characteristics and country control variables. The sample consists of 608 mergers announced between 1998 and 2015 involving acquirers globally.

		Mean	Std. dev.	Min	Median	Max
Risk Measures	MES: before merger (-180 days, 11 days)	0.005	0.010	-0.014	0.003	0.036
	MES: after merger (+11 days, +180 days)	0.005	0.011	-0.015	0.003	0.042
	Change in Marginal Expected Shortfall	0.000	0.011	-0.028	0.000	0.032
	ΔCoVaR: before merger (-180 days, 11 days)	0.002	0.004	-0.003	0.001	0.018
	ΔCoVaR: after merger (+11 days, +180 days)	0.002	0.004	-0.004	0.001	0.017
	Change in ΔCoVaR	0.000	0.004	-0.015	0.000	0.013
Deal characteristics	Payment method	0.258	0.438	0.000	0.000	1.000
	Status of target	0.987	0.114	0.000	1.000	1.000
	Log of deal size (in million US dollar)	5.299	1.932	2.486	4.868	10.331
	Relative size	0.426	0.772	0.032	0.237	1.000
	Cross border	0.082	0.274	0.000	0.000	1.000
	Product diversification	0.106	0.309	0.000	0.000	1.000
Pre-merger acquiring bank charateristics	ROA (%)	1.223	0.627	0.007	1.152	3.544
	Market to book ratio (%)	1.610	0.730	0.476	1.441	4.021
	Leverage (%)	7.240	7.619	0.000	5.404	66.187
	Operating efficiency (%)	2.829	0.980	0.706	2.783	6.425
	Capital ratio (%)	9.201	3.057	2.382	9.027	20.838
	Total assets (in million US dollar)	8.742	1.852	5.942	8.303	13.459
	Too big to fail motive	0.250	0.433	0.000	0.000	1.000
Country control	GDP (%)	3.122	1.874	-2.780	2.810	8.899
	HHI index	0.083	0.074	0.050	0.070	0.540
	Political stability (from 2.5 to 2.5)	0.467	0.548	-1.600	0.575	1.425
	Rule of Law (from 2.5 to 2.5)	1.372	0.516	-0.700	1.546	1.915

3.2 Deal characteristics

In this section, we address the concern of how merger-related changes in acquirers' contribution to systemic risk can be explained in the cross-section by a group of bidders and deal characteristics as well as variables on the acquiring banks' macroeconomic environment. First, deal characteristics used in the cross-sectional analysis as control variables consist of deal size, relative size, payment method, the status of target, geographic and product diversification are controlled for. Regarding the deal size and relative size, both variables' signs are expected to be unrestricted. On the one hand, large deals may produce a risk-reducing effect on acquirers' contribution to systemic risk as larger banks can be able to diversify their credit and asset portfolios better. Nevertheless, larger deals are positively connected with organisational and procedural complexity integrating with the target, hence reduce transparency (Beck et al., 2006; Huang et al., 2012; Laeven et al., 2016). The deal payment method is represented by a dummy variable which equals one if the merger is financed in cash only and zero otherwise. This dummy is motivated by hypothesis three of this chapter which predicts that deals financed by cash only will have a risk-increasing effect on systemic risk. Furthermore, target status is controlled via a dummy variable which differentiates between private (1) or public-listed (0) target institutions. Merger deals involved in private targets are expected to generate risk-increasing effect for acquirers because private firms are subject to lower disclosure requirements; thus, it limits the acquirers' capabilities to evaluate the risks associated with private targets themselves as well as making bidders' due diligence ineffective (Furfine and Rosen, 2011).

Apart from that, two more dummy variables are adding to the regressions to capture the geographic nature and product-diversifying nature of merger: geographic diversification (cross-border deals versus domestic deals) or product diversification (diversifying versus focusing deals). Dummy product diversification is stimulated by the second hypothesis of this chapter, predicting that product-diversifying deals generate more risk-reducing effect than focusing deals. It is because diversification can bring about benefits through co-insurance (Asquith and Kim, 1982), expansion and development, efficiency achievement through scale and scope economies and improved profit; thereby lower firm's default risk (Halpern, 1983) and maintain the stability of the financial system.

3.3. Acquirer characteristics

The second group we use is pre-merger bidding banks' characteristics. We utilise the return on assets (ROA) of acquirers as proxy for the their level of profitability; acquirers' total assets (log value) to proxy for bank's size; the market-to-book-ratio to monitor for the hubris of acquiring banks' management (see Hagendorff and Vallascas, 2011) and capital ratio to monitor for acquirers' leverage. The profitability performance proxy (ROA) is expected to have a systemic risk-reducing effect for acquirers. Moreover, the projected sign of the coefficient for the market-to-book ratio is unknown. Vallascas & Hagendorff (2011) suggest negative effects of market-to-book ratio to the bidding banks' risk. On the other hand, Keeley (1990) asserts that more valuable banking institutions have fewer motivations to take part in risky transactions because valuable charters cannot be traded if they go bankrupt. For acquirers' leverage, it is expected that variables leverage's signs and capital ratio's signs (an additional proxy for leverage) are unrestricted. On the one hand, leverage increases liquidation risk (with the outlook of pay losses for executives) and puts pressures on the executive to produce high, and sufficiency cash flows for interest payments. Thus, executives at banking firms with low leverage might be more interested in engaging in risky transactions such as M&As with their free cash flows which raise their pay level and the possibility of organisational failures (Vallascas and Hagendorff, 2011). On the other hand, banking firms with a low level of leverage can simply be overcapitalised in comparison to their target's capital ratio. Therefore, acquiring bank can be motivated to acquire a target with a high level of leverage instead of, e.g. issuing new debt. In case of acquiring bank simply altering its capital structure, the rise in leverage should not be associated with any substantial changes in acquiring bank's total risk (Weiß et al., 2014). The operating efficiency ratio is added to the regressions to assess the influence of management quality on the merger-related changes in bidders' contribution to systemic risk. Indeed, a more efficient operation is expected to reduce systemic risk (or have a positive relationship with the change in distance to default). Regarding acquirer's total assets, the influence of bidding bank's pre-merger size on systemic risk measures is hypothesised to be positive. It is because smaller banks tend to be motivated to engage in M&As and become too-big-to-fail which, in turn, increase bidders' contribution to systemic risk (see Benston et al., 1995).

Motives for banks M&As were different before and during the crisis, and the occurrence of the 2007-09 global financial crisis raises the need to consider a major motive for M&A which is called "too-big-to-fail motive". During the global financial crisis, banking firms can be stimulated to engage in M&A transactions to become SIFIs to exploit the safety net, government bailouts or to establish a more solid institution (see Molyneux et al., (2014)). Therefore, too-big-to-fail variable is included in the regressions to test if the findings are driven by banks with the motivation to merge to become too-big-to-fail (i.e., banks that were near default and had the lowest possibilities of obtaining a bailout before the merger). To construct the variable, first, the pre-merger default risk of acquirers in the sample utilising the Merton distance-to-default methodology as in Vallascas and Hagendorff (2011) will be extracted from the previous empirical chapter. Following that, this dummy variable takes the value of 1 for banks in the first distance to default quartile (i.e. banks with the highest level of pre-merger default risk) and 0 otherwise.

3.4 Macroeconomic control variables

The third set of control variables we use consists of a relevant macroeconomic environment of acquirers because they may influence the relation between bank mergers and systemic risk. To be precise, the annual real GDP growth rate as a percentage, an indicator of political stability, an indicator for the rule of law and the HHI (market concentration index) of the bidding bank's home country are included. Higher concentration implies fewer effective bidders, which enhance the pricing power of the acquirer (James and Wier, 1987). Likewise, a country with the stable political environment may promote safer markets for a bank to operate. All the macroeconomic control variables are retrieved from the World Bank's World Development Indicator (WDI) database.

4. Methodology

The purpose of this section is to briefly demonstrate the methodology used for measuring the systemic risk effects of bank mergers. More specifically, two reliable and strong approaches: Marginal Expected Shortfall as in Brownlees and Engle (2012) and ΔCoVaR as in Girardi and Tolga Ergün (2013) are employed to assess the acquiring banks' contribution to systemic risk.

4.1 Marginal expected shortfall

In our empirical analysis, we measure the merger-related change in the contribution of an individual bank to systemic risk by the use of the bank's marginal expected shortfall as in Brownlees and Engle (2012). Let us consider a financial system composed of n institutions. The financial system's global return (market return after that) is defined as the value-weighted average of all firm returns

$$r_{mt} = \sum_{i=1}^{n} w_{it} r_{it} \quad (1)$$

r_{mt} denotes the aggregate return of the financial system on day t
r_{it} is the corresponding return of firm i.
w_{it} is the weight of the ith firm in the financial system at time t

These weights are given by the relative market capitalisation of the financial institutions. Let us assume that the aggregate risk of the financial system is measured by the conditional Expected Shortfall (ES). By actuarial convention, the ES is the expected market loss conditional on the return being less than the α quantile, i.e. the VaR. It can also be extended to a more general case, where the distress event is defined by a threshold C. The conditional ES (for past information) at time t is formally given by

$$ES_{mt}(C) = -\mathbb{E}_{t-1}(r_{mt} | r_{mt} < C) \quad (2)$$

threshold C is the distress event

Acharya et al., (2017) proposed the concept of MES. This systemic risk measure corresponds to the marginal contribution of a firm to the risk of the financial system measured by ES. It corresponds to the change in the market's ES engendered by a unit increase in the weight of the i*th* institution in the financial system (see Appendix A.1 for the derivation of this expression)

$$MES_{it}(C) = \frac{\partial ES_{mt}(C)}{\partial w_{it}} = \mathbb{E}_{t-1}(r_{it} | r_{mt} < C) \quad (3)$$

Let us consider a bivariate GARCH model for the demeaned return processes, which corresponds to a simple market model (CAPM) with time-varying conditional betas (Brownlees and Engle, 2012)

$$r_t = H_t^{1/2} v_t \ (4)$$

where $r_t' = (r_{mt} r_{it})$ denotes the vector of market and firm returns and where the random vector $v_t' = (\varepsilon_{mt} \xi_{it})$ is independently and identically distributed (*i.i.d*) shocks and has the following first movements: $\mathbb{E}(v_t) = 0$ and $\mathbb{E}(v_t v_t') = I_2$, a two-by-two identity matrix. The H_t matrix denotes the time-varying conditional variance-covariance matrix:

$$H_t = \begin{pmatrix} \sigma_{mt}^2 & \sigma_{it}\sigma_{mt}\rho_{it} \\ \sigma_{it}\sigma_{mt}\rho_{it} & \sigma_{it}^2 \end{pmatrix} (5)$$

where σ_{it} and σ_{mt} denote the conditional standard deviations for the firm and the system, ρ_{it} the time-varying conditional correlation. No particular assumptions are made about the bivariate distribution of the standardised innovations v_t, which is assumed to be unknown. We only assume that the time-varying conditional correlations ρ_{it} fully captures the dependence between firm and market returns. Formally, this assumption implies that the standardised innovations ε_{mt} and ξ_{it} are independently distributed at time *t*.

Given Equations (4) and (5), the MES can be expressed as a function of the firm's return volatility, its correlation with the market return, and the comovement of the tail of the distribution (See Appendix A.2 for the derivation of this expression):

$$MES_{it}(C) = \sigma_{it}\rho_{it}\mathbb{E}_{t-1}\left(\varepsilon_{mt}\middle|\varepsilon_{mt} < \frac{C}{\sigma_{mt}}\right) + \sigma_{it}\sqrt{1-\rho_{it}^2}\,\mathbb{E}_{t-1}\left(\xi_{it}\middle|\varepsilon_{mt} < \frac{C}{\sigma_{mt}}\right) (6)$$

Therefore, MES is a non-linear combination of four elements: volatility, correlation, tails expectations and the weight of the firm.

To compute the MES for each financial institution, we implement the estimation method of Brownlees and Engle (2012) and the models defined in Equations (4) and (5) will be used. The steps followed in developing the model are listed below.

Step 1: We model the time-varying correlations of each couple 'market-firm' using a dynamic conditional correlation (DCC) model (Engle, 2001). From this, conditional volatilities and standardised residuals for the market and each institution are obtained by modelling volatilities in a GJR- GARCH(1,1) framework (Glosten et al., 1993). We estimate the parameters by Quasi Maximum Likelihood (QML), since it provides consistent and asymptotically normal estimators under mild regularity conditions, without making any distributional assumptions about the innovations process.

Step 2: Relying on the *i.i.d*. Property of the innovations, we next proceed to a non-parametric kernel estimation of the tail expectations $\mathbb{E}_{t-1}\left(\varepsilon_{mt}\middle|\varepsilon_{mt} < \frac{C}{\sigma_{mt}}\right)$ and $\mathbb{E}_{t-1}\left(\xi_{it}\middle|\varepsilon_{mt} < \frac{C}{\sigma_{mt}}\right)$ along the lines of (Scaillet, 2005):

$$\widehat{\mathbb{E}}_{t-1}(\varepsilon_{mt}|\varepsilon_{mt} < k) = \frac{\sum_{t=1}^{T}\varepsilon_{mt}\emptyset(\frac{k-\varepsilon_{mt}}{h})}{\sum_{t=1}^{T}\emptyset(\frac{k-\varepsilon_{mt}}{h})} \quad (7)$$

$$\widehat{\mathbb{E}}_{t-1}(\xi_{it}|\varepsilon_{mt} < k) = \frac{\sum_{t=1}^{T}\xi_{it}\emptyset(\frac{k-\varepsilon_{mt}}{h})}{\sum_{t=1}^{T}\emptyset(\frac{k-\varepsilon_{mt}}{h})} \quad (8)$$

where $k = {}^{C}/_{\sigma_{mt}}$ is the threshold, $\emptyset(.)$ represents the normal c.d.f. (Gaussian Kernel function), and h is the bandwidth. In the empirical application, we set C to *VaR-HS*(5%) of the system and h to $T^{-1/5}$ as in Scaillet (2005). For a formal proof, see Appendix A.3.

Step 3. We apply the volatilities and correlations obtained in step 1 and tail expectations gained from step 2 back to equation (6) to calculate the Marginal Expected Shortfall of institution i at each date t.

Later, we run a test to check whether the differences between the banks' post- and pre-merger marginal expected short falls are, on average, different from zero. A day t is defined to belong to the pre-merger period if it falls into the interval [–180; -11] relative to the merger announcement. Similarly, a day t is considered to belong to the post-merger period if it falls into the interval [+11; +180] relative to the merger completion. To test the hypothesis that the mean of the changes in the acquirers' MES post-merger is different from zero, we employ a standard t-test. 5% is the risk level of the VaR.

$$\Delta MES_i^{5\%} = MES_{i;[+11;+180]}^{5\%} - MES_{i;[-11;-180]}^{5\%} \quad (9)$$

The first advantage of this method is that MES is an explicit economic model where systemic risk measurement relies on observable market data and statistical techniques; therefore, it is simple to calculate and easy for banking supervisors to implement. Second, MES and leverage are a good predictor of a firm's contribution to a systemic crisis unlike other standard measures of firm-level risks, such as VaR or volatility with no explanatory power or beta with modest explanatory power. Third, being model-based enhance the logical consistency of the measurement of MES and SES. Finally, this measure scales naturally with the size of the firm and is additive concerning mergers and spinoffs. These properties do not hold in many of the reduced form approaches. However, as noted by Acharya et al. (2010), the definition and estimation of the MES do not capture the true tails of the return distribution as it is computed from the moderately bad days of the market and not the worst performance of the market during a true financial crisis. Moreover, the data for this method is based on share returns only and exclude reference to a bank's size or its capital capacity which are considered as important elements of systemic risk (Kupiec and Guntay, 2016).

4.2 Conditional Value at Risk

In addition to MES, we follow Adrian and Brunnermeier (2016) to measure systemic risk via the conditional value- at-risk (CoVaR) of the financial system, conditional on institutions being in a state of distress. A firm's contribution to systemic risk is defined as the difference between the CoVaR of the firm being in distress and the CoVaR in the median state of the firm. This measure is based on the concept of Value-at-Risk, denoted VaR(α), which is the maximum loss within the α%-confidence interval (see Jorion, 2007). Then, the CoVaR corresponds to the VaR of the market return obtained conditionally on some event $\mathbb{C}\,(r_{it})$ observed for firm *i*.

$$Pr\left(r_{mt} \leq CoVaR_t^{m|\mathbb{C}\,(r_{it})} \middle| \mathbb{C}\,(r_{it})\right) = \alpha \text{ (10)}$$

r_{mt} denotes the aggregate return of the financial system on day t

r_{it} is the corresponding return of firm i.

α is the confidence interval (%)

threshold $\mathbb{C}$ is the distress event

The ΔCoVaR of firm i is then defined as the difference between the VaR of the financial system conditional on this particular firm being in financial distress and the VaR of the financial system conditional on firm i being in its median state. To define the distress of a financial institution (a condition when a bank could not meet or has difficult to pay back its financial obligations to its creditors, normally because of illiquid assets or high fixed costs), we consider various definitions of $\mathbb{C}\,(r_{it})$.

A more general approach would consist in defining the financial distress of firm i as a situation in which the losses exceed its VaR (see Girardi and Ergün, 2013):

$$\Delta CoVaR_{it}(\alpha) = CoVaR_t^{m|r_{it} \leq VaR_{it}(\alpha)} - CoVaR_t^{m|r_{it} = Median(r_{it})} \text{ (11)}$$

In this theoretical framework, it is also possible to express ΔCoVaR, defined for a conditioning event $\mathbb{C}\,(r_{it})\colon r_{it} = VaR_{it}(\alpha)$, as a function of the conditional correlations, volatilities, and VaR. Given Equations (4) and (5), the following result is obtained (see Appendix B.1 for the derivation of this expression):

$$\Delta CoVaR_{it}(\alpha) = \gamma_{it}[VaR_{it}(\alpha) - VaR_{it}(0.5)] \text{ (12)}$$

where $\gamma_{it} = \sigma_{mt}\rho_{it}/\sigma_{it}$. If the marginal distribution of the returns is symmetric around zero, ΔCoVaR is strictly proportional to VaR:

$$\Delta CoVaR_{it}(\alpha) = \gamma_{it} VaR_{it}(\alpha) \text{ (13)}$$

Then we perform the GARCH estimation of CoVaR based on the following three steps procedure:

Step 1: First, we compute VaR of each institution i by estimating the following univariate model:

$$r_{it} = \mu_{it} + \varepsilon_{it} \text{ (14)},$$

where $\mu_{it} = \omega_0 + \omega_1 r_{i,t-1}$ and $\varepsilon_{it} = \nu_{it}\sigma_{it}$ where ν_{it} is independently and identically distributed (*i.i.d*) with zero mean and unit variance and the conditional variance has the standard GARCH (1,1) specification

$$\sigma^2_{it} = \beta_0^i + \beta_1^i \varepsilon_{i,t-1}^2 + \beta_2^i \sigma_{i,t-1}^2 \text{(15)}$$

Given a distributional assumption for ν and, hence, the q-quantile of the estimated conditional distribution, for each time period, we calculate the VaR of each institution i

Step 2: for each institution i, a bivariate GARCH model is estimated with Engle's (2002) DCC specification for the returns of institution i and the financial system. Let $r_t = (r_{mt} r_{it})'$ whose joint dynamics is given by

$$r_t = \mu_t + \varepsilon_t \text{ (16)}$$

$$\varepsilon_t = H_t^{1/2} v_t \text{ (17)}$$

where $H_t^{1/2}$ is the (2 x 2) conditional covariance matrix of the error term ε_t and μ_t is the (2 x 1) vector of conditional means. The standardized innovation vector $v_t = H_t^{-\frac{1}{2}}(r_t - \mu_t)$ is independently and identically distributed (*i.i.d*) with $E(v_t) = 0$ and $VaR(v_t) = I_2$

D_t is defined to be the (2 x 2) diagonal matrix with the conditional variances σ_{xt}^2 and σ_{yt}^2 along the diagonal so that $\{D_{xx}\}_t = \{H_{xx}\}_t, \{D_{yy}\}_t = \{H_{yy}\}_t$ and $\{D_{xy}\}_t = 0$ for *x,y=m,i.* The conditional variances are modeled as GARCH (1,1)

$$\sigma^2_{xt} = \phi_0^x + \phi_1^x \varepsilon_{x,t-1}^2 + \phi_2^x \sigma_{x,t-1}^2 \text{(18)}$$

$$\sigma^2_{yt} = \phi_0^y + \phi_1^y \varepsilon_{y,t-1}^2 + \phi_2^y \sigma_{y,t-1}^2 \text{(19)}$$

and the conditional covariance $\sigma_{xy,t}$ is

$$\sigma_{xy,t} = \rho_{xy,t}\sqrt{\sigma^2_{xt}\sigma^2_{yt}} \text{ (20)}$$

Let $C_t = D_t^{-1/2} H_t D_t^{-1/2} = \{\rho_{xy}\}_t$ be the (2 x 2) matrix of conditional correlations of ε_t. Following Engle (2001) the conditional correlation matrix will be as follows

$$C_t = diag(Q_t)^{-1/2} * Q_t * diag(Q_t)^{-1/2} \text{(21)}$$

$$Q_t = (1 - \delta_1 - \delta_2)\bar{Q} + \delta_1(\lambda_{t-1}\lambda_{t-1}') + \delta_2 Q_{t-1} \text{ (22)}$$

where $\bar{Q}$ is the unconditional covariance matrix of $\lambda_t = \{\varepsilon_{xt}/\sigma_{xt}\}_{x=m,i}$ and $diag(Q_t)$ is the (2 x 2) matrix with the diagonal of Q_t on the diagonal and zeros off-diagonal.

Step 3: Once the bivariate density $pdf_t(r_{mt}r_{it})'$ pair is estimated in step 2, in step 3, we obtain $\Delta CoVaR_{it}(\alpha)$ to measure for each financial institution i and period t in equation (12).

Similar to marginal expected shortfall, a test is run to check whether the differences between the banks' post- and pre-merger ΔCoVaR are, on average, different from zero. To test the hypothesis that the mean of the changes in the acquirers' ΔCoVaR post-merger are different from zero, we employ a standard t-test. 5% is considered the risk level of the VaR.

$$\Delta(\Delta CoVaR_i^{5\%}) = \Delta CoVaR_{i;[+11;+180]}^{5\%} - \Delta CoVaR_{i;[-11;-180]}^{5\%} \quad (23)$$

There are several advantages associated with CoVaR as a measure. First, while ΔCoVaR emphasises on the contribution of each firm to overall system risk, conventional risk measures rely on the risk of individual firms. Banking regulations and policies based on the risk of firms in segregation may result in excessive risk-taking along systemic risk measurements. Another benefit of this co-risk measure is that it is general enough to study the risk spillovers from banks to banks throughout the entire financial system. Furthermore, the authors establish that the "forward- ΔCoVaRs" have out-of-sample predictive power for realised correlation in tail events. The forward- ΔCoVaR can be utilised to oversee the build-up of systemic risk in a forward-looking mode. This forward-looking measure can potentially be used in macro-prudential policy applications. Finally, it reduces the effect of the arbitrary selection of a single level of confidence on expected losses (Sum, 2016).

5. Results

In this section, we discuss the results of our analysis of merger-related changes in acquirers' contribution to systemic risk. Our objective is to answer the question whether bank mergers in general lead to a lower contribution of the acquirer to systemic risk. Moreover, we recognise the factors driving these changes in systemic risk.

5.1 Systemic risk effects

Table 5 below reports the Marginal Expected Shortfall (MES) and ΔCoVaR of acquiring banks before and after mergers based on the global sample of 608 banks M&As.

Table 5: Merger-related changes in MES and ΔCoVaR

Merger-induced changes in Marginal Expected Shortfall and ΔCoVaR. The table reports the pre- and post-merger value as well as changes in the bidding banks' Marginal Expected Shortfall (MES) and ΔCoVaR for a full sample of 608 bank mergers and for my regional sub-samples. MES and ΔCoVaR before the merger is computed as the average of the MES and ΔCoVaR over the period from 180 days to 11 days relative to the announcement date (a), while the MES and ΔCoVaR after the merger is computed as the average MES and ΔCoVaR over the period from +11 days to +180 days after the effective date (c). The change in the MES and ΔCoVaR is the difference between the post-effective date and the pre-announcement period, winsorized at the 1%-level. The statistical significance of the changes in the MES and ΔCoVaR is then tested by the use of a standard t-test. The P-values are denoted in parentheses.

	N	Acquirers' Systemic risk (MES)			Acquirers' Systemic risk (ΔCoVaR)		
		MES Pre-merger	MES Post-merger	Change in MES	ΔCoVaR Pre-merger	ΔCoVaR Post-merger	Change in ΔCoVaR
U.S.	451	**0.0052 *****	**0.00547 *****	0.00023	**0.0022 *****	**0.0024 *****	0.0002
		0	**0**	0.6209	**0.0000**	**0.0000**	0.2056
Europe	65	**0.0065 *****	**0.0058 *****	-0.0009	**0.004 *****	**0.0031 *****	-0.0010
		0.0000	**0.0000**	0.6010	**0.0000**	**0.0000**	0.1259
Asia	53	**0.0026 ****	**0.0042 *****	0.0017	**0.0012 *****	**0.00117 *****	0.0000
		0.0396	**0.0001**	0.3107	**0.0000**	**0.0001**	0.9393
Others	39	**0.007 *****	**0.0051 *****	-0.0018	**0.0034 *****	**0.0023 *****	**-0.0010***
		0.0000	**0.0058**	0.1693	**0.0001**	**0.0056**	**0.0634**
Total	608	**0.0052 *****	**0.0053 *****	0.0001	**0.0024 *****	**0.00239 *****	0.0000
		0.0000	**0.0000**	0.7875	**0.0000**	**0.0000**	0.9273
**, * Denotes significance at 5%;10%							
*** Denotes significance at 1%							

For acquirers' MES, the results show that before M&A, European, U.S. and bidding banks from other countries (excluding Asia) pose greater contribution to systemic risk than their Asian peers. The MES of European, US and other countries' bidders are 0.0065, 0.0052, 0.007 respectively compared to 0.0026 of Asia bidders. Noticeably, acquiring banks' MES post-merger show the same consensus. The reasons for this observation may be because, for European acquirers, empirical evidence tend to suggest that cross-border bank mergers within the EU may involve regulatory arbitrage. Banking firms in the EU can relocate their activities geographically, thereby shifting their poorly controlled risk to the taxpayers in other nations which can destabilise the entire banking system (see Hagendorff et al., 2012; Molyneux et al., 2014). For US acquirers, Rao-nicholson and Salaber (2016) detect an increase in bank concentration in the US where the consequences of the 2007-09 global financial crisis are severe. As discussed in section 6.2.2.3, a highly concentrated banking market with few tremendous players may contribute to a less stability in the banking system which is consistent with the concentration fragility hypothesis.

To analyse whether mergers impact the contribution to systemic risk of acquirers, the merger-related change in MES is tested to check if it is equal to zero. The findings of the full-sample analysis show that the change in the bidding banks' MES is 0.0001 and it is not statistically significant. At the regional level, it is seen that the increase in the bidding banks' MES is strongest for the mergers in the U.S. and Asia; nevertheless, the change in MES of U.S. and Asian acquirers are not statistically significant either. In short, these first results show that mergers do not produce a statistically significant reduction in the acquiring banks' contribution to systemic risk. This finding contradicts with Weiß et al. (2014) as they found a significant increase in merging banks' contribution to systemic risk following mergers. The possible reason why their findings are not as optimistic as this finding is that their sample excludes mergers that involve insurance companies, loan or security bankers. Such sample may not offer considerable diversification benefits as well as risk-reducing effects deriving from product diversification. Moreover, this sample period extends beyond the 2007-09 global financial crisis; banks may no longer merge to become too-big-to-fail and engage in excessive risk-taking. Instead, they may pursue M&A for healthy growth, expansion of business lines and locations or acquisitions of new customer bases; thereby increase business profit and enhance the stability of the banking system. Therefore, the result from this sample is at best risk neutral.

Regarding the ∆CoVaR of acquirers, it recorded that the pre-merger level of the ∆CoVaR is higher for the banks in Europe, the U.S. and other nations (excluding Asia) than acquiring banks in Asia and it is statistically significant at 1% level for the full sample. However, similar to MES of acquirers, the change in ∆CoVaR for the full sample is not statistically significant. It can be concluded that M&A does not modify the contribution of acquiring banks to systemic risk. Therefore, the first hypothesis that bank mergers coincide with a significant reduction in the bidding bank's contribution to systemic risk is rejected.

For a more precise analysis, the sample is divided into nine sub-samples including deal value, different market types, geographic diversification, product diversification, relative size, payment method, total assets, ROA, acquirers' risk profile before the merger and analyse the changes in the bidding banks' contribution to systemic risk. Table 6 reports the investigation of the sub-samples based on (A) deal characteristics, (B) acquirer characteristics.

Table 6: Sub-sample analysis

Sub-sample analysis. The table presents the changes in systemic risk (MES and ΔCoVaR) for the different sub-samples of acquirers. The sub-samples are built using the dummy variables for cross-border mergers, activity-diversifying mergers, deal value, relative size, payment method, acquirers' total assets and ROA as well as different markets and acquirers risk profile before merger. The statistical significance of the changes in the MES and ΔCoVaR are then tested by the use

	N	Change in MES	Change in ΔCoVaR		N	Change in MES	Change in ΔCoVaR
Panel A: Deal Characteristics							
Deal value				**Markets**			
High deal value	203	-0.00034	-0.00033	Emerging markets	55	0.0016	-0.00083
		0.6691	0.2943			0.2801	0.1424
Medium deal value	203	0.00015	0	Developed markets	539	-0.0001	0
		0.8155	0.704			0.8183	0.6495
Low deal value	202	0.00053	0.00019	Frontier markets	14	0.0024	-0.00034
		0.467	0.4484			0.4988	0.7627
Geographic diversification				**Product diversification**			
Cross-border merger	50	0.00064	0.000184	Activity-diversifying merger	58	-0.001	-0.00042
		0.6236	0.6909			0.4586	0.442
Domestic merger	558	0	0	Focusing merger	543	0.00025	0
		0.8798	0.849			0.5777	0.8405
Relative size							
Low relative size	202	**0.0013 ***	**0.000755 *****	**Payment method**			
		0.0575	**0.0054**	Cash only	157	**0.0016 ****	0.0004
Medium relative size	203	-0.0002	-0.000478			**0.0445**	0.1808
		0.7879	0.107	Others	451	-0.0004	-0.0001
High relative size	203	-0.0007	-0.000317			0.4262	0.4014
		0.3062	0.2328				
Panel B: Acquirer characteristics							
Total asset				**ROA**			
High total assets	203	-0.00016	-0.00032	High ROA	203	0.00049	0
		0.837	0.3137			0.4569	0.7345
Medium total assets	203	0.001	0.00033	Medium ROA	203	0	0
		0.1607	0.2331			0.9957	0.7461
Low total assets	202	-0.00039	0	Low ROA	202	-0.00015	0.000125
		0.5597	0.9068			0.8617	0.7018
Acquirers risk profile before merger							
High risk profile before merger	203	-0.0011	-0.00049				
		0.2331	0.1482				
Medium risk profile before merger	203	0.0007	0.000133				
		0.2477	0.6092				
Low risk profile before merger	202	0.000718	0.00032				
		0.1982	0.1397				
**,* Denotes significance at 5%;10%							
*** Denotes significance at 1%							

Panel A of table 6 shows deal characteristics, differentiating between high, medium, and low deal values. The results of the computations show that all the change in MES and ΔCoVaR for the bidding banks are statistically insignificant for all of the sub-samples based on the deal size. This finding is interestingly contradicting Mühlnickel and Weiß (2015) as they find that the larger the size of the merger, the more massive the incremental increase in the insurance acquirers' contribution to the probability of a crash of the insurance industry will be. The different results may be because the authors measure extreme systemic risk by using lower tail dependence methodology as opposed to MES which measures the marginal contribution to systemic risk. Further, the nature of the acquirers' markets is considered, differentiating between developing market, developed market and frontier market. Bank M&As still do not produce any risk-reducing or risk-increasing effects for systemic risk.

In the next two specifications, the cross-border mergers and domestic deals, as well as focusing deals and product diversifying deals, are distinguished from one another. The results offer evidence that neither the two forms of geographic and product diversification influence acquirers' contribution to systemic risk. This finding is quite similar with Vallascas and Hagendorff (2011) in the sense that they find European bank consolidations do not affect acquiring banks' change in default risk regardless of the high potential for risk reduction displayed by product-diversifying or cross-border deals. This result raises doubt on the capability of bank consolidation, in general, to make use of a risk-decreasing and stabilising effect on the banking sector.

Moving onto the next specification, we employ the relative deal value and differentiate between high, medium, and low relative size. The results show that for deals where the target size is small compared to acquirers' market value, there is an increase in the MES and ΔCoVaR (statistically and economically significant at 10% level for MES and 1% level for ΔCoVaR); therefore, the contribution to systemic risk of acquiring banks increase. To justify this finding, Acharya and Yorulmazer (2007) show in their theoretical setup that when many banks default, it is optimal for the regulator to bail out some or all banks in distress. However, when the number of failed banks is small, the failed banks will exit the market via the acquisition channel, making them the target of other predators. As a consequence, small banks are motivated to engage in M&A with larger banks to gain an implicit bailout guarantee which in turn increases overall systemic risk.

The last specification in panel A is distinguishing between mergers financed by cash only and mergers financed by other methods (shares only, shares and cash). There is an increase in the MES for cash-only deals (statistically and economically significant at 5%); thereby such deals contribute to the increase in acquirers’ contribution to systemic risk. Indeed, Furfine & Rosen (2011) propose that deals which are fully paid for in cash are expected to raise acquiring banks' default risk as acquirers are replacing safe liquid assets (cash) with a riskier balance sheet of the target; thereby may also lead to the increase in acquirers' contribution to systemic risk.

Panel B of Table 6 presents the results attained using acquirer characteristics. The first two specifications based on the bidding banks’ total assets and ROA as a proxy for the level of profitability performance, all of the change in the MES and ΔCoVaR is statistically insignificant. It indicates that mergers do not alter the level of acquirers' contribution to systemic risk regardless of their size or pre-merger profitability performance. The last specification in this panel divides the pre-merger default risk profile of acquirers into high risk, medium risk and low-risk bidders. No statistically significant change in MES and ΔCoVaR is observed for this category for all sub-samples based on acquirers' risk profile.

Overall, results from the univariate test reveal that mergers and acquisitions, on average, do not influence the acquiring banks' contribution to systemic risk regardless of the increased potential for risk diversification exhibited by cross-border and cross-industry bank mergers. However, for a group of deals that target size is relatively small compared to acquirers' market value and deals that financed by cash-only, mergers increase acquirers' contribution to systemic risk.

5.2 Determinants of merger-related systemic risk effects

In this section, we examine if certain types of deal and acquirer characteristics or the acquirers' macroeconomic environment influence acquirers' contribution to systemic risk. We estimate the regressions via OLS with heteroskedasticity-consistent Huber–White standard errors. The results of the multiple regressions of systemic risk effects around bank mergers focus on the determinants of merger-related changes on acquirers' MES presented in table 7 and acquirers' ΔCoVaR in table 8 below.

Table 7: Determinants of the changes in MES

Determinants of the changes in MES: deal characteristics, acquirer characteristics and acquirers' macroeconomic environment. The dependent variable is the change in MES. The model is estimated via OLS with heteroskedasticity-consistent Huber–White standard errors. Model (1) uses all acquirers, model (2) uses the same acquirers but without country controls, model (3) uses US acquirers and model (4) uses non-US acquirers. All variables and data sources are defined in chapter 4. Statistically significant coefficients are highlighted in bold type. The P-values are denoted in parentheses.

	(1) All banks		(2) All banks		(3) US banks		(4) Non-US banks	
Acquirers and deal characteristics								
Payment method	**0.0024**	**	**0.0027**	**	0.0015		**0.0053**	***
	0.0195		**0.0121**		0.2178		**0.0068**	
Status of target	0.0032		0.0026		0.0012		0.0048	
	0.1974		0.1540		0.3681		0.1960	
Deal size	0.0715		0.1170		0.2000		1.2870	
	0.9049		0.8442		0.5320		0.4055	
Relative size	**-0.0014**	***	**-0.0012**	***	**-0.0029**	**	**-0.0014**	**
	0.0023		**0.0050**		**0.0314**		**0.0232**	
Cross-border	0.0006		-0.0001		0.0001		-0.0005	
	0.7231		0.9305		0.9696		0.8557	
Product diversification	-0.0017		-0.0019		0.0018		**-0.0042**	*
	0.2403		0.1984		0.3459		**0.0630**	
ROA	-0.0238		-0.0001		-0.0100		0.0428	
	0.7905		0.9986		0.9061		0.7349	
Market to book ratio	0.0596		0.0797		0.0009		0.1568	
	0.5175		0.3367		0.9919		0.4921	
Leverage	-0.0063		-0.0044		-0.0064		-0.0005	
	0.3162		0.4929		0.5627		0.9507	
Operating efficiency	-0.0577		-0.0247		-0.0500		-0.0986	
	0.3085		0.6427		0.4954		0.2717	
Capital ratio	-0.0037		-0.0010		-0.0002		-0.0334	
	0.8295		0.9517		0.9930		0.2958	
Acquirers total assets	-0.0099		-0.0699		0.1000		-1.1680	
	0.9882		0.9172		0.6920		0.4818	
Too big to fail motive	0.0015		0.0013		**0.0018**	*	0.0035	
	0.2216		0.2588		**0.0856**		0.1436	
Country control								
GDP	-0.0144						-0.0027	
	0.6250						0.9429	
HHI	**-0.0086**	*					-0.0038	
	0.0907						0.4800	
Political stability	-0.0013						-0.0031	
	0.2970						0.1940	
Rule of Law	-0.0015						-0.0008	
	0.2850						0.7445	
R-squared	0.0436		0.0287		0.0261		0.1751	
Adj. R-squared	0.0159		0.0073		-0.0029		0.0735	
Number of observations	608		608		451		157	
**, * Denotes significance at 5% and 10%								
*** Denotes significance at 1%								

Table 8: Determinants of the changes in ΔCoVaR

Determinants of the changes in Δ CoVaR : deal characteristics, acquirer characteristics and acquirers' macroeconomic environment. The dependent variable is the change in Δ CoVaR. The model is estimated via OLS with heteroskedasticity-consistent Huber–White standard errors. Model (1) uses all acquirers, model (2) uses the same acquirers but without country controls, model (3) uses US acquirers and model (4) uses non-US acquirers. All variables and data sources are defined in chapter 4. Statistically significant coefficients are highlighted in bold type. The P-values are denoted in parentheses.

	(1) All banks		(2) All banks		(3) US banks		(4) Non-US banks	
Acquirers and deal characteristics								
Payment method	**0.0007**	*	**0.0006**	*	0.0001		**0.0024**	***
	0.0861		**0.0978**		0.7557		**0.0019**	
Status of target	**0.0022**	**	**0.0022**	***	0.0003		0.0022	
	0.0251		**0.0082**		0.4651		0.1003	
Deal size	-0.0736		-0.1000		0.0728		0.4540	
	0.7364		0.5679		0.5832		0.3927	
Relative size	**-0.0004**	**	**-0.0004**	**	**-0.0008**	*	**-0.0005**	**
	0.0241		**0.0241**		**0.0857**		**0.0374**	
Cross-border	0.0008		0.0004		0.0017		0.0004	
	0.2069		0.4714		0.1562		0.6481	
Product diversification	-0.0005		-0.0006		0.0003		-0.0012	
	0.3186		0.2187		0.6807		0.1270	
ROA	-0.0145		-0.0200		-0.0100		0.0004	
	0.6564		0.4149		0.6898		0.9940	
Market to book ratio	0.0010		0.0100		0.0090		-0.0430	
	0.9756		0.6604		0.7803		0.5675	
Leverage	-0.0014		-0.0012		-0.0028		0.0023	
	0.5639		0.6225		0.5257		0.4803	
Operating efficiency	-0.0003		0.0003		-0.0047		0.0012	
	0.9904		0.9898		0.8854		0.9714	
Capital ratio	-0.0001		0.0005		0.0034		-0.0213	
	0.9908		0.9421		0.7322		0.1220	
Acquirers total assets	0.0952		0.0940		0.1000		-0.4320	
	0.6913		0.6972		0.1279		0.4189	
Too big to fail motive	0.0006		0.0005		0.0005		0.0013	
	0.1512		0.2233		0.2288		0.1555	
Country control								
GDP	-0.0016						0.0145	
	0.8955						0.2747	
HHI	-0.0019						0.0003	
	0.3732						0.8982	
Political stability	**-0.0009**	**					-0.0012	
	0.0275						0.1518	
Rule of Law	0.0008						0.0005	
	0.1034						0.6098	
R-squared	0.0343		0.0244		0.0194		0.1472	
Adj. R-squared	0.0063		0.0029		-0.0098		0.0421	
Number of observations	608		608		451		157	
**, * Denotes significance at 5% and 10%								
*** Denotes significance at 1%								

Regression (1) of table 7 estimates the relationship between the changes in the acquirers' MES using acquirer and deal characteristics as well as acquirers' macroeconomic environment for the full sample of mergers. The payment method variable in the regression has positive and statistically significant coefficient at 5% level. This finding is consistent with the univariate test in the previous section that mergers financed by cash only increase acquirers' contribution to systemic risk. It is also consistent with the hypothesis that when the safe liquid assets (cash) is replaced for the riskier balance sheet of targets, the bidders' default risk may increase which, in turns increase bidders' contribution to systemic risk (Furfine and Rosen, 2011). Therefore, hypothesis 3 which predicts that cash-only mergers increase acquirers' contribution to systemic risk is confirmed. Also, relative size has a negative and statistically significant coefficient (at 1% level). It indicates that the smaller the deal value compared to acquirers' market value, mergers will increase acquirers' contribution to systemic risk which is consistent with the univariate test in the last section. This effect may be explained as small banks are motivated to engage in M&A with larger banks to gain an implicit bailout guarantee from the government which in turn increases overall systemic risk (Acharya and Yorulmazer, 2007). This result is somehow consistent with the findings in Weiß et al. (2014) as they detect the systemic risk increase regardless the relative size is small, medium or large. The bank concentration index HHI has a negative and statistically significant coefficient (at 10% level). It implies that for a more concentrated a banking system, the acquirers' contribution to systemic risk will decrease which is an initial signal of the "concentration-stability hypothesis" as in Beck et al. (2006). Nevertheless, this evidence is not strong enough because the significance of the coefficient of this variable is at 10% only.

A further check is conducted to study whether these results hold when switching to the acquirers' ΔCoVaR as a measure of systemic risk contribution. Regression (1) of table 8 constitutes the baseline regression in which acquirer and deal characteristics, as well as the macroeconomic environment of acquirers, are used as independent variables. Similar to the results of the regressions based on MES changes, relative size again has a negative and statistically significant coefficient. Payment method, on the other hand, witnesses weakly significant positive coefficients. Surprisingly, the status of target variable shows positive and statistically significant coefficient in this regression. It indicates that private target is a determinant of the increase in acquirers' contribution to systemic risk post-merger as hypothesised. Indeed, mergers involved in private targets are projected to produce a risk-increasing effect for acquirers because private firms are subject to lower disclosure requirements; hence, it restricts the acquirers' capabilities to evaluate the risks associated with private targets themselves as well as making acquirers' due diligence ineffective. Therefore, the acquisitions of hidden risks from target firms may contribute to the increase in acquirers' default risk as well as their contribution to systemic risk. Dissimilar to the regressions using acquirers' MES, political stability witnesses negative and statistically significant coefficient. It means that a macroeconomic environment with high political stability will help to decrease acquirers' contribution to systemic risk which is somehow consistent with what is found in Weiß et al., (2014).

Moving onto regression (2) of table 7, the motivation for this specification is that acquirers and deals characteristics can solely drive the cross-sectional variation in the deal-related changes in acquiring banks' MES. Therefore, excluding country controls might improve the overall fit of the model. Regression (2) continues to observe the positive and statistically significant coefficient of payment method. Also, the relative size is the negative and statistically significant predictor of the merger-induced change in acquirer' MES which is similar to regression (1). However, the adjusted R-squared of regression (2) is smaller than regression (1), indicating that acquirers and deals characteristic variables alone possess less power for explaining the changes in MES than including also country controls. The R-squared of regression (2) compared to regression (1) of table 8 confirms the same observation. Results from the regression (2) regarding ΔCoVaR changes support the previous findings from regression (1) that payment method, the status of targets and relative size are significant determinants of merger-related change in ΔCoVaR.

Regression (3) of table 7 only uses 451 mergers of U.S. banking acquirers to check the results on the relation between the acquirer as well as deal characteristics and the change in acquirers' MES when non-U.S. mergers are excluded. The relative size is again found to be statistically significant and negatively related to the merger-induced change in the acquirer's MES (at 5% level of confidence). Payment method, on the other hand, is not significant in this case. It indicates that the statistically significant coefficient of a payment method from regression (1) is affected by non-US acquirers. The regression also witnesses a positive and significant coefficient of too-big-to-fail motive (although weak at 10% level). This finding somehow signals that the destabilising effect of bank merger is caused by bank's desire to become too big to fail although the evidence is not strong enough. It is also in line with the result from Weiß et al., (2014) as they find that too-big-to-fail motive is one of the main factors that cause the increase in acquiring banks' contribution to systemic risk among large banks using MES model. The motivation to become SIFIs to exploit government safety net and bailouts urges banks to pursue even risky M&As or value-destroying merger deals, which in turns increase banks' contributions to systemic risk. In regression (3) of table 8, there is weak evidence that small relative size contributes to an increase in U.S. acquirers' ∆CoVaR post-merger. It is important to note that regression (3) in both tables for US acquirers possesses negative adjusted R-squared. It can be interpreted as merger-related changes in MES and ∆CoVaR of US acquirers are insignificant. In other words, mergers do not affect US acquirers' contribution to systemic risk. Also, US acquirers' contribution to systemic risk could predominantly be driven by irrational contagion rather than acquirer or market fundamentals.

In regression (4) of table 7, acquirer and deal characteristics, as well as macroeconomic variables for the respective acquirer' country, are used for the sample including non-US acquirers. Similar findings are found when payment method and relative size are a significant predictor of the acquirer's change in MES post-merger. Product diversification variable in the regression has negative and statistically significant coefficient (at 10% level). It indicates that product-diversifying deals help to decrease non-US acquirers' contribution to systemic risk following a merger. Therefore, the second hypothesis which projects that product-diversifying deals produce a systemic risk-reducing effect cannot be rejected. In regression (5) of table 8, the findings are consistent with the full sample regressions with payment method, and relative size are significant determinants of the change in non-US acquirers' ∆CoVaR.

Overall, the findings in all specifications based on acquirers' MES and ∆CoVaR confirms the results of the univariate test in the previous section. First, for deals financed by cash only, the acquirers' contribution to systemic risk is increasing. This study also considers other financing methods such as stock or stock and cash. Because payment method is a dummy variable; it indicates that deals financed by stock or stock and cash are associated with the decrease in acquirers' contribution to systemic risk. Second, the smaller the deal size in comparison with acquirers' market value, mergers will increase acquirers' contribution to systemic risk. Third, private targets prevent acquirers in realising the systemic risk-reduction effect. Also, product-diversifying deals produce a systemic risk-reducing effect for acquirers. Finally, the more stable a political environment and a more concentrated banking system in an acquirer' country before a merger, the higher the reduction of bidders' contribution to systemic risk will be.

5.3 Robustness checks

As can be seen, the results of this study are robust in both the univariate tests and in all specifications of the regressions using both systemic risk measures MES and ∆CoVaR of acquirers because the findings are consistent in all analyses. To further verify the robustness of the results obtained in the empirical analysis, we conduct the following robustness check. Apart from the acquirers' ΔCoVaR estimated based on multivariate GARCH-DCC model as in this paper, a further estimation method of ΔCoVaR is conducted based on the standard quantile regression as in Adrian and Brunnermeier (2016). It is found that the conclusions are drawn from the OLS regressions with Huber–White standard errors with ΔCoVaR estimated based on both quantile regression and GARCH-DCC model in the univariate test above remain unchanged.

6. Conclusion

In this paper, we investigate the systemic risk implications of bank mergers covering the period from 1998 until 2015, six years after the 2007-09 global financial crisis. We find that mergers and acquisitions, on average, do not impact on the acquiring banks' contribution to systemic risk regardless of the increased potential for risk diversification exhibited by cross-border and cross-industry bank mergers. When examining the influence of potential factors that we anticipate having an impact on the change in bidding banks' contribution to systemic risk, payment method, the status of target, relative size, product diversification, HHI and political stability are all found to be significant determinants.

Overall, the results convey a critical view of the risk-reduction potential of bank M&A. Bank mergers, at best, are risk neutral, yet offer substantial scope for increases in the likelihood of acquirers' contribution to systemic risk. If risk reductions tend not to materialise, but there is a clear possibility that the acquiring bank exhibits a higher contribution to systemic risk post-M&A, it is necessary for banking supervisors to consider the aspect of financial stability as a further important criterion within the approval process for bank mergers. As the empirical findings indicate, especially mergers that financed by cash only, smaller relative size, as well as involved private targets, need to be carefully examined by regulators as these are particularly prone to destabilise the banking sector. Also, it is important that policy makers maintain a stable political environment so that bank mergers in such environment enhance the systemic stability of the banking sector. Future research should further look at the deal-induced risk implications of target characteristics in explaining the changes in bidders' contribution to systemic risk post-merger. Also, due to the fact that the data for worldwide surveys on bank regulation and supervision in Barth et al. (2013) are only available until 2012 from World Bank, a further study may examine the systemic risk effects of bank mergers on bidding banks taken the regulatory variables into account as control variables when more updated data become available.

Appendix A. Marginal Expected Shortfall

A.1 Derivation of equation 3

Starting with the expression for the expected loss of the financial system at time t

$$ES_{mt}(C) = -\mathbb{E}_{t-1}(r_{mt}|r_{mt} < C) \text{ (A.1)}$$

following Scaillet (2005), it is shown that the first order derivative for the weight associated with the *i*th asset, i.e. MES, is given by

$$\frac{\partial ES_{mt}(C)}{\partial w_i} = \mathbb{E}_{t-1}(r_{it}|r_{mt} < C) \text{ (A.2)}$$

For this, $\breve{r}_{mt}$ is the return for the financial system except for the contribution of the *i*th asset, where $\breve{r}_{mt} = \sum_{j=1\ j\neq i}^{n} w_j r_{jt}$and $r_{mt} = \breve{r}_{mt} + w_i r_{it}$

Besides, the threshold C is not restricted to being a scalar. It is assumed to depend on the distribution of the market returns and hence on the weights and the specified probability to be in the tail of the distribution *p,* as in the case of the VaR (Gourieroux et al., 2000), thus providing a general proof for Eq. (A.2). It follows that:

$$ES_{mt}(C) = \mathbb{E}_{t-1}\left(\breve{r}_{mt} + w_i r_{it}\middle|\breve{r}_{mt} + w_i r_{it} < C(w_i, p)\right) = \frac{1}{p}\int_{-\infty}^{\infty}(\int_{-\infty}^{C(w_i,p)-w_i r_{it}}\breve{(}r_{mt} + w_i r_{it})f(\breve{r}_{mt}, r_{it})d\breve{r}_{mt})dr_{it} \quad \text{(A.3)}$$

where $f(\breve{r}_{mt}, r_{it})$ stands for the joint probability density function of the two series of returns. Consequently,

$$\frac{\partial ES_{mt}(C)}{\partial w_i} = \frac{1}{p}\int_{-\infty}^{\infty}(\int_{-\infty}^{C(w_i,p)-w_i r_{it}}\breve{(}r_{it})f(\breve{r}_{mt}, r_{it})d\breve{r}_{mt})\, dr_{it} + \frac{1}{p}\int_{-\infty}^{\infty}\left(\frac{\partial C(w_i,p)}{\partial w_i} - r_{it}\right) C(w_i, p) f C(w_i, p) - w_i r_{it}, r_{it}) dr_{it} \text{ (A.4)}$$

However, the probability of being in the left tail of the distribution of the market return is constant, i.e. $\Pr(\breve{r}_{mt} + w_i r_{it} < C) = p$

A direct implication of this fact is that the first order derivative of this probability is null. To put it differently, using simple calculus rules for cumulative distribution functions, it can be shown that $\left(\frac{\partial C(w_i,p)}{\partial w_i} - r_{it}\right) f(C(w_i, p) - w_i r_{it}, r_{it}) = 0$ (A.5)

Therefore Eq. (A.4) can be written compactly as

$$\frac{\partial ES_{mt}(C)}{\partial w_i} = \frac{1}{p}\int_{-\infty}^{\infty}(\int_{-\infty}^{C(w_i,p)-w_i r_{it}}\breve{(}r_{it})f(\breve{r}_{mt}, r_{it})d\breve{r}_{mt})\, dr_{it} = \mathbb{E}_{t-1}\left(r_{it}\middle|\breve{r}_{mt} + w_i r_{it} < C(w_i, p)\right) = \mathbb{E}_{t-1}(r_{it}|r_{mt} < C) \text{ (A.6)}$$

which completes the proof.

A.2 Derivation of equation 6

Let consider the Cholesky decomposition of the variance-covariance matrix Ht:

$$H_t^{1/2} = \begin{pmatrix} \sigma_{mt} & 0 \\ \sigma_{it}\rho_{it} & \sigma_{it}\sqrt{1-{\rho_{it}}^2} \end{pmatrix} \text{ (A.7)}$$

Given Equation (4), the market and firm's returns can be expressed as:

$$r_{mt} = \sigma_{mt}\varepsilon_{mt} \text{ (B.2)}$$

$$r_{it} = \sigma_{it}\rho_{it}\varepsilon_{mt} + \sigma_{it}\sqrt{1-\rho_{it}^2}\xi_{it} \text{ (A.8)}$$

For any conditioning event C:

$$MES_{it}(C) = \mathbb{E}_{t-1}(r_{it}|r_{mt} < C) = \sigma_{it}\rho_{it}\mathbb{E}_{t-1}\left(\varepsilon_{mt}\middle|\varepsilon_{mt} < \frac{C}{\sigma_{mt}}\right) +$$

$$\sigma_{it}\sqrt{1-\rho_{it}^2}\mathbb{E}_{t-1}\left(\xi_{it}\middle|\varepsilon_{mt} < \frac{C}{\sigma_{mt}}\right) \text{ (A.9)}$$

which completes the proof.

A.3 Tail expectations

The tail expectations $\mathbb{E}_{t-1}\left(\varepsilon_{mt}\middle|\varepsilon_{mt} < \frac{C}{\sigma_{mt}}\right)$ and $\mathbb{E}_{t-1}\left(\xi_{it}\middle|\varepsilon_{mt} < \frac{C}{\sigma_{mt}}\right)$ can be easily estimated in a non-parametric kernel framework by elaborating on (Scaillet, 2005).

For ease of notation, let denote the systemic risk event $\frac{C}{\sigma_{mt}}$ by k. The tail expectation on the market returns $\mathbb{E}_{t-1}\left(\varepsilon_{mt}\middle|\varepsilon_{mt} < \frac{C}{\sigma_{mt}}\right)$, which becomes $\mathbb{E}_{t-1}(\varepsilon_{mt}|\varepsilon_{mt} < k)$. (A.10)

Using the definition of the conditional mean, (A.10) is rewritten as a function of the probability density function f

$$\mathbb{E}_{t-1}(\varepsilon_{mt}|\varepsilon_{mt} < k) = \int_{-\infty}^{k} \varepsilon_{mt} f(u|u < k)du \text{ (A.11)}$$

where the conditional density $f(u|u < k)$ can be stated as

$$\frac{f(u)}{\Pr(u<k)} \text{ (A.12)}$$

To complete the proof, the numerator and denominator in (A.12) are computed. For this, the standard kernel density estimator of the density f at point *u* given by

$$\hat{f}_u = \frac{1}{Th}\sum_{1}^{T} \emptyset\left(\frac{u-\varepsilon_{mt}}{h}\right)$$

where h stands for the bandwidth parameter, and T is the sample size (Silverman, 1986).

Second, the probability of being in the tail of the distribution can be defined as the integral of the probability density function over the domain of definition of the variable *u*, i.e. $p = \Pr(u < k) = \int_{-\infty}^{k} f(u)du$. Consequently, by replacing $\hat{f}_u$ with the kernel estimator, the following is obtained

$$\hat{p} = \frac{1}{Th}\sum_{t=1}^{T} \emptyset(\frac{k - \varepsilon_{mt}}{h})$$

The expectation in (A.10) hence takes the form

$$\widehat{\mathbb{E}}_{t-1}(\varepsilon_{mt}|\varepsilon_{mt} < k) = \frac{\sum_{t=1}^{T} \varepsilon_{mt}\emptyset(\frac{k-\varepsilon_{mt}}{h})}{\sum_{t=1}^{T} \emptyset(\frac{k-\varepsilon_{mt}}{h})} \text{ (A.13)}$$

Similarly, it can be shown that

$$\widehat{\mathbb{E}}_{t-1}(\xi_{it}|\varepsilon_{mt} < k) = \frac{\sum_{t=1}^{T} \xi_{it}\emptyset(\frac{k-\varepsilon_{mt}}{h})}{\sum_{t=1}^{T} \emptyset(\frac{k-\varepsilon_{mt}}{h})} \text{ (A.14)}$$

Appendix B. CoVaR

B1. Derivation of equation 12

Considering two cases: a general case with $\rho_{it} \neq 0$ and a special case with $\rho_{it}= 0$. Given Equations (4) and (5), $\rho_{it} \neq 0$ then the market return can be expressed as:

$$r_{mt} = \frac{\sigma_{mt}}{\sigma_{it}\rho_{it}} r_{it} - \frac{\sigma_{mt}\sqrt{1-\rho_{it}{}^2}}{\rho_{it}} \xi_{it} \text{ (A.15)}$$

For each conditioning event form $\mathbb{C}\ (r_{it})$: $r_{it} = C$, CoVaR is defined as follows:

$$Pr\left(r_{mt} \leq CoVaR_t^{m|r_{it}=C} \middle| r_{it} = C\right) = \alpha \text{ (A.16)}$$

or equivalently:

$$Pr\left(\xi_{it} \leq \frac{\rho_{it}}{\sigma_{mt}\sqrt{1-\rho_{it}{}^2}}(\frac{\sigma_{mt}}{\sigma_{it}\rho_{it}} C - CoVaR_t^{m|r_{it}=C}) \middle| r_{it} = C\right) = 1 - \alpha \text{ (A.17)}$$

In the special case where the conditional mean function of ξ_{it} is linear in r_{it}, the first two conditional moments of ξ_{it} given $r_{it} = C$ can be expressed as:

$$\mathbb{E}(\xi_{it}|r_{it} = C) = \frac{cov(\xi_{it}, r_{it})}{\sigma_{it}^2} * C = \frac{\sigma_{it}\sqrt{1-\rho_{it}{}^2}}{\sigma_{it}^2} * C = \frac{\sqrt{1-\rho_{it}{}^2}}{\sigma_{it}} * C \text{ (A.18)}$$

$$\mathbb{V}(\xi_{it}|r_{it}) = \mathbb{V}(\xi_{it}) - \mathbb{V}(r_{it})[\ \mathbb{E}(\xi_{it}|r_{it})] = \mathbb{V}(\xi_{it}) * \left[1 - \left(\frac{cov(\xi_{it}, r_{it})}{\sigma_{it}^2}\right)^2 \sigma_{it}^2\right] = \rho_{it}^2 \text{(A.19)}$$

Consider G(.) the conditional (location-scale) demeaned and standardized cdf of ξ_{it} such that:

$$\mathbb{E}\left[\frac{1}{\rho_{it}}\left(\xi_{it} - \frac{\sqrt{1-\rho_{it}{}^2}}{\sigma_{it}} * C\right) \middle| r_{it} = C\right] = 0 \text{ (A.20)}$$

$$\mathbb{V}\left[\frac{1}{\rho_{it}}\left(\xi_{it} - \frac{\sqrt{1-\rho_{it}{}^2}}{\sigma_{it}} * C\right) \middle| r_{it} = C\right] = 1 \text{ (A.21)}$$

Thus, Equation (A.17) is expressed as:

$$\frac{1}{\rho_{it}}\left(\frac{\rho_{it}}{\sigma_{mt}\sqrt{1-\rho_{it}{}^2}}(\frac{\sigma_{mt}}{\sigma_{it}\rho_{it}} C - CoVaR_t^{m|r_{it}=C}) - \frac{\sqrt{1-\rho_{it}{}^2}}{\sigma_{it}} * C\right) = G^{-1}(1 - \alpha) \text{ (A.22)}$$

By rearranging these terms, we write the general expression of the CoVaR:

$$CoVaR_t^{m|r_{it}=C} = -\sigma_{mt}\sqrt{1-\rho_{it}{}^2}G^{-1}(1-\alpha) + \frac{\rho_{it}\sigma_{mt}}{\sigma_{it}}C \text{(A.23)}$$

The CoVaR defined for the conditioning event

$\mathbb{C}\ (r_{it})$: $r_{it} = Median(r_{it})$ has a similar expression:

$$CoVaR_t^{m|r_{it}=Median(r_{it})} = -\sigma_{mt}\sqrt{1-\rho_{it}{}^2}G^{-1}(1-\alpha) + \frac{\rho_{it}\sigma_{mt}}{\sigma_{it}}F^{-1}(0.5) \text{ (A.24)}$$

where F (:) denotes the marginal cdf of the firm return. Then, for each conditioning event form $\mathbb{C}\ (r_{it})$: $r_{it} = C$, the ΔCoVaR is defined as:

$$\Delta CoVaR_{it}(C) = CoVaR_t^{m|r_{it}=C} - CoVaR_t^{m|r_{it}=Median(r_{it})} = \frac{\rho_{it}\sigma_{mt}}{\sigma_{it}} * [C - Median(r_{it})] \text{(A.25)}$$

$$= \gamma_{it} * [C - Median(r_{it})] \text{ (A.26)}$$

where $\gamma_{it} = \sigma_{mt}\rho_{it}/\sigma_{it}$ denotes the time-varying linear projection coefficient of the market return on the firm return. If the marginal distribution of r_{it} is symmetric around zero, then $F^{-1}(0.5) = 0$, and we have:

$$\Delta CoVaR_{it}(C) = \frac{\rho_{it}\sigma_{mt}}{\sigma_{it}} * C = \gamma_{it} * C \text{ (A.27)}$$

As in Adrian and Brunnermeier (2011), ΔCoVaR denoted $\Delta CoVaR_{it}(\alpha)$ and defined for a conditioning event $\mathbb{C}\ (r_{it})$: $r_{it} = VaR_{it}(\alpha)$ is:

$$\Delta CoVaR_{it}(\alpha) = \gamma_{it}[VaR_{it}(\alpha) - VaR_{it}(0.5)] \text{ (A.28)}$$

or

$$\Delta CoVaR_{it}(\alpha) = \gamma_{it}VaR_{it}(\alpha) \text{ (A.29)}$$

if the marginal distribution of the firm return is symmetric around zero. Considering the case where $\rho_{it} = 0$ and the bivariate process becomes:

$$r_{mt} = \sigma_{mt}\varepsilon_{mt} \text{(A.30)}$$

$$r_{it} = \sigma_{it}\xi_{mt} \text{(A.31)}$$

$$(\varepsilon_{mt}, \xi_{mt}) \sim D \text{(A.32)}$$

where $v_t = (\varepsilon_{mt}, \xi_{mt})'$ satisfies $\mathbb{E}(v_t) = 0$ and $\mathbb{E}(v_t v_t') = I_2$ and D denotes the bivariate distribution of the standardized innovations. It is straightforward to show that:

$$Pr\left(r_{mt} \leq CoVaR_t^{m|r_{it}=VaR_{it}(\alpha)} \middle| r_{it} = VaR_{it}(\alpha)\right) = Pr\left(r_{mt} \leq CoVaR_t^{m|r_{it}=VaR_{it}(\alpha)}\right) = \alpha$$

(A.33)

Hence, we have $CoVaR_{it}(\alpha) = \sigma_{mt}F_m^{-1}(\alpha)$ and $\Delta CoVaR_{it}(\alpha) = 0$ where $F_m(.)$ denotes the cdf of the marginal distribution of the standardized market return.

Appendix C. Variable definition

Variable name	Definition	Data source
Risk Measures		
Pre-merger MES	Pre-merger MES (180 days to 11 days before merger announcement)	Bloomberg, own calculation
Post-completion MES	Post-merger MES (11 days to 180 days after the deal completes)	Bloomberg, own calculation
ΔMES	Merger-related change in MES	Bloomberg, own calculation
Pre-merger ΔCoVaR	Pre-merger ΔCoVaR (180 days to 11 days before merger announcement)	Bloomberg, own calculation
Post-completion ΔCoVaR	Post-merger ΔCoVaR (11 days to 180 days after the deal completes)	Bloomberg, own calculation
Change in ΔCoVaR	Merger-related change in ΔCoVaR	Bloomberg, own calculation
Acquirer and deal characteristics		
Payment method	Equals 1 if the deal is fully financed by cash (zero otherwise)	Bloomberg
Status of target	Equals 1 if the target is a private firm (zero otherwise)	Bloomberg
Deal size	Natural logarithm of the deal value (in millions of US dollar)	Bloomberg
Relative size	Ratio of the deal value to the acquirer's market value the year before the announcement (%)	Bloomberg, own calculation
Cross-border	Equals 1 for cross-border mergers (0 for domestic mergers)	Bloomberg
Product diversification	Equals 1 if the acquirer and the target do not share the same four-digit ICB[1] code (0 otherwise)	Bloomberg
ROA	Pre-tax profits over total assets (%)	Bloomberg
Market to book ratio	Market-to-book ratio (%)	Bloomberg

[1] The Industry Classification Benchmark (ICB) is an industry classification taxonomy owned by FTSE. The ICB is used globally to divide the market into increasingly specific categories, allowing investors to compare industry trends between well-defined subsectors. The ICB uses a system of 10 industries, partitioned into 19 super-sectors, which are further divided into 41 sectors, which then contain 114 subsectors.

Leverage	Long-term debt over total assets (%)	Bloomberg
Operating efficiency	Ratio of operating costs over total assets (%)	Bloomberg
Capital ratio	Book value of equity over total assets (%)	Bloomberg
Acquirers' total assets	Natural logarithm of acquirers' total assets (in millions of US dollar)	Bloomberg, own calculation
High-risk banks	The pre-merger default risk of acquirers, which takes the value of 1 for banks in the first distance to default quartile (i.e. banks with the highest level of pre-merger default risk) and zero otherwise	Bloomberg, own calculation
Country control		
GDP	Annual real GDP growth rate (in %)	Bloomberg
HHI	Herfindahl–Hirschman Index computed as the sum of the squared market shares of a country's domestic and foreign banks	* WITS, World Bank
Political stability	This indicator measures the perceptions of the likelihood that the government will be destabilised or overthrown by unconstitutional or violence. Indicator ranges from (-2.5) to (2.5). A higher indicator value indicates greater political stability	** WDI, World Bank
Rule of Law	The Rule of Law indicator measures the individual's degree of confidence in rules of society and the likelihood of crime and violence. The scores range between -2.5 and 2.5. Higher scores correspond with better outcomes	*** WDI, World Bank

* http://wits.worldbank.org/CountryProfile/en/Country/BY-COUNTRY/StartYear/2011/EndYear/2015/Indicator/HH-MKT-CNCNTRTN-NDX

** http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators

*** http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators

References

Acharya, V. V. et al. (2017). Measuring systemic risk. *Review of Financial Studies*, 30 (1), 2–47.

Acharya, V. V and Yorulmazer, T. (2007). Too many to fail - An analysis of time-inconsistency in bank closure policies. *Journal of Financial Intermediation*, 16 (1), 1–31.

Adrian, T. and Brunnermeier, M.K. (2016). CoVaR. *American Economic Review*, 106 (7), 1705–1741.

Allen, F. and Gale, D. (2000). Financial Contagion. *The Journal of Political Economy*, 108 (1), 1–33.

Allen, F. and Gale, D. (2004). Financial Intermediaries and Markets. *Econometrica*, 72 (4), 1023–1061.

Asquith, P. and Kim, E.H. (1982). The Impact of Merger Bids on the Participating Firms' Security Holders. *Journal of Finance*, 37 (5), 1209–1228.

Barth, J.R. et al. (2013). Do bank regulation, supervision and monitoring enhance or impede bank efficiency? *Journal of Banking and Finance*, 37 (8), 2879–2892.

Beck, T., Demirgüç-Kunt, A. and Levine, R. (2006). Bank concentration, competition, and crises: First results. *Journal of Banking and Finance*, 30 (5), 1581–1603.

Benston, G.J., Hunter, W.C. and Wall, L.D. (1995). Motivations for Bank Mergers and Acquisitions: Enhancing the Deposit Insurance Put Option versus Earnings Diversification. *Journal of Money, Credit and Banking*, 27 (3), 777–788.

Berger, A.N. (2000). The Integration of the Financial Services Industry. *North American Actuarial Journal*, 4 (3), 25–45.

Berger, A.N., Klapper, L.F. and Turk-ariss, R. (2009). Bank Competition and Financial Stability. *Journal of Financial Services Research*, 35 (2), 99–118.

Bierth, C., Irresberger, F. and Weiß, G.N.F. (2015). Systemic risk of insurers around the globe. *Journal of Banking and Finance*, 55 232–245.

Black, L. et al. (2016). The systemic risk of European banks during the financial and sovereign debt crises. *Journal of Banking and Finance*, 63 107–125.

Boyd, J.H. and De Nicoló, G. (2006). The Theory of Bank Risk Taking and Competition Revisited. *Journal of Finance*, 60 (3), 1329–1343.

Brownlees, C.T. and Engle, R.F. (2012). *Volatility, Correlation and Tails for Systemic Risk Measurement*.

Caminal, R. and Matutes, C. (2002). Market power and banking failures. *International Journal of Industrial Organization*, 20 (9), 1341–1361.

Campa, J.M. and Hernando, I. (2008). The reaction by industry insiders to M&As in the European financial industry. *Journal of Financial Services Research*, 33 (2), 127–146.

Cetorelli, N. et al. (2007). Trends in financial market concentration and their implications for market stability. *Federal Reserve Bank of New York: Economic Policy Review*, 13 (1), 33–51.

Chu, K.H. (2015). Bank consolidation and stability: The Canadian experience, 1867-1935. *Journal of Financial Stability*, 21 46–60.

De Jonghe, O. (2010). Back to the basics in banking? A micro-analysis of banking system stability. *Journal of Financial Intermediation*, 19 (3), 387–417.

De Nicolo, G., Bartholomew, P., Zaman, J. and Zephirin, M. (2004). Bank Consolidation, Internationalization, and Conglomeration: Trends and Implications for Financial Risk. *Financial Markets, Institutions and Instruments*, 13 (4), 173–217.

De Nicolo, G. and Kwast, M.L. (2002). Systemic risk and financial consolidation: Are they related? *Journal of Banking and Finance*, 26 (5), 861–880.

Diamond, D.W. (1984). Financial Intermediation and Delegated Monitoring. *The review of Economic Studies*, 51 (3), 393–414.

Ellis, L., Haldane, A. and Moshirian, F. (2014). Systemic risk, governance and global financial stability. *Journal of Banking and Finance,* 45 175–181.

Engle, R.F. (2001). *DCC Multivariate GARCH*. UCSD Economics Discussion Paper, .

Furfine, C.H. and Rosen, R.J. (2011). Mergers increase default risk. *Journal of Corporate Finance*, 17 (4), 832–849.

Girardi, G. and Tolga Ergün, A. (2013). Systemic risk measurement: Multivariate GARCH estimation of CoVaR. *Journal of Banking and Finance*, 37 (8), 3169–3180.

Glosten, L.R., Jagannathan, R. and Runkle, D.E. (1993). On the Relation between the Expected Value and the Volatility of the Nominal Excess Return on Stocks. *The Journal of Finance*, 48 (5), 1779–1801.

Gourieroux, C., Laurent, J.P. and Scaillet, O. (2000). Sensitivity analysis of Values at Risk. *Journal of Empirical Finance*, 7 (3), 225–245.

Guerra, M.S. et al. (2016). Systemic risk measures. *Physica A: Statistical Mechanics and its Applications*, 442 329–342.

Hagendorff, J. and Vallascas, F. (2011). CEO pay incentives and risk-taking: Evidence from bank acquisitions. *Journal of Corporate Finance*, 17 (4), 1078–1095.

Hagendorff, J. et al. (2012). What do premiums paid for bank M&As reflect? The case of the European Union. *Journal of Banking & Finance*, 36 (3), 749–759.

Halpern, P. (1983). Corporate Acquisitions: A Theory of Special Cases? A Review of Event Studies Applied to Acquisitions. *The Journal of Finance*, 38 (2), 297–317.

James, C.M. and Wier, P. (1987). Returns to acquirers and competition in the acquisition market: the case of banking. *Journal of Political Economy*, 95 (2), 355–370.

Jorion, P. (2007). *Value at Risk: The New Benchmark for Managing Financial Risk.*, 3rd ed. McGraw-Hill.

Kane, E.J. (2000). Incentives for Banking Megamergers: What Motives Might Regulators

Infer from Event-Study Evidence? *Journal of Money, Credit and Banking*, 32 (3), 671–705.

Keeley, M.C. (1990). Deposit Insurance, Risk, and Market Power in Banking. *The American Economic Review*, 80 (5), 1183–1200.

Koerniadi, H., Krishnamurti, C. and Tourani-rad, A. (2015). Cross-border mergers and acquisitions and default risk. *International Review of Financial Analysis*, 42 336–348.

Kupiec, P. and Guntay, L. (2016). Testing for Systemic Risk using Stock Returns. *Journal of Financial Services Research*, 49 (2), 203–227.

Lim, P.Y., Khong, R.W.L. and Tan, H. (2015). Bank Integration and Systemic Risk: Panacea or Pandemic? *The Journal of Developing Areas*, 49 (4), 301–312.

Méon, P.-G. and Weill, L. (2005). Can mergers in Europe help banks hedge against macroeconomic risk? *Applied Financial Economics*, 15 (5), 315–326.

Mishkin, F.S. (1999). Financial consolidation: Dangers and opportunities. *Journal of Banking & Finance*, 23 (2), 675–691.

Molyneux, P., Schaeck, K. and Zhou, T.M. (2014). 'Too systemically important to fail' in banking - Evidence from bank mergers and acquisitions. *Journal of International Money and Finance*, 49 258–282.

Mühlnickel, J. and Weiß, G.N.F. (2015). Consolidation and systemic risk in the international insurance industry. *Journal of Financial Stability*, 18 187–202.

Northcott, C.A. (2004). *Competition in Banking: A Review of the Literature*.

Raffestin, L. (2014). Diversification and systemic risk. *Journal of Banking and Finance*, 46 (1), 85–106.

Rao-nicholson, R. and Salaber, J. (2016). Impact of the Financial Crisis on Cross- Border Mergers and Acquisitions and Concentration in the Global Banking Industry. *Thunderbird International Business Review*, 58 (2), 161–174.

Scaillet, O. (2005). Nonparametric Estimation of Conditional Expected Shortfall. *Insurance and Risk Management Journal*, 74 (1), 639–660.

Silverman, B.W. (1986). *Density Estimation for Statistics and Data Analysis*. London: Chapman and Hall.

Sum, K. (2016). A review of individual and systemic risk measures in terms of applicability for banking regulations. *Contemporary Economics*, 10 (1), 71–82.

Uhde, A. and Heimeshoff, U. (2009). Consolidation in banking and financial stability in Europe: Empirical evidence. *Journal of Banking and Finance*, 33 (7), 1299–1311.

Vallascas, F. and Hagendorff, J. (2011). The impact of European bank mergers on bidder default risk. *Journal of Banking and Finance*, 35 (4), 902–915.

Wagner, W. (2010). Diversification at financial institutions and systemic crises. *Journal of Financial Intermediation*, 19 (3), 373–386.

Weiß, G.N.F., Neumann, S. and Bostandzic, D. (2014). Systemic risk and bank consolidation: International evidence. *Journal of Banking and Finance*, 40 165–181.

Winton, A. (1999). Don't Put All Your Eggs in One Basket? Diversification and Specialization in Lending. *SSRN Electronic Journal*,.