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SYSTEMIC RISK IN THE INSURANCE SECTOR-WHAT DO WE KNOW?

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Running title: Systemic Risk in the Insurance Sector

Abstract: This paper reviews the extant research on systemic risk in the insurance sector and outlines potential new areas of research in this field. We summarize 43 theoretical and empirical research papers from both academia and practitioner organizations and provide a classification of existing research. Our results show, in general, that traditional insurance activity in the life, non-life, and reinsurance sectors neither contribute to systemic risk, nor increase insurers' vulnerability to impairments of the financial system. However, non-traditional activities (e.g., CDS writing) might increase vulnerability and life insurers might be more vulnerable than non-life insurers due to higher leverage. Furthermore, it is especially CDS and financial guarantees in the underwriting process as well as securitization of business, including guarantees and short-term funding, in the funding and investing process that are likely to contribute to systemic risk. This paper is of interest not only to academics, but is also highly relevant for the industry, regulators, and policymakers.

Keywords: Systemic Risk; Insurance; Solvency II; Financial Crisis

1 Introduction

In the wake of the financial crisis and the collapse of Lehman Brothers and AIG, systemic risk has been widely discussed in the financial services sector. The events of 2008 also attracted a great deal of attention from the academic community. Thus it is not surprising that a number of research papers on systemic risk, as well as reports by regulators and industry think-tanks, have been published. Recently, the Financial Stability Board (FSB) published a list of nine global systemically important insurers and intends to implement several special policy measures for these institutions by January 2019.¹ Although most academics and practitioners generally agree that the insurance sector is not as prone to systemic risk as is the banking sector, a more detailed review of the work already done on this topic and a look at what remains to be investigated appears to be a worthwhile project.² Such a project needs to begin with a definition of systemic risk, since there is a lot of variation in how this term is understood.

This paper reviews what we know about systemic risk in the insurance sector and highlights areas in need of more research. Our results deepen the understanding of systemic risk in the insurance sector and also should motivate more research in this field. Our results indicate that policymakers and regulators need to closely analyse systemic risk, especially with respect to non-traditional insurance activities.

The remainder of the paper is organised as follows. In Section 2 we examine the definition of systemic risk and related issues so as to create a common basis of understanding. In Section 3 we review the extant insurance literature with respect to systemic risk and

¹ See FSB (2013). The FSB is an international organization that was established by the G-20 in April 2009. Its purpose is to monitor the finance industry and make recommendations for addressing systemic risk.

² A detailed review is necessary for at least two reasons. First, researchers document that selected business activities might also contribute to systemic risk in the insurance sector. The systemic risk contribution of the insurance sector is thus not trivial and depends on the respective situation; the structured review helps identify these situations. Second, mixed results regarding systemic risk are documented in literature, e.g., with respect to reinsurance, which calls for a structured review of the analysed aspects and open research problems.

summarize the main results for different lines and activities of insurance companies. We conclude and discuss future research directions in Section 4.

2 Definition and Classification of Systemic Risk

There is no generally agreed-to definition of ‘systemic risk’; indeed, the only thing that is agreed upon regarding the term is that it involves uncertainty³ about the occurrence of a specific event. In the following, we review 43 definitions of systemic risk and identify three elements common to most of them. We first briefly describe these three elements and then discuss an appropriate classification of the term ‘systemic risk’.

- **Risk of an event:** For each risk there must be an associated event that can occur. The associated event is the dysfunction of financial services, default of financial institutions, or a shock to the economy.⁴
- **Impact of the event:** Most definitions specify the consequences if the event occurs, which is usually that the real economy is negatively affected.
- **Causation of the event:** Some definitions require the risk to have a certain causation before it is labelled systemic. These causations can be general in nature and/or specific⁵ and are mostly related to the financial services sector.

Table 1 classifies definitions according to the three criteria (the definitions themselves are listed in Table A1 in the Appendix).

³ From the perspective of risk theory, the term ‘risk’ could be considered misleading since it typically implies that the probability of the occurrence of an event is measurable and exactly known. In contrast, ‘uncertainty’ implies that the probability of the occurrence of an event is not measurable and not exactly known. Most scholars base their definition of uncertainty and risk on Knight (1921, p. 233). See, e.g., Tversky and Kahneman (1992), Camerer and Weber (1992), and Zweifel and Eisen (2012, p. 1). There are various approaches to measuring systemic risk; however, none provides anything close to an exact probability. For an overview of systemic risk measures, see, e.g., Bisias et al. (2012). In the following, for the sake of simplicity, we use the term ‘risk’ as it is used in the systemic risk literature.

⁴ The first two aspects refer to financial services; the latter event involves the general economy. For a further explanation of key terms used in this paper, see Table A2 in the Appendix. We use ‘financial instability’ as a synonym for ‘dysfunction of financial services’. It must be kept in mind that neither financial ‘stability’ or ‘instability’ have clear-cut definitions. See, e.g., Allen and Wood (2006), European Central Bank (2013, p. 5), and Federal Reserve Bank of Cleveland (2013).

⁵ Klein (2011, p. 5) writes that idiosyncratic events (e.g., the failure of a single entity or cluster of entities) or general conditions in financial intermediaries might cause systemic risk. The general conditions are related to the linkages between financial institutions, which can lead to a cascading effect of bankruptcies, especially in the case of excessive risk taking.

Reference	1. Event (Risk of ...)	2. Event impact (... with the consequence of ...)	3. Causation (... caused by ...)
Acharya et al. (2011)	<ul style="list-style-type: none"> • Failure of significant part of financial sector 	<ul style="list-style-type: none"> • Reduction of availability of credit and risk management products and • Negative effect on real economy 	-
Adrian and Brunnermeier (2011)	<ul style="list-style-type: none"> • Impairment of financial system 	<ul style="list-style-type: none"> • Negative effect on credit supply 	-
Bach and Nyuyen (2012), Rodriguez-Moreno and Peña (2013)	<ul style="list-style-type: none"> • Malfunction of the financial system 	<ul style="list-style-type: none"> • Negative effect on economic growth and welfare 	-
Baur et al. (2003), Chen et al. (2013b), Cummins and Weiss (2011, 2013), Group of Ten (2001), Weiß and Mühnickel (2013a)	<ul style="list-style-type: none"> • Loss of economic value or • Confidence in financial system 	<ul style="list-style-type: none"> • Negative effect on real economy 	-
Baluch et al. (2011)	<ul style="list-style-type: none"> • Contractual obligations that cannot be met 	<ul style="list-style-type: none"> • Chain reaction of defaults and • Financial difficulties 	-
Bernanke as reported by Boles (2009)	<ul style="list-style-type: none"> • Instability of the financial system as a whole 	<ul style="list-style-type: none"> • Negative effect on real economy 	-
Billio et al. (2010)	<ul style="list-style-type: none"> • Correlated defaults of financial institutions over a short period of time 	<ul style="list-style-type: none"> • Withdrawal of liquidity and • Confidence from the financial system 	-
Chen et al. (2013a), Huang et al. (2009)	<ul style="list-style-type: none"> • Multiple simultaneous defaults of major financial institutions 	-	<ul style="list-style-type: none"> • The co-movement of key financial variables measuring the health of stability of financial institutions
Committee on Capital Markets Regulation (CCMR) (2009)	<ul style="list-style-type: none"> • Collapse of an entire system or • Entire market 	-	<ul style="list-style-type: none"> • Links and interdependencies, where the failure of a single entity or cluster of entities can cause a cascading failure
DeBandt and Hartmann (2000)	<ul style="list-style-type: none"> • Significant part of financial institutions fail 	-	<ul style="list-style-type: none"> • Narrow shock (few institutions affected) and contagion or • Wide shock (many institutions affected)
Harrington (2011)	<ul style="list-style-type: none"> • Macroeconomic shock • Limited shock with its negative effects spread by contagion 	-	<ul style="list-style-type: none"> • Extensive interdependencies or • 'Interconnectedness' among firms
IAIS (2009), IMF/FSB/Geneva Association, Jobst (2012), Radice (2010)	<ul style="list-style-type: none"> • Disruption to the flow of financial services 	<ul style="list-style-type: none"> • Negative effect on real economy 	<ul style="list-style-type: none"> • Impairment of all or parts of the financial system
Klein (2011)	<ul style="list-style-type: none"> • Market or • Financial system instability 	-	<ul style="list-style-type: none"> • Idiosyncratic events or • Conditions in financial intermediaries and • Contagion
Kress (2011)	<ul style="list-style-type: none"> • Contagion 	-	-
Rodriguez-Moreno and Peña (2013)	<ul style="list-style-type: none"> • Malfunctioning in the financial system 	<ul style="list-style-type: none"> • Negative effect on real economy 	

Table 1: Various definitions of systemic risk

Table 1 makes obvious the enormous difficulty involved in differentiating between cause, impact, and events when discussing systemic risk.⁶ Thus, it is not surprising that, to date, no agreement on *the* definition of systemic risk has been reached.⁷ However, most of the definitions considered in this paper refer to the 2008 financial crisis,⁸ and it thus might be useful to look at the events of 2008 as a means of differentiating systemic risk from other risks.

- **Event:** Certain financial services became no longer available (e.g., inter-bank lending) or had virtually no market (e.g., availability of credit).
- **Impact of the event:** As a consequence, there was a substantial negative effect on the economy.
- **Causation of the event:** In 2008, an external shock (falling prices in the U.S. subprime mortgage market) impaired several financial institutions. Due to contagion and interdependence, other financial institutions and services became impaired as well.

An appropriate definition should comprise all risks that can lead to the reoccurrence of the 2008 crisis and exclude all other risks. It is especially the last point that is ignored in many studies. An exception is the concept of systemic risk proposed by De Bandt and Hartmann (2000), which distinguishes between risks of shocks based on their second-round effects (the focus is not on institutions affected by the shock, but on the consequences of these institutions being impaired due to the shock). In these authors' view, only when most institutions or markets would be affected indirectly and fail is the risk a systemic one. In addition, Harrington (2009) distinguishes systemic risk from the risk of common shocks. According to him, only the risk of an event that involves 'interdependency-transmitted contagion' (p. 802)

⁶ For example, it is not clear whether the shock to the real economy is the event or the consequence of the event. Similarly, it is far from clear whether default of institutions is the event or the causation of an event.

⁷ See, e.g., Liedtke (2010) and Dwyer (2009) for a critical discussion of several definitions of systemic risk.

⁸ See, e.g., Bach and Nguyen (2012, p. 128), Billio et al. (2012, p. 535), and Rodríguez-Moreno and Peña (2013, p. 1817).

should be labelled systemic. Our requirements for an appropriate definition of ‘systemic risk’ are as follows.

- **Risk of an event:** The definition should address the dysfunction of financial services. Mandating that the event must involve simultaneous default of institutions or contagion effects would result in a too narrow definition of systemic risk, since such events can conceivably occur without the financial services sector becoming dysfunctional.
- **Impact of the event:** The definition should include that the event has to cause a substantial negative impact on the real economy. The term ‘substantial negative impact on the real economy’ is important since without this level of specificity the definition could cover insignificant events. The term ‘substantial’ should be understood in terms of severity. Furthermore, the negative impact must be a definite consequence of the occurring event. Otherwise, as Liedtke (2010) points out, risks of wars, floods, and diseases would also be systemic risks, making the definition too broad to be useful.
- **Causation of the event:** Likewise, unless causation of the risk is included, the definition will again be too broad. For example, without putting some limits on ‘causation’, the risk that the regulator will issue a regulation that impairs financial services with the consequence that the real economy is affected could be labelled a systemic risk. However, the limits on causation must not be too narrow either. For example, some extant definitions only consider as systemic the risk of a certain event caused by the impairment of a few institutions that starts a chain reaction. However, the situation where one shock affects the entire financial services industry is omitted. Basically, it is important that the definition makes clear that systemic risk emerges within the financial system.

Based on these considerations, in the remainder of this paper we use the frequently employed definition of systemic risk set out by the FSB and IAIS.⁹ Systemic risk is defined as ‘a risk of

⁹ See FSB (2009) and IAIS (2009).

disruption to financial services that is (i) caused by an impairment of all or parts of the financial system and (ii) has the potential to have serious negative consequences for the real economy'. This definition's occurring event meets our requirements. Also, the definition covers spillover effects to the real economy and causal relationships. Moreover, only risks that emerge due to issues within the financial system are included. The downside of this definition is that the terms 'serious' and 'consequences for the real economy' are not exactly specified.

A conceptualization of systemic risk is illustrated in Figure 1. Systemic risk describes the risk of an event (B) that has a cause (A) and a certain impact (C). The three elements need to have a causal connection. The definition we use in this paper takes the dysfunction of financial services as the event (B), the impairment of the financial system as the cause (A), and the negative effect on the real economy as the impact (C).¹⁰

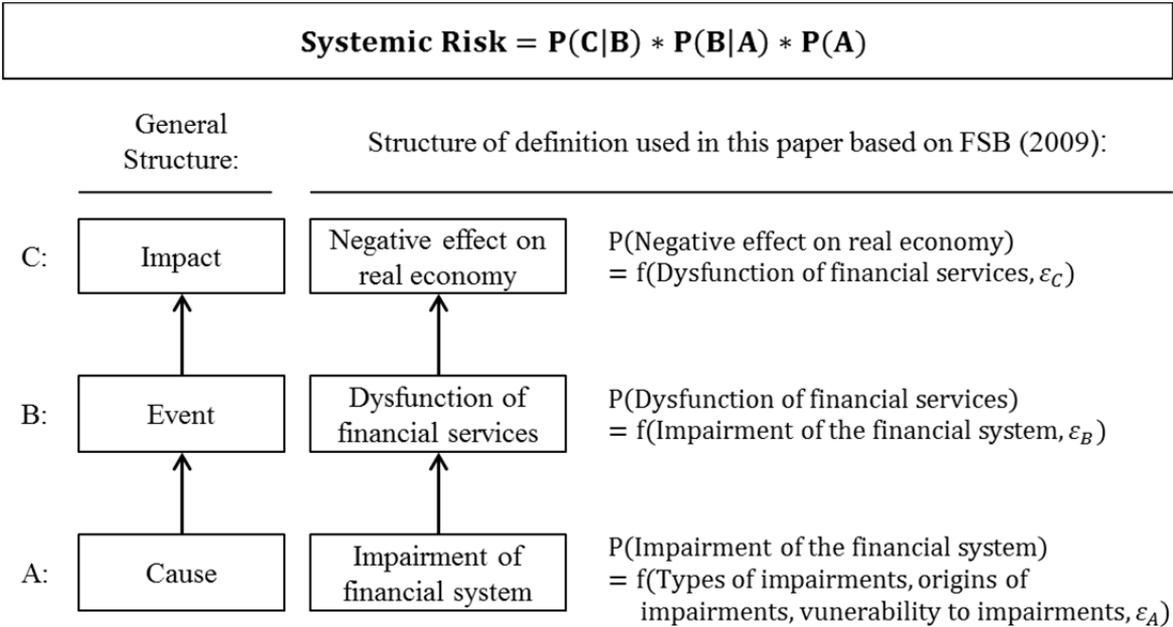


Figure 1: Conceptualization of systemic risk

¹⁰ P(a|b) describes the conditional probability of a given b. P(a) stands for the independent probability of a and f(a) describes a function of a. ϵ_A , ϵ_B , and ϵ_C stand for all factors that influence the probability of the occurrence of A, B, and C, but are not considered by the systemic risk definition. For example, a natural catastrophe could influence A, B, and C, but it is not a systemic risk. The black arrows in Figure 1 indicate a causal relationship.

The probability of the occurrence of A, B, or C can be understood as a function of different determinants. The determinants that define the probability of an impairment of the financial system (A) will be discussed in Sections 2.1, 2.2, and 2.3. The probability of a dysfunction of financial services (B) is mainly defined by the occurrence of an impairment of the financial system (A), and the probability of a negative effect on the real economy (C) is influenced by the dysfunction of financial services (B). Under this conceptualization, systemic risk is the product of the conditional probability of a negative impact on the economy given a dysfunction of financial services, the conditional probability of a dysfunction of financial services given an impairment of the financial system, and the probability of an impairment of the financial system.

In the following subsection we discuss three different impairments the financial system can suffer. In Section 2.2, we discuss whether to focus on institutions or business activities when looking for the origins of these impairments. In this context and in the remainder of the paper, we use the term ‘contribution to systemic risk’ for an institution or business activity that increases systemic risk.¹¹ In Section 2.3, we discuss again whether to focus on institutions or business activities when looking for those parts of the financial system that are most vulnerable to impairments of the financial system.¹²

2.1 Types of Impairments

There are two ways in which impairments can take place—a *system-wide shock* or a *limited shock with subsequent contagion*.

- A *system-wide shock* is one external shock that has a direct negative impact on most or all financial services companies; as a consequence, these institutions can no longer offer their

¹¹ For a further explanation of key terms used in this paper, see Table A2 in the Appendix.

¹² Sections 2.2 and 2.3 are related to the ‘contribution approach’ and ‘participation approach’ as defined by Tarashev et al. (2010, p. 2) and used by Drehmann and Tarashev (2011) as well as by Jobst (2012). We do not use that terminology here because, for our purposes, it is too narrow. The ‘contribution approach’ and the ‘participation approach’ consider only institutions and bankruptcies. Institutions that are in distress, but not insolvent, and business activities are neglected in these approaches.

full range of services. Like De Bandt and Hartmann (2000, p. 10), we also understand that the availability of new information can be a shock of this type. E.g., suppose a certain regulatory requirement suddenly encourages financial institutions to sell a certain asset. As a consequence, most institutions start to sell this asset, the price of the asset decreases, and the institutions become distressed because the remaining assets of this type that they still hold have lost value. In this way, the institutions' aligned behaviour caused by the new information impairs the financial system.

- *A limited shock with subsequent contagion* occurs when one or a few market participants cannot meet their obligations, e.g., for internal reasons or due to an external shock. This shock spreads in a chain reaction across the entire financial system. Contagion can take different forms:
 - bankruptcies of institutions, which trigger insolvencies of other companies due to unfulfilled commitments,
 - contracts based on credit ratings,
 - decrease in asset prices caused by sales by a few institutions that forces other market participants to sell assets as well,
 - investor uncertainty, eventually resulting in aligned behaviour, due to the distress of one company combined with non-transparency as to whether other companies are experiencing the same problem,¹³
 - information, eventually resulting in aligned behaviour, about the distress of one company from which markets conclude that other companies face similar problems, and
 - irrationality.¹⁴

Some definitions of contagion differentiate between the state of the economy at the time the contagion occurs (normal vs. extreme economic conditions) and whether the shock is

¹³ See Harrington (2009, p. 802) and Cummins et al. (2012).

¹⁴ See Harrington (2009, pp. 801–803), Harrington (2011), and Park and Xie (2011).

based on rational or irrational reasons (see Figure 2).¹⁵ In this paper, we define contagion as ‘a significant increase in linkages between financial institutions after a shock to one institution (or a group of institutions)’.¹⁶ Therefore, we differentiate only between the conditions in which interdependence and contagion (including spillover effects) occurs (i.e., normal vs. extreme); we do not differentiate between how a shock is transmitted (rational vs. irrational).

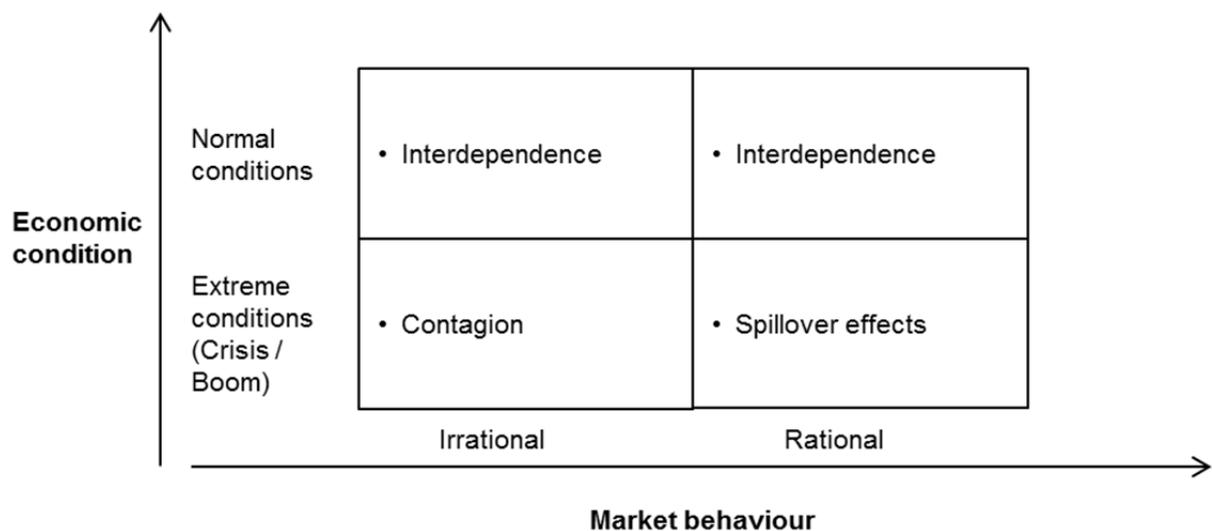


Figure 2: Classification of different shock transmission mechanisms

2.2 Origins of Impairments

The financial system can be thought of as a network with two kinds of nodes (financial institutions and non-financial actors having business relations with financial institutions) and edges (business activities).¹⁷ To identify the origins of a possible impairment and the contributors to systemic risk, one can focus on the nodes, the edges, or both.

Regulators focus on the nodes and try to identify those institutions most likely to cause an impairment to the financial system. The FSB initially suggested three criteria for evaluating the systemic risk potential of financial services firms: *size*, *interconnectedness*, and *substitutability*. Later, the IAIS, in cooperation with the FSB, added *global activity* and *non-*

¹⁵ For an overview of different perceptions of contagion, see Forbes (2012, pp. 4–7, 42).

¹⁶ This definition of contagion, interdependence, and spillover effects is based on Forbes and Rigobon (2002).

¹⁷ See, e.g., Anand et al. (2013).

traditional insurance to this list.¹⁸ According to the FSB/IAIS, these criteria should be used to identify companies, not business activities, which can impair the financial system. Recently, nine insurance companies and 28 banks have been identified as systemically important financial institutions (SIFIs).¹⁹ The literature dealing with measuring systemic risk also mainly focuses on the nodes and not on the edges of the financial network. This body of work attempts to identify the financial and non-financial institutions most likely to contribute to systemic risk; however, the determinants that make an institution contribute to systemic risk are not usually analysed.²⁰

Another branch of the literature focuses on the edges of the network, or the business activities of institutions, in attempting to identify possible origins of financial system impairment. Indeed, the Geneva Association—an insurance industry think-tank—suggests that it might be more effective, when searching for the origins of impairments, to concentrate on business activities instead of focusing on whole institutions. Otherwise, the Geneva Association warns, institutions may focus on avoiding being labelled a SIFI instead of on better managing their potentially risky business activities. Also, systemically relevant business activities may migrate to institutions currently not considered SIFIs.²¹

We agree with the Geneva Association that it is more effective for regulatory purposes and for understanding the systemic riskiness of the financial industry to focus on business activities than to focus on institutions. From a regulatory perspective, business activities should be considered because otherwise regulatory arbitrage—the migration of risky business activities from highly regulated institutions to less regulated institutions—is likely. Also, market distortions can occur because distressed SIFIs are likely to be bailed out and therefore

¹⁸ See FSB (2009) and IAIS (2013b).

¹⁹ See FSB (2013) and FSB (2012).

²⁰ See, e.g., Billio et al. (2012). Exceptions are Cummins and Weiss (2013) and Weiß and Mühlhnickel (2013b).

²¹ See Geneva Association (2010a).

have a competitive advantage over non-SIFI institutions.²² When it comes to understanding systemic risk, an activity-based view is advantageous, too, because, in most cases, it is not the whole institution that contributes systemic risk and can severely impair the financial system, but only certain of its activities.²³ The AIG financial services division, for example, was not regulated by the strict framework applicable to insurance companies despite its very risky business model. Only the much less riskier parts of AIG were subject to insurance regulation, and thus the company's severe systemic risk was not visible.²⁴ Furthermore, assume one focuses initially only on institutions. As soon as it is tried to identify the determinants what makes a particular institution contributing to systemic risk out of necessity the discussion will lead to business activities.²⁵ So why not begin at that point?

Furthermore, applying the systemic risk criteria of the FSB/IAIS to institutions can be misleading. For example, the *size* of an insurance company does not necessarily increase systemic risk if the company has a well-diversified underwriting portfolio.²⁶ In fact, the insurance company business model is based on the underwriting and pooling of idiosyncratic risks that are not correlated.²⁷ As long as the size of a certain business line is not the result of risk concentration, but instead a manifestation of the law of large numbers, there should be no increased potential for systemic risk.²⁸ Another aspect of analysing systemic risk suggested by the IAIS is the time it takes for the potential impairment of the financial system to evolve.²⁹ If the impairment takes a long time to reach its apex of severity, regulators will have time to intervene. If this is not the case, prevention becomes crucial and the systemic risk is much

²² See, e.g., Keller (2011) and Kessler (2013, p. 9).

²³ See, e.g., Cummins and Weiss (2011), who focus on activities in their assessment of the systemic riskiness of the U.S. insurance industry.

²⁴ See Harrington (2009, p. 799), Brady (2009), and Acharya et al. (2011, p. 259).

²⁵ See, e.g., Radice (2010), who takes an activity-based view, albeit an indirect one, since he defines a systemic-relevant institute as one with at least one systemic-relevant function. Cummins and Weiss (2013) calculate a systemic risk measure which focuses on institutions, but consider business activities in order to explain the results.

²⁶ See Adrian and Brunnermeier (2011).

²⁷ For most business lines, this is true even during times of extreme stresses. For example, neither catastrophes nor car accidents are more likely in times of financial crisis, nor is the mortality rate affected.

²⁸ See IAIS (2011, 2012a) and, e.g., Kessler (2013, p. 9).

²⁹ See Geneva Association (2010a), IAIS (2009), and Radice (2010).

higher. In our view, this criterion should be applied to business activities, too. Regardless of the institution's characteristics, the process of claims settlement, for example, in non-life insurance, can take several years and therefore delay any impairment of the financial system. In contrast, computer-based security trading can impair the financial system almost immediately if, for example, the price of a security falls below a certain threshold and a chain reaction is triggered by automatic selling algorithms. So, in our view, the time it takes until the financial system is impaired is not a function of the institution but of its business activity.

2.3 Vulnerability to Impairments

It is important not only to identify which parts of the financial system can originate impairment and contribute to systemic risk, but also to discover which parts are most vulnerable to impairment. If the financial system is thought of as a network, we argue that both nodes (institutions) and edges (business activities) can be vulnerable.

The FSB proposes four factors for assessing an institution's resilience in an unfavourable economic environment—*leverage*, *liquidity risk*, *maturity mismatch*, and *complexity*—all of which can be applied to institutions and/or activities.³⁰ That a highly *leveraged* financial institution has a high risk of insolvency in the event of a cyclical downturn is obvious; less obvious is that the same is true for individual investments. In the case of an adverse price movement, an investor will more quickly close highly *leveraged* positions than unleveraged ones. Thus, the higher an institution's and investment's leverage, the faster the assets have to be sold if there is a negative change in prices. *Liquidity risks* and *maturity mismatches* are two sides of the same coin and can lead to problems when rolling over the funding of an insurance company. The FSB guidelines can assist in determining whether an institution should be considered *complex*. According to the FSB, a complex institution is a financial group that (a)

³⁰ See FSB (2009). Other literature uses the same criteria to assess the vulnerability of insurance companies, which is why we rely on FSB (2009). These criteria are applied to both institutions and business activities (e.g., Cummins and Weiss, 2011). Cummins and Weiss (2011) also include *reinsurance counterparty risk* in their assessment.

operates diverse types of activities through numerous legal entities; (b) operates across borders with centrally managed capital and liquidity; and/or (c) sells or provides new and complex products that have not been sufficiently tested.³¹ The Common Framework for the Supervision of Internationally Active Insurance Groups (ComFrame) considers an insurance company to be complex if the institution (a) writes premiums in at least three jurisdictions and (b) the percentage of gross premiums written outside the home jurisdiction is not less than 10% of the institution's total premiums written.³² However, it can be argued that it is not *complexity* itself that increases vulnerability to impairment of the financial system, but the lack of transparency implied by complexity. In times of crisis it might be unclear—to regulators, market participants, and maybe even the company itself—what kind of exposure the institution or activity engaged in has.³³

³¹ See FSB (2009, p. 13). Klein (2012, p. 194) does not use the same criteria, but identifies 'excessive financial risk ...' taking as one key activity that increases vulnerability.

³² See IAIS (2013a).

³³ That lack of transparency can be a problem is illustrated by the recent example of FMS Wertmanagement, the 'bad bank' of the German company Hypo Real Estate. The company was bailed out and nationalized during the financial crisis. Due to a 'misunderstanding', liabilities were overestimated by €55 billion. See Wiesmann (2011).

3 Systemic Risk in the Insurance Sector

One of the first institutions hit by the financial crisis was AIG. Several bailout programs had to be instituted to prevent its insolvency. AIG received the first rescue funds in September 2008 and by July 2009, US\$135 billion had been spent on the company.³⁴ Against this background, it is reasonable to ask whether, and if so, to what extent insurers and their business activities contribute to systemic risk.

We thus discuss the different business activities of insurance companies and look at how certain activities contribute to systemic risk. Furthermore, we evaluate which business activities and which kinds of insurers are vulnerable to impairments of the financial system. Our assessment of systemic risk in the insurance industry is based on the studies listed in Table 2. These were selected from five different sources: peer-reviewed journal articles, working papers, reports by international government organisations or regulators, books or chapters in books, and industry reports.

It is important to consider the source of a study when interpreting its results. For example, industry reports typically take an industry perspective, while peer-reviewed journal articles are usually more neutral, since typically they are written by independent academics and undergo independent review before publication. We put most weight on the findings from the peer-reviewed journal articles, but think it is important to also present the results of industry studies.³⁵ Where our results are based on work coming from an industry perspective, we explicitly mention this fact, thereby furthering our intent to present an unbiased and neutral report as possible. To make sure that all relevant studies are included, we used a search strategy based on Biener and Eling (2012, p. 81). Details of the search strategy are presented in the Appendix.

³⁴ See Harrington (2009).

³⁵ Of course, authors of peer-reviewed journal articles also might take an industry perspective, e.g., Kessler (2013), who is CEO of the insurance company SCOR.

Kind of source:	Study:
Peer-reviewed journal articles	Trichet (2005), Harrington (2009), Baluch et al. (2011), Van Lelyveld et al. (2011), Besar et al. (2011), Bach and Nguyen (2012), Billio et al. (2012), Baranoff (2012), Kessler (2013), Chen et al. (2013a)
Working papers	Radice (2010), Cummins and Weiss (2011, 2013), Park and Xie (2011), Klein (2011), Grace (2011), Harrington (2011), Berry-Stölzle et al. (2012), Cummins et al. (2012), Neale et al. (2012), Engle et al. (2012), Jobst (2012), Weiß et al. (2013), Weiß and Mühlnickel (2013a, 2013b), Grace et al. (2013), Chen et al. (2013) and Chen et al. (2013b), Baranoff et al. (2013)
Books/chapter in books	Acharya et al. (2011)
Reports by international government organisations/regulators	Zufferey (2000), FSB (2009), IAIS (2009, 2010, 2011, 2012a, 2012b)
Industry reports	Baur et al. (2003), Geneva Association (2010a, 2010b, 2011, 2012), Keller (Geneva Association) (2011)

Table 2: Reviewed studies on systemic risk in insurance classified by source

Table 3 provides an overview of insurance activities and their systemic risk potential. The structure of the table is similar to that employed by the IAIS in classifying insurance activities (see IAIS, 2011, p. 15). We differentiated the business activities according to processes and degree of innovation. In our view, insurance activities belong either to the underwriting or the funding and investing process. Degree of innovation determines whether the activity belongs to the traditional or non-traditional insurance business. This classification is not always clear cut but, in general, we consider an activity to be traditional when its accompanying risks are mostly (a) idiosyncratic, (b) not correlated with each other, and (c) not influenced by economic business cycles (see IAIS, 2012b, p. 12).³⁶ Using this classification system, we identify papers that discuss a particular business model and derive its systemic importance.

³⁶ For example, many market participants (especially in German-speaking countries) view life insurance contracts with embedded guarantees as their traditional business model. According to our classification, however, guaranteed annuities are non-traditional since they are influenced by the economic business cycle. In this context, we also discuss modern variable annuities with different types of guarantees.

Process	Business Activity	Systemic Risk Contribution	Rationale & Source
Underwriting	Traditional Life • Life insurance • Annuities Non-life • Health insurance • Property & casualty insurance • Liability insurance • Legal insurance Reinsurance	Very low (all studies agree there is no systemic risk contribution)	<ul style="list-style-type: none"> • Between life, non-life sector, and banks interconnectedness (counterparty credit risk/cross-holdings) is low; between reinsurance companies and primary insurers the relation is hierarchical (e.g., Zufferey, 2000; Baur et al., 2003; Trichet, 2005; Baluch et al., 2011; IAIS, 2011, 2012b; Cummins and Weiss, 2011, 2013; Grace et al., 2013; Kessler, 2013) • A reinsurance retrocession spiral affects the insurance industry but not the rest of the economy (e.g., Geneva Association, 2010a; Cummins and Weiss, 2011, 2013) • Claims are contingent on loss events and therefore an ‘insurance run’ is not possible (e.g., Radice, 2010; Baluch et al., 2011; Cummins and Weiss, 2011; Park and Xie, 2011; Geneva Association, 2012; Kessler, 2013) • Cash outflow if loss events occur is slow (e.g., Cummins and Weiss, 2011; Jobst, 2012; Kessler, 2013) • Entry barriers are low and classical insurance activities are substitutable as long as insurability is given, e.g., via alternative risk transfer and self-insurance or the absence would not substantially affect the real economy (e.g., Baur et al., 2003; Geneva Association, 2010b; Cummins and Weiss, 2011, 2013; IAIS 2012a) • Primary insurers diversify their exposure to reinsurance (e.g., Baur et al., 2003; Geneva Association, 2010a; Baluch et al., 2011; Besar et al., 2011); however, there are contrary views (e.g., Park and Xie, 2011; IAIS, 2012b) • Studies show that bankruptcies of reinsurers would not lead to market failure (e.g., van Lelyveld et al., 2011; Park and Xie, 2011) • <u>Insurance is a necessary function for the economy (Bach and Nguyen, 2012), but individual insurance companies are substitutable (e.g., IAIS, 2011; Jobst, 2012)</u>
	Non-Traditional Life • Annuities with guarantees/variable annuities • Group annuities • Separate accounts Non-life • Credit insurance • Financial guarantees • CDSs/CDOs Reinsurance • Insurance-linked securities (e.g., catastrophe bonds) • Industry-loss warranties	Medium (except for credit insurance and cat bonds, studies agree that these activities increase vulnerability; most studies agree there is a systemic risk contribution)	<ul style="list-style-type: none"> • Life products with guarantees might exacerbate a crisis if assets have to be sold during a downturn (Geneva Association, 2011) • Systemic risk measures give some indication that group annuities and separate accounts might create systemic risk (Cummins and Weiss, 2013) • Credit insurance has no direct liquidity impact and has only very limited volume (e.g., Baur et al., 2003; Geneva Association, 2010a) • Financial guarantees impose market risk on insurance companies and can have a direct liquidity impact; they thus increase vulnerability to financial crisis (e.g., Geneva Association, 2010a; IAIS, 2010; Cummins and Weiss, 2011, 2013; Chen et al., 2013) • CDSs/CDOs have direct liquidity impact and make the selling party vulnerable to systemic crisis <ul style="list-style-type: none"> - Majority view: contribution to systemic risk because CDS buyer faces counterparty risk if CDS seller defaults (e.g., Trichet, 2005; Geneva Association, 2010a; Baluch et al., 2011; Klein, 2011; Grace, 2011; Baranoff, 2012; Chen et al., 2013; Cummins and Weiss, 2013) - Minority view: no contribution systemic risk because if CDS seller defaults, CDS buyer does not face direct liquidity impact (e.g., Radice, 2010; Wallison reported by Harrington, 2009, p. 803; cf. Harrington, 2011, p. 14) • In comparison to the market for financial derivatives, the market volume of alternative risk transfer products is small, the insurer remains liable, and the insurer keeps a certain amount of the risk on its balance sheet (IAIS, 2011, 2012b); in particular, cat bonds help the underwriting issuer to diversify and decrease its underwriting risk to catastrophes (e.g., Weiß et al., 2013; Kessler, 2013) • It is not clear if the prices of alternative risk transfer products are uncorrelated with the financial market in times of crisis (IAIS, 2012b) • Industry-loss warranties are not linked to an individual loss event, but cover the downturn of a whole industry, which can lead to an increased basis risk and credit risk since there is no collateral (IAIS, 2012b)
Funding & Investing	Traditional Life, Non-Life, Reinsurance • Premiums funding • Asset liability management & hedging • Liquidity management	Very low (all studies agree there is no systemic risk contribution)	<ul style="list-style-type: none"> • Premiums are paid upfront for contingent claims; no risk caused by maturity mismatches (e.g., Trichet, 2005; Cummins and Weiss, 2011; Kessler, 2013) • Contingent claims prohibit fire sale of assets in case of an insolvency (e.g., Cummins and Weiss, 2013; Kessler, 2013) • In contrast to banks, insolvencies of insurers are lengthy and orderly processes (e.g., IAIS, 2009, 2010; Geneva Association, 2012) • Relatively high equity levels in non-life and reinsurance; life insurers are more vulnerable to crisis due to higher leverage (e.g., Harrington, 2009; Chen et al., 2013b) • In many markets, high lapse fees for life products with saving components make immediate cash outflows unlikely (e.g., Radice, 2010; Geneva Association, 2010b; Kessler, 2013); also life insurers would have enough liquidity without the need to sell assets (Baranoff et al., 2013) • Even during the financial crisis external funding was available for life insurers (Berry-Stölzle et al., 2012) • Limited fungibility of liquidity within insurance groups could lead to increased vulnerability in times of crisis (e.g., Radice, 2010; Baranoff, 2012)
	Non-Traditional Life • Securitization of embedded value in upfront paid commissions • Securitization of present value of future profits • Short-term funding Life, Non-Life, Reinsurance • Securities lending Non-Life, Reinsurance • Credit rating utilization	Medium (studies agree that these activities increase vulnerability, but whether there is a systemic risk contribution is unclear)	<ul style="list-style-type: none"> • Short-term funding can lead to (e.g., Radice, 2010; Geneva Association, 2010a) <ul style="list-style-type: none"> - fire sales if liquidity dries up, especially in the case of securities lending and credit rating utilization (e.g., Acharya et al., 2011; Besar et al., 2011; Jobst, 2012); however, it is also argued that securities lending does not contribute to systemic risk since counterparties receive collateral (Baranoff, 2012) - direct contagion in times of crisis if supervisors prohibit the payment of cash to counterparties (e.g., Radice, 2010) • Eventually substantial interest rate risks for investors if securitized products contain a) guarantees and/or b) the discount factor is inadequate (IAIS, 2010, 2012b) • Performance (stock market returns) of financial institutions is becoming increasingly interconnected (e.g., Acharya et al., 2011; Baluch et al., 2011; Cummins et al., 2012; Billio et al., 2012; Weiß and Mühlnickel, 2013b); however, banks still have a stronger impact on insurers than vice versa (e.g., Grace, 2011; Engle et al., 2012; Chen et al., 2013a) and it seems that this interrelation is mainly driven by non-traditional insurance activities (e.g., Neale et al., 2012; Cummins and Weiss, 2013) • Exploitation of non-regulated subsidies and information asymmetries (e.g., Zufferey, 2000; Harrington, 2009; IAIS, 2010; Acharya et al., 2011; Baranoff, 2012)

Table 3: Evaluation of systemic risk of traditional and non-traditional insurance activities classified according to business processes

A comprehensive summary of all studies reviewed for this analysis can be found in Table A3 in the Appendix. In that table, we distinguish between academic work published in scientific journals or as a working paper and more applied work by industry associations and regulators.³⁷

3.1 Systemic Risk in Traditional Insurance Underwriting

Traditional insurance activities include underwriting life, health, property, accident, liability, and legal risks in the life and non-life sectors, as well as the transfer of risk via reinsurance.

The literature qualitatively assessing the systemic risk of business activities agrees that the systemic risk contribution of traditional *non-life insurance* (property, accident, liability, legal, and, in some jurisdictions, health) is very low due to low interconnectedness within the field and the fact that claims are bound to specific loss events that are in most cases independent from the business cycle. In addition, claims settlement can take several years. Thus, all these activities contribute very little, if any, to systemic risk and do not increase the company's vulnerability to impairments of the financial system. This conclusion and line of reasoning is found in peer-reviewed journals, working papers, and in reports by regulators and the industry.³⁸

However, the results from two different strands of the literature cast some doubt on this conclusion. The first strand is represented by, for example, Billio et al. (2010) and Chen et al. (2013a). Both studies empirically show that the stock market returns of life as well as non-life insurers and banks have become more correlated in recent years. The second strand of literature calculates systemic risk measures for insurers.³⁹ For example, Cummins and Weiss (2013) and Weiß and Mühlhnickel (2013a) show that, according to systemic risk measures,

³⁷ In Table A3 we also categorise the papers according to the methodology employed. Most papers are qualitative discussion papers (27 papers), but a few take a quantitative approach (16 papers). For the quantitative papers, we explain the underlying methodology in more detail, i.e., the use of event studies, systemic risk measurement calculation, or regression analysis.

³⁸ See, e.g., Trichet (2005) (peer-reviewed journal article), Cummins and Weiss (2011) (working paper), IAIS (2011) (report by regulator), and Geneva Association (2010a) (report by industry association).

³⁹ For a description of the different measures applied in the literature on systemic risk in the insurance sector, see Table A4 in the Appendix.

insurers do contribute to systemic risk and are vulnerable to impairments of the financial system. In our opinion, these findings do not really contradict the results mentioned above because they focus on insurance companies, not specific business activities. Indeed, the mentioned studies conclude that the increased systemic risk contribution and vulnerability are due to non-traditional insurance activities. Furthermore, one can challenge the assumption made in both strands of literature that an interrelationship of stock prices indicates systemic risk.⁴⁰

The same conclusion of low systemic risk contribution and low vulnerability is basically true for underwriting *life insurance* risks and annuities where the policyholder bears the investment risk.⁴¹ The main reason life insurance products do not contribute to systemic risk is that this line of business does not have a strong impact on other financial market participants or the economy in general in the case of bankruptcy.⁴² Moreover, in most countries, customers are protected by guarantees.⁴³ There is no known case of the bankruptcy of a single life insurance company triggering a contagion effect and other insolvencies because the risks that led to the insolvency were of an idiosyncratic nature (e.g., management failures).⁴⁴

Cummins and Weiss (2011) and Baluch et al. (2011) are more critical of *reinsurers* and mention that the reinsurance market is highly concentrated. There is high interconnection

⁴⁰ Note, also, that the employed systemic risk measures neither consider causal relationships nor provide a scale for interpreting whether the results indicate high, medium, or low systemic risk.

⁴¹ Life insurance products for which the insurer bears the investment risk are considered in the next section.

⁴² See Cummins and Weiss (2011, p. 33, 2013, p. 15) and Geneva Association (2010b).

⁴³ See Geneva Association (2012, pp. 45–56), Harrington (2011), and Oxera (2007).

⁴⁴ Moreover, even the insolvency of very large life insurers might not cause systemic risk. Even if guarantees are not sufficient, policyholders do not suffer a total loss; instead, their claims will be reduced, as was the case with Equitable Life (Radice, 2010, pp. 73–74). Again, the crucial point, as pointed out by Harrington (2011), Cummins and Weiss (2011, p. 32), and Klein (2012), is that a life insurer's insolvency does not impair the financial system; the payment system is not disrupted nor is short-term lending diminished, which is a danger in the aftermath of bank bankruptcies. Finally, even very large insurers should not be thought of as too big to fail because of their life underwriting business. The reason for this has to do with time. The windup of an insurer is an orderly process and does not lead to an immediate default on liabilities, the fire sale of assets, or increased cash outflow (Geneva Association, 2010a, pp. 29–31, 2010b, pp. 13–16). This view, in principle, is shared by the IAIS (2012a), which assesses global systemically important insurers and puts only minor weight on traditional life and non-life underwriting activities.

among reinsurers and between reinsurers and insurance companies. They argue that there is a danger of a retrocession spiral⁴⁵ and in the event one reinsurer goes bankrupt, the balance sheet of the ceding insurer would be hit automatically. Also, the rating downgrade of a reinsurance company could trigger a chain reaction due to reinsurance contracts, which, typically, can be cancelled in such circumstances. This view is supported by some results of Park and Xie (2011), which show that up- and downgrades of reinsurers' ratings have an effect on primary insurers' ratings as well. However, a scenario analysis by Park and Xie (2011) and Van Lelyveld et al. (2011) shows that even the failure of several large reinsurers would result in only a limited number of primary insurer insolvencies. Furthermore, Kessler (2013) argues that reinsurance does not contribute to systemic risk, since primary insurers diversify their counterparty risk to reinsurers. In addition, he states that retrocession spirals are unlikely due to a hierarchal market structure between reinsurers and primary insurers. This reasoning is in accordance with the industry and regulator's viewpoint.⁴⁶ Cummins and Weiss (2013), however, continue to argue that the failure of reinsurance companies could lead to problems within the insurance industry due to the connections between reinsurers and primary insurers. Nevertheless, they do agree that reinsurance does not contribute to systemic risk since reinsurers 'are not sufficiently interconnected with non-insurance institutions'.

In this context, the question arises as to whether unavailability of insurance coverage is a systemic risk in the sense that the real economy is affected. For example, after September 11, 2001, it was nearly impossible to obtain insurance coverage against terrorism. This situation was not due to an impairment of the financial system, but due to the fact that the risk of terror attacks became unquantifiable. Certainly, if financial turmoil leads to an environment in which insurance coverage can no longer be offered because of insurers' weak balance sheets,

⁴⁵ Premiums are not only ceded between primary insurers and reinsurers, but also within the reinsurance industry. A retrocession spiral is when the bankruptcy of reinsurers is caused by other reinsurers due to these links.

⁴⁶ See IAIS (2012b) (report by regulator) and Baur et al. (2003) (report by Swiss Re).

the situation is slightly different. However, as long as the risk is quantifiable, in principle at least, insurance companies and their products can be substituted by other market participants, for example, by catastrophe bonds due to low market entry barriers. Also, insurance coverage can be created within a certain industry in the form of self-insurance cooperatives between companies.⁴⁷ Thus, the possibility of the temporary absence of insurance companies and/or their products does not contribute to systemic risk.⁴⁸ This conclusion is shared by academic studies, regulator reports, and industry association reports.⁴⁹

3.2 Systemic Risk in Non-Traditional Insurance Underwriting Activities

As non-traditional insurance underwriting activities in the life segment we consider only annuities for which the insurer bears the investment risk and guarantees a certain payout. In the non-life sector we classify credit insurance, financial guarantees, and financial derivatives underwriting as non-traditional activities. For the reinsurance sector, we consider as non-traditional activities insurance-linked securities and industry-loss warranties.

Some aspects of *guaranteed annuities* arguably increase the issuing company's vulnerability in times of crisis.⁵⁰ In the case of life insurance products with an investment component or a guaranteed annuity, a sudden cancellation of many contracts and a subsequent cash outflow is possible, but not very likely. Policyholders normally have to pay high cancellation fees, making cancellation unattractive.⁵¹ An exception is the bankruptcy of the Belgian insurance company Ethias in 2008 (see Geneva Association, 2010b). When the company became financially distressed, many of its life insurance products were cancelled.

⁴⁷ An example is the absence of industry liability insurance in 1984/1985 in the United States. Insurers had to excessively increase their provisions for potential claims due to asbestos hazards and stopped writing new business. In response, industrial companies founded an insurance cooperative for these risks. For further details, see Radice (2010).

⁴⁸ This conclusion should not be misunderstood to mean that the insurance industry is unnecessary. We only argue that the temporary absence of selected coverage might be compensated for with substitute products or by more self-protection and self-insurance measures and thus will not necessarily lead to an economic breakdown.

⁴⁹ See, e.g., Radice (2010) and Cummins and Weiss (2011, 2013) (working papers), IAIS (2012a) (report by regulator), and Geneva Association (2010b) (report by industry association).

⁵⁰ See Klein (2011), Cummins and Weiss (2011), IAIS (2011), and Grace (2011).

⁵¹ See Radice (2010) and Geneva Association (2011).

However, it can be argued that the insurance products were in fact saving accounts—cash could be withdrawn and the contracts cancelled any time without any fee or discount. Recently, Cummins and Weiss (2013) calculated the systemic risk measure SRISK and discovered that it is related to separate account assets and group annuity premiums. Their reasoning is that separate accounts are especially used to provide annuities with options and guarantees, which lead to withdrawals in times of crisis. Also, large companies would be likely to cancel group annuities in times of crisis. Their conclusion is that separate accounts and group annuities both contribute to systemic risk. This is interesting since Weiß et al. (2013) also use SRISK, but as a measure for the vulnerability of an institution to impairments of the financial system, not as a measure for systemic risk contribution.⁵² Another critical aspect is the rate of return on guaranteed annuities. If the promised return can be generated only in a bullish market, insurers will suffer financial distress when interest rates plunge and they are not sufficiently hedged. To date, this has happened only to single insurance companies since the practice of guaranteeing a rate of return on an annuity takes several business cycles into account. Also, even if insurers fail to deliver the guaranteed return, the impact on the economic system is minor.⁵³

Our conclusion is that writing guaranteed annuities might contribute to systemic risk and increases the company's vulnerability in certain circumstances.

In the non-life segment, the area of *credit protection* can be divided into three categories: credit insurance, credit guarantees, and derivatives (especially credit default swaps (CDS)). In the case of credit insurance, two industry studies—Baur et al. (2003) and Geneva Association (2010a)—argue that in contrast to CDS underwriting, substantial reserves must be held on the

⁵² An evaluation of systemic risk measures is not the focus of this paper. However, we argue that the measures applied to the insurance sector (except ΔCoVaR) measure more the vulnerability of an institution to impairments of the financial system, than its contribution to systemic risk. In one way or the other, most measures focus on stock market returns in times of crisis. See also Table A4 in the Appendix for a short description of systemic risk measures.

⁵³ The Japanese insurance company Nissan Mutual Life and Equitable Life in Great Britain are two cases in which declining interest rates and unhedged, guaranteed annuities caused substantial financial distress for the companies. However, neither case triggered a systemic crisis. For more details, see Radice (2010).

balance sheet for loss events and a cash outflow occurs only in the event of loss when loans can no longer be fully repaid, not in the case of a downgrading. In addition, interconnection with the rest of the financial sector is weak. Thus, they conclude that credit insurance's contribution to systemic risk and vulnerability are both low.

The financial guarantee business, which underwrites public and private debt as well as structured finance products, is a different story. Interconnection with the financial system is strong due to the exposure of large banks to guaranteed derivatives. Also, the products react very quickly to market downturns since the securities are valued mark-to-market and losses (or collateral demands) can spread quickly through the financial services industry. Furthermore, this business activity significantly increases the issuing insurer's vulnerability to economic downturns. Some products contain implicitly guaranteed interest rates and rating downgrades of the underwriting entity can trigger immediate collateral calls, as well as contract cancellations.⁵⁴ Chen et al. (2013) support this argument in an empirical study finding that the systemic risk measures BANKBETA and MES can explain the stock market returns of insurers offering financial guarantees and writing CDS. They interpret the results as an indication that these business activities contribute to systemic risk. However, again, it is uncertain whether it is a contribution to systemic risk or vulnerability to an impairment of the financial system that is being measured.⁵⁵

We conclude that offering financial guarantees increases vulnerability and might also contribute to systemic risk.

The most common credit derivative is the credit default swap.⁵⁶ In its plain-vanilla form, the company selling the swap receives money continuously throughout the duration of the

⁵⁴ See Geneva Association (2010a, pp. 58–63) and Drake and Neale (2011) for a comprehensive study of financial guarantee insurance.

⁵⁵ See Acharya et al. (2012b).

⁵⁶ There is controversy over whether CDS qualify as insurance or are, instead, another type of capital market product. See, e.g., NAIC (2000), Schwartz (2007), and Acharya et al. (2011). In the context of this paper, the question is of minor relevance. What matters is that the insurance sector in total underwrites more CDS than

contract and promises to pay out money in the event the entity mentioned in the contract goes bankrupt. To buy a CDS relating to a certain entity, one does not need to have a claim against the entity itself.⁵⁷ The purchaser of a CDS, however, is exposed to the risk that the counterparty cannot meet its obligation in the event the entity mentioned in the contract goes bankrupt. Therefore, it is common for the CDS seller to provide collateral based on that risk of bankruptcy.⁵⁸ Consequently, CDS writing businesses are exposed to liquidity risk. They have an increased cash outflow as soon as there is an economic downturn and the risk of credit defaults increases.⁵⁹

We found no papers by academics, regulators, or from the industry that argue against the conclusion that CDS writing, at the very least, increases vulnerability to impairments of the financial system. Also, a majority of the papers agree that underwriting CDS contributes to systemic risk; only a few argue that CDS writing has no effect. Wallison, as reported by Harrington (2009), argues that CDS holding companies are well diversified and, consequently, the insolvency of a CDS writing business would have only a limited effect.⁶⁰ Furthermore, Radice (2010) does not think defaulting CDS would have a huge impact on counterparties. In contrast, Heyde and Neyer (2010) conduct market simulations and find that CDS have a destabilizing effect on the financial system. Market participants are not sufficiently diversified and the risk transfers encourage CDS buying banks to invest more in high-profit, but illiquid and risky, assets. The majority of academic papers, reports by

it buys for hedging (see Barrett and Ewan, 2006) and in no paper have CDS been considered a form of traditional insurance.

⁵⁷ Short selling and/or buying uncovered CDS on sovereign debt were forbidden temporarily during the peak of the financial crisis in order to prevent speculation on sovereign debt in many countries. Since then, regulation of the CDS business has systemically become stricter, especially with regard to sovereign debt; see, e.g., regulation of the European Parliament and European Council (2012).

⁵⁸ See Kress (2011).

⁵⁹ Of course, CDS can be designed so that there are immediate, realizable losses and not only margin calls. For example, Swiss Re had to realize 1.2 bn CHF in 2007 because of the underwriting of a CDS protecting MBS from rating downgrades (see Swiss Re, 2008).

⁶⁰ Wallison (associated with American Enterprise Institute, a think-tank), reported in Harrington (2009), is quoted as follows on the subject of a potential bankruptcy of AIG: 'If Goldman, AIG's largest counterparty, would not have suffered significant losses, there is no reason to believe that anyone else would have suffered systemically significant losses either'.

regulators, and the industry agree that the failure of a CDS writing entity would trigger a cascading chain reaction that could impair the whole financial system.⁶¹ This assessment is based on the size of the CDS business, its interconnectedness with the whole financial sector, the short time it takes for an impairment caused by a CDS default to evolve, and the non-transparency of the CDS business.⁶²

In the reinsurance sector, *industry-loss warranties* and *insurance-linked securities* such as cat bonds can be viewed as non-traditional insurance activities. Cat bonds do not contribute to systemic risk or increase vulnerability to impairments of the financial system. Basically, these products use the financial markets to further diversify the underwriting risk of events like pandemics or hurricanes among a wider group of investors. A study by Cummins and Weiss (2009) shows that returns on cat bonds are not correlated with returns on bonds or stocks during normal times and only slightly so in times of crisis. They conclude that cat bonds are valuable for diversification even during crisis. This view is supported in a recent study by Weiß et al. (2013). The authors relate the issuing of cat bonds to systemic risk measures and find that cat bonds have no statistical impact on SRISK (measuring vulnerability to impairments of the financial system) or ΔCoVaR (measuring contribution to systemic risk). Finally, Kessler (2013) and IAIS (2011, 2012b) point out that the volume of cat bonds is currently still relatively low and thus cannot be counted as either a contribution to systemic risk or a vulnerability to impairments of the financial system.

Industry-loss warranties are not linked to an individual loss event, but cover the downturn of an entire industry. According to IAIS (2012b), these products can pose an increased basis

⁶¹ Regarding the AIG bailout, Bernanke is reported by Brady (2009) in *The Washington Post* to have said: ‘AIG situation is obviously a very uncomfortable one ... [but a collapse] ... would be devastating to the stability of the world financial system’. See also Acharya et al. (2011).

⁶² See, e.g., Baluch et al. (2011) (peer-reviewed journal article), Cummins and Weiss (2011) (working paper), IAIS (2011) (report by regulator), and Geneva Association (2010a) (report by industry association). The U.S. Financial Stability Oversight Council (FSOC) takes a different perspective on CDS and argues that institutions can be systemically relevant by being reference entities (rather than buyer or seller of CDS), if the notional volume is in excess of \$30 billion. See FSOC (2012). However, we found no study that further elaborates this point with regard to insurance companies.

and credit risk since there is no collateral requirement. Also, other insurance-linked securities related to life insurance could be considerably connected to interest rate and credit risk.

We conclude that cat bonds do not appear to contribute to systemic risk or increase vulnerability to impairments of the financial system. Other insurance-linked securities and industry-loss warranties may have some systemic relevance, but at this point there are not enough studies on which to base an assessment.

3.3 Systemic Risk in Traditional Insurance Funding and Investing Activities

The traditional funding and investing activities of insurance companies include collecting upfront premiums for underwriting risks and asset and liability management, as well as liquidity management.

In the literature, there is agreement that the business model based on collecting upfront premiums for bearing risks that can lead to contingent claims is a very stable one and ensures sufficient liquidity. Therefore, an ‘insurance run’ is not possible in the non-life sector and a fire sale of assets that could have a systemic impact is unlikely.⁶³ Furthermore, regulators might anticipate the risk of fire sales and automatically relax capital requirements during a crisis (indeed, just such a procedure is expected to be included in the forthcoming Solvency II regulation).⁶⁴ The reverse situation, that is, long-term liabilities and short-term assets, increases the insurers’ exposure to interest rate risk and their vulnerability as well. However, the Geneva Association (2010a, p. 36) claims that insurance companies use ‘assets and derivatives to replicate insurers’ liability profiles and match their expected claims’. This industry viewpoint that there should be no maturity mismatch is supported by Cummins and Weiss (2011, p. 18), who analyse the balance sheets of U.S. non-life and life insurers and conclude that ‘insurer assets and liabilities tend to be matched’.

⁶³ See Geneva Association (2010b) (report by industry association), Eling and Schmeiser (2010) (peer-reviewed journal article), Lehmann and Hofmann (2010) (peer-reviewed journal article), and IAIS (2011) (report by regulator).

⁶⁴ See Article 106 in the Directive 2009/138/EC of the European Parliament and European Council (2009).

Insurer funding and asset liability management enjoy a certain degree of stability due to the generally high equity coverage in non-life and reinsurance as reported by Harrington (2009) and Cummins and Weiss (2013). Also, in the life insurance sector, an ‘insurance run’ is unlikely due to high lapse fees, as mentioned above. Even if a run did materialize, Baranoff et al. (2013) show that the likelihood of a fire sale is small since life insurers maintain a level of liquidity adequate to deal with stressful situations. Simulations based on historical lapse rates show that life insurers need not to sell assets before maturity in order fulfil their obligations. Even in a worst-case scenario in which 10 times the normal number of policies are cancelled, the volume of assets that needs to be sold before maturity makes up only a small fraction of the bond market.

When it comes to life insurers, however, a number of studies argue that their equity basis is relatively low, their assets might not be sufficiently diversified (many insurers only hold government bonds), and that some are substantially invested in mortgage-backed securities.⁶⁵ This indication of life insurers’ vulnerability to impairments of the financial system is supported by Chen et al. (2013b), who calculate the systemic risk measures SRISK and MES via a copula approach and discover that life insurers are much more affected by economic downturns than are non-life insurers. However, Berry-Stölzle et al. (2012) show that during the subprime crisis, life insurers’ access to external capital was not endangered and TARP funds for life insurers were not necessary.

There is one aspect of liquidity management that could increase vulnerability in an extremely adverse market environment: fungibility of liquidity in globally operating insurance conglomerates. On the one hand, as Radice (2010) argues, in the event of a crisis, ring-fencing of subsidies by local regulators in an effort to protect local policyholders could lead to an insolvency of the holding company or one of its other subsidiaries, even if the group as a whole continued to be solvent. On the other hand, as Drake and Neale (2011, p. 73) stress,

⁶⁵ See Harrington (2011), Cummins and Weiss (2011), Grace (2011), and Baranoff et al. (2011).

guarantees made within different judicial entities in an insurance group could lead to another AIG case: healthy subsidiaries under the oversight of insurance regulators have to pay for the poor decisions of non-insurance, non-regulated entities.⁶⁶

We conclude that none of the traditional funding and investing activities of the insurance sector contribute to systemic risk. However, leverage of life insurers and fungibility of liquidity within a group structure might increase vulnerability.

3.4 Systemic Risk in Non-Traditional Insurance Funding and Investing Activities

We consider the securitization of upfront commission payments and future profits, securities lending, and credit rating utilization, as well as short-term funding via issuing commercial papers, as non-traditional funding and investing activities. These activities can be undertaken by life, non-life and reinsurance companies.

According to the IAIS (2012b), securitization of upfront commission payments and future profits exposes the investor to substantial interest rate risk via implied guarantees, insurance risks, and market risk. However, these business activities do not contribute to systemic risk—at least not yet—since their outstanding volume is marginal compared to other asset-backed securities.

As mentioned, it is usually not necessary for insurance companies to engage in a fire sale of assets before maturity to overcome liquidity problems. However, the Geneva Association (2010a) argues that there can be an exception to this if short-term financing is used as the primary form of funding. Two profit-enhancing methods, if used excessively, can increase the systemic risk contribution of insurers as well as make them more vulnerable to impairments of the financial system:

- ‘Securities lending’, which is when the insurance company lends its long-term securities to other market participants and therefore receives collateral. The received money is typically invested in short-term assets.

⁶⁶ See also the scenario mentioned by the Geneva Association (2012, pp. 39–43) for an illustration of the issue.

- ‘Credit rating utilization’, which involves borrowing money as long as the credit rating is not endangered. Again, the additional capital is invested in short-term assets.

Both methods increase the insurance company’s liquidity risk and can lead to a situation in which a fire sale of assets becomes necessary in order to meet obligations. When the financial market is already in distress, these particular activities can intensify the situation, especially if many insurers are engaged in them. Acharya et al. (2011) point out that securities lending per se need not be a risky activity as long as the collateral is invested in safe assets with a shorter duration than the securities that are borrowed by other institutions. In contrast, AIG used securities lending very aggressively and this was a contributing reason for why the company needed financial support. Harrington (2009) makes a similar assessment of the AIG failure, but Baranoff (2012) explains why the securities lending program on its own did not and probably in general will not contribute to systemic risk: market practice normally requires 120% of the value of the security as cash collateral from the borrower, but AIG as the lender in the end had to post collateral, too, and so the borrower took no risk. In case of an AIG bankruptcy, the borrower could have just sold the borrowed securities and the additional collateral. Generally, the right to liquidate the securities in the event of the lender’s default limits the counterparty risk and strongly reduces the systemic risk contribution of this business activity. In the case of AIG, the company itself chose to reduce this business activity in the end and turned instead to the Federal Reserve Bank of New York for funding.

Finally, the Geneva Association (2010a) sheds light on another behaviour that can contribute to systemic risk and increase vulnerability to impairments of the financial system: relying extensively on short-term funding via issuing commercial papers could lead to the necessity of selling assets before maturity.

Thus, in principle, all non-traditional funding and investing activities have the potential to increase the vulnerability of insurers to impairments of the financial system. However, it is not entirely clear to what extent these activities contribute to systemic risk.

4 Conclusions and Directions for Future Research

In this paper we review the extant literature on systemic risk, a topic widely discussed among academics and practitioners in the last years. Systemic risk requires a limited shock that spreads via contagion or interdependence to other financial institutions or a system-wide shock that impacts the entire financial system at once.

On the one hand, there is agreement in the literature that insurance companies and their activities contribute less to systemic risk and are less vulnerable to impairments of the financial system than banks. Traditional underwriting and funding and investing activities in the life, non-life, and reinsurance business make very little contribution to systemic risk and do not increase insurer vulnerability to impairments of the financial system.

On the other hand, certain non-traditional insurance activities do appear to be relevant to systemic risk. The literature agrees that some underwriting activities in the life segment (annuities with guarantees), in the non-life segment (financial guarantees and CDS), and in the reinsurance sector (industry-loss warranties) increase the vulnerability of insurance companies to impairments of the financial system. A majority of academic studies, working papers, regulator reports, and industry studies claim that these activities also contribute to systemic risk. Only a minority argues that these products have a very limited contribution to systemic risk.

According to the literature, in contrast to the above-mentioned products, cat bonds neither contribute to systemic risk nor increase vulnerability. With regard to non-traditional funding and investing activities, securities lending and short-term funding can especially increase vulnerability to impairments of the financial system. However, no consensus has yet

been reached as to whether and, if so, to what extent these activities contribute to systemic risk.

In addition, especially those academic studies taking a qualitative approach and studies that calculate systemic risk measures conclude that life insurance companies are more vulnerable to impairments of the financial system than are non-life insurers. Our review of 30 academic and 13 industry papers reveals that, in general, both camps agree when it comes to systemic risk. To provide a balanced and neutral perspective, however, we list those authors who take a perspective different from that of the majority on specific issues:

- In contrast to other work Baluch et al. (2011) argue that retrocession relationships within the reinsurance sector contribute to systemic risk
- Harrington (2009) and Radice (2010) are a minority which doubts that CDS writing contributes to systemic risk
- Baranoff et al. (2012) argues in opposition to other studies that securities-lending did not contribute to systemic risk in the AIG case
- In contrast to other studies Billio et al. (2012) and Engle et al. (2012) attribute systemic risk contribution not to business activities but to insurance companies

A final contribution of this paper is that we systematically searched the extant literature for open research questions on the topic of systemic risk and, as Table 4 shows, discovered that there is a lot of room for future research. In Table 4, we also include some of our own suggestions for future research on this topic.

Main Issue	Paper	Open Research Questions
Regulation	Vaughan (2009)	<ul style="list-style-type: none"> • What is the appropriate trade-off in insurance regulation between ‘checks and balances’ and unnecessary high costs?
	Acharya et al. (2011)	<ul style="list-style-type: none"> • CDS are essentially insurance. Is some form of insurance regulation needed for such products?
	Weiß and Mühlnickel (2013a)	<ul style="list-style-type: none"> • What is the impact of divestitures of large insurers on systemic risk in the insurance industry?
	Based on Al-Darwish et al. (2011), Ashby (2011), Keller (2011), and Haldane (2012)	<ul style="list-style-type: none"> • How is systemic risk considered in insurance regulation? • Do the current regulation frameworks mitigate or contribute to systemic risk? • Is regulation arbitrage possible between the banking and the insurance sector? • Will the probably higher future capital requirements in the banking and insurance sectors transfer risk to consumers or other market participants?
	Weiß and Mühlnickel (2013a) Further questions	<ul style="list-style-type: none"> • Can differences in global insurance regulation affect an insurer’s systemic relevance? • Does the identification of global systemically important insurers lead to an implied bailout guarantee and moral hazard? • How can regulation be designed so that it is not procyclical? • Banking versus insurance: which regulation leads to stricter capital requirements and does this open the door for regulatory arbitrage?
Traditional Business Activities	Park and Xie (2011)	<ul style="list-style-type: none"> • How do insurance companies react when both insurers and reinsurers are hit by a macroeconomic shock at the same time?
	Van Lelyveld et al. (2011)	<ul style="list-style-type: none"> • What is the impact of the insolvency of a reinsurer on affiliated insurance companies? • Could primary insurers be influenced by a reinsurer default in a way other than via credit risks (e.g., reputational risks)? • What is the effect of reinsurer insolvencies if primary insurers are already impaired?
	Chen et al. (2013a)	<ul style="list-style-type: none"> • Is there the possibility of reinsurance retrocession spirals? • Banks contribute to systemic risk. What are the mechanisms through which banking shocks are transmitted to the insurance industry?
	Baluch et al. (2011) Further questions	<ul style="list-style-type: none"> • The banking and insurance sectors are interconnected, but how and to what extent? • How can contagion effects be measured? Are positive correlations in prices sufficient to imply contagion risks?
	Non-Traditional Business Activities	Harrington (2009) Cummins and Weiss (2011) IAIS (2012b) Cummins and Weiss (2013) Further questions

Table 4: Open research questions

Open research questions can be sorted into three types: (1) regulation, (2) traditional business activities, and (3) non-traditional business activities.

With regard to regulation, the major research question that remains to be answered is how regulation can be designed so that systemic risk is mitigated. This issue is currently under discussion and no consensus has yet been reached. Also, a question that is not thoroughly considered in the literature is whether new regulation (e.g., Solvency II) might contribute to

systemic risk, as is sometimes discussed in academia and practice.⁶⁷ Furthermore, how to prevent regulation arbitrage is still an open question.

With respect to traditional insurance activities, studies find that the stock market prices of insurance companies and other companies in the financial services industry are correlated. Although, more needs to be known about the details of this interconnection, which is to date mainly measured by Granger-causality tests, correlation, and principal components analysis. Furthermore, even if in general there is an agreement in the literature that systemic risk is very low in traditional insurance activities, indirect contagion effects, such as reputation risks, have not yet been analysed. Also, all studies on reinsurance risk find that traditional reinsurance activities neither contribute to systemic risk nor increase vulnerability, but all this work focuses on single facets of the reinsurance sector. A more comprehensive approach that takes into account several types of interconnection, as well as ‘second-round’ effects, would be useful.

With respect to non-traditional insurance activities, another controversial topic that has room for more research is the systemic risk contribution of derivatives and other innovative products from the field of alternative risk transfer, especially insurance-linked securities and industry-loss warranties. Furthermore, studies that link the results of systemic risk measures to characteristics of insurance companies would definitely profit from more discussion of these measures and preconditions to their application. The link between the measures and the actual systemic risk definitions is not clear. Is systemic risk as defined by the FSB/IAIS really measured? In which cases is the application of a systemic risk measure appropriate? Is it sufficient to rely on stock price information to measure an interconnection? The vast number of measures and the fact that a certain measure is sometimes used for measuring systemic risk contribution and sometimes for measuring vulnerability indicates that more work in this area is needed.

⁶⁷ See, e.g., Eling et al. (2008) or IMF (2007), which argues that regulatory convergence can decrease the variety of applied risk models and discourage contrarian behaviour in times of crisis. Consequently, regulatory regimes might destabilize the financial system.

Appendix

Reference	Definition
Acharya et al. (2011, p. 281)	'Systemic risk can be conceived as the potential failure of a significant part of the financial sector—one large institution or many smaller ones—leading to reductions in the availability of credit and/or critical risk management products such as insurance, thereby adversely affecting the real economy'.
Adrian and Brunnermeier (2011, p. 1)	'The spreading of distress gives rise to systemic risk—the risk that the intermediation capacity of the entire financial system is impaired, with potentially adverse consequences for the supply of credit to the real economy'. ... 'reflect systemic risk—the risk that the stability of the financial system as a whole is threatened'.
Adrian and Brunnermeier (2011, p. 1) based on Brunnermeier et al. (2009)	'A systemic risk measure should identify the risk on the system by individually systemic institutions, which are so interconnected and large that they can cause negative risk spillover effects on others, as well as by institutions which are systemic as part of a herd'.
Baur et al. (2003, p. 7)	'Systemic risk is the danger that an event will trigger a loss of economic value and/or confidence in the financial system that has significant adverse effects on the real economy'.
Bach and Nguyen (2012, p. 131)	'Hence, macroprudential regulation focuses on systemic risk—it refers to the risk of a malfunction of the financial system to an extent big enough to affect economic growth and welfare ...'
Baluch et al. (2011, p. 137)	'However, the term “systemic risk” is somewhat ambiguous with regard to both its definition and derivation. A widely accepted definition of systemic risk is that of Csiszar who characterise it as “the risk that the failure of a participant to meet its contractual obligations may in turn cause other participants to default, with the chain reaction leading to broader financial difficulties”. However, this definition includes only the sort of ‘micro’ systemic risk represented by a cumulative loss function caused by a domino effect ...'
Bernanke as reported by Boles (2009)	'Systemic risks are developments that threaten the stability of the financial system as a whole and consequently the broader economy, not just that of one of two institutions'.
Billio et al. (2010, p. 1)	'Systemic risk can be defined as the probability that a series of correlated defaults among financial institutions, occurring over a short time span, will trigger a withdrawal of liquidity and widespread loss of confidence in the financial system as a whole'.
Billio et al. (2012, p. 536)	'By definition, systemic risk involves the financial system, a collection of interconnected institutions that have mutually beneficial business relationships through which illiquidity, insolvency, and losses can quickly propagate during periods of financial distress'.
Chen et al. (2013a, p. 1)	'From a statistical perspective, systemic risk involves the co-movement of key financial variables measuring the health of stability of financial institutions and has also been described as the potential for multiple simultaneous defaults of major financial institutions'.
Chen et al. (2013b, p. 1)	'Systemic risk can be defined as the risk that an event will generate a loss of economic value or confidence in a substantial segment of the financial system, which in turn could also affect the entire economy'.
Csiszar (2002, p. 2)	'What is Systemic Risk? The risk that the failure of a participant to meet its contractual obligations may in turn cause other participants to default, with the chain reaction leading to broader financial difficulties'.
Committee on Capital Markets Regulation (CCMR) (2009, p. ES-3)	'Systemic risk is the risk of collapse of an entire system or entire market, exacerbated by links and interdependencies, where the failure of a single entity or cluster of entities can cause a cascading failure. We recognize that there are at least five key externalities particular to financial markets that contribute to systemic risk. First, the spread of speculative information through the market can create the perception that economic difficulties impacting one financial institution will affect similarly situated firms. Second, customers of failed institutions may subsequently find themselves in a less friendly market when looking to re-direct their business. Third, there is considerable interconnectedness between the financial institutions participating in modern financial markets, so that the failure of one firm can affect many others. Fourth, a negative spiral may be created by falling asset prices and resulting liquidity constrictions. Fifth, falling asset prices and liquidity crises could cause institutions to become reluctant to extend credit'.
Cummins and Weiss (2011, p. 1)	'Systemic risk is the risk that an event will trigger a loss of economic value or confidence in a substantial segment of the financial system that is serious enough to have significant adverse effects on the real economy with a high probability'.
De Bandt and Hartmann (2000, p. 11)	'Systemic risk (in the narrow and broad sense) can then be defined as the risk of experiencing systemic events in the strong sense'. See also page 10 for an understanding of the context.
Grace (2011, p. 2)	'First, “Systemic risk refers to the ... breakdown in an entire system. ... This ... risk ... is evidenced by a high correlation and clustering of ... failures.” A second definition concerns contagion. One failure by an institution leads to a failure of another. This chain reaction requires linkages among firms, markets or sectors. Finally, a third definition focuses on an externality caused by a shock to one firm which creates uncertainty about other firms. For example, a firm suffers a loss and the market then becomes uncertain about the value of similar firms'.
Group of Ten (2001, p. 126)	'Systemic financial risk is the risk that an event will trigger a loss of economic value or confidence in, and attendant increases in uncertainty about, a substantial portion of the financial system that is serious enough to quite probably have significant adverse effects on the real economy'.
Harrington (2009, p. 801)	'There is no generally accepted definition of “systemic risk” or agreement on its importance and scope. While the term sometimes is used to encompass the risk of any large, macroeconomic shock, the term generally is used to connote situations with extensive interdependencies or “interconnectedness” among firms and an associated risk of contagion and significant economic spillovers'.
Harrington (2011, p. 4)	'The term “systemic risk” generally is used broadly to encompass the risk of any large, macroeconomic shock and the risk arising from extensive interdependencies or “interconnectedness” among firms, with an attendant risk of contagion and significant economic spillovers. There is a distinction, however, between the risk of common shocks to the economy, such as widespread reductions in housing prices or large changes in interest rates or foreign exchange,

	which have the potential to directly harm large numbers of people and firms, and financial risk that arises from interconnectedness and contagion’.
Huang et al. (2009, p. 2036)	‘First, how to measure the systemic risk of a financial system, where systemic risk is defined as multiple simultaneous defaults of large financial institutions?’
IAIS (2009, p. 1)	‘The risk of disruption to the flow of financial services that is (i) caused by an impairment of all or parts of the financial system; and (ii) has the potential to have serious negative consequences for the real economy’.
Jobst (2012, p. 3)	‘Systemic risk refers to individual or collective financial arrangements—both institutional and market-based—that could either lead directly to system-wide distress in the financial sector and/or significantly amplify its consequences (with adverse effects on other sectors, in particular capital formation in the real economy). The potential emergence of systemic risk and its impact on financial stability is significantly influenced by institutions whose disorderly failure, because of their size, complexity and systemic interconnectedness, would cause significant disruption to the financial system and economic activity...’.
Kaufmann and Scott (2003, p. 372)	‘A search of the literature reveals three frequently used concepts. The first refers to a “big” shock or macroshock that produces nearly simultaneous, large, adverse effects on most or all of the domestic economy or system. Here, systemic “refers to an event having effects on the entire banking, financial, or economic system, rather than just one or a few institutions”...’ ... ‘The other two definitions focus more on the microlevel and on the transmission of the shock and potential spillover from one unit to others’.
Klein (2011, p. 5)	‘Systemic risk could be defined as the risk that a market or financial system could experience severe instability, potentially catastrophic, caused by idiosyncratic events or conditions in financial intermediaries. It arises from the links between firms in a system or market where the failure of one or more firms can have cascading effects which could potentially bring down an entire system or market. This is a kind of market failure that can arise from excessive risk taking by financial institutions whose failure can lead to the failure of other firms in a market or system’.
Kress (2011, p. 57)	‘The aggregation of CDS counterparty risk throughout financial markets creates systemic risk, the possibility of contagion spreading from institution to institution’.
Rodriguez-Moreno and Peña (2013, p. 1)	‘Systemic risk appears when generalized malfunctioning in the financial system threatens economic growth and welfare. The causes of this malfunction are multiple and therefore a single measure of systemic risk may neither be appropriate nor desirable’.

Table A1: Definitions of systemic risk in the literature

Term	Synonym	Definition
Systemic risk		Risk of disruption to the flow of financial services that is (i) caused by an impairment of all or parts of the financial system and (ii) has the potential to have serious negative consequences for the real economy
Dysfunction of financial services	<ul style="list-style-type: none"> • Financial instability • Malfunction of the financial system • Disruption to the flow of financial services 	State in which financial institutions can no longer offer their services or no market exists
Impairment of financial system		State in which one or a group of institutions is in distress or insolvent
Negative effect on the economy	<ul style="list-style-type: none"> • Substantial negative effect on the rest of the economy • Serious negative consequences for the real economy • Loss of economic value 	Negative impact on one or a group of industries other than the financial industry that leads to an increase in unemployment and a decline in GDP in at least one country
Default of financial institutions		Simultaneous or subsequent default of at least two financial institutions
Contagion		Significant increase in linkages between financial institutions after a shock to one institution or a group of institutions (includes spillover)
Interdependence		Linkages between financial institutions in the absence of a shock to one or a group of institutions
Spillover		Spread of shocks due to unfulfilled contractual obligations
Aligned behaviour		Similar actions of institutions caused by independent assessments of the environment and the outcome of possible actions
Institutions’/activities’ contribution to systemic risk	<ul style="list-style-type: none"> • To expose systemic risk/Systemic risk exposure • Causation of systemic risk • Creation of systemic risk • Origination of systemic risk • ≈ Contribution approach • Primary indicators of systemic risk • Trigger of systemic risk 	An increase or decrease of systemic risk caused by an institution or activity
Vulnerability to impairments of the financial system	<ul style="list-style-type: none"> • To be exposed to systemic risk • ≈ Participation approach • ≈ Victim of systemic risk • Contributing factors • Amplification of systemic risk 	Likelihood of an <ul style="list-style-type: none"> a) institution becoming insolvent or suffering distress b) activity being significantly reduced caused by the impairment of the financial system

Table A2: Definitions of terms used in the paper

Search and Identification Strategy

- We searched for the terms ‘systemic risk’ and ‘insurance’ in the journal databases EBSCOhost (Business Source Premier and EconLit) as well as in ABI/INFORM Complete. In addition, we searched for the terms in the Social Science Research Network (SSRN) and via Google Scholar.
- We reviewed all issues from January 2003 to July 2013 of the following journals: *Journal of Finance*, *American Economic Review*, *Journal of Risk and Insurance*, *Insurance: Mathematics and Economics*, *Journal of Financial Stability*, *The Geneva Papers on Risk and Insurance—Issues and Practice*, and *The Geneva Risk and Insurance Review*. Also other journals from the field of risk and insurance were reviewed (*Journal of Insurance Regulation*, *Risk Management & Insurance Review*, *ASTIN Bulletin*, *North American Actuarial Journal*, *European Actuarial Journal*).
- We reviewed all working papers from the annual meetings of the American Risk and Insurance Association (ARIA) 2009, 2011, 2012, and 2013, the 2010 World Risk and Insurance Congress, and from the Temple University Conference on Convergence, Interconnectedness, and Crises: Insurance and Banking 2011.
- We reviewed all citations in relevant studies in order to identify additional relevant material.

Part A: Academic Papers						
No.	Author	Year	Title/ Published in	Focus and Methodology	Research Question	Main Result
1	Jean-Claude Trichet	2005	Financial Stability and the Insurance Sector / The Geneva Papers on Risk and Insurance— Issues and Practice	<ul style="list-style-type: none"> • Financial stability • Life, non-life • Qualitative discussion 	<ul style="list-style-type: none"> • Which risks does the insurance industry pose to financial stability? 	<ul style="list-style-type: none"> • Due to maturity transformation and fast transmission mechanisms, banks contribute to systemic risk • Traditional insurance business is not vulnerable to ‘insurance runs’ and interconnectedness in comparison to banks is low, so traditional insurance does not contribute to systemic risk • New business activities of insurers can lead to contagion affecting banks: <ul style="list-style-type: none"> - Selling of credit risk transfer instruments (derivatives); banks are net buyers and insurers net sellers - Bancassurance (banking groups engage in insurance), regulatory arbitrage might be possible - Participation of insurers in financial markets, fire sales might trigger a downward spiral
2	Scott E. Harrington	2009	The Financial Crisis, Systemic Risk, and the Future of Insurance Regulation / Journal of Risk and Insurance	<ul style="list-style-type: none"> • AIG case • Life, non-life • Qualitative discussion based on descriptive statistics 	<ul style="list-style-type: none"> • Discussion of the AIG case • Does insurance contribute to systemic risk? • How should regulation be drafted? 	<ul style="list-style-type: none"> • AIG became distressed because of its derivative writing business and securities lending program • It is unclear if financial support was necessary; insurance subsidiaries would probably have avoid bankruptcy • Traditional insurance products do not contribute to systemic risk • Market transparency should be increased, but there should be no too-big-to-fail regulation for insurers
3	Marc P. Radice	2010 (June)	Systemische Risiken im Versicherungssektor? / Working Paper	<ul style="list-style-type: none"> • Systemic risk • Life, non-life • Scenario analysis based on qualitative assessments of the insurance industry 	<ul style="list-style-type: none"> • Can systemic risk be found within the insurance sector? 	<ul style="list-style-type: none"> • Following scenarios do not identify contributions to systemic risk: <ul style="list-style-type: none"> - Unavailability of insurance, - Insurance run on life insurers, - CDS payment default, - Credit rating utilization (long-term investment, short-term funded) • Following scenarios could be systemically risky: <ul style="list-style-type: none"> - Asset contagion, - Limited fungibility of available group liquidity, - Distress of non-regulated/non-insurance business within an insurance group
4	Viral V. Acharya, John Biggs, Hanh Le, Matthew Richardson, Stephen Ryan	2011	Systemic Risk and the Regulation of Insurance Companies / Regulating Wall Street—The Dodd-Frank Act and the New Architecture of Global Finance	<ul style="list-style-type: none"> • Regulation • Life, non-life, reinsurance • Qualitative discussion based on descriptive statistics and systemic risk measure calculation 	<ul style="list-style-type: none"> • How to shape regulation and treat systemically risky institutions? 	<ul style="list-style-type: none"> • MES is calculated for U.S. insurance companies at July 2007 • Insurers with a traditional business model pose low systemic risk in contrast to companies engaged in non-traditional insurance products • A federal regulator is proposed who manages ex ante and ex post the systemic risk of large insurers • Institutions that are too interconnected to fail should pay a fee for the implicit guarantee to be bailed out in the case of crisis • Insurance products relating to systemic risks (e.g., insolvency of AAA-CDOs or a nuclear attack) should be forbidden unless fully capitalized
5	Faisal Baluch, Stanley Mutenga, Chris Parsons	2011	Insurance, Systemic Risk and the Financial Crisis / The Geneva Papers on Risk and Insurance— Issues and Practice	<ul style="list-style-type: none"> • Systemic risk • Life, non-life, reinsurance • Qualitative discussion based on descriptive statistics and correlation analysis 	<ul style="list-style-type: none"> • What was the role of the insurance industry during the financial crisis? 	<ul style="list-style-type: none"> • The impact of the financial crisis on the insurance industry was less severe than on the banking industry • Companies with insurance and banking businesses suffered especially • Systemic risk in insurance has grown in the last years, since insurers increased their participation in the capital markets and offered more banking services

6	Dwityapoetra Besar, Philip Booth, Ka K. Chan, Alastair K. L. Milne, J. Pickles	2011	Systemic Risk in Financial Services / British Actuarial Journal	<ul style="list-style-type: none"> • Systemic risk • Life, non-life, reinsurance • Qualitative discussion and four case studies based on qualitative assessments of financial crisis 	<ul style="list-style-type: none"> • What is systemic risk? • Where does systemic risk originate in the financial system? 	<ul style="list-style-type: none"> • Systemic risk can originate in four 'networks of interconnections' between financial institutions: <ul style="list-style-type: none"> - Payment systems, financial infrastructure, systems of clearing and settlement - Short-term funding markets - Common exposure of several institutions in collateral, securities, and derivatives market - Counterparty exposure • Insurers do not contribute to systemic risk, since insurers are only affected by the last issue and in case of life insurers and pension funds by the third issue as well; however, in a much more limited way than banks
7	Iman van Lelyveld, Franka Liedorp, Manuel Kampman	2011	An Empirical Assessment of Reinsurance Risk / Journal of Financial Stability	<ul style="list-style-type: none"> • Contagion • Reinsurance • Scenario analysis based on a matrix showing the reinsurance linkages between insurers-insurers and insurers-reinsurers 	<ul style="list-style-type: none"> • Do linkages between reinsurers and insurers contribute to systemic risk via a threat of contagion? 	<ul style="list-style-type: none"> • 213 Dutch insurers and their reinsurance exposure are analysed as of 2005 • Scenario analysis shows that <ul style="list-style-type: none"> - Potential failure of any one reinsurer is not a systemic risk - Potential failure of reinsurers from a particular geographic region is not a systemic risk - Potential failure of the two largest reinsurers in the life and non-life segment is not a systemic risk • Even if many reinsurers would go bankrupt the market would not fail and only a few primary insurers would go bankrupt
8	J. David Cummins, Mary A. Weiss	2011 (July)	Systemic Risk and the U.S. Insurance Sector / Working Paper	<ul style="list-style-type: none"> • Systemic risk • Life, non-life, reinsurance • Qualitative discussion based on descriptive statistics 	<ul style="list-style-type: none"> • Does the U.S. insurance sector significantly contribute to systemic risk? 	<ul style="list-style-type: none"> • Traditional activities of insurers do not contribute to systemic risk, but derivatives trading and financial guarantees might • Life insurers are vulnerable due to leverage/MBSs to intra-sector crises • Both life and property-casualty insurers are vulnerable to reinsurance crisis • Insurance group supervision is needed to regulate non-core activities effectively
9	Robert W. Klein	2011 (October)	Insurance Market Regulation: Catastrophe Risk, Competition and Systemic Risk / Working Paper	<ul style="list-style-type: none"> • Regulation • Life, non-life, reinsurance • Qualitative discussion based on literature review 	<ul style="list-style-type: none"> • Overview of insurance regulation • How to respond to risks related to competition and catastrophes as well as systemic ones? 	<ul style="list-style-type: none"> • Core activities of insurance companies do not contribute to systemic risk • Life insurers are exposed to systemic risk due to their holdings of MBSs, privately placed bonds, minimum interest guarantees, and high leverage • CDSs (non-traditional activities) can contribute to systemic risk • In-/solvency and market conduct regulation desirable
10	Sojung C. Park, Xiaoying Xie	2011 (October)	Reinsurance and Systemic Risk: The Impact of Reinsurer Downgrading on Property-Casualty Insurers / Working Paper	<ul style="list-style-type: none"> • Contagion • Reinsurance • Empirical study (probit regressions) and scenario analysis about hypothetical equity levels of insurers if major reinsurers fail 	<ul style="list-style-type: none"> • Do reinsurer downgradings have an impact on insurers? 	<ul style="list-style-type: none"> • 516 rating up- and downgrades for U.S. insurers are analysed • Rating downgrades of reinsurers increase likelihood of rating downgrades of insurers, since companies are interconnected • No indication that defaults of large reinsurers contribute to systemic risk • Scenario analysis shows that even if three leading reinsurers would go bankrupt the market would not fail
11	Martin F. Grace	2011 (December)	The Insurance Industry and Systemic Risk: Evidence and Discussion / Working Paper	<ul style="list-style-type: none"> • Systemic risk • Life, non-life • Event study, empirical study (Granger-causality tests) 	<ul style="list-style-type: none"> • What are the systemic effects of insurance companies? • What kind of regulation is appropriate? 	<ul style="list-style-type: none"> • Insurers do not contribute to systemic risk, since duration of assets and liabilities are more closely matched than in the case of banks • Event studies show no indication that insurers contribute to systemic risk nor Granger-causality tests (however, insurers are victims just like other market participants) • Stock market returns of banks can explain stock market returns of insurers, but not vice versa • No institution should be classified too big to fail, since this would lead to moral hazard • Financial guarantees should be minimized in any new regulation
12	Scott E. Harrington	2011 (December)	Insurance Regulation and the Dodd-Frank Act	<ul style="list-style-type: none"> • Regulation • Life, non-life, reinsurance 	<ul style="list-style-type: none"> • Discussion of the Dodd-Frank Act and systemic risk 	<ul style="list-style-type: none"> • Regulation should take differences between insurers and banks into account, especially the facts that the insurance industry's contribution

			/ Working Paper	<ul style="list-style-type: none"> • Qualitative discussion 	<ul style="list-style-type: none"> • How should regulation be framed? 	<p>to systemic risk is lower and its market discipline higher in comparison with the banking industry</p> <ul style="list-style-type: none"> • Stronger financial guarantees for insurers increase moral hazard • No insurer should be labelled systemically important, since this would create moral hazard • Federal Insurance Office should consider: modernisation of regulation, promoting market discipline, policyholder guarantees, capital requirements, and group supervision
13	J. David Cummins, Ran Wei, Xiaoying Xie	2012 (January)	Financial Sector Integration and Information Spillovers: Effects of Operational Risk Events on U.S. Banks and Insurers / Working Paper	<ul style="list-style-type: none"> • Contagion • Life, non-life • Event study and weighted least squares regressions for explaining the cumulative abnormal returns 	<ul style="list-style-type: none"> • Does the announcement of an operational loss event of a financial services company have an impact on other companies in the market? 	<ul style="list-style-type: none"> • 415 bank events and 158 insurance events between 1978 and 2010 are analysed • Operational loss announcements of banks and insurers have intra- and inter-industry wide negative effects • Contagion effects identified by the event studies seem to be information based; regressions show that investors can differentiate to what degree a particular institution is affected
14	T. R. Berry-Stölzle, Gregory P. Nini, Sabine Wende	2012 (January)	External Financing in the Life Insurance Industry: Evidence from the Financial Crisis / Working Paper	<ul style="list-style-type: none"> • Capitalization • Life • Empirical study (probit and fixed-effects regression models) to identify the determinants of equity issuing and its consequences 	<ul style="list-style-type: none"> • Can life insurers raise external capital in times of crisis? • What are causes and consequences of capital raisings? 	<ul style="list-style-type: none"> • 6,960 U.S. insurers are considered between 1997 and 2010 • Capital is mostly raised if net income is negative or unfunded growth opportunities exist • Insurers had no difficulty in raising money during the crisis; there is no evidence that insurers had more difficulty in raising capital between 2007 and 2009 than at any other given period • Open TARP funds for insurers were unnecessary • Additional regulation for insurers is not needed since they could deal very well with the crisis
15	Wolfgang Bach, Tristan Nguyen	2012	On the Systemic Relevance of the Insurance Industry: Is a Macro Prudential Insurance Regulation Necessary? / Journal of Applied Finance & Banking	<ul style="list-style-type: none"> • Regulation • life, non-life, reinsurance • Qualitative discussion 	<ul style="list-style-type: none"> • Is a system-oriented regulation necessary? 	<ul style="list-style-type: none"> • Even though traditional insurance activities might not be systemically risky, macro prudential regulation is necessary due to <ul style="list-style-type: none"> - Economic costs if insurance markets are impaired - High public interest in the availability of large insurance capacity • Providing insurance is a systemic relevant function
16	Etti Baranoff	2012	An Analysis of the AIG Case: Understanding Systemic Risk and its Relation to Insurance / Journal of Insurance Regulation	<ul style="list-style-type: none"> • AIG case • Life, non-life • Qualitative discussion based on descriptive statistics 	<ul style="list-style-type: none"> • What were the internal and external factors for the distress of AIG? 	<ul style="list-style-type: none"> • Internal factors: a) dependency on credit ratings based on insurance operations, b) regulatory arbitrage, c) poor financial models, d) poor CDS contracts, e) CDS growth, and f) poor internal risk management and controls • External factors: a) free markets philosophy, b) 'everyone deserves to own a home' ideology, c) trust in credit ratings, d) poor banking regulation, e) no derivatives regulation, and f) growth of bundling securities with poor underwriting standards • CDS writing contributed to systemic risk • Securities lending did not contribute to systemic risk but exacerbated the situation • Insurance operations do not contribute to systemic risk
17	Monica Billio, Mila Getmansky, Andrew W. Lo, Lorian Pelizzon	2012	Econometric Measures of Connectedness and Systemic Risk in the Finance and Insurance Sectors / Journal of Financial	<ul style="list-style-type: none"> • Contagion • Life, non-life, reinsurance • Empirical study (principal component analysis and Granger-causality tests) that 	<ul style="list-style-type: none"> • Are banks, insurers, hedge funds, and brokers interconnected? • How to quantify systemic risk? 	<ul style="list-style-type: none"> • The 25 largest banks, insurers, hedge funds, and brokers in the world are analysed between 1996 and 2008 • Stock market returns of banks, insurers, hedge funds, and brokers have become highly interconnected over the last decade • Banks and insurers are especially prone to transmit shocks and therefore contribute to systemic risk

			Economics	measures the interconnectedness of stock market returns between financial institutions		<ul style="list-style-type: none"> • Interconnectedness as an indicator for systemic risk can successfully be measured by principal components analysis and Granger-causality tests
18	Faith R. Neale, Pamela Peterson Drake, Patrick Schorno, Elias Semaan	2012 (August)	Insurance and Interconnectedness in the Financial Services Industry / Working Paper	<ul style="list-style-type: none"> • Contagion • Life, non-life, reinsurance • Empirical study (principal components analysis and Granger-causality test) that measures the interconnectedness of stock market returns between financial institutions 	<ul style="list-style-type: none"> • Are insurance companies interconnected with the financial services industry? 	<ul style="list-style-type: none"> • U.S. financial institutions are analysed between 1994 and 2010 • Insurance companies became more interrelated with other financial services firms over time • Insurance companies have to be differentiated according to their line of business to understand the interconnectedness of the insurance sector • Companies involved in life insurance and financial guarantees are interconnected most with the financial services industry and it can be concluded that the interconnectedness between insurance and other institutions can be attributed to these lines
19	Robert Engle, Eric Jondeau, Michael Rockinger	2012 (December)	Systemic Risk in Europe / Working Paper	<ul style="list-style-type: none"> • Systemic risk measures • Life, non-life, reinsurance • Systemic risk measure calculation (LRMES and SRISK) 	<ul style="list-style-type: none"> • Which European financial institutions are risky? 	<ul style="list-style-type: none"> • 196 European financial institutions between 1990 and 2012 are analysed • Based on LRMES, an approximated 40% decline in world markets leads to an approximated negative return of 40% for European banking and insurance companies • Based on SRISK, the total amount of capital needed by the European financial system in times of crisis (capital shortfall) is calculated - 80% can be attributed to the banking sector - 18% can be attributed to the insurance sector
20	Andreas A. Jobst	2012 (December)	Systemic Risk in the Insurance Sector—A Review of General Issues and Some Findings on Large Insurers in Bermuda / Working Paper	<ul style="list-style-type: none"> • Regulation and systemic risk • Non-life, reinsurance • Qualitative discussion based on descriptive statistics 	<ul style="list-style-type: none"> • Are the current systemic risk indicators suggested by the IAIS/industry sufficient? • Do (re)insurers from Bermuda contribute to systemic risk? 	<ul style="list-style-type: none"> • Both indicator approaches proposed by the IAIS and the industry to identify systemically risky business activities as well as institutions have shortcomings; the state of the environment affecting the resilience of the insurance industry is neglected as well as the impact of transmission mechanisms • High liquidity buffers and low holdings of speculative derivatives indicate that the insurance industry of Bermuda neither contributes to systemic risk nor is vulnerable to impairments of the financial system
21	Fang Chen, Xuanjuan Chen, Zhenzhen Sun, Tong Yu, Ming Zhong	2013	Systemic Risk, Financial Crisis, and Credit Risk Insurance / The Financial Review	<ul style="list-style-type: none"> • Contagion • Life, non-life • Systemic risk measure calculation (MES, BANKBETA) and empirical study (panel regressions of credit insurers' stock market return on systemic risk measures and other company characteristics/bond spreads on downgrading of guaranteeing insurer) 	<ul style="list-style-type: none"> • How were credit risk insurers affected by the financial crisis in comparison to life and non-life insurers? • Do credit risk insurers transmit shocks? 	<ul style="list-style-type: none"> • 20 insurers are identified that sell either CDS, offer financial guarantees, or both; 77 property-casualty insurers and 17 life insurers are used as comparisons, sample period is between 2006 and 2009 • During the financial crisis (2007–2009) performance (stock market return and return on assets) of credit risk insurers is substantially worse than the one of property-casualty or life insurers • MES can explain bad performance of credit risk insurers during the financial crisis • Rating downgrades of credit risk insurers lead to rating downgrades of insured bonds
22	Hua Chen, J. David Cummins, Krupa S. Viswanathan, Mary A. Weiss	2013	Systemic Risk and the Interconnectedness Between Banks and Insurers: An Econometric Analysis / Journal of Risk and Insurance	<ul style="list-style-type: none"> • Contagion • Life, non-life • Systemic risk measure calculation (DIP, use of Granger-causality tests to evaluate which institutions cause systemic risk) 	<ul style="list-style-type: none"> • Are insurers a source or a victim of systemic risk? 	<ul style="list-style-type: none"> • 33 U.S. financial institutions are analysed between 2002 and 2008 • In contrast to banks, insurers seem not to cause systemic risk, but are vulnerable to a banking crisis • After adjusting for heteroskedasticity, Granger-causality tests on risk measures based on CDS spreads show that banks have a much larger impact with a longer duration on insurers than vice versa • Results are confirmed by stress tests

						<ul style="list-style-type: none"> • Banks and insurers are strongly interconnected
23	Hua Chen, J. David Cummins, Krupa S. Viswanathan, Mary A. Weiss	2013 (February)	Systemic Risk Measures in the Insurance Industry: A Copula Approach / Working Paper	<ul style="list-style-type: none"> • Systemic risk measures • Life, non-life • Systemic risk measure calculation (ΔCoVaR, MES, and SRISK) 	<ul style="list-style-type: none"> • - 	<ul style="list-style-type: none"> • 40 U.S. insurers are analysed between 2002 and 2011 • Four systemic risk measures—ΔCoVaR, modified ΔCoVaR, MES, and SRISK—are estimated with the help of copula models • Insurers can be systemically risky because financial risk measures for insurers peak in times of financial crisis • Life-health insurers respond more significantly to negative financial market conditions than property-casualty insurers
24	David Cummins, Mary A. Weiss	2013 (March)	Systemic Risk and Regulation of the U.S. Insurance Industry / Working Paper	<ul style="list-style-type: none"> • Systemic risk • Life, non-life, reinsurance • Qualitative discussion based on descriptive statistics, systemic risk measure calculation (SRISK, OLS regressions of systemic risk measure on company characteristics) 	<ul style="list-style-type: none"> • Does the U.S. insurance industry contribute to systemic risk or is it vulnerable to impairments of the financial system? • Which characteristics determine the vulnerability of an insurer to crisis? 	<ul style="list-style-type: none"> • U.S. insurers are analysed between 2001 and 2011 • Core property-casualty insurance and reinsurance activities do not contribute to systemic risk • Most core life insurance activities do not contribute to systemic risk—except separate accounts and group annuities • The following non-core insurance activities can contribute to systemic risk <ul style="list-style-type: none"> - Trading in derivatives - Asset lending and management - Financial guarantees • SRISK calculations and regressions on characteristics of insurers show that non-core insurance activities, size, MBS underwriting, and total reinsurance underwriting can explain vulnerability to crisis
25	Gregor N. F. Weiß, Janina Mühlnickel	2013 (May)	Consolidation and Systemic Risk in the International Insurance Industry / Working Paper	<ul style="list-style-type: none"> • Systemic risk • Life, non-life • Systemic risk measure calculation (MES, LTD before and after M&A activity), empirical study (OLS regression of changes in systemic risk measure on company characteristics) 	<ul style="list-style-type: none"> • Do M&A activities increase systemic risk? • What determinants can explain changes in the level of systemic risk after M&A activities? 	<ul style="list-style-type: none"> • 409 international, domestic, and cross-border mergers are analysed between 1984 and 2010 • There are mixed results; if consolidation leads to higher systemic risk (measured by LTD), however, the vulnerability of insurers to impairments of the financial system increases (measured by MES) • Firm size, leverage, and diversification can explain changes in systemic risk measures
26	Martin F. Grace, Jannes Rauch, Sabine Wende	2013 (July)	Systemic Risk and Interconnectedness in the Financial Industry: Implications on Regulation of Financial Conglomerates / Working Paper	<ul style="list-style-type: none"> • Systemic risk • Life, non-life • Event study 	<ul style="list-style-type: none"> • Can insurance-specific events contribute to systemic risk? 	<ul style="list-style-type: none"> • 12 insurance-specific events are analysed between 2001 and 2012, which include terror attacks, natural catastrophes, frauds, and financial bailouts • In comparison to the S&P 500, almost no significant abnormal returns for insurers and banks can be identified • There is only a low degree of interconnectedness between the different financial sectors • No evidence is found that insurance-specific events contribute to systemic risk
27	Gregor N. F. Weiß, Janina Mühlnickel	2013 (July)	Why Do Some Insurers Become Systemically Relevant? / Working Paper	<ul style="list-style-type: none"> • Systemic risk • Life, non-life, reinsurance • Systemic risk measure calculation (ΔCoVaR, MES, SRISK), empirical study (OLS and probit regressions of systemic risk measures and TARP funding on approximated IAIS indicators for systemic risk) 	<ul style="list-style-type: none"> • Do insurers contribute to systemic risk? • Which factors determine the contribution of an insurer to systemic risk? 	<ul style="list-style-type: none"> • 89 publicly listed U.S. insurers are analysed with data from 2006 • Insurers can contribute to systemic risk and are vulnerable to impairments of the financial system • Size and other income are the only significant factors of the IAIS criteria in determining the systemic risk contribution of an insurer as well as its vulnerability to impairments of the financial system

28	Etti Baranoff, Daniel Haefeli, Thomas Sager	2013 (August)	Surrenders in the Life Insurance Industry: A Systemic Risk of Runs? / Working Paper	<ul style="list-style-type: none"> • Systemic risk • Life • Qualitative discussion based on descriptive statistics, scenario analysis (potential cash outflows in the life insurance industry due to policy cancellations are compared with available liquidity) 	<ul style="list-style-type: none"> • Is a potential run on life insurers a systemic risk? 	<ul style="list-style-type: none"> • Between 2001 and 2011, U.S. life insurers were always able to endure the cash outflows due to the cancellation of contracts without selling assets • Simulations based on the historical distribution of lapse rates show the same results • Only if lapse rates were 10 times higher, would assets have to be sold before maturity; however, in comparison to the whole bond market, the assets on sale would only be a small fraction
29	Gregor N. F. Weiß, Denefa Bostandzic, Felix Irresberger	2013 (August)	Catastrophe Bonds and Systemic Risk / Working Paper	<ul style="list-style-type: none"> • Systemic risk • Reinsurance • Systemic risk measure calculation (ACoVaR, MES, SRISK) before and after the issuing of cat bonds, empirical study (cross-sectional regression analysis of changes in the systemic risk measure on issuer characteristics) 	<ul style="list-style-type: none"> • Does the issuing of catastrophe bonds increase or decrease the systemic risk contribution of insurers? 	<ul style="list-style-type: none"> • 176 cat bonds and their issuers are analysed between 1996 and 2013 • The issuing of cat bonds neither increases nor decreases the systemic risk contribution of an insurer or its vulnerability to impairments of the financial system (results not significant) • Pre-issue leverage, higher firm valuation, and previous cat bond issues decrease changes in systemic risk (not significant) after issuing cat bonds
30	Denis Kessler	2013 (forthcoming)	Why (Re)insurance is Not Systemic / Journal of Risk and Insurance	<ul style="list-style-type: none"> • Systemic risk • (Re)insurance • Qualitative discussion 	<ul style="list-style-type: none"> • Does reinsurance contribute to systemic risk? 	<ul style="list-style-type: none"> • Reinsurance does not contribute to systemic risk <ul style="list-style-type: none"> - Insolvencies of reinsurers are lengthy and orderly processes - Claims settlements and cash outflows are conditional on loss events and pre-funded - Life insurance guarantee funds and lapse fees prevent 'insurance runs' in case of life insurance activities - Retrocession spirals are unlikely due to the hierarchical structure of the reinsurance market - Underwritten risks are diversified (uncorrelated)

Part B Industry Studies and Practitioner Papers

No.	Author	Year	Title/ Publication Type	Focus	Research Question	Main Result
1	Jean-Baptiste Zufferey (Experten-gruppe Finanzmarkt-aufsicht)	2000	Finanzmarkt-regulierung und -aufsicht in der Schweiz / Report	<ul style="list-style-type: none"> • Regulation • Life, non-life, reinsurance • Qualitative discussion 	<ul style="list-style-type: none"> • What are the challenges for the regulation of the financial sector in Switzerland? 	<ul style="list-style-type: none"> • In regard to insurance and systemic risk: <ul style="list-style-type: none"> - Regulation of insurers should take differences between banking and insurance into account, not differentiate according to the size of a company, and focus on the protection of policyholders - Contagion risks are low in insurance - The insurance sector is vulnerable to macroeconomic shocks - Underwriting of derivatives could lead to systemic risk if information asymmetries are exploited by the industry
2	Patrizia Baur, Rudolf Enz, Aurelia Zanetti (Swiss Re)	2003	Reinsurance—A Systemic Risk? / Report	<ul style="list-style-type: none"> • Systemic risk • Reinsurance • Qualitative discussion 	<ul style="list-style-type: none"> • Does reinsurance contribute to systemic risk? 	<ul style="list-style-type: none"> • Reinsurance does not contribute to systemic risk <ul style="list-style-type: none"> - Unavailability of reinsurance not sign of systemic risk but due to changes in the environment - Primary insurers diversify their reinsurance exposure - Retrocession spiral due to reinsurer bankruptcies would not reach critical volume - In the past, insurers failed mostly due to management problems and not due to

						reinsurance failures
3	Financial Stability Board (FSB)	2009	Guidance to Assess the Systemic Importance of Financial Institutions, Markets and Instruments: Initial Considerations / Policy Guidance	<ul style="list-style-type: none"> • Regulation • Life, non-life, reinsurance • Qualitative discussion 	<ul style="list-style-type: none"> • Policy guidance • Report to the G20 Finance Ministers 	<ul style="list-style-type: none"> • Indicators for systemic risk of organizations: <ul style="list-style-type: none"> - Size - Lack of substitutability - Interconnectedness • Institutions and markets have to be considered • Indicators of financial vulnerability <ul style="list-style-type: none"> - Leverage - Liquidity risk - Maturity mismatches - Complexity of products and services
4	International Association of Insurance Supervisors (IAIS)	2009	Systemic Risk and the Insurance Sector / Report	<ul style="list-style-type: none"> • Systemic risk • Life, non-life, reinsurance • Qualitative discussion 	<ul style="list-style-type: none"> • Identification of further challenges of insurance regulators 	<ul style="list-style-type: none"> • Time as another aspect should be added to the FSB's assessment criteria of systemic risk • Insurers should be supervised on a group-wide basis, which should include non-regulated business activities • Different business model of insurers in contrast to banks has to be taken into account when framing regulation policies
5	Geneva Association	2010	Systemic Risk in Insurance—An Analysis of Insurance and Financial Stability / Report	<ul style="list-style-type: none"> • Systemic risk • Life, non-life, reinsurance • Qualitative discussion based on descriptive statistics 	<ul style="list-style-type: none"> • Discussion of systemic risk in Solvency II • Which activities of insurance companies contribute to systemic risk? • How should regulation be framed? 	<ul style="list-style-type: none"> • Whether companies contribute to systemic risk should be decided according to size, interconnectedness, substitutability, and the speed of potential liquidity outflow • Regulation should focus on activities, not institutions • Traditional insurance activities do not contribute to systemic risk • Non-traditional activities can contribute to systemic risk <ul style="list-style-type: none"> - Short-term funding and securities lending - Derivatives trading (e.g., CDS writing)
6	Geneva Association	2010	Key Financial Issues in Insurance / Report	<ul style="list-style-type: none"> • Systemic risk • Life, non-life • Qualitative discussion based on descriptive statistics 	<ul style="list-style-type: none"> • Follow-up report on the report: 'Systemic Risk in Insurance' 	<ul style="list-style-type: none"> • Severe decline in asset values would affect insurance companies • Traditional business model does not incorporate liquidity or 'insurance run' risks because <ul style="list-style-type: none"> - There is normally no short-term funding - Upfront fees exist - No withdrawals at will possible • Uninsurability is not a systemic risk but a reflection of reality and regulation in this regard would create systemic risk
7	International Association of Insurance Supervisors (IAIS)	2010	Position Statement on Key Financial Stability Issues / Report	<ul style="list-style-type: none"> • Regulation • Life, non-life, reinsurance • Qualitative discussion 	<ul style="list-style-type: none"> • Position statement 	<ul style="list-style-type: none"> • Traditional insurance business does not generate systemic risk, but is affected by systemic risk in other sectors • Life insurers might amplify a crisis in case of an equity downturn • Insolvencies no problem, since policyholder claims are not instantly due and no risk of fire sales • Cross-sectorial macro-prudent (banks + insurance) supervision as well as international (group-wide) supervision desirable
8	Geneva Association	2011	Variable Annuities with Guarantees and Use of Hedging / Insurance and Finance SC10	<ul style="list-style-type: none"> • Systemic risk • Life • Qualitative discussion 	<ul style="list-style-type: none"> • Discussion of systemic risk regarding annuities/hedging • Do variable annuities with guarantees and hedging activities contribute to systemic risk? 	<ul style="list-style-type: none"> • Neither variable annuities with guarantees nor hedging activities are a potential source of systemic risk
9	International Association of Insurance Supervisors (IAIS)	2011	Insurance and Financial Stability / Report	<ul style="list-style-type: none"> • Systemic risk • Life, non-life, reinsurance • Qualitative discussion 	<ul style="list-style-type: none"> • Which business lines of insurers contribute to systemic risk? How should regulation be framed? 	<ul style="list-style-type: none"> • Life and non-life insurance activities neither cause nor amplify systemic risk • Non-traditional and non-insurance activities like CDS writing can contribute to systemic risk • Group-wide supervision including insurance and non-insurance businesses should be established

10	Philipp Keller (Geneva Association)	2011	Solvency II and Incentives for Systemic Risk Exposure / Progres No. 54	<ul style="list-style-type: none"> Regulation Life, non-life, reinsurance Qualitative discussion 	<ul style="list-style-type: none"> Discussion of Solvency II How will Solvency II deal with the future risks? 	<ul style="list-style-type: none"> Despite opposition, market-consistent valuation of assets and liabilities should be kept since in this way the highest number of securities can be priced most accurately Sovereign debt risks are neglected Solvency II provides incentives to use standard formula, which can cause systemic risk (aligned behaviour) Solvency II provides incentives to invest in illiquid and risky assets
11	Geneva Association	2012	Insurance and Resolution in Light of the Systemic Risk Debate / Report	<ul style="list-style-type: none"> Systemic risk Life, non-life, reinsurance Qualitative discussion 	<ul style="list-style-type: none"> Do failing insurers contribute to systemic risk? 	<ul style="list-style-type: none"> Impaired insurers that need to be wound up generally do not contribute to systemic risk Exceptions could be mismanagement of short-term funding and extensive underwriting of CDS
12	International Association of Insurance Supervisors (IAIS)	2012	Reinsurance and Financial Stability / Report	<ul style="list-style-type: none"> Systemic risk Reinsurance Qualitative discussion based on descriptive statistics and quantitative stress tests 	<ul style="list-style-type: none"> Does reinsurance contribute to systemic risk? 	<ul style="list-style-type: none"> Reinsurance does not contribute to systemic risk <ul style="list-style-type: none"> Interconnectedness is mainly vertical between reinsurers and insurers; interconnectedness on a horizontal level is weak Stress tests show that reinsurers can absorb severe catastrophic events and financial market stress simultaneously In the past, insurers did not fail due to reinsurance insolvencies Engagement in insurance derivatives without an insurable interest could make the insurer vulnerable and be a potential cause of systemic risk
13	International Association of Insurance Supervisors (IAIS)	2012	Global Systemically Important Insurers: Proposed Assessment Methodology / Report	<ul style="list-style-type: none"> Systemic risk assessment Life, non-life, reinsurance Methodology description 	<ul style="list-style-type: none"> How to assess systemically important insurers? How should regulation be framed? 	<ul style="list-style-type: none"> Indicator-based assessment according to: <ul style="list-style-type: none"> Size Global activity Interconnectedness Non-traditional and non-insurance activities Substitutability Structural proposed regulation measures: <ul style="list-style-type: none"> Separate legal structures for non-traditional/non-insurance activities Restrictions on cross-subsidies within a group Disallowance of certain diversification benefits from non-traditional/non-insurance activities for calculating solvency requirements Regulation of subsidiaries with non-traditional/non-insurance activities within a group

Table A3: Papers on systemic risk in insurance

Systemic Risk Measure	Description	Reference
BANKBETA	Measures linkages between stock returns and the portfolio returns of the banking sector.	Chen et al. (2013)
Δ CoVaR	Measures the impact of a certain institution's distress on the value at risk of the financial system.	Adrian and Brunnermeier (2011)
DIP (distressed insurance premium)	Measures the price of insurance against financial distress based on asset return calculations and default probabilities of individual institutions.	Huang et al. (2009)
LRMES	Measures the long-run marginal expected shortfall of a company's return in the event of a financial crisis.	Engle et al. (2012)
LTD (lower tail dependence)	Measures the probability that an observation of stock returns' joint distribution will lie in the distribution's lower tail.	WeiB et al. (2012)
MES (marginal expected shortfall)	Measures the stock return of a company when the whole equity market is in a downturn.	Acharya et al. (2012b)
SRISK	Measures the capital a company needs if there is a crisis.	Acharya et al. (2012a)

Table A4: Systemic risk measures applied to the insurance sector

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