Essays on Systemic Risk and Financial Regulation

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The University of St.Gallen, School of Management, Economics, Law, Social Sciences and International Affairs hereby consents to the printing of the present dissertation, without hereby expressing any opinion on the views herein expressed.

St. Gallen, May 19, 2015

The President:

Prof. Dr. Thomas Bieger

To my dear parents

Helga & Hans

Outline

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Introduction

“Given the low probability of the stress test shock occurring, and assuming that Fannie Mae and Freddie Mac hold sufficient capital to withstand that shock, the exposure of the government to the risk that the GSEs [Government Sponsored Enterprises] will become insolvent appears quite low.” Joseph E. Stiglitz, Jonathan M. Orszag and Peter R. Orzag in 2002[1]

In 2008 Fannie Mae and Freddie Mac had to be bailed out by the U.S. government and reminded academia that systemic risk in the financial services sector is a relevant topic. It became clear that old questions are not sufficiently answered: What is systemic risk? Can systemic risk be measured and if yes, how? Which institutions are systemically relevant? How can regulation be designed to mitigate this risk? These questions motivate my dissertation and I hope that my research project makes a contribution to this important discussion leading to better regulatory frameworks. My dissertation begins with a clear focus on systemic risk (papers one and two) and evolves by taking financial regulation into account (papers three to four).

The first paper with the title “Systemic Risk in the Insurance Sector: Review and Directions for Future Research” is written by Martin Eling and David Pankoke. This paper reviews the extant research on systemic risk in the insurance sector and outlines new areas of research in this field. We summarize and classify 43 theoretical and empirical research papers from both academia and practitioner organizations. The survey reveals that traditional insurance activity in the life, non-life, and reinsurance sectors neither contributes to systemic risk, nor increases insurers’ vulnerability to impairments of the financial system. However, non-traditional activities (e.g., CDS underwriting) might increase vulnerability and life insurers might be more vulnerable than non-life insurers due to higher leverage. Whether non-traditional activities also contribute to systemic risk is not entirely clear; however, the activities with the

[1] Stiglitz, J.E., Orszag, J.M., Orzag, P.R., 2002. Implications of the new Fannie Mae and Freddie Mac risk-based capital standard. FannieMae Papers (2)1: 1-10. Available at: http://www.pierrelemieux.org/stiglitzrisk.pdf (17th November 2014)

potential to contribute to systemic risk include underwriting financial derivatives, providing financial guarantees, and short-term funding. This paper is of interest not only to academics, but is also highly relevant for the industry, regulators, and policymakers. We submitted the paper to the *Risk Management and Insurance Review* where it is in the third round of the review process.

The second paper of this dissertation has the title "Sophisticated vs. Simple Systemic Risk Measures" and is single-authored. This paper evaluates whether sophisticated or simple systemic risk measures are more suitable to identify institutions which contribute to systemic risk. As sophisticated systemic risk measures I consider ΔCoVaR, Marginal Expected Shortfall (MES), SRISK and Granger-Causality Networks. As simple systemic risk measures I consider the market capitalization, total debt, leverage and stock market returns of an institution as well as the correlation between stock market returns of an institution and the market. Systemic relevance is approximated by the receipt of financial support during the financial crisis and the classification as a systemically important institution by national or international regulators. The analyses are performed for all companies in the S&P 500 composite index. My findings indicate that in general, simple systemic risk measures have more explanatory power than sophisticated risk measures. In particular total debt is the most suitable indicator according to explanatory power and model fit to detect institutions which contribute to systemic risk. The most suitable sophisticated risk measure is SRISK. The paper was presented at the Asia-Pacific Risk and Insurance Association (APRIA) Annual Conference 2014 in Moscow, the American Risk and Insurance Association (ARIA) Annual Meeting 2014 in Seattle and the European Group of Risk and Insurance Economists (EGRIE) Annual Seminar 2014 in St. Gallen.

The third paper with the title "Basis Risk, Procyclicality, and Systemic Risk in the Solvency II Equity Risk Module" is written by Martin Eling and David Pankoke. This paper analyzes the equity risk module of Solvency II, the new regulatory framework for insurance companies in the European Union. The equity risk module contains a symmetric adjustment mechanism called equity dampener that is meant to reduce procyclicality of capital requirements and thus systemic risk in the insurance sector. We critique the equity risk module in three steps: we first analyze the sensitivities of the equity risk module with respect to the underlying technical basis, then work out potential basis risk (i.e., deviations of insurers' actual equity risk from the Solvency II equity risk), and—based on these results—measure the impact of the symmetric adjustment mechanism on the goals of Solvency II. The equity risk module is backward-looking in nature and a substantial degree of basis risk exists if realistic equity portfolios are considered. Both of these aspects underline the importance of the "Own Risk and Solvency Assessment" (ORSA) under Solvency II. Moreover, we show that the equity dampener leads to substantial deviations from the proposed 99.5% confidence level and thereby reduces procyclicality of capital requirements. Our results are of interest to academics who study regulation and risk management and of practical relevance to practitioners and regulators working on the implementation of such models. The paper was presented at the American Risk and Insurance Association (ARIA) Annual Meeting 2012 in Minneapolis as well as at the Annual Congress 2013 of the German Insurance Science Association in Berlin. The paper is published in the *Journal of Insurance Regulation*.

"Costs and Benefits of Financial Regulation – An Empirical Assessment for Insurance Companies" is the title of my fourth paper. It is co-authored by Martin Eling. We empirically analyze the costs and benefits of financial regulation based on a survey of 76 insurers from Austria, Germany and Switzerland. Our analysis includes both established and new empirical measures for regulatory costs and benefits. This is the first paper that takes costs and benefits combined into account using a latent class regression with covariates. Another feature of this paper is that it analyzes regulatory costs and benefits not only on an industry level, but also at the company level. This allows us to empirically test fundamental principles of financial regulation such as proportionality: the intensity of regulation should reflect the firm-specific amount and complexity of the risk taken. Our empirical findings do not support the proportionality principle; for example, regulatory costs cannot be explained by differences in business complexity. One potential policy implication is that the proportionality principle needs to be more carefully applied to financial regulation. The paper was presented at the Asia-Pacific Risk and Insurance Association (APRIA) Annual Conference 2014 in Moscow and the American Risk and Insurance Association (ARIA) Annual Meeting 2014 in Seattle.

The final paper of this dissertation has the title "Discontinued Business in Non-Life Insurance—An Empirical Test of the Market Development in the German-Speaking Countries". It is written together with Martin Eling as well. Although every company has discontinued business, its active management is a relatively new topic in practice and an entirely new field of study in academia. Based on a survey of 85 non-life insurers from Germany, Switzerland, Austria, and Luxembourg, we empirically test the market development and find indication that Swiss insurers seem to have more experience with the active management of discontinued business than insurers in other countries. We explain this phenomenon by that country's more advanced solvency capital requirements that better reflect the risk of discontinued business activities. We thus conclude that with the introduction of Solvency II, active management of discontinued business will become more important since insurers will have to hold higher equity capital for discontinued business portfolios. We illustrate this fact within a numerical example which shows that 23% of the Solvency II non-life premiums and reserve risk can be traced back to discontinued business. The paper is published in the *European Actuarial Journal*.

What is the bottom line of this dissertation? Quick fixes, short answers and bold political actions with regard to systemic risk and financial regulation are likely to do more harm than good. The findings of my dissertation suggest that there are no simple answers: In general, insurance companies do not contribute to systemic risk, but in certain circumstances they do. Current systemic risk measures cannot indicate systemically relevant institutions. However, this finding only holds true under the assumption that financial support during the financial crisis of 2008 was allocated correctly. The equity risk module of Solvency II is well suited for crises which took place in the past, but it is not clear if it is suited for future crises, too. In theory financial regulation should be proportional to the risk of institutions, but in practice no evidence for this claim can be found. Finally, it seems that Swiss insurers are more advanced in the management of discontinued business. However, whether this is due to advanced regulation, is not entirely proven, yet.

Furthermore, my findings suggest that it would be wise to focus more on the robustness of the financial system and the economy in general than on the avoidance of crises. The theoretical models – whether incorporated in sophisticated systemic risk measures or in Solvency II – seem not to be robust to changing assumptions and specifications. Therefore, with reoccurrence of severe crises in the future being likely, we should learn from past experiences in order to mitigate the negative effects instead of trying to avoid crises altogether.

Einführung

„Angesichts der geringen Wahrscheinlichkeit, dass der im Stresstest unterstellte Schock eintritt und der Annahme, dass Fannie Mae und Freddie Mac genügend Kapital besitzen, um diesen standzuhalten, ist das Risikopotenzial der Insolvenz von GSEs [≈ staatsnahen Instituten] sehr gering.“ Joseph E. Stiglitz, Jonathan M. Orszag und Peter R. Orzag in 2002.

Im Jahr 2008 konnten Fannie Mae und Freddie Mac nur vor einer Insolvenz bewahrt werden durch die finanzielle Unterstützung der US-Regierung. Dies zeigte, dass für die Wissenschaft systemische Risiken im Finanzdienstleistungssektor nach wie vor ein relevantes Thema sind. Alte Fragen müssen neu beantwortet werden: Was ist unter systemischen Risiken zu verstehen? Kann man systemische Risiken messen und wenn ja, wie? Welche Institutionen sind systemisch relevant? Wie kann die Regulierung ausgestaltet werden, um diese Risiken zu minimieren? Diese Fragen sind die Motivation für meine Dissertation und ich hoffe, dass mein Forschungsprojekt einen Beitrag zu dieser wichtigen Diskussion um systemische Risiken leistet und hilft, bessere rechtliche Rahmenbedingungen zu schaffen. Meine Dissertation beginnt mit einem klaren Fokus auf systemische Risiken (Aufsätze eins und zwei) und entwickelt sich dahin gehend, dass die Finanzregulierung mehr und mehr in Betracht gezogen wird (Aufsätze drei, vier und fünf).

Der erste Artikel mit dem Titel "Systemic Risk in the Insurance Sector: Review and Directions for Future Research“ stammt von Martin Eling und David Pankoke. In diesem Artikel besprechen wir die vorhandene wissenschaftliche Literatur zu systemischen Risiken im Versicherungssektor und identifizieren offene Forschungsfragen. Wir fassen zusammen, klassifizieren und rezensieren 43 theoretische und empirische Forschungsarbeiten aus Wissenschaft und Praxis. Unser Review zeigt, dass die traditionellen Versicherungsfelder - Leben, Nicht-Leben und Rückversicherung - weder systemische Risiken erhöhen noch die Anfälligkeit von Versicherern gegenüber Krisen im Finanzbereich steigern. Nicht-traditionelle

Versicherungsaktivitäten (z.B. CDS Underwriting) könnten jedoch die Krisenanfälligkeit der Versicherer erhöhen, insbesondere die der Lebensversicherer, da jene mit einem hohen Fremdkapitalverhältnis arbeiten. Ob diese nicht-traditionellen Aktivitäten auch das systemische Risiko eines Versicherers steigern, ist nicht abschliessend geklärt. In Frage kommen jedoch insbesondere der Handel mit Finanzderivaten, das Geben von Finanzgarantien und die Finanzierung über Schuldverschreibungen mit kurzer Laufzeit. Dieses Papier ist nicht nur von Interesse für Wissenschaftler, sondern auch von grosser Bedeutung für die Industrie, Regulierungsbehörden und politische Entscheidungsträger. Unser Artikel befindet sich derzeit in der dritten Runde des Review Prozesses des *Risk Management and Insurance Review*.

Der zweite Artikel wurde in Einzelarbeit von David Pankoke erstellt und trägt den Titel "Sophisticated vs. Simple Systemic Risk Measures". Diese Arbeit untersucht, ob anspruchsvolle Risikomasse oder einfache Indikatoren besser geeignet sind, um Institutionen zu identifizieren, welche in erheblichem Masse zu systemischen Risiken beitragen. Als anspruchsvolle Risikomasse wurden ΔCoVaR, Marginal Expected Shortfall (MES), SRISK und Granger-Causality Networks gewählt. Als einfache Indikatoren dienen die Marktkapitalisierung, die Gesamtverschuldung, das Fremdkapitalverhältnis und die Aktienmarktrenditen einer Institution sowie die Korrelation zwischen Aktienmarktrenditen einer Institution und einem Referenzmarkt. Systemrelevanz der verschiedenen Institute wird durch den Erhalt von finanzieller Unterstützung während der Finanzkrise 2008 approximiert und der Einstufung als systemrelevantes Institut durch Aufsichtsbehörden. Die Analysen werden für alle Unternehmen im S&P 500 Composite Index durchgeführt. Die Ergebnisse zeigen, dass im Allgemeinen einfache Indikatoren mehr Aussagekraft als ausgefeilte Risikomasse besitzen. Insbesondere die Gesamtverschuldung ist der am besten geeignete Indikator nach Erklärungskraft und Modellanpassung zu urteilen, um die Systemrelevanz von Unternehmen zu ermitteln. Das am besten geeignete anspruchsvolle Risikomass ist SRISK. Die Arbeit wurde 2014 auf Versicherungskonferenzen in Moskau (APRIA), Seattle (ARIA) und St. Gallen (EGRIE) vorgestellt.

Die dritte Arbeit meiner Dissertation ist wiederum in Zusammenarbeit mit Martin Eling entstanden. Sie trägt den Titel “Basis Risk, Procyclicality, and Systemic Risk in the Solvency II Equity Risk Module”. Dieser Aufsatz analysiert das Aktien-Risikomodul von Solvency II (neuer Rechtsrahmen für Versicherungsunternehmen in der Europäischen Union). Das Aktien-Risikomodul enthält einen symmetrischen Anpassungsmechanismus, um Prozyklizität der Kapitalanforderungen und damit das systemische Risiko im Versicherungssektor zu reduzieren. Wir evaluieren das Aktien-Risikomodul in drei Schritten: zunächst führen wir Sensitivitätsanalysen durch in Bezug auf die zugrunde liegenden Annahmen, dann erarbeiten wir das potenzielle Basisrisiko (d.h. Abweichungen zwischen dem tatsächlichen Risiko der Versicherer und dem angenommenen Risiko nach Solvency II) und schliesslich prüfen wir die Auswirkungen des symmetrischen Anpassungsmechanismus auf die Ziele von Solvency II. Wir stellen fest, dass das Aktien-Risikomodul auf die Vergangenheit fokussiert ist und besonders ein hohes Basisrisiko besteht, wenn die tatsächlichen Aktienportfolios der Versicherer sich von den Annahmen unter Solvency II unterscheiden. Beide Aspekte unterstreichen die Bedeutung des „Own Risk and Solvency Assessment“ (ORSA) unter Solvency II. Darüber hinaus zeigen wir, dass der symmetrische Anpassungsmechanismus zu erheblichen Abweichungen von dem vorgeschlagenen 99,5% Konfidenzniveau führt und die Prozyklizität der Kapitalanforderungen verringert. Unsere Ergebnisse sind von Interesse einerseits für Wissenschaftler, die sich mit Regulierung und Risikomanagement auseinandersetzen und andererseits für Praktiker und Regulierungsbehörden, die sich mit der Implementierung solcher Modelle beschäftigen. Die Arbeit wurde 2012 in Minneapolis vorgestellt (ARIA) und 2013 in Berlin (DVfVW). Sie ist im *Journal of Insurance Regulation* veröffentlicht.

“Costs and Benefits of Financial Regulation – An Empirical Assessment for Insurance Companies” ist der Titel des vierten Artikels meiner Dissertation, welcher in Zusammenarbeit zwischen Martin Eling und David Pankoke entstanden ist. Wir analysieren empirisch die Kosten und Nutzen der Regulierung der Finanzmärkte auf der Grundlage einer Befragung von 76

Versicherern aus Österreich, Deutschland und der Schweiz. Dies erlaubt uns, empirisch zu überprüfen, ob das Prinzip der Proportionalität der Regulierung von Aufsichtsbehörden umgesetzt wird: die Intensität der Regulierung sollte die firmenspezifischen Risiken nach Art, Ausmass und Komplexität reflektieren. Unsere Ergebnisse zeigen, dass das Prinzip der Proportionalität nicht vollumfänglich umgesetzt wird; Regulierungskosten können z.B. nicht durch Unterschiede in der Komplexität des Geschäftsmodells erklärt werden. So ist eine wichtige Implikation unserer Resultate, dass die Umsetzung der Proportionalität durch Aufsichtsbehörden noch stärker fokussiert werden muss. Die Arbeit wurde 2014 auf Konferenzen in Moskau (APRIA) und Seattle (ARIA) vorgestellt.

Der letzte Artikel dieser Dissertation trägt den Titel "Discontinued Business in Non-Life Insurance—An Empirical Test of the Market Development in the German-Speaking Countries". Es handelt sich um eine Gemeinschaftsarbeit von Martin Eling und David Pankoke. Obwohl jedes Unternehmen Geschäftsbereiche besitzt in welchen die Zeichnung von Neugeschäft eingestellt wurde (Run-off, Discontinued Business), ist die aktive Steuerung dieser Bestände und deren versicherungstechnischer Rückstellungen ein relativ neues Thema in der Praxis und ein völlig neues Forschungsgebiet in der Wissenschaft. Basierend auf einer Befragung von 85 Nicht-Lebensversicherern aus Deutschland, Schweiz, Österreich und Luxemburg, testen wir empirisch die Marktentwicklung. Wir finden Hinweise darauf, dass die Schweizer Versicherer mehr Erfahrung mit dem aktiven Management des nicht fortgeführten Geschäfts haben als Versicherer in anderen Ländern. Wir erklären dieses Phänomen durch die Solvenz-Kapitalanforderungen der Schweiz, welche besser die Risiken von nicht fortgeführten Geschäftsbereichen abbilden. Wir folgern daraus, dass mit der Einführung von Solvency II ein aktives Management des nicht fortgeführten Geschäfts wichtiger wird, da die Versicherer mehr Eigenkapital für aufgegebene Geschäftsbereiche halten müssen. Wir illustrieren diese Tatsache in einem Zahlenbeispiel, welches zeigt, dass 23% der Solvency II Nicht-Leben-Prämien und das Reserverisiko auf nicht fortgeführte Geschäftsbereiche zurückgeführt werden kann. Der Artikel wurde im *European Actuarial Journal* in 2014 veröffentlicht.

Was ist die Quintessenz dieser Dissertation? Schnelle Lösungen, kurze Antworten und mutige politische Massnahmen im Hinblick auf systemische Risiken und die Regulierung der Finanzmärkte würden wahrscheinlich mehr schaden als nützen. Die Ergebnisse meiner Dissertation zeigen, dass es keine einfachen Antworten gibt: In der Regel sind Versicherungen nicht systemrelevant, aber in bestimmten Fällen eben doch. Die derzeitigen systemischen Risikomasse können systemrelevante Institute nicht identifizieren, aber nur unter der Annahme, dass die Institute, welche während der Finanzkrise finanziell unterstützt wurden auch wirklich das systemische Risiko erhöht haben. Das Aktien-Risikomodul von Solvency II ist für Krisen, die in der Vergangenheit stattgefunden haben gut geeignet, aber es ist nicht klar, ob es auch für künftige Krisen geeignet ist. In der Theorie sollte die Intensität der Regulierung proportional zur Art, zum Ausmass und zur Komplexität der eingegangenen Risiken der verschiedenen Finanzinstitute sein, aber empirisch lassen sich keine Beweise für diese Behauptung finden. Schliesslich scheint es, dass Schweizer Versicherer weiter fortgeschritten im Management von nicht fortgeführten Geschäftsbereichen sind. Ob dies jedoch an den Solvenz-Kapitalanforderungen liegt, ist nicht bewiesen.

Zusammengefasst lassen sich meine Resultate so interpretieren, dass es klug wäre, sich mehr auf die Robustheit des Finanzsystems und der Wirtschaft im Allgemeinen zu konzentrieren, als auf die Vermeidung von Krisen. Die theoretischen Modelle - egal ob innerhalb von systemischen Risikomassen oder Solvency II - scheinen nicht robust gegenüber veränderten Annahmen und Spezifikationen zu sein. Deshalb ist davon auszugehen, dass es auch in Zukunft Krisen geben wird. Wir sollten also aus der Vergangenheit lernen mit diesen umzugehen, nicht diese gänzlich zu vermeiden

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I Systemic Risk in the Insurance Sector: Review and Directions for Future Research[2]

This paper reviews the extant research on systemic risk in the insurance sector and outlines new areas of research in this field. We summarize and classify 43 theoretical and empirical research papers from both academia and practitioner organizations. The survey reveals that traditional insurance activity in the life, non-life, and reinsurance sectors neither contributes to systemic risk, nor increases insurers' vulnerability to impairments of the financial system. However, non-traditional activities (e.g., CDS underwriting) might increase vulnerability and life insurers might be more vulnerable than non-life insurers due to higher leverage. Whether non-traditional activities also contribute to systemic risk is not entirely clear; however, the activities with the potential to contribute to systemic risk include underwriting financial derivatives, providing financial guarantees, and short-term funding. This paper is of interest not only to academics, but is also highly relevant for the industry, regulators, and policymakers.

[2] Authors: Martin Eling and David Pankoke

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. A number of research papers on the subject have been published, and reports have been issued by regulators and industry think-tanks (for an overview see Table 2). 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.[3]

A more detailed review of the work already done on this topic and a look at what remains to be investigated is worthwhile for at least two reasons. First, researchers document that certain business activities might contribute to systemic risk in the insurance sector (see, e.g., Acharya et al., 2011 and Besar et al., 2011for securities lending). A structured review can identify those activities and the situations under which they may be cause for alarm. Second, the literature shows mixed results regarding systemic risk, for example, in the case of credit default swaps,[4] which calls for a structured review of what has been studied to date and what remains to be done to settle this issue.

This paper makes three contributions to the ongoing discussion. First, we discuss how systemic risk can be understood conceptually and how it can (or cannot) be measured. Second, based on this framework, we review the literature on systemic risk in the insurance sector (see Table 2). Third, we highlight areas in need of more research. The survey is intended to enhance understanding of systemic risk in the insurance sector and also to motivate more research in this field. The literature indicates that policymakers and regulators need to closely analyze systemic risk, especially with respect to non-traditional insurance activities (for an overview of the main results see Table 3).

3 See FSB (2013a). 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 to make recommendations for addressing systemic risk.

4 See Trichet, 2005; Baluch et al., 2011; Klein, 2013; Grace, 2011; Baranoff, 2012; Chen et al., 2013 and Cummins and Weiss, 2013 as well as the industry study by the Geneva Association, 2010a versus Radice, 2010; Wallison reported by Harrington, 2009 and Harrington, 2011.

The remainder of the paper is organized as follows. We start by discussing the definition and classification of systemic risk as well as systemic risk measures. Subsequently, we review the extant insurance literature on systemic risk and summarize the main results for different lines and activities of insurance companies. After that we investigate whether banking regulation should be extended to insurance companies. We close the article with a conclusion and a discussion of future research directions.

2 Classification of Systemic Risk

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).[5] To identify the origins of a possible impairment and the contributors to systemic risk, one can focus on the nodes, the edges, or both. Furthermore, 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.

In the remainder of the paper, we use the term 'contribution to systemic risk' for an institution or business activity that increases systemic risk. We use 'vulnerability' when describing those parts of the financial system (institution or business activity) that are most vulnerable to impairment.[6]

2.1 Systemic Risk Definitions

There is no generally agreed-upon definition of 'systemic risk' other than that it involves uncertainty about the occurrence of a specific event. We reviewed 26 definitions of systemic risk and identified three important elements:

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5 See, e.g., Anand et al. (2013).

6 Our classification is similar to the 'contribution approach' and 'participation approach' defined by Tarashev et al. (2010) and used by Drehmann and Tarashev (2011) and Jobst (2012). We do not use that terminology here because, for our purposes, it is too narrow. Both approaches consider only institutions and bankruptcies and ignore, for example, institutions that are in distress, but not insolvent, as well as business activities. Our approach is also employed by others, for example, Klein (2013).

- *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.[7]

- *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 specific[8] and are mostly related to the financial services sector.

The variety of definitions makes obvious the enormous difficulty involved in differentiating between cause, impact, and events when discussing systemic risk.[9] Thus, it is not surprising that, to date, no agreement on *the* definition of systemic risk has been reached.[10] However, most of the definitions considered in this paper refer to the 2008 financial crisis,[11] 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 unavailable (e.g., inter-bank lending) or had virtually no market (e.g., credit).

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7 The first two aspects refer to financial services; the latter event involves the general economy. We use 'financial instability' as a synonym for 'dysfunction of financial services'. It must be kept in mind that neither financial 'stability' nor 'instability' have clear-cut definitions. See, e.g., Allen and Wood (2006), European Central Bank (2013), and Federal Reserve Bank of Cleveland (2013).

8 Klein (2011) 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.

9 E.g., 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.

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

11 See, e.g., Bach and Nguyen (2012), Billio et al. (2012), and Rodríguez-Moreno and Peña (2013).

- *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 encompass all risks that can lead to the reoccurrence of the 2008 crisis and exclude all others. It is this last point that is usually 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 systemic. 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' should be labelled systemic. In general, we argue that a systemic risk definition should be judged against the following criteria:

- *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 too narrow a 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, the 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. Basically, the definition makes clear that systemic risk emerges within the financial system. However, the limits on causation must not be too narrow either. In general there are two ways impairments can take place and both should be considered[12]—a *system-wide shock* or a *limited shock with subsequent contagion*.

A system-wide shock is an 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 full range of services. As discussed by De Bandt and Hartmann (2000) also new information can be a shock of this type. For example, suppose that before the financial crisis the financial industry would have suddenly realized that investing in mortgage-backed securities bears a high concentration risk (exposure to the same mortgages via several securities) and therefore offers only limited diversification. Immediately, a wide range of financial institutions would have been impaired and had to deal with a much higher risk exposure. As a consequence, institutions would have to hold more risk bearing capital and the financing of risky projects in the real economy would have been more difficult or even not possible anymore.

A limited shock with subsequent contagion occurs when one or a few market participants cannot meet their obligations 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:

[12] Note that a number of definitions only consider a limited shock with subsequent contagion. (See, e.g., Csiszar, 2002; Adrian and Brunnermeier, 2011; Billio et al., 2010, 2012).

- bankruptcies of institutions, which trigger insolvencies of other companies due to unfulfilled commitments,
- contracts conditional on credit ratings, which can be canceled in case of a downgrading,
- decrease in asset prices caused by sales by a few institutions that force other market participants to sell assets as well,
- investor uncertainty, eventually resulting in aligned behavior, 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 behavior, about the distress of one company from which markets conclude that other companies face similar problems, and
- irrationality.[14]

In this paper we use as a working definition of systemic risk the one set out by the FSB (2009) and the IAIS (International Association of Insurance Supervisors) (2009). Systemic risk is defined as 'a risk of 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 causational 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.

[13] See Harrington (2009) and Cummins et al. (2012).
[14] See Harrington (2009, 2011) and Park and Xie (2014, p. 30).

2.2 Systemic Risk Measures

There is no common definition of systemic risk, so there is no standard for systemic risk measures and the literature cannot agree on one specific measure.[15] Broadly, there are two strands of literature according to Bisias et al. (2012), one dealing with macro- and the other with microprudential systemic risk measures. Macroprudential measures attempt to access systemic risk at the level of the whole economy; microprudential measures are used to discover individual institutions that contribute most to systemic risk or are especially vulnerable to an impairment of the financial system. The studies we reviewed for this paper focus on microprudential measures. The most common measures are shown in Table 1.

Systemic Risk Measure	**Description**	**Focus**	**Reference**
BANKBETA	Measures linkages between stock returns and the portfolio returns of the banking sector.	Interconnection between institutions (interdependence)	Chen et al. (2013)
ΔCoVaR	Measures the impact of a certain institution's distress on the value at risk of the financial system.	Interconnection between institutions (contagion)	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.	Market price of insurance against the institution's default	Huang et al. (2009)
LRMES	Measures the long-run marginal expected shortfall of a company's return in the event of a financial crisis.	Shortfall in times of crisis	Engle et al. (2014)
LTD (lower tail dependence)	Measures the probability that an observation of stock returns' joint distribution will lie in the distribution's lower tail.	Interconnection between institutions (contagion)	Weiß et al. (2012)
Granger-causality networks	Measures Granger-causality between the stock market returns of institutions.	Interconnection between institutions (interdependence)	Billio et al. (2012)

15 Bisias et al. (2012) provide a broad overview and explanation of currently discussed systemic risk measures.

Systemic Risk Measure	Description	Focus	Reference
MES (marginal expected shortfall)	Measures the stock return of a company when the entire equity market is in a downturn.	Shortfall in times of crisis	Acharya et al. (2012b)
SRISK	Measures the capital a company needs if there is a crisis.	Shortfall in times of crisis	Acharya et al. (2012a)

Table 1: Systemic risk measures applied to the insurance sector.

BANKBETA, ΔCoVaR, LTD, and Granger-causality networks focus on the interconnection of institutions in normal times (interdependence) as well as in times of crisis (contagion). They are based on the assumption that the institutions that are highly interconnected contribute most to systemic risk. Naturally, the studies endorsing these measures use a definition of systemic risk that focuses on contagion effects.[16] LRMES, MES, and SRISK (and, to a certain extent, DIP) measure the impact of a crisis on an institution and do not capture contagion effects. Therefore, work focusing on LRMES, MES, or SRISK does not consider interrelations between institutions as crucial for systemic risk.[17] Some differences in the literature are due to the definition of systemic risk used and the measure employed to measure it, as we show in the following section. Generally, though, the first group of measures assesses contribution to systemic risk, whereas the second one assesses the vulnerability of an institution (see Chen et al., 2013; Cummins and Weiss, 2013; Weiß and Mühlnickel, 2014).

Nevertheless, even if the characteristics of the systemic risk measures are kept in mind there is still plenty of room for improvements. All systemic risk measures rely to a certain extent on co-movements of stock market returns. It is quite intuitive to use this information as a measure for ‘interconnectedness’. However, whether systemic risk can be measured with this information in its entirety is not clear. For example, from a theoretical perspective no measure is able to distinguish between financial and non-financial firms. This is crucial to

[16] See Chen et al. (2013), Adrian and Brunnermeier (2011), and Billio et al. (2012). Summaries of these authors’ understanding of systemic risk are set out in Table 4 in the Appendix.

[17] See, e.g., Acharya et al. (2011).

our working definition since the impairment has to origin within the financial system. Furthermore, it is not clear that co-movements in stock prices or variables based on this information are a sufficient approximation of a chain reaction – the pattern that the bankruptcy of one institution automatically leads to bankruptcies of other institutions. Empirical findings support this critical view. Benoit at al. (2013) argue that ΔCoVaR, MES, and SRISK have no advantages over traditional market risk measures. For a U.S. sample of 2,000 financial institutions they show that identifying systemically important institutions by ΔCoVaR leads to the same results as using Value at Risk. Similarly, MES can be substituted for by market beta and SRISK by leverage in normal times or liabilities in times of crisis. The authors conclude 'that these measures fall short in capturing the multifaceted nature of systemic risk' (Benoit at al., 2013). Another, more practical, shortcoming of these systemic risk measures is that they only provide information about the *relative* contribution to systemic risk/vulnerability of an institution; *absolute* risk remains unknown. In boom times, even the most significant systemically relevant institution might not be a problem, whereas in times of crisis, even events at an institution which is no. 28 in line could be cause for concern.

3 Systemic Risk in the Insurance Sector

We discuss the different business activities of insurance companies and look at how certain activities might contribute to systemic risk. Furthermore, we evaluate which business activities and which kinds of insurers are vulnerable to an impairment 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 sources: peer-reviewed journal articles, working papers, reports by international government organizations 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, whereas peer-reviewed journal articles are usually more neutral, seeing as they typically 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.[18] Where our results are based on work coming from an industry perspective, we explicitly mention this fact so that this report is as unbiased and neutral as possible. To make sure that all relevant studies are included, we used a search strategy based on Biener and Eling (2012).

Type 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), Weiß and Mühlnickel (2014), Cummins and Weiss (2014), Engle et al. (2014), Berry-Stölzle et al. (2014), Park and Xie (2014)
Working papers	Radice (2010), Cummins and Weiss (2013), Grace (2011), Harrington (2011), Cummins et al. (2012), Neale et al. (2012), Jobst (2012), Weiß et al. (2013), Weiß and Mühlnickel (2013), Grace et al. (2013), Chen et al. (2013, 2013b), Baranoff et al. (2013)
Books/chapter in books	Acharya et al. (2011), Klein (2013)
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. We classify insurance activities either related to underwriting or to funding and investing processes. This view can be justified by the actuarial distinction into insurance and financial risks. The classical ruin process as described for example by Kaas et al. (2008) considers this distinction and focuses only on insurance risks.[19] Furthermore, it is used by regulatory bodies

18 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.

19 Dhaene et al. 2002a/b give an overview of the research about modeling portfolios of risks which are not mutually independent. As an application, the combination of insurance and financial risks in an insurance context is mentioned.

(see, e.g., IAIS, 2011) as well as by industry organisations (see, e.g., Geneva Association, 2010a).[20]

Specifically, we define as underwriting related, all activity that has as its purpose the transfer of a risk to the insurer from a third party in exchange for a fee. Therefore, we understand not only the transfer of life and non-life risks as underwriting, but also reinsurance and all kinds of alternative risk transfer products.[21] We define funding and investing processes as all activities with the purpose of increasing investment income and ensuring that liabilities are met. This includes not only investment of premium income and asset liability management (see, e.g., Rejda and MacNamara, 2014, chapters 6 and 7; Zweifel and Eisen, 2012, chapter 1.4), but also profit-enhancing activities as described by the Geneva Association (2010a, chapter 3.4.1).[22] Furthermore, we differentiate business activities according to their degree of innovation, thus classifying them as either traditional or non-traditional insurance business as done commonly in the literature (see, e.g. Baluch et al. 2011 as well as Kessler 2013; Cummins and Weiss 2014 who use instead the terms core and non-core activities). 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).[23] Using this classification system, we identify papers that discuss a particular business model and evaluate that

[20] It is important to note that the classification of insurance activities in Table 3 is not meant to be a final assessment, but more a framework for evaluating the systemic risk of insurance. Therefore, the classification of a certain activity could be arguable; for example, compare IAIS (2013b).

[21] Compare with Rejda and McNamara (2014, chapter 6), who distinguish between underwriting and reinsurance. Using their framework, we consider all risk transfer activities as underwriting within life insurance, health insurance, and property and liability insurance, as well as reinsurance.

[22] The non-insurance activity of CDS underwriting, as mentioned by IAIS (2011), belongs, according to our definition, to the underwriting processes, whereas capital market business, banking, and third-party asset management are funding and investing processes.

[23] 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.

business model's contribution to systemic risk and its vulnerability to impairments of the financial system.

A list and summary of all studies reviewed for this analysis can be found in Table 5 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.[24]

We already mentioned some limitations of systemic risk measures. In the discussion of the literature one should keep in mind that none of the quantitative measures captures systemic risk in its entirety, so that all studies are limited to a specific content. Another general shortcoming of all reviewed empirical studies is that the considered time horizons are very short. For example, no empirical study takes the time of the Great Depression in the United States during the late 1920s and early 1930s into account. This is understandable, given data availability issues, but in order to make assessments about infrequent events like systemic crises, one needs to look across centuries, not just decades.[25]

[24] In Table 5 we also categorize the papers according to the methodology employed. Most papers are qualitative discussion papers (27 papers), but some 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.

[25] Basically, we share the opinion of Taylor (2012).

Business Activity	Contri-bution/ Vulner-ability	Rationale & Source
Underwriting		
Traditional: Life • Life insurance • Annuities Non-Life • Health insurance • Property & casualty insurance • Liability insurance • Legal insurance Reinsurance	**Very low / Very low**	• 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 2013; Grace et al., 2013; Kessler, 2013) • A reinsurance retrocession spiral affects the insurance sector but not the rest of the economy (e.g., Cummins and Weiss, 2013, 2014) • 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, 2014; Geneva Association, 2012; Kessler, 2013) • Cash outflow if loss events occur is slow (e.g., Cummins and Weiss, 2014; 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 its absence would not substantially affect the real economy (e.g., Baur et al., 2003; Geneva Association, 2010b; Cummins and Weiss, 2013, 2014; 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, 2014, p. 10; IAIS, 2012b) • Studies show that bankruptcies of reinsurers would not lead to market failure (e.g., van Lelyveld et al., 2011; Park and Xie, 2014) • Insurance is a necessary function for the economy (Bach and Nguyen, 2012), but individual insurance companies are substitutable (e.g., IAIS, 2011; Jobst, 2012)
Non-Traditional: Life • Annuities with guarantees • Separate accounts Non-Life • Credit insurance • Financial guarantees • CDSs/CDOs	**Me-dium / High**	• 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 rick (Cummins and Weiss, 2013) • Credit insurance has no direct liquidity impact and has 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, 2013, 2014; Chen et al., 2013) • CDSs/CDOs have direct liquidity impact and make the selling party vulnerable to systemic crisis - 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, 2013; Grace, 2011; Baranoff, 2012; Chen et al., 2013) - Minority view: no contribution to systemic risk because if CDS seller defaults, CDS buyer does not face direct liquidity impact (e.g., Radice, 2010; Wallison reported by Harrington, 2009; cf. Harrington, 2011)
Funding & Investing		

Traditional: Life, Non-Life, Reinsurance • Premiums funding • Asset liability management & hedging • Liquidity management • Insurance-linked securities (catastrophe bonds)	**Very low** / **Me-dium**	• Premiums are paid upfront for contingent claims; no risk caused by maturity mismatches (e.g., Trichet, 2005; Cummins and Weiss, 2014; 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., 2014) • Limited fungibility of liquidity within insurance groups could lead to increased vulnerability in times of crisis (e.g., Radice, 2010; Baranoff, 2012) • Compared 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)
Non-Traditional: Life • Short-term funding Life, Non-Life, Reinsurance • Securities lending Non-Life, Reinsurance • Credit rating utilization • Industry-loss warranties	**Me-dium** / **High**	• Short-term funding can lead to fire sales if liquidity dries up, especially in the case of securities lending and credit rating utilization (e.g., Geneva Association, 2010; 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) • There is an interest rate risk 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, 2014); however, banks still have a stronger impact on insurers than vice versa (e.g., Grace, 2011; Engle et al., 2014; Chen et al., 2013a); 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) • Not clear whether prices of alternative risk transfer products are uncorrelated with the 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)

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

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.[26] The reasons are 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. The major argument is that claims settlement can take several years. Thus, 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 as well as in reports by regulators and the industry.

Two further strands of the literature using quantitative methods support this conclusion. The first strand is represented by Billio et al. (2012) 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. Billio et al. (2010) use monthly returns data from the 25 biggest U.S. hedge funds, brokers, and banks, as well as insurers, and test pairwise for Granger-causality. Basically, Chen et al. (2013b) do the same for 11 insurers and 22 banks in the United States; however, their analysis is not based on stock market returns, but on the Distressed Insurance Premium (DIP) measure. Both studies find that banks and insurers are interdependent, but that shocks in the banking industry affect insurers much more than vice versa.

The second strand of literature calculates systemic risk measures directly for insurers. For example, Weiß and Mühlnickel (2013) apply LTD (lower tail dependence) as a systemic risk measure in an attempt to discover whether insurance mergers increase the contribution to systemic risk of an insurer. The authors only find slightly significant results for the North American banking

[26] See, e.g., Trichet (2005) and Cummins and Weiss (2014) (peer-reviewed journal articles), IAIS (2011) (regulator report), and Geneva Association (2010a) (industry association report).

sector, indicating that insurance mergers might affect the systemic risk contribution of banks. Generally, however, they find no evidence for increased systemic risk contribution due to M&A activities in the insurance sector. Furthermore, Cummins and Weiss (2013) and Weiß and Mühlnickel (2013) show that, based on SRISK and MES, insurers' stock prices are severely negatively affected in times of crisis. These findings do not really contradict the results mentioned above because they focus on insurance companies, not specific business activities. Indeed, both studies conclude that the results are due to non-traditional insurance activities.

The Geneva Association (2010b) and Klein (2012), as well as Cummins and Weiss (2013, 2014), argue that there is no systemic risk from *life insurance* or annuities, either. Their main argument is that this line of business does not have a strong impact on other financial market participants or on the economy in general in the case of bankruptcy. Moreover, in most countries, customers are protected by guarantees.[27] This is a convincing argument in view of the fact that there is no known case of a bankruptcy of a single life insurance company triggering a contagion effect and other insolvencies. The risks that led to insolvency in these cases were of an idiosyncratic nature (e.g., management failures). Radice (2010) supports this argument by pointing out that even the insolvency of very large life insurers might not contribute to 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. Finally, as argued by the Geneva Association (2010a, 2010b), life insurance should not contribute to systemic risk for reasons having 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. Indeed, this process can take up to several years as described by Kessler (2013). 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.

[27] See Geneva Association (2012), Harrington (2011), and Oxera (2007).

Cummins and Weiss (2014) and Baluch et al. (2011) are more critical of *reinsurers* and mention that the reinsurance market is highly concentrated. There is high interconnection among reinsurers and between reinsurers and insurance companies. They argue that there is a danger of a retrocession spiral. Premiums are not only ceded between primary insurers and reinsurers, but also within the reinsurance industry and thus the bankruptcy of one reinsurer could trigger the bankruptcies of others. Similarly, 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 argument is presented by Park and Xie (2014), who show that up- and downgrades of reinsurers' ratings have an effect on primary insurers' ratings as well. However, scenario analyses by Park and Xie (2014) and Van Lelyveld et al. (2011) show that even the failure of several large reinsurers would result in only a few primary insurer insolvencies and therefore there seems not to be a contribution to systemic risk by reinsurers. Furthermore, Kessler (2013), too, 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 that of the IAIS (2012b) and the conclusions of a study by Swiss Re (see Baur et al., 2003). However, to our knowledge, there are no academic studies analyzing such a hierarchical market structure. Cummins and Weiss (2013) argue that the failure of reinsurance companies could lead to problems within the insurance industry due to the connections between reinsurers and primary insurers, but they 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. The answer to this question is one on which academic studies, regulator reports, and industry association reports all agree and goes as follows.[28] As long as the risk is quantifiable, insurance companies and their products are substitutable by other market participants and products, 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 a self-insurance cooperative.[29] Furthermore, as long as an insurance business is profitable, there will be new market entries if there is demand and a shortage of supply.

In our opinion, the issue of the substitutability of an individual insurance company should not be confused with the situation where the whole insurance context changes. 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 because the risk of terror attacks became unquantifiable. Therefore, there is no contribution to systemic risk since a link to the financial system is necessary for systemic risk.

Another argument, why traditional underwriting risks are not likely to increase the vulnerability of insurers is market discipline. As we discuss in more detail below, the literature shows that market discipline is strong in the insurance industry and policyholders prefer to do business with financially healthy insurers (see, e.g., Epermanis and Harrington, 2006). Therefore, insurance companies are careful not to underwrite risks which endanger their financial stability, which in turn makes them more resilient in times of crisis.

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,

[28] See, e.g., Cummins and Weiss (2014) (peer-reviewed journal article), Radice (2010) (working paper), IAIS (2012a) (regulator report), and Geneva Association (2010b) (industry association report).

[29] 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).

financial guarantees, and financial derivatives underwriting as non-traditional activities.

Klein (2013), Cummins and Weiss (2014), IAIS (2011), and Grace (2011) point out that some aspects of guaranteed annuities could increase the issuing company's vulnerability in times of crisis. The literature agrees that 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 theoretically possible. The likelihood of such an event, however, is disputed. Radice (2010) and a study by an industry association (see Geneva Association, 2011) argue that policyholders normally have to pay high cancellation fees, making cancellation unattractive.

However, consider the bankruptcy of the Belgian insurance company Ethias in 2008. When the company became financially distressed, many of its life insurance products were cancelled. Nevertheless, the Geneva Association (2010b) argues that the insurance products were in fact saving accounts—cash could be withdrawn and the contracts cancelled any time without any fee or discount. In addition, Cummins and Weiss (2013) provide further evidence throwing some doubt on the conventional wisdom that cancellations of policies are unlikely. They employed the systemic risk measure SRISK and discovered that it is related to separate account assets and group annuity premiums. Their interpretation is that separate accounts can be associated with increased withdrawals in times of crisis since these accounts are especially used to provide annuities with options and guarantees. Furthermore, large companies are likely to cancel group annuities in times of crisis. Therefore, in line with the discussion of systemic risk measures as mentioned above, it could be argued that life insurance products containing annuities with options or guarantees can indeed increase the vulnerability of an insurer.

Another critical aspect is the rate of return on guaranteed annuities, as pointed out by Radice (2010). 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 a few insurance companies since the practice of guaranteeing a rate of return on an annuity generally takes several business cycles into account. Even if insurers fail to deliver the guaranteed return, the impact on the economic system is minor. In two cases, that of the Japanese insurance company Nissan Mutual Life and Equitable Life in Great Britain, declining interest rates and unhedged, guaranteed annuities caused substantial financial distress for the companies. However, neither case triggered a systemic crisis.

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 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, there is only a weak interconnection between credit insurance and the rest of the financial sector. Thus, the authors conclude that credit insurance's contribution to both systemic risk and vulnerability is low.

Drake and Neale (2011) present a comprehensive study of the financial guarantee business, which underwrites public and private debt as well as structured finance products. The interconnection between this type of business and the financial system is strong due to the exposure of large banks to guaranteed derivatives. In addition, 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. Indeed, the Geneva Association (2010a) argues that 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. This argument finds support in an empirical study by Chen et al. (2013), which calculates BANKBETA and MES for a broad range of U.S. insurers underwriting CDS.[30] They find that according

[30] Both measures, as described in the Section *Systemic Risk Measures*, only consider the interconnectedness between institutions. Further aspects of systemic risk are neglected. For

to both measures, systemic risk levels for financial guarantee insurers exceed those of property-casualty insurers. Therefore, conditional on the appropriateness of these particular systemic risk measures, the findings support the view that financial guarantees increase the contribution to systemic risk as well as the vulnerability of institutions.

The most common credit derivate is the credit default swap.[31] In its plain-vanilla form, the company selling the swap receives money continuously throughout the duration of the 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. 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 (see Kress, 2011). Consequently, CDS underwriting 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.[32]

We found no disagreement by academics, regulators, or from the industry that CDS underwriting, at the very least, increases vulnerability to impairments of the financial system. When it comes to the contribution to systemic risk, a few studies argue that CDS underwriting has no effect. Wallison (associated with the American Enterprise Institute, a think-tank), as reported by Harrington (2009), argues that CDS holding companies are well diversified and, consequently, the insolvency of a CDS underwriting business would have only limited effect. For example, with regard to AIG, he argues that '[i]f Goldman, AIG's largest counterparty, would not have suffered significant losses, there is

example, financial and non-financial institutions cannot be distinguished; one shock which could severely impair the whole financial industry is not considered and if interconnectedness implies automatically the risk of a chain reaction of bankruptcies is not clear.

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

32 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 due to underwriting CDS protecting mortgage-backed securities from rating downgrades (see Swiss Re, 2008).

no reason to believe that anyone else would have suffered systemically significant losses either'. Furthermore, Radice (2010) does not think defaulting CDS would have a huge impact on counterparties. In a qualitative scenario analysis, he, too, argues that the systemic risk contribution of CDS can be easily mitigated by diversifying the counterparties.

In contrast, Heyde and Neyer (2010) build a banking model with and without CDS and compared the results of each with regard to financial stability. They define financial stability as the shock-absorbing ability of the system, that is, the likelihood that a bank goes bankrupt and triggers a chain effect. They 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. This assessment is in line with the majority of academic papers as well as reports by regulators and the industry. They all agree that the failure of a CDS underwriting entity would trigger a chain reaction that could impair the entire financial system.[33] 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.[34]

The U.S. Financial Stability Oversight Council (see FSOC, 2012) provides a different perspective on CDS. It argues that institutions can be systemically relevant also, by being reference entities if the notional volume is in excess of $30 billion. We found no study that further elaborates this point with regard to insurance companies.

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33 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).

34 See, e.g., Baluch et al. (2011) and Cummins and Weiss (2014) (peer-reviewed journal articles), IAIS (2011) (regulator report), and Geneva Association (2010a) (industry association report).

3.3 Systemic Risk in Traditional Insurance Funding and Investing Activities

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 addition, insurance-linked securities, specifically, catastrophe bonds, are considered traditional.

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.[35] 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).[36] The opposite situation, that is, long-term liabilities and short-term assets, increases insurers' exposure to interest rate risk and their vulnerability as well. However, the Geneva Association (2010a) claims that insurance companies use 'assets and derivatives to replicate insurers' liability profiles and match their expected claims'. This industry view that there should be no maturity mismatch is supported by Cummins and Weiss (2014), who analyze the balance sheets of U.S. non-life and life insurers and conclude that 'asset and liability maturities are both long term for insurers'.

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). When it comes to life insurers, however, Harrington (2011), Cummins and Weiss (2014), Grace (2011), and Baranoff et al. (2011) argue that the equity basis of life insurers is relatively low. These companies' assets might not be sufficiently diversified (many insurers only hold government bonds), and some companies

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

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

are substantially invested in mortgage-backed securities. Furthermore, it could be argued that the business model of life insurers in general is more vulnerable to impairment of the financial systems than that of non-life insurers because of contract duration. Life insurance is long-tail business and involves contracts spanning decades. In contrast, non-life insurance is short tail and contracts tend to be short term. Therefore, if loss frequency is low, life insurers have to invest more capital over a longer period of time and are therefore more affected by adverse capital market movements. 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, a few studies express some doubt that life insurers are vulnerable to impairments of the financial system. Even if an insurance 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 sell assets before maturity in order fulfil their obligations. Even in a worst-case scenario in which 10 times the normal number of policies is cancelled, the volume of assets that needs to be sold before maturity makes up only a small fraction of the bond market. This line of reasoning is supported by Berry-Stölzle et al. (2014), who show that during the subprime crisis, life insurers' access to external capital was not endangered and TARP funds for life insurers were unnecessary. By using regression analyses, they show for the period between 1999 and 2010 that the reasons for issuing new capital—compensating for operational losses or funding growth opportunities—were the same during the subprime crisis as during normal times. In addition, capital issuance can be predicted by the same factors during normal times and times of crisis. No evidence of a shortage of capital for insurers during times of crisis could be found.

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. 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 continues to be solvent.[37] Drake and Neale (2011) argue in the opposite direction and stress that guarantees given among different judicial entities within 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.[38]

Like the IAIS (2013b), we regard *insurance-linked securities* (ILS) as a traditional insurance funding and investing activity as long as the underwritten risks are (a) idiosyncratic, (b) not correlated with each other, and (c) not influenced by economic business cycles. The most common ILS are catastrophe bonds. 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 catastrophe 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 or ΔCoVaR. 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.

Another factor that should prevent contribution to systemic risk by insurers is the high level of market discipline in insurance and reinsurance. Harrington (2004, 2011) argues that policyholders are risk sensitive and prefer to deal with financially sound insurers. Furthermore, agents, brokers, and advisors, as well as

37 The crucial point in this argument is that an affiliated insurance company could be part of a group wide cash management – formally or informally. The market expects that losses in one company of the group are compensated by profits in other companies. If this assumption is not made, of course, from a systemic risk perspective there is no fundamental difference between an affiliated and a single, unaffiliated one.

38 See also the scenario mentioned by the Geneva Association (2012).

rating agencies, monitor insurance companies. Therefore, insurance companies limit their risk taking and are careful to maintain a financially healthy position.[39] Nevertheless, one should not be overconfident that market discipline prohibits all incidents of excessive risk taking. For example, as Drake and Neale (2011) argue, financial guarantee insurers were hiding substantial risk exposures in special purpose vehicles outside of the balance sheet.

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

We consider the securitization of embedded value securitization, 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.

Insurance companies pay commissions to agents and brokers for new policies sold. These commission payments are typically upfront since they are often paid out immediately after the sales process but refer to the whole life span of the policy. Therefore, from an accounting perspective, these payments are not immediately expensed but deferred over the duration of the policy and are recognized as an intangible asset on the balance sheet. The securitization of these intangible assets is called embedded value securitization and increases the liquidity of the insurer. According to the IAIS (2012b), this activity exposes the investor who buys these intangible assets to substantial interest rate risk via implied guarantees, insurance risks, and market risk. However, embedded value securities do not contribute to systemic risk—at least not yet—since their outstanding volume is marginal compared to other asset-backed securities.

As mentioned above, it is usually not necessary for insurance companies to engage in a fire sale of assets before maturity to overcome liquidity problems. The Geneva Association (2010a) argues that there can be an exception to this if

[39] Empirical evidence for this reasoning is provided by Epermanis and Harrington (2006). They show for U.S. property-casualty insurers that premium income is decreasing if the insurer's rating is downgraded. More recently, Eling and Schmit (2012) provide evidence of market discipline in the insurance sector for Germany.

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. The vulnerability of an insurer increases if the additional capital is invested instead in long-term assets. This might also increase the insurance company’s liquidity risk and lead to a situation in which a fire sale of assets becomes necessary in order to meet obligations.

- ‘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. If the capital is instead invested in long-term assets the liquidity risk and subsequently the vulnerability of the insurer might increase. In times of crisis it can be expected that the rating of an insurer is under pressure and assets have to be sold in order to keep an investment grade.

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 engaged in very aggressive securities lending and this was one reason 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. However, AIG as the lender in the end had to post collateral, too, and so the borrower took no risk. In the event of an AIG bankruptcy, the borrower could have just sold the borrowed securities and keep 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 eventually chose to reduce this business activity and turned instead to the Federal Reserve Bank of New York for funding.

Finally, the Geneva Association (2010a) sheds light on another practice that can contribute to systemic risk and increases 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. One should keep in mind, though, that this is a highly unusual practice for standard insurance companies. Effectively, this issue illustrates why one should not focus on the company level, but on the level of business activities. There are systemic risk contributing practices in which insurance companies can engage, but that does not mean that a substantial part of the insurance sector is doing so.

In the reinsurance sector, *industry-loss warranties (ILW)* can be viewed as non-traditional insurance activities. These 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 and credit risk since there is no collateral requirement. With the exception of the case of catastrophe bonds, there are not enough studies on which to base a solid assessment of alternative risk transfer products (ILS and ILW). In addition to ILW, other insurance-linked securities related to life insurance could be strongly connected to interest rate and credit risk as well.

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

4 Regulation of Systemic Risk in Insurance and Banking

One major remaining question is whether regulatory requirements designed to mitigate systemic risk should be the same for banking and insurance sectors. Basically, there are two lines of thought on this question.

- O*ne size fits all*. One possibility is to treat insurers exactly the same as banks and to require higher equity levels from insurers that are deemed to be systemically important. This logic is partially followed by the FSB, which states that '[h]igher loss-absorption capacity, more intensive supervision and resolution planning requirements will apply to all these institutions [globally systemically important institutions]' (FSB, 2013b).

- *No systemic risk, no additional regula*tion. As discussed above, many papers find that insurers much less contribute to systemic risk and are much less vulnerable to impairment than banks (e.g., Kessler, 2013 in the case of reinsurers). Therefore, no additional regulation is required. In addition, market discipline is strong in the insurance sector. As long as there is the realistic risk that an insurer can go bankrupt market participants will closely monitor insurance companies. According to this line of thought, well-intended regulatory initiatives can easily have a bad outcome, for example, if regulation becomes more intense, but undermines market discipline. Harrington (2004, 2009, 2011) is skeptical of additional regulation for systemically important institutions. He argues that a designation as systemically important could be interpreted as a bailout guarantee, which would reduce market discipline.

We believe that both perspectives are valuable as long as they are applied to activities rather than to institutions. We argue in favor of the principle: *same business, same risks, same regulation*. There is no indication that an improved regulation of AIG's property-casualty division would have resulted in a less severe financial crisis. At the same time, higher capital requirements would have been a good idea for AIG's financial services division as well as for many banks. Therefore, we approve that an activities-based view has entered the policy debate.[40] It is important, though, to focus not only on capital requirements but also on transparency and the structure of large financial groups. Market discipline can have a beneficial impact only if it is publicly known which business activities are conducted by institutions. In the current discussion, it is sometimes overlooked that it was not only high leverage that was a problem during the crisis, but also the opacity of an institution's risk exposure. Furthermore, it would be beneficial if separate business activities are conducted in separate business units which can go bankrupt individually. In this way market discipline would work better to monitor even specific activities. Dubious activities could fail (and their respective business units go bankrupt) without affecting traditional activities. This would mean for example that a customer could trust or mistrust an insurer even if some activities are regarded as (not) sustainable. As a conclusion, we see no necessity to introduce additional systemic-risk-oriented regulation of traditional insurance activities, since they do not contribute to systemic risk.

5 Conclusions and Directions for Future Research

In this paper we discuss, and review the extant literature on, systemic risk, a topic of high interest for academics and practitioners in the last few years. Systemic risk can occur when there is a limited shock that spreads via contagion or interdependence to other financial institutions or upon the occurrence of a system-wide shock that impacts the entire financial system at once.

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 are banks. Traditional underwriting and funding and investing activities in the life, non-life, and reinsurance business contribute very little to systemic risk and do not increase insurer vulnerability to impairments of

[40] The IAIS (2014) plans to differentiate between traditional and non-traditional activities in their formula for basic capital requirements.

the financial system. However, 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) and in the non-life segment (financial guarantees and CDS) increase insurers' vulnerability 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 make a very limited contribution to systemic risk.

According to the literature, in principle, traditional funding and investing activities (including catastrophe bonds) neither contribute to systemic risk nor increase the vulnerability of an institution in times of crisis. With regard to non-traditional funding and investing activities, it is securities lending, short-term funding, and industry-loss warranties that 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. Furthermore, there is to date very little work on alternative risk transfer products.

Studies taking a qualitative approach to the issue 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 groups agree when it comes to systemic risk.

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 discovered that there is a lot of room for future research. In our opinion the currently most important research strands can be sorted into three types: (1) definition of systemic risk (2) systemic risk measures (3) regulation of systemic risk in the financial services industry.

In the literature, there is still no common understanding of systemic risk (see for an overview Table 4 in the Appendix). In this paper we argue that the starting point should be the financial crisis and we provide a framework for how to think about a systemic risk definition. Our argument is that the whole systemic risk discussion is based on the goal of preventing such a crisis from ever occurring again. Therefore, it would be helpful if the scientific community could agree on a definition of the risks that led to this disaster. Accomplishing this first step would be of benefit for the next step of designing an appropriate systemic risk measure.

Currently, as shown in the Section Systemic Risk Measures, too many issues regarding these measures remain open. For example, in which cases is the application of a systemic risk measure appropriate? Is it sufficient to rely on stock price information to measure interconnection and captures interconnectedness really systemic risk in its entirety? Is a macro-prudential systemic risk measure necessary, one that would indicate, for example, when the overall systemic risk level in the financial system is high? How can the quality of systemic risk measures be assessed? In our opinion, 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 research in this area is needed.

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 (see, e.g., Eling et al., 2008). In particular, the IMF (2007) argues that regulatory convergence can decrease the variety of applied risk models and discourage contrarian behavior 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

Reference	Definition
	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 inter-connectedness 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 (2014, p. 2)	'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 uncertainly 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

Reference	Definition
	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 form 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 4: Definitions of systemic risk in the literature as well as from the perspective of industry organizations and regulatory bodies.

Part A: Academic Papers				
No.	**Author and 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	• Financial stability • Life, non-life • Qualitative discussion / • Which risks does the insurance industry pose to financial stability?	• 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: - 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	• AIG case • Life, non-life • Qualitative discussion based on descriptive statistics / • Discussion of the AIG case • Does insurance contributes to systemic risk? • How should regulation be drafted?	• 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 avoided 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 Versicherungs-sektor? / Working Paper	• Systemic risk • Life, non-life • Scenario analysis based on qualitative assessments of the insurance industry / • Can systemic risk be found within the insurance sector?	• Following scenarios do not identify contributions to systemic risk: - 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: - 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	• Regulation • Life, non-life, reinsurance • Qualitative discussion based on descriptive statistics and systemic risk measure calculation / • How to shape regulation and treat systemically risky institutions?	• 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 of being 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	• Systemic risk • Life, non-life, reinsurance • Qualitative discussion based on descriptive statistics and correlation analysis / • What was the role of the insurance industry during the financial crisis?	• 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	• Systemic risk • Life, non-life, reinsurance • Qualitative discussion and four case studies based on qualitative assessments of financial crisis / • What is systemic risk? • Where does systemic risk originate in the financial system?	• Systemic risk can originate in four 'networks of interconnections' between financial institutions: - 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 the 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	• Contagion • Reinsurance • Scenario analysis based on a matrix showing the reinsurance linkages between insurers–insurers and insurers–reinsurers / • Do linkages between reinsurers and insurers contribute to systemic risk via a threat of contagion?	• 213 Dutch insurers and their reinsurance exposure are analyzed as of 2005 • Scenario analysis shows that - 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 went bankrupt, the market would not fail and only a few primary insurers would go bankrupt
8	Martin F. Grace 2011 (December)	The Insurance Industry and Systemic Risk: Evidence and Discussion / Working Paper	• Systemic risk • Life, non-life • Event study, empirical study (Granger-causality tests) / • What are the systemic effects of insurance companies? • What kind of regulation is appropriate?	• 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 do 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
9	Scott E. Harrington 2011 (December)	Insurance Regulation and the Dodd-Frank Act / Working Paper	• Regulation • Life, non-life, reinsurance • Qualitative discussion / • Discussion of the Dodd-Frank Act and systemic risk • How should regulation be framed?	• Regulation should take differences between insurers and banks into account, especially the facts that the insurance industry's contribution to systemic risk is lower and its market discipline higher in comparison with the banking industry • 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: modernization of regulation, promoting market discipline, policyholder guarantees, capital requirements, and group supervision

10	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	• Contagion • Life, non-life • Event study and weighted least squares regressions for explaining the cumulative abnormal returns / • Does the announcement of an operational loss event of a financial services company have an impact on other companies in the market?	• 415 bank events and 158 insurance events between 1978 and 2010 are analyzed • 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
11	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	• Regulation • Life, non-life, reinsurance • Qualitative discussion / • Is a system-oriented regulation necessary?	• Even though traditional insurance activities might not be systemically risky, macro-prudential regulation is necessary due to - Economic costs if insurance markets are impaired - High public interest in the availability of large insurance capacity • Providing insurance is a systemic relevant function
12	Etti Baranoff 2012	An Analysis of the AIG Case: Understandin g Systemic Risk and its Relation to Insurance / Journal of Insurance Regulation	• AIG case • Life, non-life • Qualitative discussion based on descriptive statistics / • What were the internal and external factors for the distress of AIG?	• 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
13	Monica Billio, Mila Getmansky, Andrew W. Lo, Loriana Pelizzon 2012	Econometric Measures of Connectedness and Systemic Risk in the Finance and Insurance Sectors / Journal of Financial Economics	• Contagion • Life, non-life, reinsurance • Empirical study (principal component analysis and Granger-causality tests) / • Are banks, insurers, hedge funds, and brokers interconnected? • How to quantify systemic risk?	• The 25 largest banks, insurers, hedge funds, and brokers in the world are analyzed 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 • Interconnectedness as an indicator of systemic risk can be successfully measured by principal components analysis and Granger-causality tests
14	Faith R. Neale, Pamela Peterson Drake, Patrick Schorno, Elias Semaan 2012 (August)	Insurance and Interconnectedness in the Financial Services Industry / Working Paper	• 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 / • Are insurance companies interconnected with the financial services industry?	• U.S. financial institutions are analyzed 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
15	Andreas A. Jobst 2012 (December)	Systemic Risk in the Insurance Sector—A Review of General Issues and Some Findings on Large Insurers in Bermuda	• Regulation and systemic risk • Non-life, reinsurance • Qualitative discussion based on descriptive statistics / • Are the current systemic risk indicators suggested	• 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

		/ Working Paper	by the IAIS/industry sufficient? • Do (re)insurers from Bermuda contribute to systemic risk?	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
16	Fang Chen, Xuanjuan Chen, Zhenzhen Sun, Tong Yu, Ming Zhong 2013	Systemic Risk, Financial Crisis, and Credit Risk Insurance / The Financial Review	• Contagion • Life, non-life • Systemic risk measure calculation (MES, BANKBETA) and empirical study (panel regressions) / • How were credit risk insurers affected by the financial crisis? • Do credit risk insurers transmit shocks?	• 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
17	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	• Contagion • Life, non-life • Systemic risk measure calculation (DIP, use of Granger-causality tests to evaluate which institutions cause systemic risk) / • Are insurers a source or a victim of systemic risk?	• 33 U.S. financial institutions are analyzed 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 • Banks and insurers are strongly interconnected
18	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	• Systemic risk measures • Life, non-life • Systemic risk measure calculation (ΔCoVaR, MES, and SRISK)	• 40 U.S insurers are analyzed 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 finical crisis • Life-health insurers respond more significantly to negative financial market conditions than do property-casualty insurers

19	David Cummins, Mary A. Weiss 2013 (March)	Systemic Risk and Regulation of the U.S. Insurance Industry / Working Paper	• Systemic risk • Life, non-life, reinsurance • Qualitative discussion based on descriptive statistics, systemic risk measure calculation (SRISK, OLS) / • 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?	• U.S. insurers are analyzed 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 - 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
20	Gregor N. F. Weiß, Janina Mühlnickel 2013 (May)	Consolidation and Systemic Risk in the International Insurance Industry / Working Paper	• 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) / • Do M&A activities increase systemic risk? • What determinants can explain changes in the level of systemic risk after M&A activities?	• 409 international, domestic, and cross-border mergers are analyzed 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
21	Martin F. Grace, Jannes Rauch, Sabine Wende 2013 (July)	Systemic Risk and Intercon-nectedness in the Financial Industry: Implications on Regulation of Financial Conglomerate s	• Systemic risk • Life, non-life • Event study - • Can insurance-specific events contribute to systemic risk?	• 12 insurance-specific events are analyzed 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

		/ Working Paper		interconnectedness between the different financial sectors • No evidence is found that insurance-specific events contribute to systemic risk
22	Etti Baranoff, Daniel Haefeli, Thomas Sager 2013 (August)	Surrenders in the Life Insurance Industry: A Systemic Risk of Runs? / Working Paper	• 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) / • Is a potential run on life insurers a systemic risk?	• Between 2001 and 2011, U.S. life insurers were always able to survive 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
23	Gregor N. F. Weiß, Denefa Bostandzic, Felix Irresberger 2013 (August)	Catastrophe Bonds and Systemic Risk / Working Paper	• Systemic risk • Reinsurance • Systemic risk measure calculation (ΔCoVaR, 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) / • Does the issuing of catastrophe bonds increase or decrease the systemic risk contribution of insurers?	• 176 cat bonds and their issuers are analyzed 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
24	Robert W. Klein 2013	Insurance Market Regulation: Catastrophe Risk, Competition and Systemic	• Regulation • Life, non-life, reinsurance • Qualitative discussion based on literature review -	• 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

		Risk / Handbook of Insurance	• Overview of insurance regulation • How to respond to risks related to competition and catastrophes as well as systemic ones?	• CDSs (non-traditional activities) can contribute to systemic risk • In-/solvency and market conduct regulation desirable
25	Denis Kessler 2013 (forthcoming)	Why (Re)insurance is Not Systemic / Journal of Risk and Insurance	• Systemic risk • Reinsurance • Qualitative discussion / • Does reinsurance contribute to systemic risk?	• Reinsurance does not contribute to systemic risk - 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)
26	Gregor N. F. Weiß, Janina Mühlnickel 2014	Why Do Some Insurers Become Systemically Relevant? / Journal of Financial Stability	• 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) / • Do insurers contribute to systemic risk? • Which factors determine the contribution of an insurer to systemic risk?	• 89 publicly listed U.S. insurers are analyzed 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
27	J. David Cummins, Mary A. Weiss 2014 (forthcoming)	Systemic Risk and the U.S. Insurance Sector / Journal of Risk and Insurance	• Systemic risk • Life, non-life, reinsurance • Qualitative discussion based on descriptive statistics / • Does the U.S. insurance sector	• 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

			significantly contribute to systemic risk?	• Insurance group supervision is needed to regulate non-core activities effectively
28	Robert Engle, Eric Jondeau, Michael Rockinger 2014 (forthcoming)	Systemic Risk in Europe / Review of Finance	• Systemic risk measures • Life, non-life, reinsurance • Systemic risk measure calculation (LRMES and SRISK) / • Which European financial institutions are risky?	• 196 European financial institutions are analyzed for the period from 1990 to 2012 • Based on LRMES, an approximately 40% decline in world markets leads to an approximately 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
29	T. R. Berry-Stölzle, Gregory P. Nini, Sabine Wende 2014 (forthcoming)	External Financing in the Life Insurance Industry: Evidence from the Financial Crisis / Journal of Risk and Insurance	• Capitalization • Life • Empirical study (probit and fixed-effects regression models) to identify the determinants of equity issuing and its consequences / • Can life insurers raise external capital in times of crisis? • What are causes and consequences of capital raising?	• 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
30	Sojung C. Park, Xiaoying Xie 2014 (forthcoming)	Reinsurance and Systemic Risk: The Impact of Reinsurer Downgrading on Property-Casualty Insurers / Journal of	• Contagion • Reinsurance • Empirical study (probit regressions) and scenario analysis about hypothetical equity levels of insurers if major reinsurers fail • / • Do reinsurer	• 516 rating up- and downgrades for U.S. insurers are analyzed • Rating downgrades of reinsurers increase likelihood of rating downgrades of insurers, since companies are interconnected • No indication that reinsurers contribute to systemic risk • Scenario analysis shows that even if three leading reinsures went bankrupt the market would not fail

		Risk and Insurance	downgradings have an impact on insurers?	
Part B Industry Studies and Practitioner Papers				
No.	**Author and 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	• Regulation • Life, non-life, reinsurance • Qualitative discussion / • What are the challenges for the regulation of the financial sector in Switzerland?	• In regard to insurance and systemic risk: - 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	• Systemic risk • Reinsurance • Qualitative discussion / • Does reinsurance contribute to systemic risk?	• Reinsurance does not contribute to systemic risk - 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 Consideration s / Policy Guidance	• Regulation • Life, non-life, reinsurance • Qualitative discussion / • Policy guidance • Report to the G20 Finance Ministers	• Indicators for systemic risk of organizations - Size - Lack of substitutability - Interconnectedness • Institutions and markets have to be considered • Indicators of financial vulnerability - Leverage - Liquidity risk - Maturity mismatches - Complexity of products and services
4	Internationa	Systemic Risk	• Systemic risk	• Time as another aspect should be

	l Association of Insurance Supervisors (IAIS) 2009	and the Insurance Sector / Report	• Life, non-life, reinsurance • Qualitative discussion / • Identification of further challenges of insurance regulators	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	• Systemic risk • Life, non-life, reinsurance • Qualitative discussion based on descriptive statistics / • Discussion of systemic risk in Solvency II • Which activities of insurance companies contribute to systemic risk? • How should regulation be framed?	• 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 - Short-term funding and securities lending - Derivatives trading (e.g., CDS writing)
6	Geneva Association 2010	Key Financial Issues in Insurance / Report	• Systemic risk • Life, non-life • Qualitative discussion based on descriptive statistics / • Follow-up report on the report: 'Systemic Risk in Insurance'	• Severe decline in asset values would affect insurance companies • Traditional business model does not incorporate liquidity or 'insurance run' risks because - 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	Internationa l Association of Insurance Supervisors (IAIS) 2010	Position Statement on Key Financial Stability Issues / Report	• Regulation • Life, non-life, reinsurance • Qualitative discussion • / • Position statement	• 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	• Systemic risk • Life • Qualitative discussion / • Discussion of systemic risk regarding annuities/hedging • Do variable annuities with guarantees and hedging activities contribute to systemic risk?	• 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	• Systemic risk • Life, non-life, reinsurance • Qualitative discussion • / • Which business lines of insurers contribute to systemic risk? • How should regulation be framed?	• 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	• Regulation • Life, non-life, reinsurance • Qualitative discussion / • Discussion of Solvency II • How will Solvency II deal with the future risks?	• 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 behavior) • 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	• Systemic risk • Life, non-life, reinsurance • Qualitative discussion / • Do failing insurers contribute to systemic risk?	• 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	• Systemic risk • Reinsurance • Qualitative discussion based on descriptive statistics and quantitative stress	• Reinsurance does not contribute to systemic risk - Interconnectedness is mainly vertical between reinsurers and insurers; interconnectedness on a horizontal level is weak

			tests / • Does reinsurance contribute to systemic risk?	- 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	• Systemic risk assessment • Life, non-life, reinsurance • Methodology description • / • How to assess systemically important insurers? • How should regulation be framed?	• Indicator-based assessment according to - Size - Global activity - Interconnectedness - Non-traditional and non-insurance activities - Substitutability • Structural proposed regulation measures - 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 5: Papers on systemic risk in insurance.

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II Sophisticated vs. Simple Systemic Risk Measures[41]

This paper evaluates whether sophisticated or simple systemic risk measures are more suitable in identifying which institutions contribute to systemic risk. In this investigation, Δ*CoVaR*, *Marginal Expected Shortfall* (*MES*), *SRISK* and *Granger-Causality Networks* are considered as sophisticated systemic risk measures. Market capitalization, total debt, leverage, the stock market returns of an institution, and the correlation between the stock market returns of an institution and the market, are considered as simple systemic risk measures. Systemic relevance is approximated by the receipt of financial support during the financial crisis and the classification, as a systemically important institution, by national or international regulators. The analyses are performed for all companies included in the S&P 500 composite index. The findings suggest that simple systemic risk measures have more explanatory power than sophisticated risk measures. In particular, total debt is found to be the most suitable indicator to detect institutions which contribute to systemic risk, according to the explanatory power and model fit. The most suitable sophisticated risk measure seems to be *SRISK*.

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1 Introduction

In the aftermath of the financial crisis of 2008, a wholly new strand of literature emerged with the goal of measuring systemic risk.[42] These measures can broadly be divided into two categories: (1) macroprudential measures with the goal of measuring the systemic risk of the entire financial system, and (2) microprudential measures which have the goal of identifying the individual contribution of companies to the overall systemic risk of the financial system. The four most relevant sophisticated microprudential measures are: $\Delta CoVaR$ (Adrian and Brunnermeier, 2011), *Marginal Expected Shortfall* (*MES*) (Acharya et al., 2010; Corvasce, 2013), *SRISK* (Acharya et al., 2012),[43] and *Granger-Causality Networks* (Billio et al., 2012).[44]

Besides these attempts to develop systemic risk measures, there is also the contrasting view in in the literature that systemic risk measures, with an increasing degree of sophistication, have some shortfalls. More specifically, the application of sophisticated systemic risk measures is difficult; hence, they lack transparency (Drehmann and Tarashev, 2011). Therefore, sophisticated measures might not necessarily be the best choice for identifying and regulating systemically relevant institutions. Consequently, simple measures might be more suitable (see, for example, Pottier and Sommer, 2002; Drehmann and Tarashev, 2011; Haldane, 2012; Patro et al., 2013; Rodríguez-Moreno and Peña, 2013).

This paper evaluates whether sophisticated or simple systemic risk measures are more suitable in indicating which companies contribute to systemic risk. In a first approach, I examine the explanatory power of various measures with respect to governmental support received during the financial crisis of 2008. My analysis is based on U.S. companies listed in the S&P 500 composite index in

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[42] An overview of the various measures is provided by Bisias et al. (2012).

[43] *SRISK* is not an acronym, but the name of the systemic risk measure indicating how much capital a company needs in a future crisis.

[44] According to Neale (2012), Benoit et al. (2013), Balla et al. (2014), Eling and Pankoke (2014) and Jobst (2014), *ΔCoVaR*, *MES*, *SRISK* and *Granger-Causality Networks* are the most widely used systemic risk measures; hence, this is why I focus on these measures in this paper.

2007. In a second approach, I investigate which measures correctly predict companies that were recently labeled systemically important. The analysis is based on U.S. companies listed in the S&P 500 composite index in 2013.

The contribution of this paper is threefold. Firstly, this is the first empirical comparison of sophisticated and simple systemic risk measures by means of a benchmark approximating systemic risk. Other studies usually either only provide rankings (Rodríguez-Moreno and Peña, 2013; Huang et al., 2012) or only test sophisticated systemic risk measures (Idier et al., 2013).[45] Secondly, to the best of my knowledge, this is the first study using a heterogeneous and large sample in the context of systemic risk measures.[46] This carries the advantage that companies are included in the analyses, which are not banks, but which can still be systemically important (e.g., AIG).[47] Thirdly, this paper is the first using information about which companies received financial support during the financial crisis and information about the classification of institutions by regulators to evaluate the usefulness of systemic risk measures. So far, there have only been a few papers that tested systemic risk measures in a way other than by the measure's ability to forecast the company's stock market returns.[48]

There are two basic assumptions made in this paper. The first is that, during the financial crisis, as well as during the present time, regulators have been able to detect the institutions which are contributing to systemic risk. The second is

[45] As additional examples, each paper introducing a new systemic risk measure can be named. Normally, each paper introduces a new concept for measuring systemic risk and presents a small empirical implementation, which should prove the superiority of the systemic risk measure at hand. Alternative sophisticated or simple systemic risk measures are usually ignored (see, e.g., Huang et al., 2009; Acharya et al., 2010; Adrian and Brunnermeier, 2011; Billio et al., 2012).

[46] Recent studies only consider very small sample sizes. For example, Patro et al. (2013) only consider 22 U.S. banks, Balla et al. (2014) consider 29 U.S. depositories and Papanikolaou and Wolff (2014) focus on 20 U.S. banks.

[47] The financial crisis has been caused by institutions of the financial sector (see, e.g., Gorton and Metrick, 2012). Consequently, systemic risk measures should indicate companies belonging to this sector. However, one cannot only focus on the financial sector, since a few companies from other sectors, like General Electric (see, e.g., Katz, 2013), are also highly contributing to systemic risk.

[48] An exception is the study by Duca and Peltonen (2013). They use a dependent variable in their regressions based on a financial stress index. As explanatory variables, they use macroprudential systemic risk indicators as GDP growth, inflation and the current account deficit of a country.

that microprudential risk measures are independent of the general state of the system. The idea to use the regulator's point of view in a regression analysis as the dependent variable is first mentioned by Benoit et al. (2013), but has not yet been implemented. The first study using the information about which institutions received financial support to approximate systemic risk is Weiß and Mühlnickel (2014). The second assumption is generally implicitly made in the literature. For example, none of the previously mentioned systemic risk measures are sensitive to the market context in the sense that it takes feedback effects into account. Whether the stock market is in a slump or booming it has no impact on the methodology of the measures.

The primary empirical findings are as follows. 1) Simple systemic risk measures have more explanatory power than sophisticated ones, in determining the institutions which received financial support during the financial crisis. In addition, they can better explain the amount of financial support each company received. 2) Simple systemic risk measures have more explanatory power than sophisticated ones, in determining which institutions are currently considered systemically relevant by national or international regulators. 3) The size of a company and its total debt level are the most suitable indicators to determine the systemic risk contribution of an institution. The explanatory power of the size variables is higher than the one of leverage, stock market returns or correlation variables. 4) Among the sophisticated risk measures, *SRISK* seems to be the most suitable, since it has explanatory power in various model settings; in comparison to the other sophisticated risk measures, it is the most significant.

The rest of the paper is structured as follows. Section 2 explains the methodology, including the sophisticated and simple systemic risk measures. Section 3 describes the data. Section 4 discusses the results. Finally, Section 5 concludes and further research questions are discussed.

2 Methodology

This paper empirically evaluates whether sophisticated or simple systemic risk measures are more suitable to identify institutions which contribute to systemic risk. Therefore, I regress the systemic relevance of institutions on sophisticated and simple systemic risk measures. The suitability of measures is finally interpreted according to the significance of the results and the model fit.

The systemic relevance of companies is approximated via two different approaches. The first approach focuses on the receipt of financial support during the financial crisis and leads to two different dependent variables. A dichotomous variable is created by taking into account whether financial support is received, and a cardinal variable, by focusing on the amount of received financial support. The second approach takes into account the institutions which are classified as systemically important institutions (SII) in 2013 and leads to a dichotomous variable.[49] Consequently, there will be two dummy variables approximating systemic relevance: the reception of financial support and the classification as *SII* by national or international supervisors. The extent of the systemic relevance of an institution will be approximated by the amount of financial support the institution received. These three variables are used as dependent variables in the regression analyses. This approach follows Weiß and Mühlnickel (2014, p. 109), who "define the most systemically important insurers as those companies that required aid under TARP [Troubled Asset Relief Program]".[50]

For the first approach, the following programs are considered, all of which target individual institutions to ensure financial stability or to reduce systemic risk:[51] TARP, Temporary Liquidity Guarantee Program (TLGP), Maiden Lane I, II, III, AIG Revolving Credit Facility and Securities Borrowing Facility for AIG.

The second approach, and the selection of the *SIIs*, is based on the Financial Stability Board's (FSB) designations of global systemically important banks and global systemically important insurers, as well as on the U.S. Financial Stability

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49 Two different samples are used in the analyses. The first approach is based on the companies included in the S&P 500 composite index as of January 2007. The second approach is based on S&P 500 companies as well, but in contrast, as a reference point, January 2013 is considered.

50 In addition, see Papanikolaou and Wolff (2014) who relate the participation in TARP of an institution to systemic risk as well.

51 See Congress of the U.S. (2008, Sec 2 [1]), Federal Deposit Insurance Corporation (2008) and Federal Reserve System (2014).

Oversight Council's (FSOC) designations of Nonbank Financial Companies and Financial Market Utilities, which are systemically important.[52] The participation in the Comprehensive Capital Analysis and Review by the Federal Reserve Board is not considered an indicator for systemic relevance, because only the 50 largest banks are considered in the review. An inclusion would have led to problems of endogeneity.

As mentioned previously, there is a variety of microprudential sophisticated systemic risk measures. In this paper, *ΔCoVaR, MES, SRISK* and *Granger Causality Networks* are applied, since they are considered the most relevant by the literature. In addition, they cover a wide field of different approaches to systemic risk (Neale, 2012; Benoit et al., 2013; Balla et al., 2014; Eling and Pankoke, 2014; Jobst, 2014)

The simple systemic risk measures used in this paper are motivated by Haldane (2012), in the case of leverage, as well as by Drehmann and Tarashev (2011), in the case of size. The motivation for using stock market returns as a simple systemic risk measure is based on the calculation of *MES* (Acharya et al., 2010). The *MES* of a company considers the stock market returns, but only considers the returns of a company when the entire market is in a slump. However, previous studies have not tested if the "tail returns" considered by *MES* do have more explanatory power ex ante than stock market returns. The same logic applies to the linear correlation between the stock market returns of a company and the returns of the entire market. Many researchers argue that correlation should play an important part in the design of any systemic risk measure. For example, Billio et al. (2012) and Chen et al. (2014) use *Granger-Causality Networks* to access systemic risk. In particular, Balla et al. (2014) argue that the tail correlations between different entities should be considered. The Pearson correlation should not be such a good indicator since the goal is to focus on spillover effects and not to focus on general co-movements in the

[52] See FSB (2013a), FSB (2013b) and FSOC (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 to make recommendations for addressing systemic risk. The FSOC is a committee chaired by the U.S. Secretary of the Treasury and an insurance expert appointed by the U.S. President. Its purpose is to identify threats to the stability of the financial system.

market. Nevertheless, Patro et al. (2013) propose the Pearson correlation as a simple systemic risk measure. In an empirical application they show for 22 large U.S. banks that during times of crisis overall correlation spikes and seems to be a useful systemic risk measure.

An overview of the variables and their expected relationships can be found in Table 6. Detailed descriptions of the systemic risk measures can be found in Sections 2.1, 2.2, 2.3 and 2.4. The regression models are illustrated in Section 2.5.

	Explanation	Rationale
Dependent Variables - First Approach		
Support	Dichotomous variable. One, if the company received financial support in 2008, otherwise zero.	Goal of financial support is to ensure financial stability (see, e.g, Congress of the U.S., 2008, Sec 2 [1]).
Amount	Continuous variable. Amount of received financial support in million USD in 2008.	Goal of financial support is to ensure financial stability (see, e.g, Congress of the U.S., 2008, Sec 2 [1]).
Dependent Variables - Second Approach		
SII	Dichotomous variable. One, if company is classified as systemically important in 2013, otherwise zero.	Goal of classification is to indicate institutions which can contribute to a systemic crisis (see, e.g., IAIS, 2013, p. 6).
Independent Variables - Sophisticated Systemic Risk Measures		
ΔCoVaR	Systemic risk measure which considers the entire contribution of a company to systemic risk (Section 2.1). The smaller the ΔCoVaR, the higher the systemic risk contribution.	For an institution to be in distress at the same time as the market is a sign of a high contribution to systemic risk (Adrian and Brunnermeier, 2011).
MES	Systemic risk measure which focuses on the stock market returns of an institution during a crisis (Section 2.2). The smaller the MES (Marginal Expected Shortfall), the higher the systemic risk contribution.	Does not focus on the contribution of an institution to the probability of a systemic crisis, but on its impact on the severity (see, e.g., Acharya et al., 2010).
SRISK	Systemic risk measure which determines how much capital in million USD an institution needs if a crisis occurs (Section 2.3).	Advancement of MES which takes debt into account and is supposed to be forward looking. Does not take the probability of a crisis into account (Acharya et al., 2012).
GrangerOut	Systemic risk measure which takes Granger-causality relationships between the stock market returns of institutions into account (Section 2.4). The more interconnections, the higher the systemic risk contribution.	The focus lies on the interconnections within a system. Institutions which are highly interconnected are considered to contribute strongly to systemic risk (Billio et al., 2012).

	Explanation	Rationale
Independent Variables - Simple Systemic Risk Measures		
Size	Natural logarithm of market capitalization in million USD.	On the one hand, size increases impact in the case of bankruptcy (see, e.g., FSB, 2009; Drehmann and Tarashev, 2011). On the other hand, size as an indicator ignores aligned behavior (see, e.g. Adrian and Brunnermeier, 2011). Debt is an alternative measure for the size of a company.
Debt	Natural logarithm of total debt in million USD.	
Leverage	Market leverage: total debt / market capitalization.	Leverage (Leverage and Book) increases the vulnerability of a company in adverse market situations. Increased forecasting power of leverage for bank bankruptcies is assumed (Haldane, 2012).
Book	Book leverage: total debt / total assets.	
Return	One year stock market return of the company.	MES and SRISK approximate tail returns. The question is if simple stock market returns are sufficient to determine companies which contribute to systemic risk.
Correlation	Linear correlation between the stock market returns of a company and the market index.	ΔCoVaR and Granger-Causality Networks both approximate the interconnectedness between companies (see, e.g., Adrian and Brunnermeier, 2011; Billio et al., 2012). Correlation is a simpler approach to assess the interconnections. The question is if it is viable.

Table 6: Description of dependent and independent variables used in the regression analyses.

2.1 ΔCoVaR

ΔCoVaR is a risk measure based on Adrian and Brunnermeier (2011). Its general idea is to measure the value at risk (VaR) of a market, conditional on the state of a certain institution. Hence, it measures the contribution of an institution to systemic risk.

$\Delta CoVaR_q$ indicates the difference between the $VaR_{0.5}$ of a market, conditional on an institution at its $VaR_{0.5}$, and the VaR_q of a market, conditional on an institution at its VaR_q. Weekly stock market returns can be used to calculate the *ΔCoVaR* if the focus only lies on the risk of adverse asset price movements. If funding liquidity risk should also be captured, weekly market-valued total asset prices should be used.

As suggested by Adrian and Brunnermeier (2011), I use quantile regressions to derive *ΔCoVaR*. To calculate the CoVaR measure, I use the quantile regression:

$$\hat{X}^{system|i}{}_q = \hat{\alpha}^i{}_q + \hat{\beta}^i{}_q X^i \tag{1}$$

where: $\hat{X}^{system|i}{}_q$ is the estimated q quantile of returns of the entire market, conditional on institution *i*. X^i are the returns of institution *i*. $\hat{\alpha}^i{}_q$ is the estimated constant and $\hat{\beta}^i{}_q$ the estimated coefficient for institution *i*. Since the *q* quantile of the market is equivalent to the VaR_q level:

$$VaR^{system|X^i}{}_q = \hat{X}^{system|i}{}_q \tag{2}$$

$$VaR^{system|VaR^i{}_q}{}_q = CoVaR^{system|i}{}_q = \hat{\alpha}^i{}_q + \hat{\beta}^i{}_q VaR^i{}_q \tag{3}$$

$CoVaR_q$ is then generated by only considering the case where $X^i = VaR^i{}_q$, as in Equation (3). Finally, *ΔCoVaR* as applied in this paper, is the difference between the CoVaR of the system at a 1% level and the CoVaR of the system at a 50% level. I choose 1%, to replicate the measure *ΔCoVaR* by Adrian and

Brunnermeier (2011) as close as possible.[53] Mathematically, $\Delta CoVaR$ is described in Equation (4).

$$\Delta CoVaR^{system|i}{}_{0.01} = \hat{\beta}^{i}{}_{0.01}(VaR^{i}{}_{0.01} - VaR^{i}{}_{0.5}) \tag{4}$$

The growth rate of the market-valued total asset prices is generated as:

$$X^{i}{}_{t} = \frac{Equity^{i}{}_{t} + Debt^{i}{}_{t}}{Equity^{i}{}_{t-1} + Debt^{i}{}_{t-1}} - 1 \tag{5}$$

where: $X^{i}{}_{t}$ indicates the growth rate of the market-valued total assets of company i at time *t*. $Equity^{i}{}_{t}$ denotes the market value of company i's equity value at time *t* (measured by total market capitalization). $Debt^{i}{}_{t}$ denotes the book value of company i's total debt.

2.2 MES

The *MES* is a systemic risk measure introduced by Acharya et al. (2010). The general idea is to measure the expected magnitude of a crisis. Therefore, the measure focuses on the expected contribution of an institution to the aggregated capital loss during a crisis but not on the probability of a systemic crisis to occur.[54]

The *MES* of a company is simply the weighted average of the company's historical stock market returns during the time when the entire market is in distress. The *MES* of a company is defined as:

$$MES^{i}{}_{5\%} = \mathrm{E}\left[\frac{\mathrm{Equity^{i}{}_{t}}}{\mathrm{Equity^{i}{}_{t-1}}} - 1|\mathrm{I}_{5\%}\right] \tag{6}$$

53 Robustness tests for 5% and 10% quantils are conducted as well. Results do not offer further insights and are displayed in Table 18 and Table 19 in the Appendix.

54 The fact that the *MES* focuses on the expected magnitude, and not on the probability of a crisis, is often neglected in the literature (Rodríguez-Moreno and Peña, 2013). For the analysis in this paper *MES* is fine since both aspects contribute to the systemic relevance of an institution. An institution can contribute to systemic risk by either increasing the probability or the magnitude of a crisis.

$MES^{i}{}_{5\%}$ indicates the *MES* of company *i,* conditional on the 5% worst trading days of the market in the last year.[55] I choose 5% to replicate the measure *MES* by Acharya et al. (2010) as close as possible. $Equity^{i}{}_{t}$ denotes the equity value of company i at time t and $I_{5\%}$ is an indicator function, denoting the 5% worst market outcomes. The time invariant MES, in this paper considers only the last year of the stock market movements. The applied calculation in this paper is:

$$MES(t)^{i}{}_{5\%} = \frac{1}{13}\sum_{t-261}^{t}\left[\frac{\mathrm{w^{i}{}_{t}}}{\mathrm{w^{i}{}_{t-1}}} - 1|\mathrm{I}_{5\%,261}\right] \tag{7}$$

where: $MES(t)^{i}{}_{5\%}$ stands for the *MES* at time *t* and $I_{5\%,261}$ is an indicator function for the 5% worst market returns during the last 261 trading days.

2.3 SRISK

SRISK is a systemic risk measure developed by Acharya et al. (2012) and is related to *MES*. It is a measure for the expected capital shortfall of a company, given a crisis, and indicates how much additional capital is needed by a company to stay solvent during the next crisis. *SRISK* can be seen as a substitute for stress tests.

The major advancement of *SRISK* over *MES* is that it takes the total debt of a company into account and is supposed to be forward looking. However, as *MES*, *SRISK* does not account for the probability of a crisis to occur. *SRISK* is defined as:

$$SRISK^{i}{}_{t} = E_{t-1}(Capital\ Shortfall^{i}|\text{Crisis}) \tag{8}$$

where: $SRISK^{i}{}_{t}$ indicates the expected capital shortfall of a company *i* at a time *t* given a crisis. *Crisis* is an indicator function, denoting the presence of a crisis. Acharya et al. (2012) suggests measuring the expected capital shortfall of a company via simulated equity returns and the crisis via a broad stock market index, which is simulated for six months in the future. Whenever it falls by

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[55] Robustness tests for the 1% and 10% worst trading days are conducted as well. Results do not offer further insights and are displayed in Table 13 and Table 14 in the Appendix.

more than 40%, this is viewed as a crisis. As Acharya et al. (2012), due to practical reasons, I employ a version of *SRISK* which can be derived directly from certain book and market based variables. The calculations are:

$$SRISK^{i}{}_{\mathrm{t}} = E_{t-1}((\mathrm{k}(Debt^{i} + \mathrm{Equity}^{i}) - \mathrm{Equity}^{i})|\mathrm{Crisis})$$

$$= kDebt^{i}{}_{t} - (1-k)(1 - LRMES^{i}{}_{t}) * Equity^{i}{}_{t} \qquad (9)$$

where: k stands for the capital ratio (equity as a fraction of total liabilities), which I assume to be 8%, as in Acharya et al. (2012). $Debt^{i}{}_{t}$ indicates the total book value of debt and $Equity^{i}{}_{t}$ is the market value of equity, whereas i stands for the company and *t* indicates the time. $LRMES^{i}{}_{t}$ indicates the Long Run *MES* and is approximated by $1 - e^{-18*-MES^{i}{}_{t}}$, whereas $-MES^{i}{}_{t}$ represents the *MES*, as in Section 2.2.[56]

2.4 Granger-Causality Networks

Billio et al. (2012) propose *Granger-Causality Networks* to measure interconnectedness and systemic risk. The underlying idea is to measure the systemic risk of a market with *m* companies by evaluating the interconnection of all *m*(m-1)* pairs in the market. A pair is regarded as interconnected if a Granger-causality relationship between the stock market returns of the two companies cannot be rejected at a 5% significance level.[57] The systemic risk of the system is finally measured by the sum of pairs which are considered interconnected. The order of the pairs must be considered. Otherwise, the direction of the interconnection is ignored. Companies which Granger-cause stock market returns of many other companies contribute most to systemic risk.

56 For the sake of consistency, I calculate *MES* as in Acharya et al. (2010). Therefore, I use a different threshold for indicating a crisis by using a market downfall of -5%, instead of -2%. In addition, I have to use a different algebraic sign in the approximation for *LRMES*, since in Acharya et al. (2010), *MES* is a negative number, whereas in Acharya et al. (2012), *MES* is considered positive. For a further discussion of *LRMES*, see Brownlees and Engle (2012). Robustness tests for *SRISK* considering different *MESs* are displayed in Table 13 and Table 14 in the Appendix.

57 I conduct robustness tests in which 1% and 10% significance levels are considered as well. The results do not offer further insights and are displayed in Table 13 and Table 14 in the Appendix.

In addition, companies whose stock market returns are heavily influenced by the returns of other companies can be considered vulnerable. Mathematically, Granger-causality can be described as follows:

$$R^{i}{}_{t+1} = a^{i}R^{i}{}_{t} + b^{ij}R^{j}{}_{t} + \varepsilon^{i}{}_{t+1} \tag{10a}$$

$$R^{j}{}_{t+1} = a^{j}R^{j}{}_{t} + b^{ji}R^{i}{}_{t} + \varepsilon^{j}{}_{t+1} \tag{10b}$$

where: $R^{i}{}_{t}$ and $R^{j}{}_{t}$ represent the time series of the stock market returns, whereas *i* and *j* indicate the two companies of a given pair. *t* stands for the time and ε indicates an error term. $a^{i}, b^{ij}, a^{b},\ b^{ji}$ are the coefficients of the model. If b^{ij} is different from zero, then R^j Granger-causes R^i and if b^{ji} is different from zero, then R^i Granger-causes R^j. Mathematically, the indicator of Granger-causality is:

$$(i \rightarrow j) = \begin{cases} 1 \text{ if } R^{i} \text{ Granger} - \text{causes } R^{j} \\ \quad 0 \text{ otherwise} \end{cases} \tag{11}$$

Finally, the number of Granger-causality connections used as a measure for the systemic risk contribution of a company is derived as:

$$GrangerOut_{i} = \sum_{i=1, j \neq i}^{m} (i \rightarrow j) \qquad (12)$$

where: $GrangerOut_i$ represents the number of companies whose stock market returns are influenced by the stock market returns of company i. The variable m indicates the sample size.[58]

[58] In contrast to Billio et al. (2012), I do not adjust *GrangerOut* (the number of connections) to the sample size, since the sample size is rather stable and the focus of this paper does not lie in the comparison of the systemic risk contributions of companies over time.

2.5 Regression Models

For the logistic regressions regarding the dependent variables, *Support* (first approach, companies which received financial support during the financial crisis) and *SII* (second approach, companies lately classified as systemically important institutions by regulators), the respective models are:

$$logit(Support)_i = \alpha + \sum_{j=1}^{n}(\beta_j X_{ji}) + \varepsilon_i \quad (13a)$$

$$logit(SII)_i = \alpha + \sum_{j=1}^{n}(\beta_j X_{ji}) + \varepsilon_i \quad (13b)$$

where: $logit(Support)_i$ and $logit(SII)_i$, respectively stand for the natural logarithm of the odds ratios of the variables *Support* and *SII*. Note that α indicates the constant and ε_i the error term. β_j represents the regression coefficient of variable *j*. X_{ji} stands for the independent variable *j*. *i* displays the company. The total amount of variables is represented by *n* and is varying according to the different model specifications.

For the multivariate linear regressions regarding the first approach, the following model is used:

$$Amount_i = \alpha + \sum_{j=1}^{n}(\beta_j X_{ji}) + \varepsilon_i \quad (14)$$

The notation is the same as for the models in Equations (13a) and (13b). Again, the number of considered independent variables is varying according to the model specifications.

2.6 Data

The data used in this paper is entirely available from public sources. Table 7 provides an overview of the data used to derive the variables employed in the analyses. Moreover, the source of the data is listed.

	Necessary Data	Source
Dependent Variables - First Approach		
Support	• Information about which institutions received financial support	• U.S. Department of the Treasury (website) • Federal Reserve System (website) • Federal Deposit Insurance Corporation (website)
Amount	• Information about the amount of support the concerning institutions received	
Dependent Variable - Second Approach		
SII	• Information about which institutions are designated as systemically important	• Financial Stability Oversight Council (FSOC) (website) • Financial Stability Board (FSB) (website)
Independent Variables - Sophisticated Systemic Risk Measures		
ΔCoVaR	• Market capitalization • Total debt • Returns of market index	• DataStream • Thomson One
MES	• Market capitalization • Returns of market index	• DataStream
SRISK	• *MES* • Total liabilities • Market capitalization	• DataStream • Thomson One
GrangerOut	• Market capitalization	• DataStream
Independent Variables - Simple Systemic Risk Measures		
Size	• Market capitalization	• DataStream
Debt	• Total debt	• Thomson One
Leverage	• Market capitalization • Total debt	• DataStream •
Book	• Total debt • Total assets	• Thomson One
Return	• Market capitalization	• DataStream
Correlation	• Market capitalization	• DataStream

Table 7: Description of the data used to generate the dependent and independent variables.

The samples of my analyses are based on the S&P 500 composite index; therefore, my initial samples consist of 500 companies. The advantage of not only focusing on financial institutions is that financial institutions which are not labeled as such are included as well. The AIG case has proven that, from a systemic risk perspective, it is important to incorporate a very broad perspective, since it is not possible to conclude from the industry specification of a company that certain activities are not undertaken.[59]

Based on the S&P 500 composite index, I use two different samples for my analyses. For the first approach, regarding the variables *Support* and *Amount* as a reference point, the constituents list of the index is considered as of January 2007. The explanatory power, ex ante and ex post, of the sophisticated and simple systemic risk measures is evaluated. Companies going bankrupt after January 2007 are not excluded from the sample to avoid a survivorship bias. From the initial sample of 500 companies, 26 companies are excluded, due to missing data, so that the final sample consists of 474 institutions. For the second approach, regarding the variable *SII* as a reference point, the constituents list of the index is considered as of January 2013. The final sample consists of 470 companies. Overall, 30 companies are excluded again due to missing data.

In order to calculate the *MES* risk measure of the individual companies, returns of a reference stock market are necessary. I use the S&P 500 composite index as an approximation for the U.S. market. For the calculation of the *MES* risk measure, daily stock market returns are used. All information are taken from DataStream.

ΔCoVaR is calculated for the companies in the S&P 500 composite index. In order to generate the weekly growth rate of the market-valued asset prices, information on the total market capitalization of the companies are obtained from DataStream on a weekly basis. Book-valued total debt data is obtained from Thomson One on a quarterly basis. Linear interpolation is used to compute the weekly book-valued total debt information for each company in the sample. In total, the *ΔCoVaR* calculations consider data from January 2000 to January 2009 in the case of the first approach and data from January 2003 to January

59 See, e.g., Harrington (2009) and Katz (2013).

2014 in the case of the second approach. Following Adrian and Brunnermeier (2011), I only consider companies for which at least 260 weeks of data are available. The growth rate of the market-valued total assets of the system is derived by taking the weighted average of institutions' growth rate.

SRISK is based on the *MES* measure and requires further information. Figures about the market capitalization of each company are obtained from DataStream and information about the total liabilities from Thomson One.[60] The variable *SRISK* indicates the capital (in million USD) a company needs for surviving the next crisis. If it is negative, no additional capital is necessary.

The *Granger-Causality Networks* are based on the Granger-causality relationships within a system. Therefore, the market capitalizations of all institutions in the samples are obtained from DataStream. In the case of the first approach, there are 224,202 possible interconnections. In the second approach, there are 220,430.

For the cross sectional analyses regarding the first approach (*Support* and *Amount* as dependent variables), the following points in time are chosen: January 2007, January 2008 and January 2009. Since all of the financial support programs during the financial crisis were introduced in 2008, the analyses for January 2007 have an ex ante character and the ones for January 2009 an ex post character.

Regarding the second approach (*SII* as dependent variable), the analyses focus on January 2013 and January 2014. Institutions have been designated as systemically important in 2013; therefore, the analyses for January 2013 have an ex ante character and the ones for January 2014 an ex post character.

For the logistic regressions regarding the first approach, further adjustments to the dependent variable *Support* are made. I consider the insurers Allstate, Principal Financial and Prudential Financial as participants in the TARP, although they received no financial support. The reason is that they were considered systemically important and were offered financial support, which

60 Acharya at al. (2012) mention total debt instead of total liabilities. Though, their results can only be replicated with the total liabilities from DataStream and not with total debt. Therefore, I decided to use total liabilities from DataStream.

they declined (Harrington, 2009). In addition, I treat Fannie Mae, Lehman Brothers and Washington Mutual as if they had received financial support. Fannie Mae did not participate in a government / FED program, but nevertheless received support (see, e.g., Federal Reserve System, 2008), not supporting Lehman Brothers was considered a mistake (see, e.g., Palank, 2013) and Washington Mutual was only taken over by JPMorgan Chase due to pressure by federal agencies (see, e.g., Isidore, 2013).

3 Results

3.1 Results of the First Approach (Financial Support in 2008)

The first approach takes into account the financial support programs initiated during the financial crisis in 2008. It is evaluated whether sophisticated or simple systemic risk measures are more suitable to explain which institutions received financial support, as well as how much support these institutions received.

Table 8 illustrates the results regarding the variable *Support* for January 2007 (Panel A) and 2009 (Panel C); the results for January 2008 (Panel B) can be found in Table 11 in the Appendix. In these cases, the evaluation involved determining if the systemically risky companies can be indicated correctly. Models one to five show the results of the regressions regarding the sophisticated systemic risk measures. Models six to thirteen illustrate the results regarding the simple systemic risk measures. The results in Table 8 (Panel A) suggest that sophisticated systemic risk measures do not have any explanatory power ex ante. The fit of all models regarding these measures (models one to five) is poor. Only *ΔCoVaR* has a significant impact at a 5% level.[61]

Regarding the simple systemic risk measures (models six to thirteen), *Debt* and *Leverage* are found to have a decent explanatory power. Both variables are significant at a 1% level and, at least in the case of *Debt*, the model fit seems to

[61] In order to evaluate the goodness of fit of a model, I apply the Nagelkerke information criterion (pseudo R^2). The values below 0.2 indicate a very poor model fit, the values above 0.2 indicate a decent fit and the values above 0.4 indicate a good fit (Backhaus et al., 2006, p. 456).

be good with a pseudo R^2 of 0.45. In model twelve, both variables *Size* and *Book* have a negative and significant impact at a 1% level. This is against economic intuition, since this means that institutions with low market capitalization and low leverage received financial support. A more likely interpretation is that this result is due to the multicollinearity issues between the two leverage variables, *Leverage* and *Book*, and both size variables, *Size* and *Debt*. In models six and thirteen, *Size* has a positive and significant impact at a level of 1%, but the fit of the models is worse than the one of the model regarding the variable *Debt* (model seven). Therefore, one can conclude that, ex ante, mainly the amount of debt seems to have explanatory power whether an institution is contributing to systemic risk.

Furthermore, market capitalization and leverage might be helpful indicators. According to the results presented in Panel A of Table 8, sophisticated systemic risk measures seem, ex ante, not be useful in determining the institutions contributing to systemic risk.

Panel A: January 2007													
Model	1	2	3	4	5	6	7	8	9	10	11	12	13
ΔCoVaR	-40.89 **	-	-	-	-47.73 **	-	-	-	-	-	-	-	-
	(4.33)				(5.33)								
MES	-	6.70	-	-	24.42	-	-	-	-	-	-	-	-
		(0.07)			(0.82)								
SRISK	-	-	0.00	-	0.00	-	-	-	-	-	-	-	-
			(0.08)		(0.17)								
Granger Out	-	-	-	0.02	0.02	-	-	-	-	-	-	-	-
				(2.48)	(2.67)								
Size	-	-	-	-	-	0.77 ***	-	-	-	-	-	-2.17 ***	0.71 ***
						(26.51)						(22.10)	(19.00)
Debt	-	-	-	-	-	-	1.24 ***	-	-	-	-	3.26 ***	-
							(55.01)					(44.63)	
Leverage	-	-	-	-	-	-	-	1.11 ***	-	-	-	-0.05	0.98 ***
								(22.96)				(0.05)	(18.23)
Book	-	-	-	-	-	-	-	-	0.47	-	-	-15.62 ***	-

									(0.24)			(33.84)	
Return	-	-	-	-	-	-	-	-	-	0.80*	-	0.79	0.80
										(3.21)		(0.88)	(2.27)
Correlation	-	-	-	-	-	-	-	-	-	-	-0.02	2.04	0.22
											(0.00)	(1.95)	(0.05)
Pseudo R^2	0.02	0.00	0.00	0.01	0.04	0.12	0.45	0.19	0.00	0.01	0.00	0.71	0.28

Panel C: January 2009

Model	1	2	3	4	5	6	7	8	9	10	11	12	13
ΔCoVaR	14.24	-	-	-	21.66	-	-	-	-	-	-	-	-
	(0.99)				(0.51)								
MES	-	-37.87 ***	-	-	-11.26	-	-	-	-	-	-	-	-
		(49.47)			(0.98)								
SRISK	-	-	0.61 ***	-	0.54 ***	-	-	-	-	-	-	-	-
			(41.41)		(27.00)								
Granger Out	-	-	-	0.01 ***	0.01	-	-	-	-	-	-	-	-
				(17.47)	(1.92)								
Size	-	-	-	-	-	0.02	-	-	-	-	-	-1.86 ***	0.64 ***
						(0.03)						(14.35)	(16.42)

Debt	-	-	-	-	-	-	1.36 ***	-	-	-	-	3.69 ***	-
							(47.54)					(34.18)	
Leverage	-	-	-	-	-	-	-	0.13 ***	-	-	-	0.01	0.11 ***
								(12.79)				(0.03)	(9.83)
Book	-	-	-	-	-	-	-	-	-0.41	-	-	-17.69 ***	-
									(0.19)			(25.91)	
Return	-	-	-	-	-	-	-	-	-	-2.90 ***	-	0.86	-3.84 ***
										(16.48)		(0.15)	(11.30)
Correlation	-	-	-	-	-	-	-	-	-	-	-1.08	1.13	-1.62
											2.61	(0.34)	(2.35)
Pseudo R^2	0.01	0.27	0.75	0.07	0.75	0.00	0.47	0.15	0.00	0.08	0.01	0.78	0.25

Table 8: Logistic regression results, based on the full sample (n = 474) for January 2007 and January 2009. Results for January 2008 are shown in Table 11 in the Appendix. The dependent variable is *Support* in all models, indicating whether a company received financial support during the financial crisis. Wald statistics are shown in brackets. ***, ** and * indicate a 1%, 5% and 10% significance level. Results regarding the constants are omitted.

In contrast, Panel C of Table 8 suggests that, ex post, sophisticated systemic risk measures can indeed explain which companies received financial support. *MES*, *SRISK* and *GrangerOut* have a significant impact at a 1% level. In addition, the goodness of fit for *SRISK* (model three) is high and the one for *MES* (model two) is decent. If all sophisticated risk measures are combined into one model (model five), only *SRISK* has a significant impact at a 1% level and the pseudo R^2 figure is not higher, as in model three, in which only *SRISK* is considered. Consequently, ex post, the application of *MES* on its own might be useful, but as soon as *SRISK* is employed, *ΔCoVaR*, *MES* and *GrangerOut* provide no further information.

The simple systemic risk measures reveal that *Debt* (model seven), *Leverage* (model eight) and *Return* (model ten) all have significant explanatory power at a 1% level. Though, only the model for *Debt* has a good model fit. Interestingly, in model twelve, which considers all simple systemic risk measures, *Size* and *Book* both have a negative and significant impact at a 1% level. This is against economic intuition, since this would imply that the lower the market capitalization of the company and the lower the book leverage ratio, the more likely it is that the company is systemically risky. The results can be explained by multicollinearity issues, since *Size* and *Debt*, as well as *Leverage* and *Debt*, are variables which measure the size and leverage of an institution. Results for model thirteen, which only considers one size variable and one leverage variable, reveal that, ex post, the size and leverage of an institution are helpful in determining which institutions are contributing to systemic risk.

In model thirteen, as in model ten, *Return* is significant and negative. This could be expected and is in line with economic intuition. More specifically, during a crisis, the most systemically contributing companies have the most adverse stock market returns. All in all, Panel C of Table 8 indicates that *SRISK* is, ex post, able to identify the institutions which are contributing to systemic risk. In addition, the amount of debt and leverage ratios of an institution can be helpful as well.

I conduct a robustness test for a subsample, only considering financial services companies, to check if the sophisticated systemic risk measures might only be applicable in the context of the financial sector. Table 13 (Panels A and C) and Table 15 (Panel B) in the Appendix illustrate the results for institutions which, according to the FTSE International Limited (2012) Industry Classification Benchmark, belong to the following sectors: banks, insurance, real estate and financial services. The subsample size is 84. Again, the results presented are for January 2007, January 2008 and January 2009.

The results for the full sample are supported. For financial services companies, ex ante, sophisticated systemic risk measures have no explanatory power. Among the simple systemic risk measures, *Debt* has the highest explanatory power and is, in all relevant models, significant at a 1% level. Interestingly, in contrast to the results for the full sample, *Correlation* has explanatory power in all relevant models at a 1% level. In the case of financial services companies, the institutions whose stock returns are negatively correlated with the S&P 500 composite index seem to have a higher likelihood of contributing to systemic risk.

From the ex post perspective (Panel C of Table 13), the results for the full sample are similar to the ones for the subsample. *SRISK* seems to be the most suitable sophisticated systemic risk measure for indicating the institutions contributing to systemic risk, and *Debt*, in the case of simple measures. In contrast to the results of the full sample, though, *Correlation* still has explanatory power and the leverage variables seem to have no impact at all. One explanation for that could be that financial services companies, which are contributing to systemic risk, had to deleverage after the financial crisis, and therefore, ex post, contributing and non-contributing institutions had similar leverage ratios (Papanikolaou and Wolff, 2014).

Table 9 illustrates the results regarding the variable *Amount* for January 2007 (Panel A) and January 2009 (Panel C). In Table 12 in the Appendix, the results for January 2008 (Panel B) are presented. It is analyzed whether the sophisticated and simple measures can correctly explain the volume of financial support that systemically risky institutions received. The results for the sophisticated systemic risk measures are shown in models one to five. The results for the simple systemic risk measures are shown in models six to thirteen.

Panel A: January 2007													
Model	1	2	3	4	5	6	7	8	9	10	11	12	13
ΔCoVaR	-0.44 ***	-	-	-	-0.12	-	-	-	-	-	-	-	-
	(-2.96)				(-0.68)								
MES	-	-0.15	-	-	-0.28	-	-	-	-	-	-	-	-
		(-0.93)			(-1.64)								
SRISK	-	-	-0.57 ***	-	-0.62 ***	-	-	-	-	-	-	-	-
			(-4.17)		(-3.84)								
Granger Out	-	-	-	-0.02	0.02	-	-	-	-	-	-	-	-
				(-0.13)	(0.13)								
Size	-	-	-	-	-	0.73 ***	-	-	-	-	-	0.73 ***	-
						(6.42)						(6.10)	
Debt	-	-	-	-	-	-	0.65 ***	-	-	-	-	-	0.84 ***
							(5.12)						(5.33)
Leverage	-	-	-	-	-	-	-	0.19	-	-	-	0.05	-0.31*
								(1.15)				(0.39)	(-1.94)
Book	-	-	-	-	-	-	-	-	0.28 *	-	-	-	-

									(1.78)				
Return	-	-	-	-	-	-	-	-	-	-0.12	-	-0.12	-0.06
										(-0.74)		(-1.02)	(-0.49)
Correlation	-	-	-	-	-	-	-	-	-	-	-0.02	-0.11	-0.04
											(-0.11)	(-0.92)	(-0.30)
Adjusted R^2	0.17	0.00	0.31	-0.03	0.38	0.52	0.41	0.01	0.06	-0.01	-0.03	0.50	0.43

Panel C: January 2009

Model	1	2	3	4	5	6	7	8	9	10	11	12	13
ΔCoVaR	-0.15	-	-	-	-0.21*	-	-	-	-	-	-	-	-
	(-0.89)				(-1.85)								
MES	-	-0.26	-	-	-0.07	-	-	-	-	-	-	-	-
		(-1.64)			(-0.56)								
SRISK	-	-	0.70 ***	-	0.67 ***	-	-	-	-	-	-	-	-
			(5.68)		(5.91)								
Granger Out	-	-	-	0.37**	0.34 ***	-	-	-	-	-	-	-	-
				(2.38)	(2.99)								
Size	-	-	-	-	-	0.37 **	-	-	-	-	-	0.79 ***	-
						(2.41)						(5.81)	

Debt	-	-	-	-	-	-	0.69 ***	-	-	-	-	-	0.75 ***
							(5.46)						(5.56)
Leverage	-	-	-	-	-	-	-	0.47 ***	-	-	-	0.47 ***	0.05
								(3.05)				(3.82)	(0.32)
Book	-	-	-	-	-	-	-	-	0.27	-	-	-	-
									(0.12)				
Return	-	-	-	-	-	-	-	-	-	-0.35 **	-	-0.55 ***	-0.43 ***
										(-2.25)		(-3.65)	(-2.92)
Correlation	-	-	-	-	-	-	-	-	-	-	0.25	-0.34 **	-0.22
											(1.55)	(-2.41)	(-1.60)
Adjusted R^2	-0.01	0.04	0.48	0.11	0.59	0.12	0.47	0.20	0.05	0.10	0.04	0.61	0.59

Table 9: Least square regression results for January 2007 and January 2009. Results for January 2008 are shown in Table 12 in the Appendix. The sample (n = 37) only includes institutions which received financial support. The dependent variable is *Amount* in all models, indicating the amount of support a certain company received during the financial crisis. T-statistics are shown in brackets. ***, ** and * indicate a 1%, 5% and 10% significance level. Results regarding the constants are omitted.

Panel A of Table 9 illustrates that sophisticated systemic risk measures (model one to five) have only limited explanatory power ex ante on the volume of received financial support. *ΔCoVaR* (model one) and *SRISK* (model two) seem to have a significant impact at a 1% level. However, the adjusted R^2 figure in the case of *ΔCoVaR* is small. Only 17% of the variation of the dependent variable can be explained by the measure. The coefficient of *SRISK* is negative, which implies that its usefulness is very limited, because *SRISK* indicates how much additional capital a company needs to stay solvent during the next crisis.

Regarding the simple systemic risk measures (models six to thirteen), the size variables *Size* (model six) and *Debt* (model seven) have explanatory power. Both are significant at a 1% level and the adjusted R^2 statistics are high, at 0.52 and 0.41, respectively. Including other variables in the models (model twelve and thirteen) does not increase their explanatory power much. Adjusted R^2 statistics are 0.50 for model twelve and 0.43 for model thirteen. Due to multicollinearity issues, *Size, Debt, Leverage* and *Book* are not included in the same models.

Panel C of Table 9 indicates that, ex post, sophisticated systemic risk measures have much more explanatory power than ex ante to indicate the volume of financial support systemically relevant institutions received. The results for model five combine all sophisticated measures and indicate that *ΔCoVaR*, *SRISK* and *GrangerOut* are useful in determining the amount of support, ex post. The adjusted R^2 statistic for the entire model is 0.59; the mentioned measures are significant at a 10% and 1% level. *SRISK* seems to be the most powerful variable, because, for the model only including *SRISK* (model three), the adjusted R^2 statistic is already 0.48.

The simple systemic risk measures, *Size* (model six), *Debt* (model seven), *Leverage* (model eight) and *Return* (model ten) are all found to have explanatory power. All of these variables are significant at least at a 5% level. The highest adjusted R^2 of 0.61 is reported for model twelve. It can be seen that *Size* and *Leverage* have a significant impact at a 1% level, while *Return* and *Correlation* have a significant impact at least at a 5% level. For model thirteen, the adjusted R^2 figure with 0.59 can still be regarded as high, but only *Debt* and *Return* have a significant impact.

All in all, sophisticated risk measures are more useful, ex post, in explaining the volume of financial support, than ex ante, but the simple systemic risk measures still have more explanatory power. A model which combines size and leverage variables is most suitable. As a robustness test, I conduct the same analyses for a subsample, only considering financial services companies. The results are presented in the Appendix (Table 14). The sample size, in these cases, is reduced to 35 observations, since I only consider financial companies according to the Industry Classification Benchmark. The analyses are performed for January 2007 (Panel A), January 2008 (Panel B) and January 2009 (Panel C).

The results of the robustness test corroborate the full sample results. For financial services companies, ex ante, sophisticated systemic risk measures only have little explanatory power. *SRISK* is significant at a 1% level and has an adjusted R^2 statistic of 0.37, but it has a negative coefficient and can be interpreted as misleading. The results suggest that institutions which do not need additional capital, according to *SRISK*, are contributing to systemic risk.

ΔCoVaR seems to be more suitable. The results are significant at a 5% level and the adjusted R^2 statistic is 0.11 in model one. However, in model five, which combines all sophisticated systemic risk measures, *ΔCoVaR* has no significant impact anymore. In contrast, as for the full sample, the simple systemic risk measures have a stronger explanatory power ex ante, if only financial services companies are considered. *Size* and *Debt* in models six and seven are significant at a 1% level and the adjusted R^2 statistics are at 0.47 and 0.36, respectively.

Regarding the ex post perspective, the results for the analyses, based on the full sample and the subsample, are the same on the level of individual variables. *SRISK, GrangerOut, Size, Debt, Leverage, Return* and *Correlation* have a significant impact at least at a 5% level. An important observation is that the sophisticated systemic risk measures seem to have more explanatory power than the simple systemic risk measures. For example, the adjusted R^2 for the model, including all sophisticated measures, is 0.69 (model five); the adjusted R^2 for each model, including most of the simple measures (model twelve and thirteen), is 0.57.

3.2 Results of the Second Approach (Classification as SII in 2013)

The second approach focuses on the information about which institutions have been labeled as systemically important in 2013 by national and international regulators. It is evaluated if sophisticated or simple systemic risk measures are more suitable to explain which institutions are designated as contributing to systemic risk. The results regarding the variable *SII* are presented in Table 10. Panel A illustrates the results for January 2013, and therefore, can be considered the ex ante perspective. In contrast, Panel B illustrates the results for January 2014 and represents the ex post perspective. Models one to five show the results of the regressions regarding the sophisticated systemic risk measures. Models six to thirteen illustrate the results regarding the simple systemic risk measures.

It seems that sophisticated systemic risk measures have explanatory power to indicate which institutions are deemed systemically important, ex ante (Panel A of Table 10). In particular, the results for *MES* (model two) and *SRISK* (model three) are significant at a 1% level. The best goodness of fit is achieved in model five, which includes all sophisticated risk measures. In this model, only *SRISK* is significant at a 1% level. In comparison with the results of the first approach in Table 8 (Panel A), the results at hand provide stronger evidence that systemic risk measures might be able to detect institutions contributing to systemic risk.

Regarding the simple systemic risk measures (models six to thirteen), *Size* (model six), *Debt* (model seven), *Return* (model ten) and *Correlation* (model eleven) are significant at least at a 10% level. The results for *Size* and *Debt* are robust in the way that these variables are significant, even when controlling for other simple systemic risk measures (models twelve and thirteen).

It is interesting that if *Debt* is included in the model, *Size* and *Leverage* are no longer significant (model twelve). However, if *Debt* is not included, *Size* and *Leverage* are significant (model thirteen). The pseudo R^2 figures are high for

Debt in model seven (0.56) and in model twelve, which includes *Debt* and other simple measures (0.78). Models without *Debt* have a pseudo R^2 statistic at the most of 0.35 (model thirteen). This pattern suggests that the total amount of debt is suitable for indicating ex ante institutions contributing to systemic risk. In addition, *Debt* seems to be a better indicator than *SRISK*, since the pseudo R^2 statistic is higher (0.56 vs. 0.35). In general, the results seem to be in line with the results of the first approach. In Table 8 (Panel A) and Table 10 (Panel A) *Debt* has the highest explanatory power.

Panel A: January 2013													
Model	1	2	3	4	5	6	7	8	9	10	11	12	13
ΔCoVaR	19.57	-	-	-	21.36	-	-	-	-	-	-	-	-
	(0.59)				(0.46)								
MES	-	-129.11 ***	-	-	-53.46	-	-	-	-	-	-	-	-
		(13.41)			(1.39)								
SRISK	-	-	0.10 ***	-	0.09 ***	-	-	-	-	-	-	-	-
			(19.83)		(13.06)								
Granger Out	-	-	-	-0.03	-0.04	-	-	-	-	-	-	-	-
				(1.14)	(0.76)								
Size	-	-	-	-	-	1.15 ***	-	-	-	-	-	-0.96	1.30 ***
						(20.18)						(1.20)	(19.68)
Debt	-	-	-	-	-	-	1.68 ***	-	-	-	-	3.55 ***	-
							(29.77)					(11.67)	
Leverage	-	-	-	-	-	-	-	0.29	-	-	-	0.05	0.32 ***

								(6.27)				(0.01)	(9.48)
Book	-	-	-	-	-	-	-	-	-2.05	-	-	-16.30 ***	-
									(1.21)			(9.57)	
Return	-	-	-	-	-	-	-	-	-	1.22*	-	-5.02*	0.60
										(2.97)		(2.88)	(0.27)
Correlation	-	-	-	-	-	-	-	-	-	-	6.52 **	13.53 *	5.42
											(6.09)	(2.97)	(2.29)
Pseudo R^2	0.01	0.13	0.35	0.02	0.38	0.20	0.56	0.08	0.01	0.02	0.07	0.78	0.35

Panel B: January 2014

Model	1	2	3	4	5	6	7	8	9	10	11	12	13
ΔCoVaR	16.46	-	-	-	13.17	-	-	-	-	-	-	-	-
	(0.40)				(0.23)								
MES	-	-60.27	-	-	-24.82	-	-	-	-	-	-	-	-
		(0.19)			(0.23)								
SRISK	-	-	0.06 ***	-	0.05 ***	-	-	-	-	-	-	-	-
			(8.57)		(7.02)								
GrangerOut	-	-	-	-0.11*	-0.12*	-	-	-	-	-	-	-	-
				(3.46)	(3.54)								

Size	-	-	-	-	-	1.30 ***	-	-	-	-	-	-0.58	1.59 ***
						(21.90)						(0.48)	(19.74)
Debt	-	-	-	-	-	-	1.67 ***	-	-	-	-	2.84 ***	-
							(30.79)					(11.06)	
Leverage	-	-	-	-	-	-	-	0.54 ***	-	-	-	0.37	0.52 ***
								(7.18)				(0.46)	(12.14)
Book	-	-	-	-	-	-	-	-	-2.65	-	-	-14.92 ***	-
									(1.84)			(9.80)	
Return	-	-	-	-	-	-	-	-	-	0.29	-	0.67	0.85
										(0.52)		(1.10)	(2.40)
Correlation	-	-	-	-	-	-	-	-	-	-	6.41 ***	0.07	6.00**
											(6.94)	(0.00)	(5.39)
Pseudo R^2	0.00	0.02	0.09	0.07	0.16	0.24	0.55	0.10	0.02	0.00	0.10	0.75	0.43

Table 10: Logistic regression results, based on the full sample (n = 470), for January 2013 and January 2014. The dependent variable is SII in all models, indicating whether a company is designated as systemically important. Wald statistics are shown in brackets. ***, ** and * indicate a 1%, 5% and 10% significance level. Results regarding the constant are omitted.

Sophisticated systemic risk measures cannot explain, ex post, which companies are designated to be systemically important, as illustrated in Panel B of Table 10. *ΔCoVaR* and *MES* are not significant in any model (model one, two and five). *GrangerOut* is significant at 5% and 10% levels in models four and five, respectively, but the algebraic signs of the coefficients are negative. This implies that the companies are systemically contributing to systemic risk, which are deemed by *Granger-Causality Networks* not to be systemically relevant.

Lastly, *SRISK* is significant at a 1% level in models three and five. However, this cannot be interpreted as evidence for the suitability of *SRISK*, since the pseudo R^2 statistics of models three and five are very low (0.09 and 0.16). These results are in contrast to the ones of the first approach in Table 8 (Panel C), since, in the first approach, *SRISK* seems to be suitable for the ex post perspective.

Considering the simple systemic risk measures in Panel C of Table 10, the results reveal that *Size* (model six), *Debt* (model seven), *Leverage* (model eight) and *Correlation* (model ten) all have significant explanatory power at a 1% level. However, taking several simple systemic risk measures together into account leads to similar results, as presented in Panel A of Table 10.

In all models in which *Debt* is included, the variable is strongly significant and the pseudo R^2 statistics are high (0.55 in model seven and 0.75 in model twelve). Models without *Debt* have much lower pseudo R^2 results and other variables are only significant in certain model specifications. For example, *Correlation* is significant at a 1% and 5% level in models eleven and thirteen, respectively, but not significant in model twelve. In contrast to the first approach (Panel C of Table 8) where, ex post, sophisticated risk measures had comparable explanatory power as simple systemic risk measures, the results at hand show that *Debt* has clearly the most explanatory power.

I again perform a robustness test for a subsample of only financial services companies. Table 17 in the Appendix illustrates the results which are for January 2013 (Panel A) and January 2014 (Panel B). The subsample size is 82. This time, the results for the full sample are only partially supported. For financial services companies, ex ante, sophisticated systemic risk measures are found to have much more explanatory power. *SRISK* is significant at a 1% level in all relevant models and the pseudo R^2 statistics are high, with 0.56 (model three) and 0.61 (model five). Regarding the simple systemic risk measures, ex ante, a combined model of all variables still has the highest pseudo R^2 figure with 0.80 (model twelve), but, in this model, no variable is significant.

For the ex post perspective in Panel B, the same pattern can be found. *SRISK* is significant at a 1% level in models three and five. Furthermore, the pseudo R^2 figures of these models are rather high, with 0.30 and 0.43. In contrast, the variable *Debt* is only significant in model seven at a 1% level, but the highest pseudo R^2 figure is still achieved by a combined simple systemic measures model with 0.82.

All in all, the results for the sophisticated systemic risk measures are much better for the subsample, than in the case of the full sample. This is not astonishing, since the measures have been developed mainly with the banking industry in mind, and therefore, are calibrated to deliver the best results in the case of banks. Other industries were not considered in the development, even though non-financial companies can also contribute to systemic risk.

3.3 Discussion

The results suggest that *ΔCoVaR* is not able to correctly identify institutions which contribute to systemic risk ex ante or ex post, neither at the moment, nor during the financial crisis. Besides its popularity, this result could be expected, since major shortcomings of this sophisticated risk measure are already pointed out in the literature. For example, Benoit et al. (2013) illustrate that an institution's *ΔCoVaR* is proportional to its Value at Risk, and therefore, an institution's contribution to systemic risk is seen in isolation from the system. In addition, Löffler and Raupach (2013) dispute the usefulness of *ΔCoVaR*, since an increase of an institution's idiosyncratic risk decreases its contribution to systemic risk, according to the risk measure.

For *MES* the results are nearly as poor as for *ΔCoVaR*. Only from the ex ante perspective of 2013 does it seem to correctly identify institutions which contribute to systemic risk. However, these results could be driven by the fact that some institutions have been already labeled as systemically relevant in 2012, and therefore, their share prices dropped substantially at the announcement date. My findings are in line with Idier et al. (2013, p. 18), who analyze whether *MES* would have been suitable, in advance, to identify the banks impaired the most by the financial crisis. According to their analysis, *MES* is not. They "thus strongly doubt that the *MES* can really help regulators identify systematically important banks on the eve of a future severe systemic crisis."

According to Benoit et al. (2013), *SRISK* is a compromise of the too-big-to-fail and the too-interconnected-to-fail paradigm. The "interconnectedness" is considered via *MES* and its proportionality to its firm beta. At the same time, "size" is considered by the equity and debt levels of a company. However, this promising approach is only partially supported by my results. On the one hand, most of the time, *SRISK* can correctly identify the institutions which contribute to systemic risk. Out of 32 models which include *SRISK* as an independent variable, in 22 models, *SRISK* is significant and the models have at least a decent fit. On the other hand, in six models, *SRISK* is not significant, and what is much more important, in two models, it is misleading. In addition, the question remains if the results are mainly driven by one of the constituents of *SRISK* – equity, debt and *MES* – or indeed are the outcome of the composition.

The last sophisticated systemic risk measure I evaluate is the *Granger-Causality Network*. In general, the key statement of Billio et al. (2012) is supported by my analyses: the overall interconnectedness in the market is increasing during the financial crisis. In January 2007, there are 10'911 (4.91% of all possible connections) Granger-causality connections between the S&P 500 companies; in January 2008, there are 12'503 (5.62%); and in January 2009, there are 22'225 (10.00%) connections. The results about whether the Granger-causality relationships can successfully indicate the companies which contribute to systemic risk are mixed. Out of the 32 models, *GrangerOut* is significant in twelve models; in 16, it is not significant, and in four, it is misleading (significant, but with a negative algebraic sign).

The robustness tests show that the results are generally the same for financial services institutions. Only in the case of the second approach, do the sophisticated systemic risk measures fare better for the subsample (only financial services companies) than for the full sample (all companies). Therefore, one cannot argue that the sophisticated risk measures are suitable conditional on the limitation that they are only relevant for the context of financial institutions.

Regarding the simple systemic risk measures, three results are worth discussing. First, the size variables, *Size* and *Debt*, are most suitable for indicating companies contributing to systemic risk. This could be expected, since the size of an institution is considered by regulators in determining the contribution of an institution to systemic risk (see, for example, IAIS, 2013). It is interesting that the market capitalization of a company is not the best indicator, but the total debt level of a company is. One explanation could be that the severity of spillover effects (i.e., interconnections in extreme conditions between institutions), are primarily driven by counterparty credit risk and not by market risks (e.g., equity and interest rate risks). The volatility of stock prices is even high in normal times.[62] Therefore, extreme stock price movements are expected by the market and the financial system is robust towards them. In contrast, default rates are extremely low and the financial system never had to prove that it is stable, even when debt cannot be paid on a large scale.[63] This puts the results for *SRISK* into perspective. As Benoit et al. (2013) suggest, *SRISK* is highly correlated to leverage and total liabilities. The goodness of fit of the models, including *Debt*, always exceeds the *SRISK* models. Consequently, the explanatory power of *SRISK* might be simply driven by debt. However, total debt as reported in the balance sheets, as an indicator for systemic relevance, does have some shortcomings. For example, all off-balance sheet exposures are not considered.

62 E.g., between 1970 and 2005, the maximal loss within one week of the S&P 500 composite index was 22%.

63 E.g., according to Vazza and Kraemer (2013), the S&P investment-grade default rates between 1981 and 2012 never exceeded 0.42%.

Second, the results for the leverage variables (*Leverage* and *Book*) are very mixed. In models without the variable *Debt, Leverage* often has explanatory power. However, in models controlling for *Debt*, the explanatory power of *Leverage* is often not significant. Furthermore, *Book* has a negative algebraic sign in all models in which the variable is significant. This means that, on the one hand, leverage ratios are not very well suited to detect companies contributing to systemic risk and, on the other hand, low leverage ratios can be an indicator of systemic risk. These results are in sharp contrast to the majority view of regulators and academics who emphasize that leverage ratios are at least a good indicator for companies which are vulnerable to systemic risk (see, e.g., FSB, 2009; Baluch et al., 2011; Haldane, 2012; IAIS, 2013; Tasca et al., 2014). An explanation for this result could be that the vulnerability and the contribution to systemic risk are indeed two different concepts: an institution vulnerable to systemic risk needs not necessarily contribute to it and vice versa. For example, a very small, highly leveraged bank is intuitively not very robust towards adverse market situations. However, the leverage itself is not a good indicator, in this case, for a contribution to systemic risk, since the total debt level of the institution is small. Therefore, its impact on other institutions, in the case of a bankruptcy, is very limited. Another argument which can explain why the results for leverage variables are mixed is presented by Papanikolaou and Wolff (2014). After the financial crisis of 2008 financial services institutions had to deleverage and put asset prices under pressure. As a consequence the amount of available credit shrank and systemic risk in the overall market went up. Therefore, according to the literature, it is possible that not so much the leverage of institutions contributes to systemic risk but a sudden deleveraging.

Third, comparing the fit of the models combining the sophisticated systemic risk measures with models combining the simple measures illustrates that simple measures are more powerful. Consequently, simple systemic risk measures can be regarded as more suitable to detect companies contributing to systemic risk than sophisticated systemic risk measures. One has to keep in mind, though, that this result is primarily due to *Debt*; other simple measures do not fare much better as their sophisticated counterparts.

As mentioned in Section 1, two main assumptions are made. First, regulators successfully supported the institutions contributing most to systemic risk during the financial crisis in 2008, as well as designated correctly the *SIIs* in 2013. Second, the contribution to the systemic risk of a company is independent from the general state of the system. If the first assumption is violated, the results of this paper would suggest that the wrong institutions have been supported during the financial crisis, since the sophisticated risk measures and the decisions of regulators are obviously not in line. Consequently, billions of USD could have been wasted for institutions which did not need the financial support. The vice versa situation, that some institutions needed financial support and received none, is unlikely, since the financial system did not break down. If the second assumption is violated and the contribution of an institution to systemic risk is dependent on the state of the system, the usefulness of all current microprudential sophisticated risk measures has to be doubted, since none takes the state of the system into account.

4 Conclusion

In this paper, I empirically evaluate whether sophisticated risk measures or simple systemic risk measures are more suitable to detect institutions which contribute most to systemic risk. I use two approaches, which use different variables approximating the systemic relevance of an institution. In the first approach, I use information about which institutions received financial support during the financial crisis and what amount they received. In the second approach, the systemic relevance is approximated by the fact of whether or not an institution is currently regarded as systemically important by national or international supervisors. Finally, I regress the systemic relevance variables on the various sophisticated and simple systemic risk measures.

The results of the paper suggest that simple systemic risk measures are more suitable to detect institutions contributing to systemic risk than sophisticated ones. This finding holds true for an ex ante and ex post perspective, regarding the point in time when the dependent and independent variables are calculated.

In addition, this finding is valid for a broad sample of diverse companies (companies included in the S&P 500 composite index), as well as for a sample only considering financial institutions (all S&P 500 composite index companies labeled as banks, insurers, real estate or financial services companies).

In particular, the total amount of debt of a company is the strongest indicator for systemic relevance, followed by its market capitalization. Interestingly, the results for the leverage variables are rather mixed. *Leverage* seems not to have such a strong impact, as currently assumed (see, e.g., FSB, 2009).

Among the sophisticated systemic risk measures, the best results are achieved for *SRISK*. Most of the time, it can successfully indicate companies which received financial support during the financial crisis and companies which are regarded currently as contributing to systemic risk. However, in the case of explaining, ex ante, the amount of financial support each institution received in 2008, it is misleading. This is a meaningful finding, since *SRISK* combines market based information (via *MES* and market capitalization), as well as balance sheet information (debt), and shows that combining sophisticated and simple systemic risk measures might be a viable attempt to measure the systemic risk of institutions.

The results are of importance to academics and their choice of an adequate risk measure. Each sophisticated measure should at least have more explanatory power than the total amount of debt in determining companies contributing to systemic risk. Furthermore, the results can be of use for regulators assessing if an indicator based approach to identify systemically important institutions is sufficient or other measures should be considered as well. In my opinion, the regulatory discussion should focus more on the robustness of the financial system towards a systemic crisis, instead of focusing on institutions contributing to systemic risk. Labeling institutions as systemically relevant might create the false impression that regulators or academics are able to do so correctly, and therefore, might create a risk of its own.

Despite the vast number of studies on measuring systemic risk and the last financial crisis, there is still a need for further research. Firstly, in this paper, the assumption is made that during the financial crisis, financial support was given to the institutions which were contributing most to systemic risk. This assumption is commonly made, but it has not been evaluated yet whether it is true in all regards. More importantly, there is no discussion if the billions of dollars for the bailout programs were spent effectively and whether the institutions really needed the financial support for keeping the financial system stable. Secondly, sophisticated risk measures currently under discussion, try to achieve additivity (i.e., the sum of the systemic risk contributions of each company within a system equals the systemic risk of the system). However, it is not clear whether feedback effects can be ruled out. Maybe the state of the system influences the systemic risk contribution of an institution as well. Finally, as illustrated in this paper, and by the discussion in the literature about systemic risk measures, there is still no commonly acceptable measure, approach or framework which can properly determine systemic risk.

Appendix

Panel B: January 2008													
Model	1	2	3	4	5	6	7	8	9	10	11	12	13
ΔCoVaR	-39.49 *	-	-	-	13.29	-	-	-	-	-	-	-	-
	(3.80				(0.25)								
MES	-	-124.81 ***	-	-	-93.59 ***	-	-	-	-	-	-	-	-
		(47.02)			(17.42)								
SRISK	-	-	0.09 ***	-	0.05 ***	-	-	-	-	-	-	-	-
			(24.82)		(6.78)								
Granger Out	-	-	-	0.05	0.04 ***	-	-	-	-	-	-	-	-
				(28.57)	(11.31)								
Size	-	-	-	-	-	0.51 ***	-	-	-	-	-	-1.44 ***	0.81 ***
						(13.51)						(15.08)	(24.64)
Debt	-	-	-	-	-	-	1.26 ***	-	-	-	-	2.63 ***	-

							(54.29)					(44.59)	
Leverage	-	-	-	-	-	-	-	0.35 ***	-	-	-	-0.72	0.25 ***
								(14.66)				(0.36)	(8.55)
Book	-	-	-	-	-	-	-	-	0.01	-	-	-12.06 ***	-
									(0.00)			(27.35)	
Return	-	-	-	-	-	-	-	-	-	-1.86 ***	-	0.61	-2.37 **
										(11.63)		(0.76)	(9.34)
Correlation	-	-	-	-	-	-	-	-	-	-	2.11 **	1.91	1.36
											(4.76)	(1.40)	(1.48)
Pseudo R^2	0.02	0.26	0.22	0.13	0.38	0.06	0.46	0.14	0.00	0.06	0.02	0.67	0.28

Table 11: Logistic regression results, based on the full sample (n = 474) for January 2008. The dependent variable is *Support* in all of the models, indicating whether a company received financial support during the financial crisis. Wald statistics are shown in brackets. ***, ** and * indicate a 1%, 5% and 10% significance level. Results regarding the constants are omitted.

Panel B: January 2008													
Model	1	2	3	4	5	6	7	8	9	10	11	12	13
ΔCoVaR	-0.33 **	-	-	-	-0.33 **	-	-	-	-	-	-	-	-
	(-2.11)				(-2.15)								
MES	-	0.15	-	-	0.36 **	-	-	-	-	-	-	-	-
		(0.93)			(2.13)								
SRISK	-	-	0.03	-	0.13	-	-	-	-	-	-	-	-
			(0.17)		(0.73)								
GrangerOut	-	-	-	0.36 **	0.31 *	-	-	-	-	-	-	-	-
				(2.33)	(1.95)								
Size	-	-	-	-	-	0.66 ***	-	-	-	-	-	0.81 ***	-
						(5.20)						(5.95)	
Debt	-	-	-	-	-	-	0.61 ***	-	-	-	-	-	0.68 ***
							(4.54)						(4.30)
Leverage	-	-	-	-	-	-	-	0.13	-	-	-	0.10	-0.22
								(0.79)				(0.67)	(-1.27)
Book	-	-	-	-	-	-	-	-	0.26	-	-	-	-

									(1.61)				
Return	-	-	-	-	-	-	-	-	-	-0.13	-	-0.36 **	-0.11
										(-0.77)		(-2.53)	(-0.69)
Correlation	-	-	-	-	-	-	-	-	-	-	0.25	-0.12	0.03
											(1.52)	(-0.86)	(0.20)
Adjusted R^2	0.09	0.00	-0.03	0.11	0.22	0.41	0.35	-0.01	0.04	-0.01	0.03	0.50	0.33

Table 12: Least square regression results for January 2008. The sample (n = 37) only includes institutions which received financial support. The dependent variable is *Amount* in all models, indicating the amount of support a certain company received during the financial crisis. T-statistics are shown in brackets. ***, ** and * indicate a 1%, 5% and 10% significance level. Results regarding the constants are omitted.

Panel A: January 2007													
Model	1	2	3	4	5	6	7	8	9	10	11	12	13
ΔCoVaR	-0.54	-	-	-	-31.52	-	-	-	-	-	-	-	-
	(1.36)				(0.75)								
MES	-	7.74	-	-	19.19	-	-	-	-	-	-	-	-
		(0.03)			(0.11)								
SRISK	-	-	-0.02	-	-0.01	-	-	-	-	-	-	-	-
			(1.01)		(0.45)								
Granger Out	-	-	-	0.03	0.03	-	-	-	-	-	-	-	-
				(2.55)	(2.35)								
Size	-	-	-	-	-	0.85 ***	-	-	-	-	-	-1.66 **	0.83 **
						(8.46)						(5.68)	(6.03)
Debt	-	-	-	-	-	-	0.68 ***	-	-	-	-	2.06 ***	-
							(15.54)					(16.57)	
Leverage	-	-	-	-	-	-	-	0.24	-	-	-	-0.33	0.10
								(2.33)				(1.50)	(0.42)
Book	-	-	-	-	-	-	-	-	-0.41	-	-	-6.33 ***	-

									(0.15)			(7.12)	
Return	-	-	-	-	-	-	-	-	-	0.88	-	1.30	0.81
										(0.66)		(0.69)	(0.48)
Correlation	-	-	-	-	-	-	-	-	-	-	-4.12 ***	-2.46	-4.47 ***
											(7.13)	(1.59)	(6.87)
Pseudo R^2	0.01	0.00	0.02	0.05	0.07	0.15	0.33	0.05	0.00	0.01	0.13	0.59	0.27
Panel C: January 2009													
Model	1	2	3	4	5	6	7	8	9	10	11	12	13
ΔCoVaR	-11.66	-	-	-	-24.71	-	-	-	-	-	-	-	-
	(0.28)				(0.70)								
MES	-	-8.89	-	-	-5.51	-	-	-	-	-	-	-	-
		(2.48)			(0.31)								
SRISK	-	-	0.06 ***	-	0.06 **	-	-	-	-	-	-	-	-
			(7.00)		(5.01)								
GrangerOut	-	-	-	0.00	0.00	-	-	-	-	-	-	-	-
				(1.30)	(0.34)								
Size	-	-	-	-	-	0.43 **	-	-	-	-	-	-0.62	1.48 ***

						(4.92)						(0.87)	(12.24)
Debt	-	-	-	-	-	-	1.01***	-	-	-	-	2.77***	-
							(16.02)					(12.90)	
Leverage	-	-	-	-	-	-	-	-0.00	-	-	-	-0.01	-0.00
								(0.37)				(0.12)	(0.36)
Book	-	-	-	-	-	-	-	-	-1.02	-	-	-10.47***	-
									(1.01)			(7.91)	
Return	-	-	-	-	-	-	-	-	-	-0.78	-	0.02	-7.11***
										(0.85)		(0.00)	(11.16)
Correlation	-	-	-	-	-	-	-	-	-	-	-2.64**	-3.42	-7.71***
											(6.40)	(1.56)	(10.03)
Pseudo R^2	0.01	0.04	0.29	0.02	0.31	0.09	0.47	0.01	0.02	0.01	0.11	0.80	0.48

Table 13: Logistic regression results, based on the subsample (n = 84) of financial services companies for January 2007 and January 2009. The dependent variable is *Support* in all models, indicating whether a company received financial support during the financial crisis. Wald statistics are shown in brackets. ***, ** and * indicate a 1%, 5% and 10% significance level. Results regarding the constants are omitted.

Panel A: January 2007													
Model	1	2	3	4	5	6	7	8	9	10	11	12	13
ΔCoVaR	-0.36 **	-	-	-	-0.19	-	-	-	-	-	-	-	-
	(-2.26)				(-1.50)								
MES	-	-0.23	-	-	-0.44 ***	-	-	-	-	-	-	-	-
		(-1.37)			(-3.27)								
SRISK	-	-	-0.62 ***	-	-0.84 ***	-	-	-	-	-	-	-	-
			(-4.62)		(-7.44)								
Granger Out	-	-	-	-0.01	-0.08	-	-	-	-	-	-	-	-
				(-0.03)	(-0.80)								
Size	-	-	-	-	-	0.70 ***	-	-	-	-	-	0.70 ***	-
						(5.63)						(5.32)	
Debt	-	-	-	-	-	-	0.62 ***	-	-	-	-	-	0.82 ***
							(4.58)						(4.64)
Leverage	-	-	-	-	-	-	-	0.21	-	-	-	0.06	-0.30

								(1.25)				(0.45)	(-1.68)
Book	-	-	-	-	-	-	-	-	0.23	-	-	-	-
									(1.36)				
Return	-	-	-	-	-	-	-	-	-	-0.07	-	-0.12	-0.05
										(-0.43)		(-0.94)	(-0.35)
Correlation	-	-	-	-	-	-	-	-	-	-	-0.01	-0.12	-0.03
											(-0.03)	(-0.89)	(-0.19)
Adjusted R^2	0.11	0.02	0.37	-0.03	0.65	0.47	0.36	0.02	0.02	-0.02	-0.03	0.44	0.37
Panel C: January 2009													
Model	1	2	3	4	5	6	7	8	9	10	11	12	13
ΔCoVaR	-0.10	-	-	-	-0.14	-	-	-	-	-	-	-	-
	(-0.57)				(-1.39)								
MES	-	-0.31*	-	-	-0.14	-	-	-	-	-	-	-	-
		(-1.87)			(-1.35)								
SRISK	-	-	0.76***	-	0.71***	-	-	-	-	-	-	-	-
			(6.49)		(7.00)								
Granger Out	-	-	-	0.39**	0.34***	-	-	-	-	-	-	-	-
				(2.43)	(3.36)								

Size	-	-	-	-	-	0.30*	-	-	-	-	-	0.73 ***	-
						(1.80)						(4.95)	
Debt	-	-	-	-	-	-	0.66 ***	-	-	-	-	-	0.70 ***
							(4.85)						(4.82)
Leverage	-	-	-	-	-	-	-	0.52 ***	-	-	-	0.49 ***	0.09
								(3.33)				(3.69)	(0.59)
Book	-	-	-	-	-	-	-	-	0.21	-	-	-	-
									(1.19)				
Return	-	-	-	-	-	-	-	-	-	-0.36 **	-	-0.55 ***	-0.43 **
										(-2.27)		(-3.36)	(2.72)
Correlation	-	-	-	-	-	-	-	-	-	-	0.23	-0.33**	-0.22
											(1.38)	(2.20)	(-1.56)
Adjusted R^2	-0.02	0.07	0.56	0.12	0.69	0.06	0.42	0.25	0.13	0.11	0.03	0.57	0.57

Table 14: Least square regression results, based on a subsample (n = 35) of financial services companies for January 2007 and January 2009.The sample only includes institutions which received financial support. The dependent variable is Amount in all models, indicating the amount of support a certain company received during the financial crisis.

Panel B: January 2008													
Model	1	2	3	4	5	6	7	8	9	10	11	12	13
ΔCoVaR	-5.18	-	-	-	23.08	-	-	-	-	-	-	-	-
	(0.03)				(0.32)								
MES	-	-25.67	-	-	35.59	-	-	-	-	-	-	-	-
		(1.61)			(1.22)								
SRISK	-	-	0.04 **	-	0.05 **	-	-	-	-	-	-	-	-
			(5.87)		(4.48)								
Granger Out	-	-	-	0.06 ***	0.06 ***	-	-	-	-	-	-	-	-
				(12.22)	(9.77)								
Size	-	-	-	-	-	0.68 ***	-	-	-	-	-	-1.01	1.18 ***
						(7.29)						(2.43)	(11.34)
Debt	-	-	-	-	-	-	0.65 ***	-	-	-	-	1.67 ***	-
							(15.40)					(14.38)	
Leverage	-	-	-	-	-	-	-	0.04	-	-	-	-0.19*	-0.00
								(0.53)				(2.82)	(0.00)
Book	-	-	-	-	-	-	-	-	-0.53	-	-	-3.64*	-

									(0.26)			(3.06)	
Return	-	-	-	-	-	-	-	-	-	-0.36	-	2.00	-2.64 **
										(0.27)		(1.17)	(5.27)
Correlation	-	-	-	-	-	-	-	-	-	-	-2.61*	-3.46	-4.96 **
											(2.91)	(1.85)	(5.96)
Pseudo R2	0.00	0.03	0.14	0.23	0.33	0.13	0.33	0.01	0.00	0.00	0.05	0.55	0.28

Table 15: Logistic regression results, based on a subsample (n = 84) of financial services companies for January 2008. The dependent variable is *Support* in all models, indicating whether a company received financial support during the financial crisis. Wald statistics are shown in brackets. ***, ** and * indicate a 1%, 5% and 10% significance level. Results regarding the constants are omitted.

Panel B: January 2008													
Model	1	2	3	4	5	6	7	8	9	10	11	12	13
ΔCoVaR	-0.25	-	-	-	-0.02	-	-	-	-	-	-	-	-
	(1.52)				(-0.14)								
MES	-	0.07	-	-	0.27*	-	-	-	-	-	-	-	-
		(0.40)			(1.86)								
SRISK	-	-	0.51 ***	-	0.50 ***	-	-	-	-	-	-	-	-
			(3.39)		(3.27)								
GrangerOut	-	-	-	0.46 ***	0.35 **	-	-	-	-	-	-	-	-
				(3.02)	(2.50)								
Size	-	-	-	-	-	0.62 ***	-	-	-	-	-	0.79 ***	-
						(4.58)						(5.24)	
Debt	-	-	-	-	-	-	0.58 ***	-	-	-	-	-	0.63 ***
							(4.05)						(3.69)
Leverage	-	-	-	-	-	-	-	0.16	-	-	-	0.10	-0.20
								(0.91)				(0.64)	(-1.07)
Book	-	-	-	-	-	-	-	-	0.20	-	-	-	-

									(1.14)				
Return	-	-	-	-	-	-	-	-	-	-0.15	-	-0.41 **	-0.10
										(-0.85)		(-2.45)	(-0.56)
Correlation	-	-	-	-	-	-	-	-	-	-	0.27	-0.17	0.05
											(1.61)	(-1.02)	(0.25)
Adjusted R^2	0.04	-0.03	0.24	0.19	0.38	0.36	0.31	-0.01	0.01	-0.01	0.04	0.45	0.27

Table 16: Least square regression results, based on a subsample (n = 35) of financial services companies for January 2008.The sample only includes institutions which received financial support. The dependent variable is *Amount* in all models, indicating the amount of support a certain company received during the financial crisis. T-statistics are shown in brackets. ***, ** and * indicate a 1%, 5% and 10% significance level. Results regarding the constants are omitted.

Panel A: January 2013													
Model	1	2	3	4	5	6	7	8	9	10	11	12	13
ΔCoVaR	5.72	-	-	-	45.01	-	-	-	-	-	-	-	-
	(0.05)				(0.83)								
MES	-	-148.38 ***	-	-	51.60	-	-	-	-	-	-	-	-
		(9.17)			(0.31)								
SRISK	-	-	0.12 ***	-	0.14 **	-	-	-	-	-	-	-	-
			(10.20)		(6.41)								
Granger Out	-	-	-	-0.09	-0.08	-	-	-	-	-	-	-	-
				(2.29)	(0.77)								
Size	-	-	-	-	-	1.94 ***	-	-	-	-	-	1.32	2.45 ***
						(14.16)						(0.56)	(11.31)
Debt	-	-	-	-	-	-	1.17 ***	-	-	-	-	1.70	-
							(15.52)					(2.10)	
Leverage	-	-	-	-	-	-	-	0.12	-	-	-	1.17	0.19 *
								(1.91)				(1.49)	(3.21)

Book	-	-	-	-	-	-	-	-	-1.87	-	-	-33.77	-
									(1.24)			(2.38)	
Return	-	-	-	-	-	-	-	-	-	1.37	-	-5.64	-3.79
Correlation	-	-	-	-	-	-	-	-	-	-	6.22 *	14.42	4.81
											(3.32)	(2.03)	(1.61)
Pseudo R2	0.00	0.21	0.56	0.14	0.61	0.45	0.51	0.04	0.03	0.02	0.08	0.80	0.53
Panel B: January 2014													
Model	1	2	3	4	5	6	7	8	9	10	11	12	13
ΔCoVaR	5.48	-	-	-	3.56	-	-	-	-	-	-	-	-
	(0.04)				(0.01)								
MES	-	-77.24	-	-	19.99	-	-	-	-	-	-	-	-
		(1.48)			(0.03)								
SRISK	-	-	0.08 ***	-	0.07 ***	-	-	-	-	-	-	-	-
			(10.75)		(6.77)								
Granger Out	-	-	-	-0.15 **	-0.15 *	-	-	-	-	-	-	-	-
				(5.19)	(3.45)								
Size	-	-	-	-	-	2.10 ***	-	-	-	-	-	2.09	2.12 ***

						(15.21)						(1.42)	(14.56)
Debt	-	-	-	-	-	-	1.19 ***	-	-	-	-	1.732	-
							(15.66)					(2.11)	
Leverage	-	-	-	-	-	-	-	0.22	-	-	-	5.48 **	0.26
								(2.37)				(3.88)	(2.43)
Book	-	-	-	-	-	-	-	-	-1.92	-	-	-84.02 **	-
									(1.23)			(4.21)	
Return	-	-	-	-	-	-	-	-	-	0.95	-	-1.07	1.53
										(0.93)		(0.15)	(1.14)
Correlation	-	-	-	-	-	-	-	-	-	-	1.50	-11.23	0.86
											(0.49)	(1.64)	(0.12)
Pseudo R2	0.00	0.03	0.30	0.23	0.43	0.50	0.51	0.05	0.03	0.02	0.01	0.82	0.54

Table 17: Logistic regression results, based on a subsample (n = 82) of financial services companies for January 2013. The dependent variable is *SII* in all models, indicating whether a company is designated as systemically important. Wald statistics are shown in brackets. ***, ** and * indicate a 1%, 5% and 10% significance level. Results regarding the constants are omitted.

Dependent Variable:	**Support**						**Amount**						**SII**			
Model	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Date	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009	2013	2014	2013	2014
Panel A:																
ΔCoVaR5%	-211.98 ***	-206.85 ***	-78.75 **	-	-	-	-0.21	-0.21	-0.24	-	-	-	23.63	12.00	-	-
	(25.30)	(22.35)	(4.69)				(-1.26)	(-1.27)	(-1.45)				(0.21)	(0.05)		
ΔCoVaR10%	-	-	-	-448.78 ***	-467.40 ***	-227.90 ***	-	-	-	-0.16	-0.22	-0.26	-	-	12.29	23.77
				(37.05)	(33.89)	(11.35)				(-0.99)	(-1.34)	(-1.61)			(0.03)	-0.09
Pseudo R2	0.13	0.12	0.02	0.22	0.20	0.06	-	-	-	-	-	-	0.00	0.00	0.00	0.00
Adjusted R2	-	-	-	-	-	-	0.02	0.02	0.03	0.00	0.02	0.04	-	-	-	-
Sample Size	472	471	472	472	471	472	37	36	37	37	36	37	470	470	470	470
Panel B:																
MES1%	-21.96	-110.06 ***	-24.39 ***	-	-	-	-0.16	0.04	0.04	-	-	-	-81.74 ***	5.00	-	-
	(1.56)	(46.01)	(43.48)				(-0.96)	(0.24)	(0.26)				(14.40)	(0.03)		
MES10%	-	-	-	28.99	-133.07 ***	-46.83 ***	-	-	-	-0.04	0.07	-0.28 *	-	-	-177.49 ***	-129.33 **
				(1.03)	(32.56)	(42.74)				(-0.21)	(0.44)	(-1.73)			(14.44)	(4.54)
Pseudo R2	0.01	0.28	0.27	0.01	0.17	0.22	-	-	-	-	-	-	0.14	0.00	0.14	0.04

Dependent Variable:	**Support**						**Amount**						**SII**			
Adjusted R2	-	-	-	-	-	-	0.00	-0.03	-0.03	-0.03	-0.02	0.05	-	-	-	-
Sample Size	472	472	472	472	472	472	37	37	37	37	37	37	470	470	470	470
Panel C:																
SRISK1%	0.01	0.11 ***	0.55 ***	-	-	-	-0.51 ***	0.16	0.70 ***	-	-	-	0.12 ***	0.08 ***	-	-
	(1.20)	(26.72)	(43.56)				(-3.57)	(0.95)	(5.63)	-0.62 ***			(20.27)	(18.14)		
SRISK10%	-		-	0.00	0.07 ***	0.58 ***	-	-	-	(-4.76)	-0.05	0.69 ***	-		0.09 ***	0.04 ***
				(0.02)	(22.00)	(39.22)					(-0.29)	(5.48)			(19.85)	(3.31)
Pseudo R2	0.01	0.27	0.68	0.00	0.16	0.65	-	-	-	-	-	-	0.45	0.18	0.31	0.05
Adjusted R2	-	-	-	-	-	-	0.24	0.00	0.47	0.37	-0.03	0.46	-	-	-	
Sample Size	472	472	472	472	472	472	37	36	34	37	36	34	470	470	470	470
Panel D:																
Granger Out1%	0.06*	0.12 ***	0.02 ***	-	-	-	0.14	0.33 **	0.45 ***	-	-	-	-0.18	-0.51*	-	-
	(3.46)	(23.58)	(17.05)				(0.85)	(2.06)	(3.01)				(1.21)	(3.65)		
Granger Out10%	-	-	-	0.01 *	0.04 ***	0.01 ***	-	-		0.01	0.34 **	0.33 **	-		-0.02	-0.06 *
				(3.35)	(29.60)	(15.86)				(0.08)	(2.14)	(2.07)			(1.52)	(3.76)

Dependent Variable:	Support						Amount						SII			
Pseudo R2	0.01	0.10	0.08	0.01	0.13	0.07	-	-	-	-	-	-	0.02	0.07	0.03	0.07
Adjusted R2	-	-	-	-	-	-	-0.01	0.08	0.18	-0.03	0.09	0.08	-	-	-	-
Sample Size	472	472	472	472	472	472	37	37	37	37	37	37	470	470	470	470

Table 18: Robustness tests for sophisticated systemic risk measures (partial models). Panel A refers to ΔCoVaR whereas ΔCoVaR5% takes into account the 5% quantil and ΔCoVaR10% the 10% quantil. Panel B refers to the Marginal Expected Shortfall whereas MES1% and MES10% focus on the 1% respectively 10% days with the most negative stock market returns within the last year. Panel C refers to SRISK using MES1% and MES10%. Finally, Panel D shows the results for GrangerOut. GrangerOut1% and GrangerOut10% consider Granger-causality relationships at a significance level of 1% and 10%. In the cases of the dependent variables Support and SII, logistic regression models are used. Models regarding the dependent variable Amount employ least square regressions. Wald statistics are shown in brackets for models one to six and thirteen to sixteen. In models seven to twelve t-statistics are displayed instead. ***, ** and * indicate a 1%, 5% and 10% significance level. Results regarding the constants are omitted.

Dependent Variable:	**Support**						**Amount**						**SII**			
Model	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Date	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009	2013	2014	2013	2014
$\Delta CoVaR_{5\%}$	-226.62 ***	-105.53 **	-17.96	-	-	-	-0.15	-0.21	-0.28 ***	-	-	-	74.70	30.55	-	-
	(25.79)	(4.04)	(0.09)				(-1.04)	(-1.24)	(-2.82)				(1.31)	(0.25)		
$\Delta CoVaR_{10\%}$	-	-	-	-523.36 ***	-367.02 ***	-206.41 *	-	-	-	-0.02	-0.19	-0.25 **	-	-	52.36	65.48
				(41.28)	(16.62)	(3.54)				(-0.14)	(-1.14)	(-2.12)			(0.32)	(0.65)
$MES_{1\%}$	10.18	-67.57 ***	2.52	-	-	-	-0.22	0.13	0.12	-	-	-	-17.95	23.99	-	-
	(0.26)	(14.88)	(0.17)				(-1.53)	(0.72)	(1.25)				(0.31)	(0.59)		
$MES_{10\%}$	-	-	-	124.60 ***	-59.94 **	13.36	-	-	-	-0.23	0.15	-0.03	-	-	-91.23	-116.99 *
				(8.98)	(4.50)	(1.33)				(-1.61)	(0.77)	(-0.25)			(2.47)	(3.19)
$SRISK_{1\%}$	0.01	0.06 ***	0.57 ***	-	-	-	-0.50 ***	0.13	0.64 ***	-	-	-	0.11 ***	0.08 ***	-	-
	(0.45)	(9.24)	(28.99)				(-3.45)	(0.72)	(6.61)				(15.55)	(14.25)		
$SRISK_{10\%}$	-	-	-	0.00	0.04**	0.62 ***	-	-	-	-0.69 ***	-0.06	0.65 ***	-	-	0.07 ***	0.03

Dependent Variable:	**Support**						**Amount**						**SII**			
				(0.19)	(5.61)	(34.72)				(-4.91)	(-0.33)	(5.43)			(11.96)	(1.86)
Granger $Out_{1\%}$	0.09 **	0.09 ***	0.02 **	-	-	-	0.17	0.25	0.43 ***	-	-	-	-0.12	-0.39	-	-
	(6.19)	(9.53)	(6.36)		0.03***		(1.17)	(1.39)	(4.36)				(0.38)	(2.25)		
Granger $Out_{10\%}$		-	-	0.02*	(18.72)	0.01	-	-	-	0.00	0.32*	0.32 ***	-	-	-0.02	-0.07 **
				(2.91)		(2.61)				(-0.02)	(1.81)	(2.77)			(1.16)	(4.50)
Pseudo R^2	0.16	0.42	0.70	0.27	0.38	0.68	-	-	-	-	-	-	0.47	0.23	0.35	0.15
Adjusted R^2	-	-	-	-	-	-	0.26	0.05	0.68	0.37	0.07	0.57	-	-	-	-
Sample Size	472	471	472	472	471	472	37	35	34	37	35	34	470	470	470	470

Table 19: Robustness tests for sophisticated systemic risk measures (full models). $\Delta CoVaR_{5\%}$ takes into account the 5% quantil and $\Delta CoVaR_{10\%}$ the 10% quantil. $MES_{1\%}$ and $MES_{10\%}$ focus on the 1% respectively 10% days with the most negative stock market returns within the last year. $SRISK_{1\%}$ and $SRISK_{10\%}$ indicate that for the calculation of *SRISK*, $MES_{1\%}$ and $MES_{10\%}$ are used. $GrangerOut_{1\%}$ and $GrangerOut_{10\%}$ consider granger-causality relationships at a significance level of 1% and 10%. In the cases of the dependent variables *Support* and *SII*, logistic regression models are used. Models regarding the dependent variable *Amount* employ least square regressions. Wald statistics are shown in brackets for models one to six and thirteen to sixteen. In models seven to twelve t-statistics are displayed instead. ***, ** and * indicate a 1%, 5% and 10% significance level. Results regarding the constants are omitted.

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III Basis Risk, Procyclicality, and Systemic Risk in the Solvency II Equity Risk Module[64]

This paper analyzes the equity risk module of Solvency II, the new regulatory framework for insurance companies in the European Union. The equity risk module contains a symmetric adjustment mechanism called equity dampener that is meant to reduce procyclicality of capital requirements and thus systemic risk in the insurance sector. We critique the equity risk module in three steps: we first analyze the sensitivities of the equity risk module with respect to the underlying technical basis, then work out potential basis risk (i.e., deviations of insurers' actual equity risk from the Solvency II equity risk), and—based on these results—measure the impact of the symmetric adjustment mechanism on the goals of Solvency II. The equity risk module is backward-looking in nature and a substantial degree of basis risk exists if realistic equity portfolios are considered. Both of these aspects underline the importance of the own risk and solvency assessment (ORSA) under Solvency II. Moreover, we show that the equity dampener leads to substantial deviations from the proposed 99.5% confidence level and thereby reduces procyclicality of capital requirements. Our results are of interest to academics who study regulation and risk management and of practical relevance to practitioners and regulators working on the implementation of such models.

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1 Purpose and Motivation

In light of the ongoing financial crisis, the scope and structure of insurance regulation is the subject of intense discussion, both in academia and practice. Regulators around the world are revising their regulatory frameworks, including in the United States (Federal Insurance Office (FIO), 2014), the European Union (Eling et al., 2007), and Switzerland (Filipović and Vogelpoth, 2008). A new and important issue on the regulatory agenda is whether the insurance industry poses systemic risk and, if so, how regulation might mitigate undesired outcomes arising from such risk (Klein, 2011; Cummins and Weiss, 2011; Harrington, 2009; Harrington and Miller, 2011; Grace, 2011).

This paper contributes to the insurance regulation discussion by focusing on the equity risk module of Solvency II. The module consists of capital requirements for equity based on a standard capital stress scenario, which is the 0.5% quantile of past returns and an additional adjustment term to counteract systemic risk (CEIOPS, 2010a)[65]. The adjustment term is intended as a mechanism that can either tighten or relax capital requirements depending on the market environment. Due to the "one-size-fits-all" approach of the standard formula, it is likely that the capital requirements for equity will not precisely match insurers' risk. Neither this potential deviation nor the proposed mechanisms for counteracting systemic risk have been the subject of academic insurance research to date.

The design of Solvency II has been the subject of a fair amount of research during the past few years, with the insurer's option to choose between a regulatory standard model and an internal risk model, one of the features that has attracted much attention. Liebwein (2006) and Albarrán et al. (2011), as well as Gatzert and Martin (2012), argue that companies should use internal risk models since these will better reflect the company's actual risk than will the

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65 In 2011, CEIOPS (Committee of European Insurance and Occupational Pensions Supervisors) was renamed EIOPA (European Insurance and Occupational Pensions Authority).

standard formula.[66] Christiansen et al. (2012) review the aggregation formula used to sum up the capital requirements for different risk classes and find that the aggregation formula is theoretically supportable, but that the underlying correlation matrix is highly questionable.[67] Pfeifer and Strassburger (2008) show that if the individual risks are skewed, then the solvency capital requirements can be largely under- or overestimated. According to Savelli and Clemente (2011), the proposed aggregation formula produces correct results for only a restricted class of independent distributions and can lead to an underestimation of the diversification effect. As an alternative, the authors propose using copula functions to model the dependencies of distributions and thus derive more appropriate capital requirements. Van Laere and Baesens (2010) discuss the calculation of the capital requirements for credit risk and suggest an approach similar to that used by Basel II to predict credit ratings for nonrated companies. Mittnik (2011) analyzes the calibration of the equity risk module and points out flaws in the return definition based on a rolling window of daily measured annual returns. Braun et al. (2013) show that private equity investments are overly penalized by the standard formula for equity risk.

Some authors claim that regulation can increase systemic risk (see, with regard to Solvency II, Keller, 2011; Huerta de Soto, 2009; more generally, see Vaughan, 2009), which is the motivation behind introducing an additional adjustment term in the equity risk module. A frequently heard argument in support of the adjustment term is that in the event of an economic downturn or a stock market crash, risk-based capital standards might force insurers to sell risky assets, which could cause a run in the market and thus intensify the crisis (Eling et al., 2007). In the case of Basel II, this possibility has been analyzed; however, to our knowledge, Solvency II's symmetric adjustment feature of its equity risk module has not been analyzed in the academic literature.

The goal of this paper is to thoroughly analyze the equity risk module of Solvency II in three steps. We first analyze the sensitivities of the equity risk

[66] Our paper contributes to this discussion by empirically showing the differences between the actual risk and the standard model risk for the equity risk module of Solvency II.

[67] Our results also contribute to this discussion in that we empirically analyze the time-varying nature of the correlations between asset classes considered in the equity risk module.

module based on the empirical data used to calibrate the model. Then, we consider more realistic insurance company investment portfolios in order to identify potential basis risk in the Solvency II model. For our context, we define basis risk as the risk that the Solvency II risk measure deviates from the insurance company's actual risk due to the simplified portfolio construction used in the standard formula. Finally, we analyze whether the symmetric adjustment mechanism reduces procyclicality of capital requirements.

We are interested in whether the proposed mechanisms of Solvency II further its stated goals, which are the protection of policyholders and financial stability.[68] To this end, we empirically backtest the equity risk module. Our work contributes to the academic discussion on the optimal design of insurance regulation and will also aid practitioners in their efforts to develop a framework for a safe and sound insurance industry. Table 20 summarizes the two main goals of Solvency II, the analysis done in this paper with respect to these goals, the results, and the conclusion that we derive from the results.

Goal of Solvency II	**Contribution of this paper**	**Result**	**Conclusion**
1. Safety at confidence level of 99.5%	Analysis of sensitivities and of basis risk with respect to the confidence level	Substantial deviations from the 99.5% confidence level depending on the data (e.g., time horizon) and portfolio composition	Need for thorough ORSA and internal risk models
2. Financial stability	Analysis of procyclicality	Symmetric adjustment mechanism reduces procyclicality of capital requirements	Equity dampener helps avoid a fire sale in the market

Table 20: Summary of main findings.

Our results complement previous work on the deficiencies of the Solvency II standard formula (Lorson et al., 2013; Christiansen et al., 2012; Savelli and Clemente, 2011; Sproule, 2009; Pfeifer and Strassburger, 2008) with a detailed

[68] According to Article 16 and 64 of the directive written by the European Parliament and the European Council (2009) the primary goal of Solvency II is to protect policyholders and guarantee a solvency probability of 99.5% for insurers. In addition, Article 16 calls also for "[f]inancial stability and fair and stable markets…".

empirical analysis of the equity risk module. The sensitivity analysis of the equity risk module illustrates the backward-looking nature of the new Solvency II capital requirements since the capital charges reflect only past crises. Our analysis of the basis risk shows that the proposed standard capital stress for equity risk can deviate substantially from individual insurers' portfolio risk; for example, we find that the actual capital stress as measured with more realistic empirical data can be 29.7 percentage points lower or 11.6 percentage points higher than the standard capital stress. All these results emphasize the need for an own risk and solvency assessment (ORSA) under Solvency II.[69] Finally, we show how the symmetric adjustment mechanism defeats the regulators' goal of setting a 99.5% confidence level, but does contribute to financial stability by reducing procyclicality of capital requirements.

Our findings are relevant not only for Solvency II, but also at the international level. The International Association of Insurance Supervisors (IAIS) (2013a) is currently working on international insurance capital standards and is planning to implement them by 2019. The initial idea for Internationally Active Insurance Groups (IAIG) is to establish an individual capital benchmark based on a scenario approach (IAIS, 2013b, p. 64, pp. 80–90). In addition, there are several upcoming insurance regulation reforms in the United States, including solvency requirements (see National Association of Insurance Supervisors (NAIC), 2012; Federal Insurance Office (FIO), 2014, especially recommendation four). In the literature, Solvency II is seen as a positive example of such regulation (see, e.g., Holzmüller, 2009; Klein and Wang, 2009 and Ashby, 2011) and can be expected to have an impact on U.S. policy decisions as well as those of other countries (see FIO, 2014, p. 25).

The remainder of this paper is structured as follows. In Section 2 we briefly explain the calculations behind the capital requirements of the equity risk module, i.e., the standard capital stress and the symmetric adjustment

[69] ORSA requires the insurers to document deviations of the actual risk from the risk shown under the Solvency II standard model. Although ORSA is still based on an insurer's actual risk profile, it might provide an opportunity to implement stress tests which do not solely reflect past crisis. An example might be to analyze the potential effects of a cure of cancer or a drastic drop in interest rates. For another positive assessment of ORSA see Cummins and Phillips (2009).

mechanism. In Section 3 we discuss the results of the sensitivity analyses of the capital requirements with respect to their technical basis. The basis risk is then evaluated in Section 4 and Section 5 focuses on procyclicality and systemic risk. Section 6 concludes and outlines several suggestions for future research.

2 Capital Requirements for Equity Risk and the Symmetric Adjustment Mechanism

The calculation of the capital requirement for the Solvency II equity risk module is set out in three publications. Directive 2009/138/EC, the bill passed by the European Parliament and European Council (2009), sets the general outline of Solvency II. It determines the 0.5% risk level for capital requirements and the cap for the symmetric adjustment mechanism. The symmetric adjustment mechanism is the algorithm which determines the capital requirements according to the market environment. The QIS5 Technical Specifications (CEIOPS, 2010b) set out the guidelines for the fifth test run of Solvency II which took place in 2010. The Solvency II Calibration Paper (CEIOPS, 2010a) presents the reasoning behind algorithms set out in the specifications. The three mentioned publications are the latest publically available information about the application of Solvency II. However, discussions between European institutions are ongoing and further changes in the specifications as well as in the directive itself are likely (e.g., see proposed changes in the directive by the European Commission, 2011, called Omnibus II or the new time schedule for the introduction of Solvency II suggested by the European Commission, 2012).

The standard capital stress is calibrated according to a Value at Risk measure with a confidence level of 99.5% (European Parliament and European Council, 2009, Article 104(4)). It differentiates between two classes of equities. Equities listed in EEA or OECD countries are considered under the class “global”. Equities not listed in EEA or OECD countries, hedge funds, commodities, private equities and other alternative investments are categorized as “other” equities. Thus, the 0.5% quantile of annual returns from different benchmark indices are taken into account. For “global” equities the MSCI World Price index is used[70] and for "other" equities the LPX 50 Total Return index, the HFRX Hedge Fund Total Return index, the MSCI BRIC Price index and the S&P GSCI Commodities Total Return index are considered. The calculations done by CEIOPS are based on a rolling window of daily measured annual returns for the longest period from which data are available.[71] The capital requirements for equity risk ($\mathrm{Mkt}_{\mathrm{eq}}$) are calculated per equity category as follows:

$$Mkt_{g \vee o} = \max(\Delta NAV \,|\, equity\ shock; 0) \tag{1}$$

where

Mkt_g= capital requirements for the equity category "global"
Mkt_o = *capital requirements for the equity category "other"*
NAV = net value of assets minus liabilities
equity shock = prescribed fall in the value of equities

The symmetric adjustment mechanism is the algorithm determining the adjusted capital stress.

equity shock = adjusted capital stress =
standard capital stress + adjustment term (2)

$$adjustment\ term = min\left\{max\left\{\frac{I_t - \frac{1}{n}\sum_{s=t-1}^{t-n} I_s}{\frac{1}{n}\sum_{s=t-1}^{t-n} I_s} * \ \beta, -0.1\right\}, 0.1\right\} \tag{3}$$

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[70] In addition, CEIOPS presents results for the MSCI Americas, MSCI Europe, and MSCI Pacific Price index. Also, the historical quantiles are compared with quantiles assuming a normal distribution. For a critical discussion of assuming normal distributions, see, e.g., Sandström (2007).

[71] The capital requirements for the equity risk class "global" are based on the MSCI World Price index. For this index daily data is available from January 1970 until January 2012. Capital requirements for "other" equities consider four indices approximating alternative investments: the LPX 50 Total Return index (Private Equity) from January 1994 to January 2012, the HFRX Hedge Fund Total Return index (Hedge Funds) from April 2003 until January 2012, the MSCI BRIC Price index (Emerging Markets) from June 1994 until January 2012 and the S&P GSCI Total Return index (Commodities) from January 1970 until January 2012. All data can be obtained via DataStream.

where

I_t = value of the MSCI World Price index at time t
n = number of days of the reference period
β = regression coefficient in the OLS regression of the MSCI World Price index on its average[72]
standard capital stress = 39% for equities listed in EEA/ OECD countries, for other equities 49%

It is important to mention that the final standard capital stress is not exactly the result of the 0.5% quantile of historical returns, but is determined by CEIOPS in a political decision making process. CEIOPS proposes a standard capital stress of 39% for "global" equities and 49% for "other" equities as mentioned in QIS5. Looking at the empirical data would result in a standard capital stress of 45% for "global" equities (CEIOPS, 2010a, p. 41). For "other" equities several indices are considered so an exact result based on historical returns should contain diversification effects. However, these effects are considered to be small and therefore are neglected. A correlation of one between the indices is assumed (CEIOPS, 2010a, p. 52).

Procyclicality and the risk of asset price contagion in the equity risk module are addressed by an adjustment term (Equation (3)), which increases or decreases the capital requirements by up to 10% depending on the market environment. The standard capital stress and the adjustment term together constitute the adjusted capital stress, which determines the stress scenario and thus the capital requirements. These calculations have to be done separately for "global" equities and "other" equities. In order to derive the capital requirements for the equity risk module, the capital requirements for "global" and "other" equities are aggregated as follows:

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72 The regression equation is as follows: $I_t = \propto + \beta * \frac{\sum_{t-n}^{t} I_t}{n} + \varepsilon_t$. For the regression analysis the time period from January 1971 until January 2012 is considered. If not otherwise indicated, we assume a β of one in this paper for further analysis, since in all regressions it is close to one regardless of the reference period. For more details see the analysis about the length of the reference period and its impact on the symmetric adjustment mechanism in Appendix A.

$$Mkt_{eq} = \sqrt{Mkt_g{}^2 + 2 * c * Mkt_g * Mkt_o + Mkt_o{}^2} \quad (4)$$

where

Mkt_{eq}= overall capital requirements for the equity risk module
c = constant for approximating the diversification effect, set to 0.75 by CEIOPS

A constant is used to consider the diversification effect between the two equity categories. It is based on the tail correlations between the different benchmark indices, but finally determined by CEIOPS. Diversification effects within an equity category are not considered.

3 Sensitivity Analyses

The purpose of this section is to review the calculation of the equity risk module. We therefore look at the assumptions behind the standard capital stress (Equation (2)), the symmetric adjustment mechanism (Equation (3)), and the aggregation formula (Equation (4)). Numerous other aspects could be looked at. We restrict ourselves to the above mentioned three aspects, while results for other tests (e.g., definition of returns, risk measures, β calculation) are given in Appendix A of the paper.

The calculation of the *standard capital stress* is based on a predefined time period. CEIOPS uses the full period of data currently (as of December 2009) available as basis for the setting of the standard capital stress, which is a constant. We analyze the impact of the chosen time horizon in Figure 1 and evaluate the effects if the standard capital stress would have been set at a different point in time. That is, for each trading day from January 1971 to January 2012 the hypothetical[73] standard capital stress based on the longest time

[73] In the following we use the term standard capital stress if we refer to the constant requirements of 39% and 49% as fixed by CEIOPS. We use the term hypothetical standard capital stress if we use the same calibration method as CEIOPS but apply it over time or to different equities.

period available on that specific date is given.[74] An important result from Figure 1 is that the recent financial crisis significantly increased the standard capital stress which would have been much lower if Solvency II would have been introduced before 2008. This emphasizes the backward-looking nature of the model since only past risks are considered.[75] Furthermore, it illustrates the shortcomings of the VaR approach for regulatory purposes as already widely discussed in literature (see, e.g., Daníelsson, 2008).

[74] In the graph we neglect the first three years because too few data points would result in misleading insights. Moreover, for Private Equity, Hedge Funds and Emerging Markets less data is available and therefore these start later in Figure 1.

[75] The Quantitative Impact Studies (QIS) done for Solvency II exactly reflect this problem. In QIS 4, the capital stress for "global" equities was set to 32% and for QIS 5 it was already set to 39%. The capital stress for QIS 4 was published in March 2008, the one for QIS 5 in March 2010. Further information regarding the results of this analysis, if time windows are considered instead of increasing time horizons, can be found in Table 24 in the first row in Appendix A.

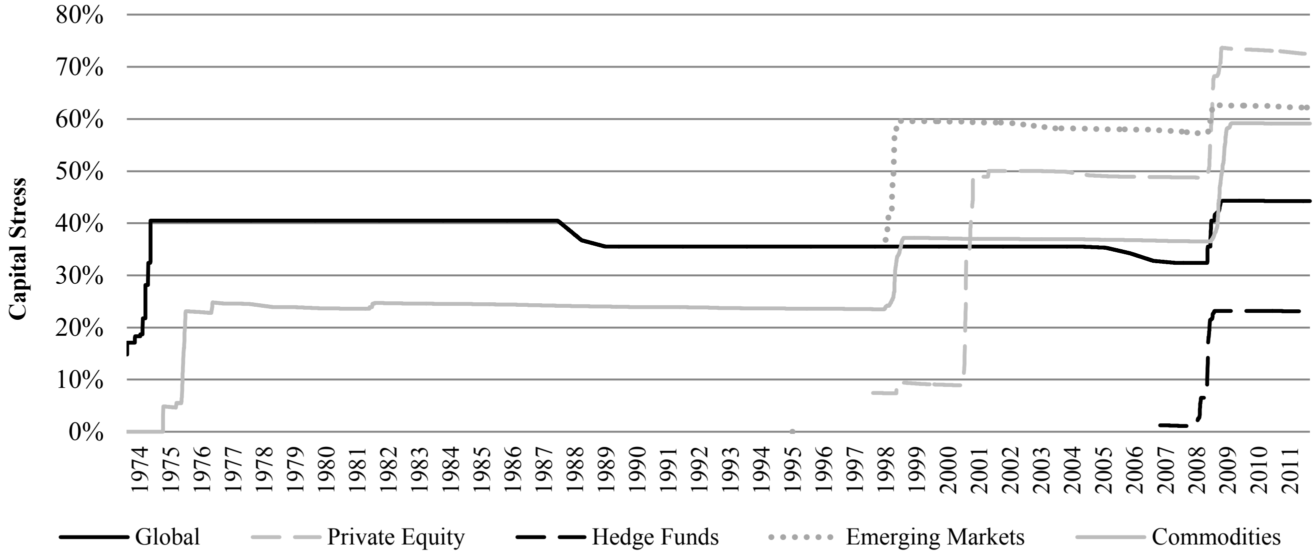

Figure 1: Hypothetical standard capital stress over time (equity classes). The standard capital stress is fixed by CEIOPS at 39% for "global" equities and at 49% for "other" equities. We refer to hypothetical standard capital stress when the same calibration method used by CEIOPS is employed, but to different points in time and different equities. This figure is based on the same equities as CEIOPS calibration but different reference dates are used.

We empirically compare the proposed correlations within the *aggregation formula* with actual correlations of the different asset classes. In QIS5 a correlation between “global” and “other” equities of 0.75 is considered. Empirically we find that the correlations range from 0.09 to 0.95 if the maximum time period is considered. In order to illustrate the time-varying nature of the correlation, Figure 2 shows the correlations between the MSCI World Price index and the other four indices used to define the standard capital stress. Returns are calculated annually based on a one year rolling window with daily data; the correlation coefficients are based on a five year rolling window. The horizontal line indicates the assumed correlation of 0.75 between the equity class “global” and “others” in the aggregation formula. Notable is the extreme variation for the commodity index and the MSCI World index. From July 1990 to July 1995 the correlation has been lowest with a coefficient of -0.69 and it has been highest from March 1977 to March 1982 with a coefficient of 0.64. These results clearly illustrate that the assumption of a fixed correlation of 0.75 which is not time-varying is not an optimal solution. Another important aspect which can be observed in Figure 2 is that in times of crisis the correlations are higher.[76]

[76] For this reason, CEIOPS (2010a) focuses on tail correlations in QIS 5, i.e., conditional correlations are calculated. We also repeated the analysis shown in Figure 2 for tail correlations (see Appendix A). They show the same result (correlations are time-varying and typically far away from the proposed 0.75), but are more difficult to interpret since there are jumps. For this reason we present the unconditional correlations in the main part of the analysis.

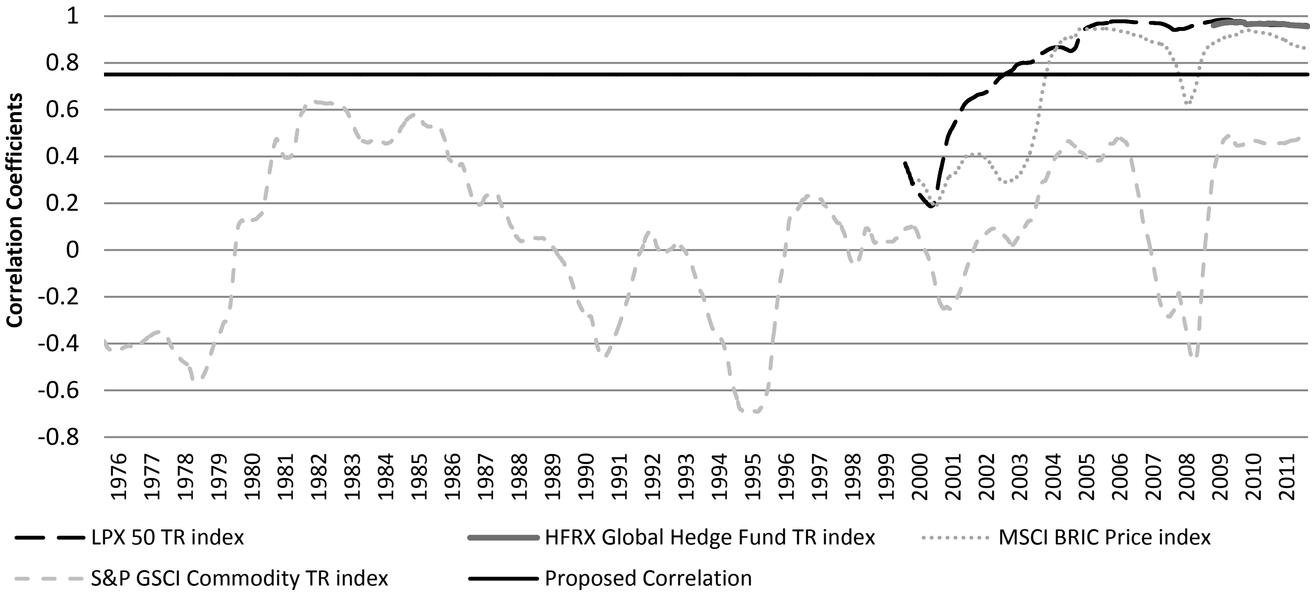

Figure 2: Pearson-correlations over time between the MSCI World Price Index and indices considered for the “other” equity category for five-year rolling windows.

Another crucial part of the equity risk module is the length of the reference period in the *symmetric adjustment mechanism*. We analyze the impact of different reference periods on overall capital requirements. This analysis is motivated by ongoing discussions between regulators as to which reference period is most appropriate. In Figure 3, we compare the most discussed reference periods – one year and three years – and analyze their impact on the capital requirements.[77] The adjustment term as well as the standard capital stress are calibrated based on the MSCI World Price index. It can be seen that a longer reference period of three years has two effects. First, on average higher adjusted capital stresses are applied and second, the adjusted capital stress becomes binominal – either the highest or the lowest possible adjusted capital stress is applied. For example, if a three year reference period is applied and the MSCI World Price index is considered, in 56.6% of the time an adjusted capital stress of 49% is applied and only 13.0% of the time an adjusted capital stress of 29%.

The sensitivity analysis presented in this Section are not more than a "what if" sensitivity analysis, but we believe that the results are important especially to empirically backtest and illustrate the dynamics of the modeling approach chosen for Solvency II. One of the drawbacks of the new Solvency II regime is that it has not been tested over time. Our results illustrate how the equity risk model would behave over time if Solvency II was already running for years. First, the model would result in a backward-looking adaption to historical crisis. Second, true correlations would be insufficiently approximated, with risk being particularly underestimated in crises. Third, capital requirements would be risk insensitive and binomial if the chosen reference period is three years.

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[77] CEIOPS (2010a) points out the longer the reference period, the more frequently the 10% band is hit and the risk sensitivity is reduced. CEIOPS concludes that a longer reference period on the one hand alters the empirical default probability and on the other hand leads to lower capital requirements in falling markets which could create moral hazard. Insurance companies might shift their investments from asset classes without an adjustment mechanism to equities. Therefore the majority of regulators proposes a one year reference period. However, a minority still argues that a three year reference horizon is more appropriate, because capital requirements fluctuate a lot if a short reference period is chosen and argue that it is not the goal of the symmetric adjustment mechanism to respond to temporary market movements.

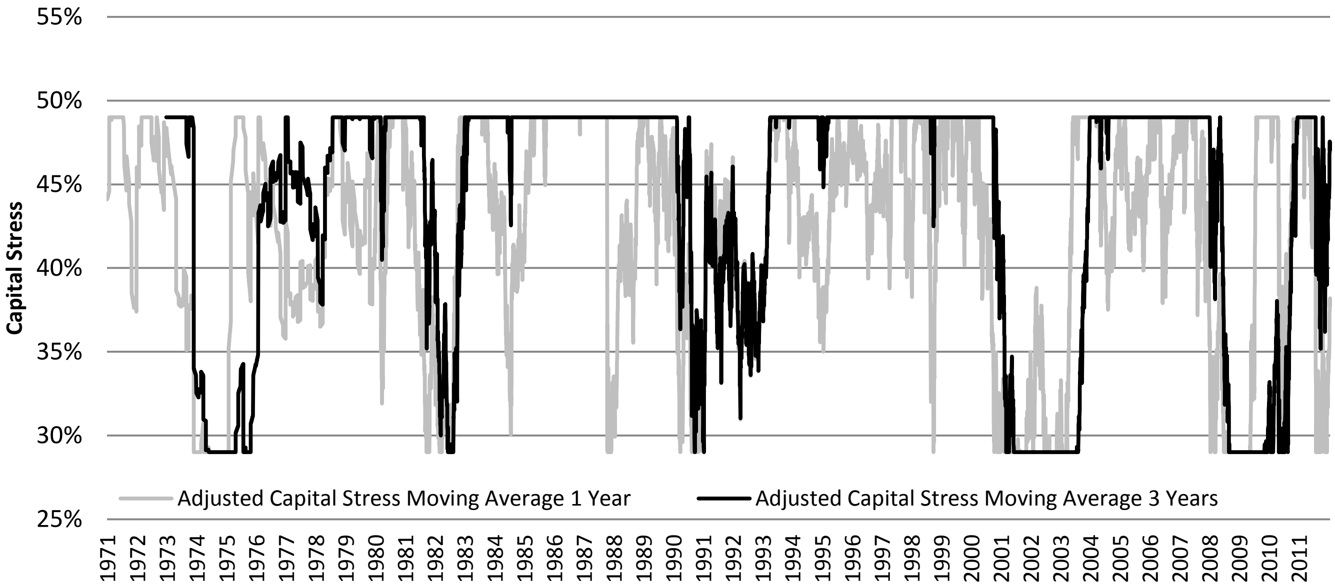


Figure 3: Backtesting of adjusted capital stress (standard capital stress + adjustment term) based on one and three year reference periods.

4 Solvency II Basis Risk

Under Solvency II, a uniform standard capital stress must be applied by all insurance companies, regardless of their actual portfolio composition. This requirement raises the question of how good this approximation is and how substantial deviations from this proxy are if we consider more realistic portfolios. Depending on the true portfolio composition of the individual insurer the standard capital stress might substantially deviate from the hypothetical one based on a 99.5% confidence level and thus basis risk emerges. Our interpretation of basis risk in a Solvency II context is thus deviations of the actual insurer's portfolio risk from the risk measured by the standard regulatory model.

To analyze basis risk, we model the investment portfolio of 16 insurance companies from 16 European countries. Rather than analyzing 16 real portfolios, we have set up 16 stylized country portfolios which proxy the typical allocation of insurers from these countries. To keep the analysis simple and comprehensible, the 16 country portfolios are equally composed of the MSCI country index, the MSCI Europe index excluding the respective country and the MSCI World index excluding Europe (only price indices are considered). 33.3% of each portfolio is thus invested in the home market, 33.3% in Europe outside the home market and 33.3% worldwide outside Europe. This approach follows Gatzert and Martin (2012) who use a stylized portfolio consisting of indices to approximate the stock portfolio of a typical insurance company as well and calculate a hypothetical standard capital stress of the equity risk module.[78] Due to the home bias for investment decisions (see, e.g., Tesar and Werner, 1995) we believe these portfolios might better approximate the actual equity allocation of insurers in Europe than the MSCI World Price index.[79] Table 21 gives some

[78] Stylized portfolios consisting of indices are also used by Eling and Schuhmacher (2007) as representative investment portfolios of a typical institutional investor. The composition of country portfolios is based on representative investment opportunities as described by Eling et al. (2009).

[79] We also calculated the basis risk for country portfolios with different weightings. Alternatives are: 50% (25%, 25%) are invested in the MSCI World index excluding Europe, 25% (50%,

descriptive information on the MSCI World Price index and the 16 country portfolios.

25%) in the MSCI Europe index excluding the respective country and 25% (25%, 50%) in the MSCI home market index. The results are basically the same, but basis risk increases if home market share increases. These results are available upon request.

	Portfolio Constituents				Descriptive Statistics of Returns			
	MSCI World	MSCI World ex Europe	MSCI Europe ex Country Index	MSCI Country Index	Mean	Standard Deviation	VaR_ 0.05	VaR_ 0.005
MSCI World	100.00%	0.00%	0.00%	0.00%	8.21%	17.80%	21.92%	44.24%
Country Portfolios								
Austria	0.00%	33.33%	33.33%	33.33%	7.92%	18.59%	20.57%	48.91%
Belgium	0.00%	33.33%	33.33%	33.33%	7.77%	18.04%	24.96%	48.73%
Denmark	0.00%	33.33%	33.33%	33.33%	9.66%	18.85%	24.14%	41.69%
Finland	0.00%	33.33%	33.33%	33.33%	9.49%	25.86%	32.21%	46.62%
France	0.00%	33.33%	33.33%	33.33%	8.45%	18.64%	25.79%	41.28%
Germany	0.00%	33.33%	33.33%	33.33%	7.97%	18.13%	24.41%	41.88%
Greece	0.00%	33.33%	33.33%	33.33%	0.67%	23.54%	43.43%	51.30%
Ireland	0.00%	33.33%	33.33%	33.33%	4.52%	19.95%	33.05%	52.24%
Italy	0.00%	33.33%	33.33%	33.33%	8.59%	20.84%	24.18%	43.43%
Netherlands	0.00%	33.33%	33.33%	33.33%	7.95%	17.87%	25.63%	42.69%
Norway	0.00%	33.33%	33.33%	33.33%	9.51%	19.66%	24.31%	45.07%
Portugal	0.00%	33.33%	33.33%	33.33%	1.57%	19.87%	34.01%	45.96%
Spain	0.00%	33.33%	33.33%	33.33%	8.25%	18.69%	22.66%	41.50%
Sweden	0.00%	33.33%	33.33%	33.33%	10.72%	21.05%	25.18%	41.40%
Switzerland	0.00%	33.33%	33.33%	33.33%	8.09%	17.77%	22.46%	42.62%
UK	0.00%	33.33%	33.33%	33.33%	9.08%	18.08%	22.24%	42.86%

Table 21: Structure of country portfolios. Returns are calculated by using a rolling window of daily measured annual returns. VaR_0.05 and VaR_0.005 correspond to a value at risk at a confidence level of 95.0% and 99.5%, respectively. The time horizon is January 1971 to January 2012 except for Finland (January 1989–January 2012), Greece (May 2002–January 2012), Ireland (May 1994–January 2012), and Portugal (December 1998–January 2012).

For these 16 country portfolios we calculate a hypothetical standard capital stress over time and compare it with the Solvency II capital stress. In this case the capital stress only considers the MSCI World index since all equities in the 16 country portfolios can be classified as "global" equities.

Figure 4 illustrates the results of this analysis for the German, Greek, Irish and Austrian country portfolios for the years 2000 to 2012. The black thick line illustrates the capital stress over time based on the MSCI World Price index (it corresponds to the line "global" in Figure 1). The other lines represent the results, if the hypothetical capital stress is based on the country portfolios. We see that the risk of the country portfolios can substantially deviate from the one proposed by Solvency II. For example, the capital stress based on the MSCI overestimates the risk of the German portfolio, but underestimates the one of the Greek portfolio. We also see that for all portfolios the risk significantly increased after 2008. As illustrated in Figure 4, these effects can be very substantial and they can occur in both directions (over- and underestimation of the actual risk). For example, on the 19th December 2000, the proposed capital stress is 29.7 percentage points higher than the capital stress of the Irish portfolio. On the 30th October 2008 the Greek portfolio was underestimated by 10.97 percentage points. In general the capital stress based on the MSCI World index seems to overestimate the risk in normal market conditions and underestimates it in times of crisis. This is a meaningful finding, since the MSCI World index is more diversified than the individual country portfolios.

In contrast, individual country portfolios rely more on a specific geographic area and thus inhibit idiosyncratic risks attached to single European countries, which were subject to specific crisis during the investigation period (especially Ireland and Greece). A regulatory question that thus arises is which of these two alternatives – a global standardized view or the more country specific one - is more adequate to account for the equity risk of insurance companies.

Moreover, the findings emphasize the need for a careful own risk and solvency assessment (ORSA). Under this provision, insurance companies are obliged to report systematic deviations of their true risk from the Solvency II standard model. Our results emphasize that the deviations can be very substantial.

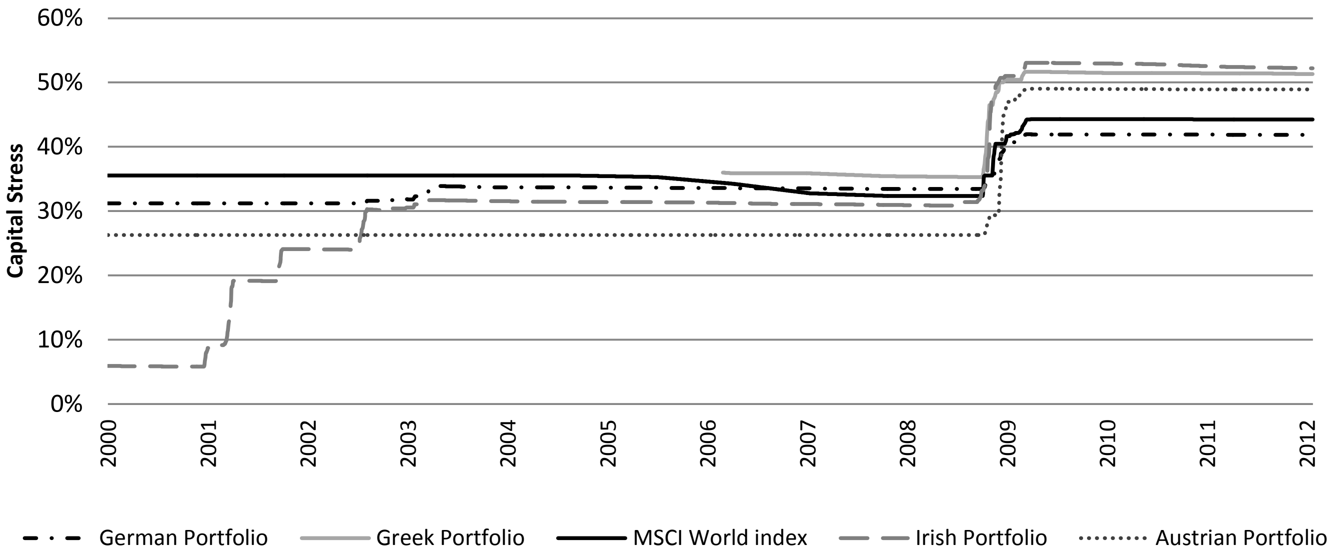


Figure 4: Hypothetical standard capital stress over time (country portfolios). The standard capital stress is fixed by CEIOPS at 39% for “global” equities. We refer to hypothetical standard capital stress when the same calibration method used by CEIOPS is employed, but to different points in time and different equities. This figure is based on different reference dates. In addition, results for CEIOPS equities (MSCI World Price Index) are compared to more realistic portfolios (country portfolios).

Table 22 shows the corresponding results for all 16 country portfolios. The second column shows the standard capital stress set by CEIOPS as described in QIS5. Since all country portfolios only invest in OECD countries, for all portfolios a standard capital stress of 39% would apply. The third column shows the hypothetical standard capital stress based on the 0.5% quantile of the returns based on the MSCI World index. In the fourth column the capital stresses are shown calibrated according to the country portfolios.[80] The maximal positive and negative deviation of the capital stress of a country portfolio from the capital stress based on the MSCI index over time are shown in column five and seven. A positive deviation means that the standard capital stress of the MSCI index underestimates the risk of the country portfolio and a negative one that the risk is overestimated. Looking at the results we see that the maximum deviation is -29.7 percentage points for the Irish country portfolio.[81]

[80] The observed time horizon ranges from January 1974 until January 2012. Different maximal time periods are used in the case of Finland (March 1993 – January 2012), Greece (March 2006 – January 2012), Ireland (May 1998 – January 2012) and Portugal (December 2002 – January 2012).

[81] Deviations would be even larger if we would compare the results for the country portfolios with the standard capital stress of 39% set by CEIOPS instead of the one based on the 0.5% quantile of the MSCI World Price index.

	Total Time Period			Analyses Over Time			
	Proposed CEIOPS Standard Capital Stress	Standard Capital Stress based on MSCI World Index	Standard Capital Stress based on Country Portfolio	Maximal Positive Deviation of Country Portfolio Stress from MSCI World Stress in Percentage Points	Period of Maximal Positive Deviation	Maximal Negative Deviation of Country Portfolio Stress from MSCI World Stress in Percentage Points	Period of Maximal Negative Deviation
Austria	39%	44.25%	48.91%	5.88	Feb 2009	-11.11	Jan 1975 - Nov 1987 Nov 2008 - Dec 2008
Belgium	39%	44.25%	48.73%	5.88	Dec 2008	-3.46	Jan 1975 - Nov 1987 Nov 2008 - Dec 2008
Denmark	39%	44.25%	41.69%	3.02	Oct 2007	-2.78	Jan 1975 - Nov 1987 Nov 2008 - Dec 2008
Finland	39%	44.25%	46.62%	6.34	Oct 2007	-7.19	March 2001
France	39%	44.25%	41.28%	5.58	Jan 2007	-3.03	April 2009
Germany	39%	44.25%	41.88%	1.07	Oct2007	-8.18	Jan 1975 - Nov 1987
Greece	39%	44.25%	51.30%	10.97	Oct 2008	-	-
Ireland	39%	44.25%	52.24%	11.63	Nov 2008	-29.70	Dec 2000
Italy	39%	44.25%	43.43%	2.74	Oct 2007	-3.93	Jan 1975 - Novr 1987 Nov 2008 - Dec 2008
Netherlands	39%	44.25%	42.69%	3.90	Oct 2007 - Oct 2008	-2.14	Jan 1975 - Nov 1987 November 2008 - Dec 2008
Norway	39%	44.25%	45.07%	3.11	Oct 2007 - Oct 2008	-1.17	Jan 1975 - Nov 1987 Nov 2008 - Dec 2008
Portugal	39%	44.25%	45.96%	7.14	Nov 2008	-2.57	March 2003
Spain	39%	44.25%	41.50%	-	-	-7.24	Jan 1975 - Nov 1987

	Total Time Period			Analyses Over Time			
							Nov 2008 - Dec 2008
Sweden	39%	44.25%	41.40%	0.65	Oct 2008	-12.08	Jan 1975 - Nov 1987
Switzerland	39%	44.25%	42.62%	1.79	Aug 1988	-1.71	Nov 2008
UK	39%	44.25%	42.86%	5.07	Aug 1988	-1.44	April 2009

Table 22: Basis risk of country portfolios. Analyses over time means that in order to calculate a hypothetical standard capital stress based on the MSCI World Price index/ country portfolios, for each point in time the maximal time period is considered up to this date. E.g., for the 25th November 2002 data from the 01st January 1971 until the 25th November 2002 is considered and for the 15th April 2005 data from the 01st January 1971 until the 15th April 2005.

5 Procyclicality and Systemic Risk

5.1 Impact of the Symmetric Adjustment Mechanism on the Confidence Level of Capital Requirements

In this section we analyze the extent to which the symmetric adjustment mechanism affects the predefined goal of Solvency II of a 99.5% confidence level. Relaxing capital requirements in bad markets will systematically decrease the confidence level, while raising capital requirements in good markets should systematically increase the confidence level. We are especially interested in the possible range of outcomes; for the overall goals of Solvency II (e.g., creating a safe industry) it might be relevant to know if this range is between 99% and 99.9% or between 90% and 99.99%.

We calculate the impact of the symmetric adjustment mechanism on the confidence level as follows. First, we take the standard capital stress which is calibrated according to a 99.5% confidence level based on the MSCI World Price index and set to 39% by CEIOPS. Second, we calculate the adjusted capital stress according to the symmetric adjustment mechanism as described in Equation (2) and (3) in Section 2. Third, we derive the confidence level based on this adjusted capital stress. For each point in time, the confidence level is simply the percentage of annual returns of the benchmark portfolio which would have been lower than the negative adjusted capital stress. Put differently: the confidence level indicates the percentage of historical annual returns for which the capital requirements based on the adjusted capital stress would have been sufficient. Figure 5 shows the confidence level of the adjusted capital stress for the MSCI World Price index over time.

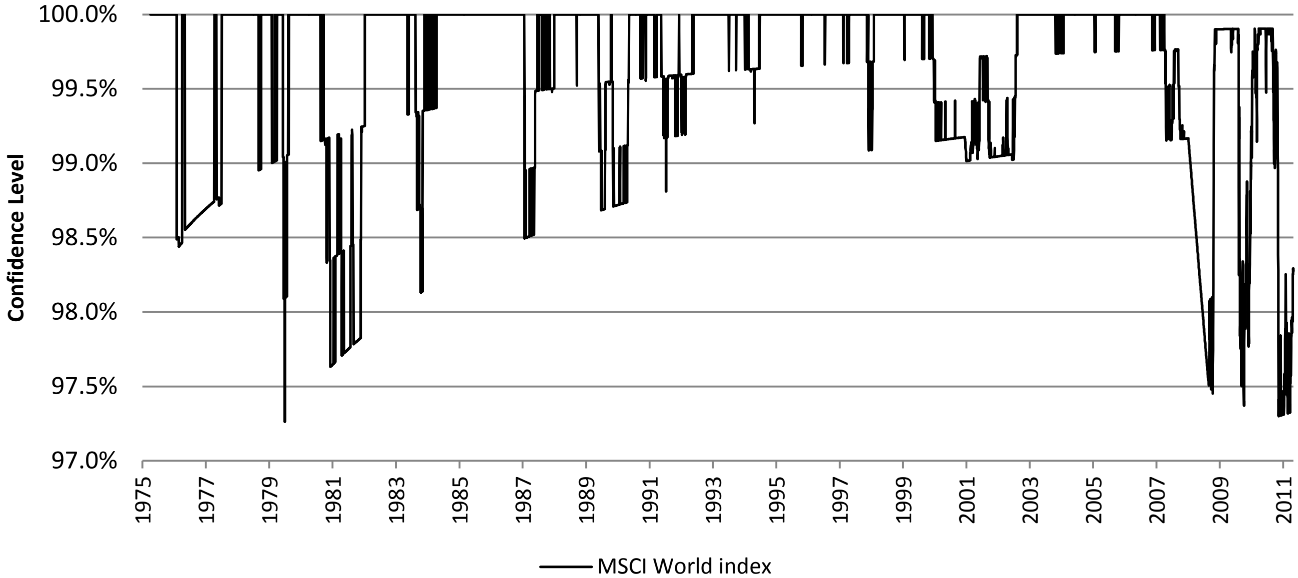


Figure 5: Confidence level of adjusted capital stress over time. The confidence level in this figure indicates the percentage of historical annual returns for which the capital requirements based on the adjusted capital stress would have been sufficient. Solvency II requires a confidence level of 99.5%.

It can be seen in Figure 5 that most of the time a confidence level of 1 is reached with temporary deviations from this level. The lowest confidence level is 97.26%. After 2008, the confidence level of 1 is not reached anymore, which can be explained by the characteristics of the adjustment term. Before 2008, there is no incident where the MCSI portfolio exceeds an annual loss of 49%. So, when the maximum adjusted capital stress of 49% is employed, the confidence level is 1 per definition. Only when the adjusted capital stress turns out to be below the maximum, the confidence level sometimes cannot meet the 99.5% threshold. After 2008, the maximal loss exceeds 49% and consequently, as seen in Figure 5, a confidence level of 1 cannot be reached anymore.[82]

The confidence level thus from time to time substantially deviates from the required confidence level when capital requirements are relaxed. Especially, during the financial crisis the goal of Solvency II to ensure that insurers can meet their obligations with a 99.5 % confidence level would have been violated. The symmetric adjustment mechanism thus reduces the capital requirements in times of financial distress and thus reduces procyclical behavior.

5.2 Alignment of the Symmetric Adjustment Mechanism with Systemic Risk

Besides the protection of policyholders and beneficiaries, Solvency II has the objective to maintain financial stability and fair and stable markets as stated in Article 16 of the directive from the European Parliament and the European Council (2009). In this section we analyze if the symmetric adjustment mechanism is contributing to this second goal of stability. Therefore we employ two systemic risk measures – CoVaR (Adrian and Brunnermeier, 2011) and Marginal Expected Shortfall (MES; Acharya et al., 2012) – to our country portfolios and review if the symmetric adjustment mechanism is pro- or anticyclical in regard to systemic risk.

CoVaR can be used to measure the VaR of a system conditional on an institution being at its VaR level. Thus, basically it is a measure to what extent

[82] We also repeated the analysis from Figure 5 for all 16 country portfolios. The results are available upon request.

the distress of the whole system coincides with the distress of a single institution. CoVaR can be calculated as time-invariant, time-variant or forward-looking measure. Since we want to compare current systemic risk with the current capital requirements of the equity risk module over time we use the time-variant version in this paper. In contrast to Adrian and Brunnermeier (2011) we adopt the CoVaR for the European market by using state variables fitting to a European environment. As Adrian and Brunnermeier (2011) we use weekly data for our evaluation. The time period ranges from May 1999 to January 2012. For further details about the calculation of the CoVaR measure in this paper we refer to Appendix B.

MES is the average return of a company during the 5% worst days of the whole market. Acharya et al. (2012) show that it can be used to approximate the losses of a company if a crisis occurs and therefore indicates its potential systemic risk. As Acharya et al. (2012) we use daily data to calculate the time-variant MES version. After transforming the daily time series into a weekly one, MES and CoVaR can be compared. The time period we use for the MES ranges from April 1999 to January 2012. Further details regarding the calculation of MES can be found in Appendix C.

A wide variety of systemic risk measures are currently under discussion by academics and regulators.[83] In this paper, we employ MES and CoVaR due to their relevance and their applicability. Regarding MES and CoVaR, Benoit et al. (2013, p. 2) state that "very few crisis-related papers made a higher impact both in the academia and on the regulatory debate …."[84] In addition, both measures are based on publicly available market data and therefore are applicable to the setting in this paper. In general, as mentioned by Drehmann and Tarashev (2011, p. 25), and in particular for our setting of stylized country portfolios, it is problematic to apply measures that require non-public, non-market information.

[83] For an overview, see Bisias et al. (2012).

[84] Several publications already use these systemic risk measures. Examples are Zhou (2010), Huang (2012), López-Espinosa et al. (2012), and Rodríguez-Moreno and Peña (2013). Furthermore, as of April 1, 2014 google scholar lists 723 and 483 citations referring to Adrian and Brunnermeier (2011) and Acharya et al. (2012), respectively.

Indeed, approximating these inputs would increase the arbitrariness of our evaluation.

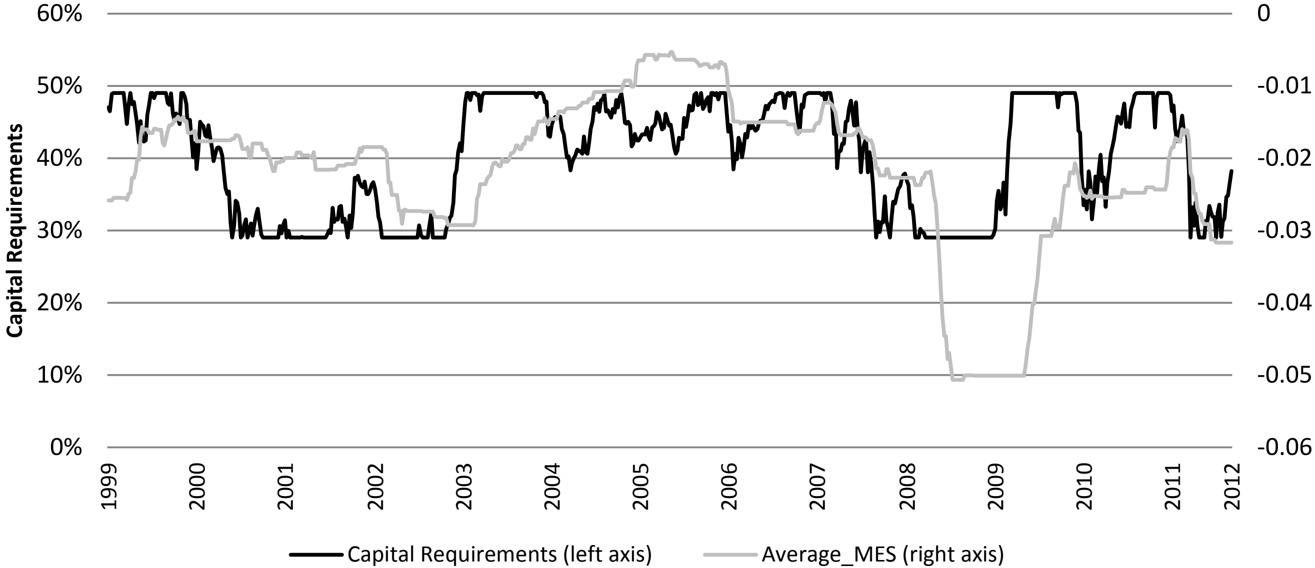
However, this does not mean that these measures are free from shortcomings. Acharya et al. (2012, p. 12) point out that MES can only estimate the impact of a crisis on an institution, not the probability that a crisis will occur. Benoit et al. (2013) show that CoVaR and MES can be understood as transformations of market risk measures and conclude that these measures “fall short in capturing the multiple facets of systemic risk.” Three further shortcomings are identified by Löffler and Raupach (2013). First, the authors show, in a linear market model, that an institution can decrease its systemic risk as measured by CoVaR simply by increasing its idiosyncratic risk. Therefore, they argue, CoVaR sets the wrong incentives. Second, they show that when contagion is considered, CoVaR attributes higher systemic risk to the institutions causing contagious effects than to the ones being affected. MES leads to opposite result. Third, using simulations, they show that it is possible for institutions to have large tail risks, which have nearly no effect on either risk measure. We agree with the authors that naively applying these measures for regulatory purposes would not be wise. In our case, though, the measures are appropriate since historical data are used and the measures have been developed only recently, meaning that no institution could have anticipated the measure’s reaction in its risk and portfolio management.

Figure 6 shows the capital requirements of the equity risk module in comparison with the average CoVaR and the average MES. We first calculate the CoVaR and MES for each country portfolio over time. In this way we approximate the contribution of a typical insurance company in a country to systemic risk of the whole system. Second, we derive the systemic risk of the whole system according to both risk measures by calculating the arithmetic average of the individual results for the 16 country portfolios at each point in time.[85]

[85] We consider the capital requirements based on the adjusted capital stress, which includes the symmetric adjustment mechanism. If the symmetric adjustment mechanism is omitted and only the standard capital stress is considered, capital requirements are 39% for all portfolios at all

It can be seen that low capital requirements coincide with a strongly negative average CoVaR and high capital requirements appear synchronously with a high average CoVaR. This impression is confirmed by the correlation coefficient of 0.43 between the capital requirements and the CoVaR measure and a correlation of 0.46 if the capital requirements are lagged by one week. The same is true for MES. The correlation between the capital requirements and the risk measure is 0.36 and increases to 0.38 if capital requirements are lagged as well. All coefficients are significant at a 1% confidence level.

times. Thus, correlations between the systemic risk measures and the capital requirements cannot be calculated.



Capital Requirements
60%
50%
40%
30%
20%
10%
0%
0
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
Capital Requirements (left axis)
Average_MES (right axis)

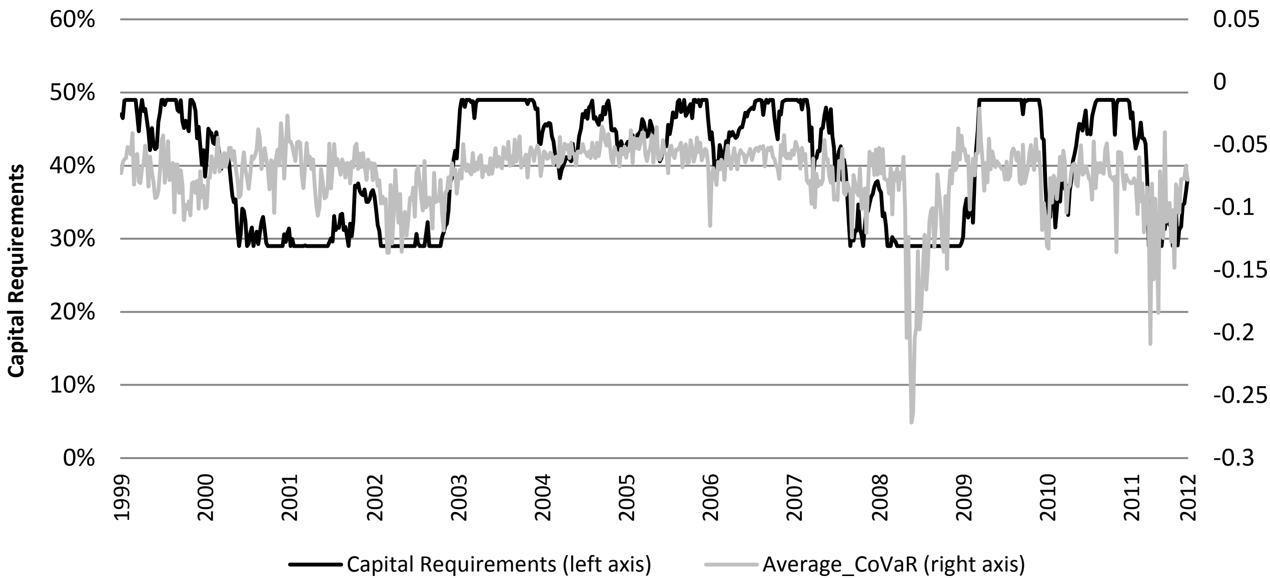


Figure 6: Capital requirements in comparison with systemic risk measures. Capital requirements according to the equity risk module of Solvency II compared to the average MES and CoVaR risk measure based on the 16 country portfolios over time.

Table 23 shows that this relationship also holds for each country portfolio. The CoVaR conditional of the Greece country portfolio has the lowest correlation coefficient (0.35) and the Portuguese one the highest (0.48) with regard to the capital requirements. For the MES, Finland and Sweden show the highest correlation with the capital requirements (0.42) and the coefficient of Greece is the smallest (0.27). In this paper only the Pearson-correlation coefficients are shown. However, we also use the Spearman rank-order correlation in order to check if the correlation is heavily influenced by outliers, which is not the case.[86]

	Capital Requirements /			**Capital Requirements /**	
	CoVaR	MES		CoVaR	MES
Total Average	0.429***	0.361***	Ireland	0.423***	0.343***
			Italy	0.442***	0.360***
Austria	0.403***	0.290***	Netherlands	0.441***	0.359***
Belgium	0.461***	0.345***	Norway	0.419***	0.323***
Denmark	0.444***	0.391***	Portugal	0.483***	0.375***
Finland	0.419***	0.419***	Spain	0.428***	0.355***
France	0.405***	0.373***	Sweden	0.364***	0.419***
Germany	0.421***	0.373***	Switzerland	0.364***	0.355***
Greece	0.354***	0.274***	UK	0.421***	0.380***

Table 23: Correlations between capital requirements and systemic risk measures. Pearson-correlation coefficients between capital requirements and systemic risk measures are shown. CoVaR considers the 1% VaR level. ***, **, * indicate a significance level of 1%, 5%, and 10%, respectively.

We further analyze the relationship between the systemic risk measures and capital requirements with statistical tests and regressions (see Appendix D). We

86 When interpreting the results, one has to keep in mind that by construction there is a relation between the CoVaR of the system and the VaR of the country portfolios, since the system is defined as the average return of the country portfolios. Moreover, the capital requirements are based on the MSCI World Price index which has a significant impact on the country portfolios as well. The same is true for the MES measure.

report only the results for the average CoVaR and average MES. We do not report the risk measures for each country portfolio individually, since we are interested in the relationship between capital requirements and the systemic risk of the whole system.

The additional tests include Chi^2 tests for independence, unit root tests, Granger causality tests, and OLS regressions. Also, we employ a vector autoregressive (VAR) model in the case of CoVaR. For the MES analysis, we build a vector error correction (VEC) model, since capital requirements and MES are non-stationary and seem to be cointegrated. Our results show that capital requirements are low when CoVaR indicates increased systemic risk, and high when systemic risk is relatively low. For MES, the results are mixed. This pattern is an indication that the equity dampener in fact reduces procyclicality with respect to systemic risk. We can thus conclude that according to the time-variant CoVaR the symmetric adjustment mechanism indeed contributes to stability of the financial system. According to our analysis it seems that in times of crisis capital requirements are low and in times of low systemic risk high. Also, the symmetric adjustment mechanism is more sensitive to equity market changes than the risk measures and therefore seems to lead them.

6 Conclusion and Future Research

The main goal of Solvency II is to protect insurance policyholders (European Parliament and European Council, 2009, Article 16). Therefore, capital requirements should ensure that insurance companies have enough economic capital to meet their obligations to policyholders over the next 12 months with a probability of at least 99.5 % (European Parliament and European Council, 2009, Article 64). Additional objectives include financial stability and fair and stable markets (European Parliament and European Council, 2009, Article 16). In light of these goals of Solvency II, the aim of this paper is to critically analyze the equity risk module.

By backtesting Solvency II using historical data we find that the hypothetical standard capital stress is highly sensitive to the considered time period and the underlying definition of returns. To guarantee a confidence level of 99.5% for

European insurers, the standard capital stress should be substantially higher. Specifically, after 2008, a standard capital stress of 39% is not sufficient. In addition, there are large deviations between individual insurers' risk situation and the risk implications of Solvency II. Furthermore, the aggregation formula might underestimate the true risk due to the fixed time-invariant correlations. Fixed correlation coefficients are problematic in general because equity correlations are not stable over time. The symmetric adjustment mechanism further decreases the confidence level when the capital requirements are relaxed.

We conclude that applying the standard model will lead to systematic deviations from the proposed 99.5% confidence level and that it is therefore not guaranteed that Solvency II's chief goal will be achieved. This result makes a strong argument for using internal models and emphasizes the importance of a thorough own risk and solvency assessment (ORSA). We thus urge insurers to evaluate whether the standard model is appropriate to their situation and to use an internal model if necessary. This implies that when evaluating internal models, regulators, also, should take into consideration the standard model's flaws. Generally, the basis risk and calibration issues of the standard formula apply to internal models as well. However, the requirements for internal models should not surpass the quality of the standard formula. Moreover, regarding systemic risk, flaws in the standard formula affect many more companies than flaws in individual internal models. As an alternative to using an internal model, insurance companies should undertake sensitivity analyses for the own risk and solvency assessment (ORSA) so as to document potential deviations of their own risk from the results of the standard model. For the regulator it will be important to pay attention to the depth and width of these sensitivity analyses; otherwise, the full extent of basis risk can be concealed by employing only very narrow analyses.

These implications are not only applicable to Solvency II, but should be considered in the design of other capital standards as well. For example, these findings support, as currently under discussion by the IAIS, the use of an individual scenario-based approach for insurance capital standards if a global regulation framework is indeed realized. For the United States, the results underline the importance of ORSA assessments, expected to be required by 2015, and the regulation reforms recommended by the Federal Insurance Office.[87]

We employ CoVaR and MES as systemic risk measures and find that capital requirements have explanatory power to anticipate systemic risk. Furthermore, they are more sensitive to stock market movements. These results indicate that the symmetric adjustment mechanism does indeed reduce procyclicality.

In future research it would be valuable to more closely analyze the basis risk and the symmetric adjustment mechanism. It would be interesting to focus on the explanatory factors behind the basis risk by focusing on the dependencies between and within the different equity categories. For the symmetric adjustment mechanism, one could distinguish between booming and falling markets. Also, to further analyze the potential procyclical nature of the adjusted capital stress, it might be beneficial to model not only the effect of markets on insurer capital requirements, but also the vice versa effects. Analyses with historical data ignore how markets are affected by the changed behavior of insurers following the introduction of new regulatory regimes. Another path of research could be to analyze ORSA information when it becomes available after the introduction of Solvency II. It would be interesting to evaluate if deviations from the standard model of the same magnitude found here really do occur in practice. And finally, research should investigate whether it is possible to calibrate capital requirements using factors other than historical data in order to mitigate backward-looking characteristics. Insurers should not only be ready for the last, but also for the next, crisis.

Appendix A – Further Sensitivity Analysis

The first row of Table 24 shows the capital requirements without the adjustment term based on different indices according to *different time periods*. It can be seen that a hypothetical standard capital stress is not constant over time and the deviation can be up to 38.1 percentage points in case for commodities.

[87] See NAIC (2014) and FIO (2014, pp. 34, 35).

The second row of Table 24 considers the *definition of returns*. The calculations done by CEIOPS are based on a rolling window of daily measured annual returns, i.e. $r_d = \frac{I_d}{I_{d-260}} - 1$. We analyze whether different definitions of returns lead to alternative outcomes. We look at a rolling window of monthly measured annual returns ($r_m = \frac{I_m}{I_{m-12}} - 1$) and yearly data ($r_y = \frac{I_y}{I_{y-1}} - 1$). I_d, I_m and I_y denote the current index value at a specific date, month or year.[88] For all indices, fewer data points would lead to a reduced capital stress. The maximum difference is observed for the LPX 50 index. A one-year rolling window of daily data leads to a capital stress of 73.3% and yearly data leads to 63.7%. We suppose this is due to the calculating method used by CEIOPS. Annual returns are calculated based on a one year rolling window of daily index values. In this way all fluctuations are considered, whereas by using only annual data points fluctuations within a certain year are ignored. So, the method used by CEIOPS seems to be appropriate since neglecting fluctuations within a year and within a month would mean underestimating the volatility of equity prices.

The standard formula recognizes a diversification effect between "global" and "other" equities by introducing a constant of 0.75 into the aggregation formula, as shown in Equation (4). We calculate *tail correlation coefficients* between the MSCI World Price index and all other employed indices as in CEIOPS (2010a). Results are shown in the third row of Table 24. We use not only the 0.5% quantile to determine which returns to consider in our analysis, but also the 1%, 5%, and 10% quantiles. Mathematically, a 99.5% confidence level does not imply that any specific quantile must be used to determine tail correlations and therefore the decision is arbitrary. However, our results show that the impact of the chosen quantile is substantial.

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88 For the MSCI World Price index as well as the S&P GSCI Commodities TR index data from January 1973 until December 2009 is used. For the LPX 50 Total Return index data from January 2000 until December 2009 is used. Calculations regarding the HFRX Global Hedge Fund Total Return index take the period from April 2004 until December 2009 into account. For the MSCI Emerging Markets BRIC Price index the period from June 1995 until December 2009 is considered.

		MSCI World Price index	LPX 50 TR index (Private Equity)	HFRX Global Hedge Fund TR index	MSCI BRIC Price index	S&P GSCI TR index (Commodities)
Standard Capital Stress based on Time Period	1971-1980	40.49%	n.a.	n.a.	n.a.	23.74%
	1980-1990	19.30%	n.a.	n.a.	n.a.	24.09%
	1990-2000	19.14%	n.a.	n.a.	n.a.	38.38%
	2000-2011	47.84%	74.82%	n.a.	62.81%	61.80%
Standard Capital Stress based on Return Definition	Daily Data	44.39%	73.34%	23.18%	62.56%	59.43%
	Monthly Data	43.79%	72.76%	22.98%	62.09%	58.36%
	Yearly Data	39.52%	63.68%	22.60%	59.77%	44.55%
Tail Correlations between MSCI World Price and other Indices	Proposed	1.00	0.84	0.45	0.77	-0.53
	0.005 Quantile	1.00	0.78	-	0.51	0.21
	0.01 Quantile	1.00	0.48	-0.84	0.11	0.30
	0.05 Quantile	1.00	0.85	0.27	0.45	0.08
	0.1 Quantile	1.00	0.95	0.78	0.81	0.50
Linear Return-Correlation between ES and VaR	Total Period	0.96	0.95	1.00	0.91	0.97
	Maximum	0.99	0.98	n.a.	0.99	0.99
	Minimum	0.00	0.61	n.a.	0.75	0.06
Frequency of Adjusted Capital Stress reaching the Maximum and Minimum according to Reference Period	Max. (22 days)	0.09%	1.64%	0.00%	1.81%	0.66%
	Min. (22 days)	0.47%	2.73%	0.00%	4.10%	0.80%
	Max. (90 days)	4.12%	5.60%	0.00%	9.16%	10.64%
	Min. (90 days)	3.33%	5.12%	0.45%	7.04%	5.02%
	Max. (260 days)	22.66%	18.13%	0.00%	17.07%	34.52%
	Min. (260 days)	9.11%	9.59%	1.34%	10.13%	9.47%
	Max. (780 days)	56.61%	21.67%	2.04%	18.13%	54.13%
	Min. (780 days)	12.98%	11.25%	2.23%	10.30%	12.53%

Table 24: Sensitivity analysis of the equity risk module

Solvency II considers a 0.5% quantile for the risk factors, which corresponds to the Value at Risk (VaR) at a 99.5% confidence level as a *risk measure*. We are motivated to look further at this issue by other regulatory approaches using different risk measures. For example, the Swiss Solvency Test employs the Expected Shortfall at a 99% confidence level. Also, the fact that companies might use other risk measures for their internal decision making makes the issue worth to consider. We test whether the Expected Shortfall (ES) at a 99.5% confidence level leads to comparable results. We calculate the differences in the hypothetical standard capital stress for each index by using the ES and VaR measure for the time period from December 1975 until January 2012. The capital stress is calculated according to a five year rolling period. Our results show that using Expected Shortfall (ES) as a risk measure instead of Value at Risk (VaR) leads to very comparable results (see Figure 7). The capital stress increases about 6.5 percentage points on average and extreme stock price movements are anticipated more quickly. Both could be expected due to the fact that ES considers all tail values and not, like VaR, only the threshold. For all equity classes the correlation over time between VaR and ES are close to 1 over the total period as shown in the fourth row of Table 24.

The last row of Table 24 shows the effect of considering different reference periods in calculating the symmetric adjustment mechanism. We compare the most discussed time horizons as mentioned by CEIOPS (2010c). It can be seen that the minimum and maximum of the symmetric adjustment mechanism are more likely to be reached the longer the reference period.

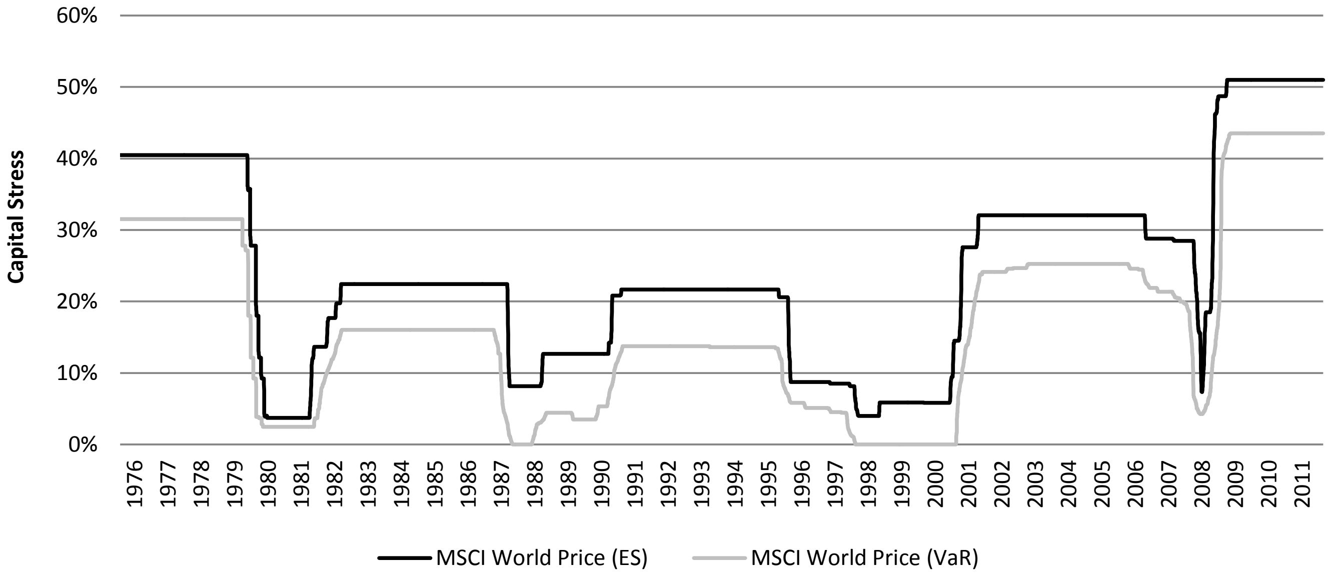

Figure 7: Value at risk and expected shortfall. Comparison of hypothetical standard capital stress employing VaR and ES. In both cases, the calculations are based on the MSCI World Price Index.

We analyze the impact of the reference period on *β of the adjustment term*, which is derived by a regression of the actual index level on the weighted average index level. Table 25 shows the results. As CEIOPS reports we find betas for the MSCI World indices and the S&P GSCI commodities Total Return indices are for all reference periods close to 1. Therefore we approximate beta in this paper by one.

Reference period	**MSCI World Price**	**MSCI World TR**	**GSCI TR**
1 month (22 days)	1.00	1.00	1.00
4 months (90 days)	1.00	1.00	0.99
1 year (260 days)	0.99	1.01	0.98
3 years (780 days)	0.98	1.02	0.98

Table 25: Adjustment term betas

We empirically compare the proposed correlations within the *aggregation formula* with actual correlations of the different asset classes. In QIS5, a tail correlation between "global" and "other" equities of 0.75 is considered. CEIOPS (2010a) defines tail correlation as the Pearson-correlation of values below a certain quantile. Thus, the only returns considered are those that are simultaneously below the 0.5% quantile of the indices at hand. Empirically, we find that the correlations range from -1 to 1 depending on the indices and time period being considered. To illustrate the time-varying nature of the correlations, Figure 8 shows the correlations between the MSCI World Price index and the other four indices used to define the standard capital stress. Returns are calculated annually based on a one-year rolling window with daily data; the correlation coefficients over time are based on the longest time period available on each specific date. In our analysis, only data below the 0.5% quantile are chosen, except for the HFRX Global Hedge Fund TR index, since there are not enough overlapping data points below this quantile. Instead, we chose the 1% quantile. Figure 8 only shows the results for January 2000 to January 2012 because, previous to this period, returns from the different indices that are below the 0.5% quantile do not occur at the same time. As described by Mittnik (2011) the small number of data points is a general flaw of the CEIOPS method for calculating tail correlations. The horizontal line indicates the assumed correlation of 0.75 between the equity class "global" and "others" in the aggregation formula. Note the extreme variations during 2001 and 2009. In 2001, the tail correlation between the private equity index and the MSCI World Price index reached both its minimum and maximum. The same is true for the commodity and the emerging markets indices. These results clearly illustrate that the assumption of a fixed correlation of 0.75 that is not time-varying is not an optimal solution. Also, the figure illustrates that tail correlations fluctuate especially in times of crisis.

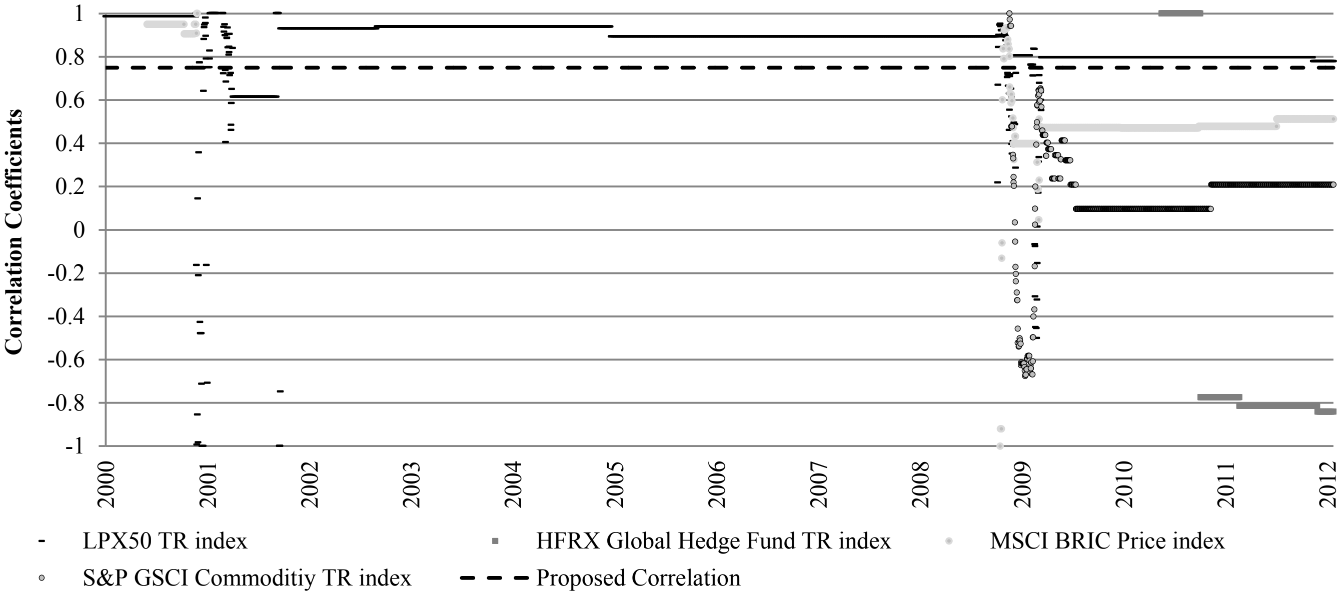

Figure 8: Tail correlations between the MSCI World Index and indices of the category "other". Tail correlations over time between the MSCI World Price Index and indices considered for the "other" equity category. The correlation coefficients are based on the longest time period available on each specific date. Tail correlations do not exist at each point in time since overlapping quantiles are required for calculation.

Appendix B – CoVaR Calculation

In order to project the time-variant CoVaR measure we use quantile regressions and seven state variables as Adrian and Brunnermeier (2011). We employ the following quantile regressions to estimate the joint distribution of X^i_t and X^{system}_t (see Equation (5) and (6)), whereas X^i_t stands for the returns of the country portfolio i and X^{system}_t for the returns of the whole system. In contrast to Adrian and Brunnermeier (2011) a conversion of asset book-values into asset market-values before calculating the return series is omitted, since in our setting the portfolios are not leveraged and the values of the stylized insurance companies are equal to the values of their constitutive market-valued assets. We estimate the returns of the whole system as in the original paper by taking the arithmetic average over i.

$$X^i{}_t = a^i + \gamma^i M_{t-1} + \varepsilon^i{}_t \tag{5}$$

$$X^{system}{}_t = a^{system|i} + \beta^{\mathrm{system}|i} X^i{}_t + \gamma^{system|i} M_{t-1} + \varepsilon^{system|i}{}_t \tag{6}$$

a^i and $a^{system|i}$ are the constants in both regressions and $\varepsilon^i{}_t$ and $\varepsilon^{system|i}{}_t$ are the error terms. System|i indicates that the system variable is conditional on i's return. γ^i and $\gamma^{system|i}$ are vectors and indicate regression coefficients as well as $\beta^{system|i}$. M_{t-1} is a vector of state variables lagged by one week. The estimated coefficients are used to predict the time-variant risk measures as shown in Equation (7) and (8).

$$VaR^i{}_t(q) = \hat{a}^i + \hat{\gamma}^i M_{t-1} \tag{7}$$

$$CoVaR^{system|i}{}_t(q) = \hat{a}^{system|\,i} + \hat{\beta}^{\mathrm{system}|i} X^i{}_t + \hat{\gamma}^{system|i} M_{t-1} \tag{8}$$

q indicates the quantile which is used in the regressions and to which the VaR and CoVaR are referring to. In this paper the following state variables are used.

- Volatility of the stock markets. Adrian and Brunnermeier (2011) use the VIX index, but we use the VSTOXX index in order to adjust to a European setting. The index is obtained from DataStream.

- Liquidity spread, which is defined as the difference between the three month general collateral repo rate and the three month US t-bill rate. For the repo rate we use the Euro Repo Benchmark from DataStream and for the t-bill rate the three month rate of German government bonds from Bloomberg.

- Tails of market-valued asset returns, which are explained in the original paper by the change in the three month US t-bill rate. In contrast, we use the change in the three month t-bill rate of German government bonds.

- Change in the slope of the yield curve. Originally, the variable is measured by the yield spread between ten year US government bonds and three month US t-bills. We use the change in the yield spread between ten year and three month German government bonds.

- Change in the credit spread. We use the change in the difference between the yield to maturity of bonds represented by the Barclays Euro Aggregate 7-10Y Corporate index and the yield to maturity of bonds represented by the Bank of America Merrill Lynch German Government 7-10Y index. Both indices are obtained from DataStream. Adrian and Brunnermeier (2011) use BAA-rated bonds and the US treasury rate.

- Equity market return. Adrian and Brunnermeier (2011) use the equity market return from CRSP. We use the MSCI Europe Price index obtained from DataStream in order to approximate the equity market return.

- Real estate sector return. Originally, the excess return above the market return of companies with a SIC code of 65 and 66 is used. In contrast, we simply employ the excess return of the MSCI Europe Real Estate Price index over the return of the MSCI Europe Price index.

Appendix C – MES Calculation

According to Acharya et al. (2012) the marginal expected shortfall of a company is defined as follows in Equation (9).

$$MES^{i}{}_{5\%} = -E\left[\frac{w^{i}{}_{t}}{w^{i}{}_{t-1}} - 1 | I_{5\%}\right] \tag{9}$$

$MES^{i}{}_{5\%}$ indicates the marginal expected shortfall of company i conditional on the 5% worst trading days of the market. $w^{i}{}_{t}$ stands for the equity value of company i at time t and $I_{5\%}$ denotes the 5% worst market outcomes. The time variant MES in this paper is following the same logic, but considers only the last year and is therefore more sensitive to recent stock market movements. The applied calculation is shown in Equation (10).

$$MES(t)^{i}{}_{5\%} = \frac{1}{261}\sum_{t-261}^{t}\left[\frac{w^{i}{}_{t}}{w^{i}{}_{t-1}} - 1 | I_{5\%,261}\right] \tag{10}$$

$MES(t)^{i}{}_{5\%}$ indicates the marginal expected shortfall at time t and $I_{5\%,261}$the 5% worst market returns during the last 261 trading days. As a reference for the equity market we use the MSCI World Price index.

As an alternative (not reported in this paper) we calculate the measure based on daily, annual rolling returns as used in the calculations for the symmetric adjustment mechanism CEIOPS (2010a). In this case $w^{i}{}_{t-1}$ in Equation (9) and (10) changes to $w^{i}{}_{t-261}$. Our key results are the same for this version. However, due to a loss of intra-year variations the MES is reacting less sensitive and looks more smoothly over time. Acharya et al. (2012) use leverage in addition to MES to predict expected losses. Since, the country portfolios are not leveraged; we omit the measure for leverage.

Appendix D – CoVaR/MES and Capital Requirements

In the following we report the results of additional statistical tests of the relationship between systemic risk measures and capital requirements. Table 26 shows the results for tests of independence, unit root tests, Granger causality tests, and OLS regressions. Table 27 and Table 28 report the results of a vector autoregressive (VAR) model and a vector error correction (VEC) model, respectively.

Chi^2 Test for Independence		**Unit Root Test**	
		Capital Requirements	-2.72*
Capital Requirements & CoVaR	100.85***	CoVaR	-5.34***
Capital Requirements & MES	157.89***	MES	-1.78
		ΔCapital Requirements	-27.49***
		ΔMES	-10.88***
Granger Causality Test		**OLS Regression Coefficients**	
Capital Requirements -> CoVaR	34.95***	CoVaR <- Capital Requirements	0.15***
CoVaR -> Capital Requirements	0.85	CoVaR <- Capital Requirements (lag)	0.15***
ΔCapital Requirements -> ΔMES	1.30	ΔMES <- ΔCapital Requirements	0.01**
ΔMES -> ΔCapital Requirements	0.37	ΔMES <- ΔCapital Requirements (lag)	0.01***

Table 26: Statistical tests regarding capital requirements and systemic risk measures. Chi2 test statistics for H0: stochastic independence. Unit root t-test statistics for H0: unit root. Granger causality f-test statistics for H0: no Granger causation. (lag) indicates a variable lagged by one week. Δ indicates the first difference in the time series and ***, **, * the 1%, 5%, and 10% significance level, respectively.

Chi[2] tests for independence reveal that stochastic independence between the risk measures and the capital requirements can be rejected at a 1% significance level. Augmented Dickey-Fuller tests (unit root tests) show that the capital requirements and CoVaR are not non-stationary at a significance level of 10% and 1%. For MES non-stationarity cannot be rejected. In order to avoid spurious regressions we use the first difference in the time series for MES analysis. Granger Causality tests show that capital requirements seem to granger cause CoVaR, since the null hypothesis of no Granger Causality can be rejected at a 1% significance level. However, CoVaR does not granger cause capital requirements. With regard to MES neither changes in capital requirements granger cause changes in the systemic risk measure, nor changes in MES granger cause changes in capital requirements. OLS regressions of the systemic risk measures on capital requirements show that there is a relationship between contemporary as well as lagged capital requirements by one week and the systemic risk measures. Especially, there appears to be a deferred relationship between CoVaR and capital requirements.[89]

We model the interrelation between capital requirements and the average CoVaR in an autoregressive model as specified in Equation (11). As endogenous variables we use capital requirements and CoVaR. A constant is the only exogenous variable.

$$y_t = A_1 y_{t-1} + A_2 y_{t-2} + A_3 y_{t-3} + c + \varepsilon_t \tag{11}$$

y_t is a column vector and denotes the capital requirements and CoVaR at time t. A_1, A_2, A_3 are the coefficient matrices which are to be estimated. c is a column vector and stands for the constants. ε_t is a column vector and stands for the error terms at time t. The lag length of three is estimated by the Hannan-Quinn and

[89] This deferred relationship can be explained by the construction of the risk measures which are not as sensitive as the symmetric adjustment mechanism. For example, CoVaR is based on state variables which are lagged by one week and therefore reacts not instantaneously to equity market changes, but the symmetric adjustment mechanism does. The deferred relationship should thus not be interpreted as a forecasting capability of the symmetric adjustment mechanism to anticipate future systemic risk.

Schwarz criterion. Results of the coefficient matrices, R^2 figures and F-Statistics are shown in Table 27.[90]

	Capital Requirements	CoVaR
Capital Requirements (-1)	0.921***	0.472***
Capital Requirements (-2)	0.072	-0.430***
Capital Requirements (-3)	-0.019	-0.024
CoVaR (-1)	0.062**	0.368***
CoVaR (-2)	-0.004	0.202***
CoVaR (-3)	-0.019	0.244***
R^2	0.958	0.637
F-Statistic	2505.692***	191.059***

Table 27: Vector autoregressive model. (-1), (-2) and (-3) indicate a lag of one, two, and three weeks of the variables and ***, **, * the 1%, 5%, and 10% significance level of the coefficients, respectively.

We cannot apply a normal VAR model to evaluate the dynamics between capital requirements and MES, since MES is a non-stationary time series. However, the Johansen Cointegration test shows that capital requirements and MES are cointegrated. Therefore, we employ a vector error correction model as specified in Equation (12). The model is based on the third deterministic trend case as described by Johansen (1995), p. 81.

$$\Delta y_t = \propto \beta'(y_{t-1} - c) + A_1 \Delta y_{t-1} + A_2 \Delta y_{t-2} + A_3 \Delta y_{t-3} + \varepsilon_t \qquad (12)$$

[90] Note that single coefficients should be interpreted with caution and can be misleading. Freeman et al. (1989) argue that only sets of coefficients should be considered. Also, Brandt and Williams (2007, p. 14) point out that VAR models are only "…an approach to modeling dynamics among a set of (endogenous) variables… ". Therefore, we put no emphasis on the highly significant and negative coefficient of Capital Requirements (-2) of -0.430 with regard to the CoVaR measure. In our view the coefficient is negative out of technical reasons since without it the model would include a positive trend. For interpreting explanatory relationships on the level of individual variables e.g. Granger Causality tests as reported in Table 26 are more suitable.

$\propto$ is a column vector and $\beta = \begin{bmatrix} 1 \\ -\beta_1 \end{bmatrix}$, whereas β_1 is the coefficient denoting the linear relationship between the capital requirements and MES. c is a column vector of constants. Results of the coefficient matrices A_1, A_2, and A_3 as well as R^2 figures and F-Statistics regarding the differences in capital requirements and MES are shown in Table 28

	ΔCapital Requirements	**ΔMES**
ΔCapital Requirements (-1)	-0.055*	0.002*
ΔCapital Requirements (-2)	0.056*	-0.001
ΔCapital Requirements (-3)	0.068*	-0.003*
ΔMES (-1)	-0.561	0.220***
ΔMES (-2)	-0.377	0.220***
ΔMES (-3)	0.659	0.061*
R^2	0.014	0.246
F-Statistic	1.357**	30.372***

Table 28: Error correction model. Δ stands for the first difference regarding the time series. (-1), (-2) and (-3) indicate a lag of one, two, and three weeks of the variables and ***, **, * the 1%, 5%, and 10% significance level of the coefficients, respectively.

Results of both models show that the optimal lag length is three. F-statistics at a 1% confidence level show that lagged capital requirements and lagged CoVaR variables can explain current CoVaR levels. In the case of the VEC model, the F-statistics show at a 1% and 5% confidence level that MES and capital requirements can be explained by lagged variables. However, in the VEC model, the significance of the coefficients is very low, thus making the explanatory relationship doubtful. Furthermore, in contrast to the R^2 (0.63) of the CoVaR equation in the VAR model, the one (0.01) of the MES equation in the VEC model is very low. This contributes to the previous findings shown in Table 26. Lagged capital requirements can significantly explain CoVaR, but the evidence for MES is weak.

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IV Costs and Benefits of Financial Regulation – An Empirical Assessment for Insurance Companies[91]

We empirically analyze the costs and benefits of financial regulation based on a survey of 76 insurers from Austria, Germany and Switzerland. Our analysis includes both established and new empirical measures for regulatory costs and benefits. This is the first paper that takes costs and benefits combined into account using a latent class regression with covariates. Another feature of this paper is that it analyzes regulatory costs and benefits not only on an industry level, but also at the company level. This allows us to empirically test fundamental principles of financial regulation such as proportionality: the intensity of regulation should reflect the firm-specific amount and complexity of the risk taken. Our empirical findings do not support the proportionality principle; for example, regulatory costs cannot be explained by differences in business complexity. One potential policy implication is that the proportionality principle needs to be more carefully applied to financial regulation.

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1 Introduction

In light of the growing amount and complexity of regulation in the financial sector (e.g., additional rules for systemically important financial institutions, Basel III, Solvency II), the costs and benefits of financial regulation is a highly relevant and timely topic. One major trend in this context is the shift from simple rules-based solvency measures towards more complex risk-based capital measures, involving the use of internal risk models and the new philosophy of principal-based regulation.[92] One fundamental principal of new insurance regulation is proportionality, meaning that regulatory requirements and their enforcement should take into account the nature, scale and complexity of an insurer's risk.

Although the increasing amount and complexity of regulation is often cited as most important threat to the insurance sector (e.g., I.VW, 2010; PwC, 2011, 2013; and Black Rock, 2013), there is almost no literature on the costs and benefits of insurance regulation. This is most likely due to the considerable difficulty of measuring the costs and benefits.[93] A few researchers have attempted to assess regulatory costs and benefits for the entire financial services sector, especially using survey methods.[94] Other researchers have assessed the costs and benefits of regulation using micro-economic equilibrium models and derive welfare implications from new insurance regulation.[95]

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92 An example in Europe is the principal-based Swiss Solvency Test (SST), introduced in 2006 and mandatory since 2011. Another example is Solvency II, which will be implemented by 2016 (Financial Times, 2013) for all countries in the European Union. In the US the solvency modernization initiative is an ongoing reform discussion with respect to the risk-based capital standards (e.g., Klein, 2012).

93 See Posner and Weyl (2013) who conceptually outline requirements for the measurement of benefits and costs in financial regulation.

94 For example, Franks, Schaefer and Staunton (1997) empirically analyze the direct and indirect costs of financial regulation in the UK and compare the direct costs with those from the US and France. For insurance, Ernst & Young (2011) have conducted a cost-benefit analysis (CBA) of Solvency II in the UK by evaluating the impact of Solvency II on the required capital of insurance companies; they also estimate the implementing and compliance costs of Solvency II as well as the impact of the new regulatory regime on the financial markets in the UK.

95 See, for example, Hoy (2006) about the impact of restricting the factors for risk classification, Dong, Gründl and Schlütter (2013) regarding the effects of guarantee funds and Sass and Seifried (2014) regarding the consequences of unisex tariffs. In addition, Lorson, Schmeiser and

We add to this strand of literature by empirically assessing the effectiveness of regulation on the insurance industry employing a sample of 76 insurers from Austria, Germany and Switzerland. Previous studies only estimate costs and benefits for the whole finance or insurance industry. We go one step further and analyze these questions at the level of the individual company. In addition, this is the first paper to analyze both costs and benefits. For this purpose, we first regress company characteristics on costs and benefits of regulation individually. Second, we take costs and benefits combined into account by using a latent class regression model with covariates. In a first step, different latent classes are generated and the likelihood of the insurers belonging to a certain class is estimated. Therefore, different insurer profiles regarding costs and benefits are made explicit. In a second step, the ways in which insurer characteristics influence latent class affiliation and their cost-benefit profiles are estimated. Our results thus draw a more differentiated picture than previous research has, and identify the characteristics that can determine if an insurer is more positively or negatively affected by regulation than its peers are.

Our results show that differences in business complexity cannot explain the costs of regulation. In addition, small insurers who compare regulatory costs relative to premium income have higher costs than large insurers. The principal of proportionality thus does not work well. A second important result is that stock insurers exhibit lower regulatory costs than mutuals. Consequently, mutuals are not only at a disadvantage in relation to stocks due to their limited access to the capital markets (Harrington and Niehaus, 2002; Viswanathan and Cummins, 2003), but also because of regulatory requirements (Zanjani, 2007). Finally, the latent class regression identifies two groups of companies with distinct perception of costs and benefits of regulation: The "balanced" insurers vs. the "pessimistic" ones. In general, Swiss insurers tend to belong to the "balanced" class and Austrian as well as German insurers to the "pessimistic" class.

Wagner (2012) evaluate the policyholders' willingness to pay for stricter regulation and compare it with the costs of Solvency II estimated by previous studies.

The rest of the paper is structured as follows. Section 2 discusses the literature on costs and benefits of financial regulation and how they are measured. Our understanding of the terms 'costs' and 'benefits' of regulation for insurance companies is also discussed. The hypotheses tested in this paper and the variables we use to measure 'costs' and 'benefits' are explained in Section 3. The data and methods used in this paper are discussed in Section 4. Section 5 presents the empirical results and is divided into three parts considering the costs, the benefits and their combination. Section 6 concludes and discusses potential policy implications.

2 Costs and Benefits of Financial Regulation

In principle, the costs and benefits of regulation can be classified along two dimensions: a) if costs and benefits are *direct* or *indirect* and b) if costs and benefits are due to *implementation of new regulation* or due to *compliance with existing regulation*. Both distinctions are far from trivial, since they result in manifold allocation problems.

Franks, Schaefer and Staunton (1997) define *direct costs* as all costs necessary to develop, enact and supervise regulation. *Indirect costs* are all costs market participants and third parties have to bear (including opportunity costs).[96] Another understanding is presented in a report commissioned by the Financial Services Authority (FSA): *direct costs* are those that can clearly be attributed to a particular business activity (Deloitte 2006, p. 64). All other costs are understood to be *indirect*.[97] For example, the labor costs of employees responsible for documentation requirements of a certain business line would be direct costs. In contrast, increased property expenditures which cannot be clearly assigned to a business line would be indirect costs.

Elliehausen (1998, p. 3) defines *implementation costs* as one-time costs of making changes to conform to the requirements of a regulation. The definition

[96] The Financial Services Authority (FSA) (2000, p. 15) initially and Zwahlen (2010, p. 29) follow this understanding.

[97] While the dividing rule in Franks, Schaefer and Staunton (1997) is government vs. market participants/third parties, the dividing rule in Deloitte (2006) is assignable to business activities vs. non-assignable.

includes a broad range of set-up costs from legal and advisory expenses for interpreting and communicating the new regulation to expenses for new IT systems. *Compliance costs* are defined as "… the recurring costs of performing activities required by a regulation." For example, expenses for preparing reports for the regulator and opportunity costs fall into this category.[98]

Most of the literature has classified the costs of regulation, but has not discussed its potential benefits. In this paper we measure both the costs and the benefits of regulation. Table 29 presents an overview of potential costs and benefits of financial regulation. Given manifold allocation problems, it is not possible to develop an unambiguous and complete model with measurable items only.[99] Table 29 should thus not be understood as a closed model, but as an open list of regulatory impacts documented in theoretical and empirical literature (in Table 30 we present these results). Empirical research will always be able to model only parts of the regulatory costs and benefits and will need proxies to measure the impact of regulation.

98 Deloitte (2006, p. 8) applies a similar classification and differentiates between one-off and ongoing costs in determining the costs of regulation for UK financial services companies. However, they report that for many companies a clear distinction between one-off and ongoing costs is difficult. A study by the CEA (2007, p. 4) focuses only on the administrative costs due to Solvency II and differentiates initial and ongoing administrative costs as well. For a further example, see Lorson, Schmeiser and Wagner (2012, p. 146).

99 In order to mitigate the allocation problem, we additionally perform robustness tests without differentiating between direct and indirect costs. Results can be provided upon request.

Costs			Benefits
Government costs:	**Company costs:**	**Wider economy impacts:**	**Microprudential benefits:**
• Costs of the supervisor • Costs of the legislative procedure • Company costs: • Administrative costs • External services costs, for example, fees for supervisors, consulting companies and auditing companies	• Opportunity costs, for example, due to the ban of certain business activities • Costs due to a change in the market, for example, decrease of demand • Capital requirements • Capital structure and risk-taking	• Impact on competition and market environment • Impact on innovation • Impact on investments • Impact on insurability of certain risks • Non-economic impacts • For example impact of dental insurance on oral health in the society [100] • For example impact on environment[101]	• Policyholder protection (reduced default probability of insurers; reduction of abusive market practices) • Reduction of asymmetrical information and more transparency (for the public and the supervisor) • Macroprudential benefits • Ensuring financial stability • Reduction of mislead incentives • Achieving social-political goals (e.g. avoidance of poverty in old age)

Table 29: Costs and benefits of insurance regulation.

[100] Bailit et al. (1985) show in a study for the US that extended dental insurance coverage improves oral health in a society especially for people under 35 and people with poor oral health. However, Brennan, Anikeeva and Teusner (2013) find mixed results in a study for Australia. Dental insurance is related to the likelihood of visiting a dentist, but not directly to oral health. For Germany and Switzerland, Staehle and Kerschbaum (2004) show that in contrast to common perception, the extent of insurance coverage cannot explain oral health.

[101] For example, Walters et al. (2012) analyze the impact of crop insurance in the United States on the environment. They find that insurance coverage influences production decisions, but the general impact on the environment seems to be small. However, insurance contract characteristics can explain adverse and beneficial effects on the environment. For instance, high coverage insurance leads to less adverse effects than low coverage contracts.

It is not only the allocation problem (e.g. direct vs. indirect) which complicates the analysis of the cost and benefits of regulation.[102] Any assessment of costs and benefits has to consider two states with their consequences – the state in which the regulation is in place and the state in which it is not. Within each jurisdiction the two states can empirically be analyzed only consecutively, not simultaneously (Lorson, Schmeiser and Wagner, 2012). A simultaneous analysis is only possible by comparing jurisdictions, but this requires controlling for country differences (as we do in this paper). Moreover, unbiased data generation and analysis might be difficult since parties affected by regulation might have a strong interest in a certain outcome and lobby for a certain result of the cost-benefit analysis (CBA). For example, the regulated companies have an incentive to increase the reported compliance costs by allocating elements that would also exist without regulation (e.g., IT systems for financial reporting). Cochrane (2014) discusses this argument in detail and points out the danger of regulatory capture, that is, analyses are guided by the interests of lobbying groups and not by the public interest, if CBA becoming mandatory. Becker (2000) likewise acknowledges the problem, but argues that it is minor since the most adversely affected groups invest most in lobbying and therefore the CBA is still useful. In this paper, regulatory capture is not an issue, since up-to-date CBA are not mandatory in Austria, Germany or Switzerland.

Table 30 gives an overview of studies about costs and benefits of regulation in the insurance industry and reports the key results. All studies are conducted by academics, practitioners (e.g., consultancies or auditing companies), and regulators. PwC (2010) and Practitioner Panel (2013) are practitioner studies. Deloitte (2006), CEA (2007) and Ernst & Young (2011) are collaborations of practitioners and regulators. All of the other 25 studies are conducted by academics. This classification does not necessarily reveal information about the quality of the studies, but is nevertheless helpful to understand the context of the

[102] See, for example, Franks, Schaefer and Staunton (1997) and Deloitte (2006) who point out that for companies it is difficult to consider a situation in which a certain regulatory requirement is absent for all market participants. Normally, companies do not take into account that the abolition of regulation also affects their competitors.

papers. We classify these studies methodologically as case studies, surveys and quantitative studies (our approach is loosely based on Elliehausen, 1998):

- Case studies are mainly based on qualitative reasoning and descriptive statistics

- Surveys include all studies based on data generated by questionnaires

- Quantitative studies include:

    - Papers using econometrical methods to explain costs and benefits
    - Conceptual papers estimating costs and benefits employing theoretical models
    - Papers using efficient-frontier estimation
    - Papers based on event studies

Study: Party evaluated (Who?)	Methodology (How?)	Proxy for costs and benefits (What?)	Key Results
Joskow (1973): Property-liability insurers	Quantitative Study (Econometrical methods)	Availability of insurance cover	Analysis of the US insurance industry regarding its structure, pricing behavior, performance and consequences for regulation: • The property-liability insurance sector represents a competitive market and deregulation is desirable. Rate regulation is not necessary, direct writing restrictions should be reduced and the insurance regulator should focus on consumer information and protection. Insurers, however, should be required to have insurance against bankruptcy. • Rate regulation and inefficient sales channels lead to unavailability of insurance for individuals representing bad risks and high prices
Lee, Mayers and Smith (1997):[103] Property-liability insurers	Quantitative Study (Event Study based on introduction of guarantee funds)	Changes in portfolio composition	Evaluation of the impact of state guaranty funds on the risk-taking of property-liability insurers in the US: • Share of equities in the asset portfolio increases after the introduction of a guarantee fund, if the insurer is a stock company • Therefore the risk-subsidy hypothesis (guaranty funds lead to increased risk-taking) is supported for stock companies
Franks, Schaefer and Staunton (1997): Regulators	Survey and official reporting	Regulatory budget	Evaluation of the costs of the financial regulator (including regulation for life insurance companies) in the US, UK and France: • Regulatory costs per employee in the life insurance sector for 1991 - 1993 • UK: £56; US: £183; France: £41

[103] Studies in addition to the ones mentioned in Table 30, which evaluate the impact of insurance guarantee funds are Brewer, Mondschean and Strahan (1997), Lee and Smith (1999) as well as Schmeiser and Wagner (2013).

Study: Party evaluated (Who?)	Methodology (How?)	Proxy for costs and benefits (What?)	Key Results
Grace and Klein (1999): Property-liability insurers	Quantitative Study (Econometrical methods)	Share of business written in an restrictive environment Number of states in which business is conducted Expense ratios	Evaluation of the compliance costs of US property-liability insurers: • Economies of scale can be observed: size has a negative impact on compliance costs relative to premium income • The claims-cost-expense ratio can explain the share of business written in an restrictive regulatory environment • Salary expenses can explain number of states in which the insurer at hand is active • The licensing costs for insurers alone result in roughly $4.5 bn compliance costs for the US property-liability insurance industry (costs per license ≈ $100,000; number of multi-state insurers ≈ 3,000; average number of states a multi-state insurer is doing business in ≈ 15)
Downs and Sommer (1999): Property-liability insurers	Quantitative Study (Econometrical methods)	Risk-taking approximated by stock market based risk measures	Analysis of the impact of US guaranty funds on insurance company's risk-taking: • Insider ownership can explain increased risk-taking which is consistent with the risk-subsidy hypothesis (guaranty funds lead to increased risk-taking). The theoretical background is that a guaranty fund represents a put option for the shareholder, but risk-taking should only increase if the management is invested in the company as well since human capital cannot be diversified and therefore according to the principal-agent theory management should have no interest in increased risk-taking. • Relationship between insider ownership and risk-taking decreases for very high levels of insider ownership and therefore the monitoring hypothesis (introduction of guaranty funds increases monitoring of risk-taking due to the fact that solvent insurance companies have to pay ex post for insolvent insurers) cannot be totally rejected
Rees and Kessner (1999): Life insurers	Quantitative Study (Efficient-Frontier Estimation)	Distance to the efficient frontier estimated by: Administration costs/stock of insurance sum Acquisition costs/new premiums	Comparison of the German and UK insurance market (1992-1994) using efficient frontier estimation method (the smaller the variation of efficiency ratios within the market the better the regulation): • In the UK a higher proportion of insurance companies is close to the most efficient insurer than in Germany • Deregulation in Germany led to a higher proportion of companies close to the most efficient insurer

Study: Party evaluated (Who?)	Methodology (How?)	Proxy for costs and benefits (What?)	Key Results
Klein, Phillips and Shiu (2002):[104] Automobile and workers' compensation insurers	Quantitative Study (Econometrical methods)	Capital structure (leverage ratio)	Evaluation of rate regulation's impact on the capital structure of insurance companies: • A cross sectional analysis of 1349 insurance companies offering automobile and workers' compensation insurance reveals that rate regulation leads to higher leverage • More stringent regulation leads to higher leveraged insurers in comparison to non-regulated peers, since high leverage increases bankruptcy risk and incentivizes regulators in allowing higher rates
Bhattacharya, Goldman and Sood (2004): Life insurance policyholders	Quantitative Study (Econometrical methods/theoretical modelling)	Welfare (Utility function of policyholders wealth)	Estimation of welfare implications due to price regulation in the secondary life insurance markets (minimum prices for selling a life insurance policy to a third party): • Price regulation as currently discussed would apply to HIV patients with a life expectancy greater than four years • Deals worth $119 million will be blocked due to price regulation each year • Welfare losses (additional wealth needed so that the utility is the same in the case with and without price regulation) is most severe for people who are poor, have a low bequest motive, have a high time value of money and a low mortality risk
Deloitte (2006): Financial Services Industry	Survey	Compliance costs (excluding costs for implementing new regulation)	Identification of regulatory requirements which create the highest compliance costs for investment banking & corporate finance, institutional fund management and investment & pension advice companies in the UK: • Companies do not monitor compliance costs • Compliance costs for investment banking & corporate finance companies are relatively low and for investment & pension advice companies relatively high • Compliance costs for investment & pension advice companies do not vary according to size but to the customer base (institutional vs. retail)

[104] Studies, in addition to the ones mentioned in Table 30, which evaluate the impact of rate regulation for automobile insurance are Grace, Klein and Phillips (2002), Tennyson, Weiss and Regan (2002), Regan, Weiss and Tennyson (2008) as well as Li et al. (2012). For rate regulation in insurance, see also Skinner, Childers and Jones (1981).

Study: Party evaluated (Who?)	Methodology (How?)	Proxy for costs and benefits (What?)	Key Results
Hoy (2006): Policyholders	Quantitative Study (Theoretical modelling)	Welfare (Utility function of policyholders wealth)	Effect estimation of prohibiting risk classification variables via several models of insurance markets: • On the one hand limiting risk classification variables induces costs, but on the other hand it may mitigate the risk of misinterpreting the risk type of an individual • If the share of high-risk individuals exceeds a critical level then limiting risk classification variables reduces social welfare; if the share of high-risk individuals is smaller than this level limiting risk classification variables increases social welfare
CEA (2007): Life and non-life insurers, reinsurers	Survey	Compliance and implementation costs for new regulation	Estimation of future administrative costs for insures due to Solvency II: • 4.0 – 6.0 bn € of administrative costs for implementing the new framework • 0.6 – 1.0 bn € per year of administrative costs for compliance with Solvency II
Eling, Gatzert and Schmeiser (2008): Life and non-life insurers	Case Study (Qualitative reasoning)	Negative and positive consequences of the Swiss Solvency Test	Discussion of Swiss Solvency Test's impact on the Swiss economy: • Asset management: increased demand for long-term bonds • Underwriting: increase in demand for reinsurance; decrease of capital intensive insurance products
Braunwarth et al. (2009): Financial Services Industry	Case Study (Qualitative reasoning/descriptive statistics)	Goal realization of individual branches Profit	Identification of business opportunities with regard to the insurance mediation directive (IMD): • The case of a major German financial services company shows that IMD can lead to increased customer data quality which in turn can result in increased marketing effectiveness and goal realization of individual branches • The insurance mediation directive (IMD) is a directive by the European Union and regulates insurance intermediaries. Its goal is to increase customer protection. For more details, see European Commission (2014)
Holzmüller (2009): Wider economy	Case Study (Qualitative reasoning)	Disadvantages and advantages of capital requirement regulations	Comparison of US RBC Standards, European Solvency II and Swiss Solvency Test (SST) based on a framework by Cummins, Harrington and Niehaus (1994): • Solvency II and SST fulfill the criteria stated by Cummins, Harrington and Niehaus (1994); Holzmüller (2009); US RBC Standards do not • It is concluded that Solvency II and SST are superior to the US RBC Standards; between Solvency II and SST such a distinction is not possible

Study: Party evaluated (Who?)	Methodology (How?)	Proxy for costs and benefits (What?)	Key Results
PwC (2010): Life and non-life insurers	Survey	Costs for introducing new regulation	Survey about the introduction of Solvency II in Europe: • 40% of the insurers have a budget less than 1 million € for the implementation of Solvency II and 9% more than 20 million € • IT infrastructure and human resource expenses are anticipated as the main cost drivers
Europe Economics (2010): Life insurers, intermediaries, banks	Survey	Compliance and implementation costs for new regulation	Evaluation of costs and benefits of Markets in Financial Instruments Directive (MiFID) regulation regarding life insurance packaged retail investment products (life insurance contracts including a savings component with an exposure to financial markets) in the European Union: • Implementation costs for insurers: 0.14% of operating costs; industry total: 175 – 250 million €; economies of scale present • Compliance costs for insurers: 0.04% of operating costs; industry total: 50 – 80 million €; economies of scale present • Impact on customer demand: increased investor confidence (positive), increased paperwork and too much information (negative)
Weiss, Tennyson and Regan (2010): Automobile insurers	Quantitative Study (Econometrical methods)	Loss costs Claims frequency	Impact analysis of rate regulation in the automobile insurance market in the US: • Loss costs and claims frequency are slightly higher in states where rate regulation is in force • States with very stringent regulation have much higher loss costs and claims frequency than states with less stringent regulation • The hypothesis that limiting insurance prices for certain risk classification variables leads to cross subsidies from low-risk individuals to high-risk individuals and therefore to adverse selection is supported
Ernst & Young (2011): Life and non-life insurers, reinsurers, wider economy	Case Study/Survey	Compliance and implementation costs for new regulation Impact on capital Consequences of Solvency II	Cost-benefit analysis (CBA) of Solvency II in the UK: • Capital impact: reduction of £34 bn in free surpluses (reduction in free surplus of 37% of total surplus) in the insurance industry for moving from Solvency I to Solvency II • Implementation costs: £1.8 bn; compliance costs: unclear • Wider economy impact: increase of premiums or decrease of insurance cover, higher ratings, increased M&A activity, more transparency and a saver insurance sector

Study: Party evaluated (Who?)	Methodology (How?)	Proxy for costs and benefits (What?)	Key Results
Derrig and Tennyson (2011): Automobile insurers	Quantitative Study (Econometrical methods)	Loss costs and change in loss costs	Impact analysis of rate regulation in the Massachusetts automobile insurance market: • Loss costs in Massachusetts where rate regulation is existent are 29% higher than in states where there is no rate regulation • The hypothesis is supported that limiting insurance prices for certain risk classification variables leads to cross subsidies from low-risk individuals to high-risk individuals and therefore to adverse selection
Lorson, Schmeiser and Wagner (2012): Life and non-life insurers, policyholders	Quantitative Study (Econometrical methods and theoretical modelling)/ Survey	Compliance and implementation costs for new regulation Additional willingness to pay of policyholders	Evaluation if policyholders are willing to pay higher premiums for the increased safety level of Solvency II: • Empirical model: 0.77% - 7.85% higher premiums are acceptable • Option-pricing model: 0.03% higher premiums are acceptable • Utility-based model: 0.16% higher premiums are acceptable
Pasiouras and Gaganis (2013): Life and non-life insurers, reinsurers	Quantitative Study (Econometrical methods)	Distance to default (z-score)	Cross-country study on the relation of an insurer insolvency probability (measured by the z-score) and regulatory policies (measured by an index based on the IAIS database): • Powerful regulators reduce the probability of insolvency • Technical provisions regulation reduces the probability of insolvency • Investment regulation reduces the probability of insolvency
Dong, Gründl and Schlütter (2013): Life and non-life insurers, reinsurers policyholders	Quantitative Study (Theoretical modelling)	Welfare (Utility function of policyholders and shareholders wealth)	Evaluation of the welfare effect of insurance guarantee funds financed by flat fees or risk-based fees: • Guarantee funds financed by flat fees paid by insurance companies regardless of their risk exposure lead to increased risk-taking which reduces policyholders' welfare • Guarantee funds financed by risk-based fees paid by insurance companies only prevent increased risk-taking and maximize total welfare if the fees are high

Study: Party evaluated (Who?)	Methodology (How?)	Proxy for costs and benefits (What?)	Key Results
Practitioner Panel (2013): Financial Services Industry	Survey	Perceived effectiveness of regulation Perception of regulator	Biennial survey of companies regulated by the Financial Conduct Authority (FCA) and the Prudential Regulation Authority (PRA) on the industry's view of the regulator in the UK: • Satisfaction with the regulator recovered after it decreased in 2010 due to increased regulation in the aftermath of the financial crisis • 37% consider the regulator as ineffective, 24% as effective • The main consequences of regulation are: higher costs (reported by 74% of the participants), lower profit margins (38%) and creation of disadvantages towards foreign competitors (32%) • Industry recommends that regulation's intensity should be proportional to risk
Sass and Seifried (2014): Life and non-life insurers, reinsurers and policyholders	Quantitative Study (Theoretical modelling)	Premium levels Welfare (Utility function of policyholders and insurers wealth)	Estimation of the effect of unisex tariffs in life insurance on social welfare. For the analysis an insurance market model is developed which is an extension of the one by Rothschild and Stiglitz (1976): • Unisex tariffs lead to small insurance premium reductions for high-risk individuals and substantial premium increases for low-risk individuals • In competitive markets unisex tariffs reduce welfare; in monopolistic markets unisex tariffs can increase welfare, but regulation to enhance competitive markets would increase welfare even more

Table 30: Studies about costs and benefits of regulation in the insurance industry.

All studies mentioned in Table 30 focus on the impact of regulation on certain market participants or the wider economy, but they do not analyze if and in which way the impact of regulation differs on the basis of individual company characteristics. Nevertheless, such research is worthwhile, since regulation takes into account different firm characteristics. For example, depending on the sub-sector a financial company has to face different levels of stringency in regulation as shown by Franks, Schaefer and Staunton (1997). In addition, Cummins, Harrington and Niehaus (1994), Skipper and Klein (2000) and Holzmüller (2009) emphasize that capital requirements should be set according to the risk profile of an insurer and support in this way the proportionality principle. Therefore, if regulation requirements differ in stringency and scope according to certain company characteristics, we argue, the costs and benefits of regulation should also vary according to these characteristics.

3 Hypotheses

Table 31 gives an overview of the hypotheses we test in this paper. Hypothesis H1 (with three sub hypotheses) is set up to test the proportionality principle and hypothesis H2 tests for differences in organizational form. While the discussion of the proportionality principle focuses on the cost of regulation, we also include the benefits of regulation in the discussion of the organizational form as well as in the additional tests we present in the empirical part.

Hypothesis	Description		
H1:	Proportionality	*Diversified vs. specialist*	The costs of regulation for a composite insurer are higher than for an insurer active in life or non-life only.
		International vs. national	The costs of regulation for an international active insurer are higher than for an insurer active only in one country.
		Primary vs. reinsurance	The costs of regulation are higher for primary insurers than for reinsurers.
H2:	Organizational form	*Stocks vs. mutuals*	Costs and benefits of regulation for insurance companies differ among organizational forms.

Table 31: Hypotheses.

Globally, the proportionality principle is incorporated in the Insurance Core Principles by the International Association of Insurance Supervisors (IAIS) (Insurance Core Principal (ICP) 2.5 in IAIS, 2013a). In the US it can be found in the Risk Management And Own Risk And Solvency Assessment Model Act by the National Association of Insurance Commissioners (NAIC) and in Europe in the upcoming Solvency II framework.[105] The principle is commonly understood as guidance for regulation to take into account the *nature*, *scale* and *complexity* of an insurer's risk.[106] In Switzerland, regulation should also follow the proportionality principle; it is just codified slightly differently. An insurer's risk is not specified and an emphasis is put on sensitive regulation pertaining to business activity. The Financial Market Supervision Act states that the regulator "…exercises its regulatory powers only to the extent required by its supervisory objectives. In doing so, it takes account in particular of: […] the various business activities and risks incurred by the supervised persons and entities ..." (Article 7 (2c) in the Federal Assembly of the Swiss Confederation, 2007).

While proportionality of risk is a fundamental principle that has already been implemented in Switzerland, this principle is also incorporated in the current regulation of insurance companies in Austria and Germany. For example, in Germany the mission statement of the Federal Financial Supervisory Authority (BaFin, 2012) requires risk-oriented regulation and in Austria the Financial Sector Assessment Program report of the IMF (2014, Article 23 and 24) confirms that regulation is already risk-oriented. Nevertheless, Solvency II is expected to trigger the proportionality of regulation regarding risk, and Swiss regulation might be one step ahead of European regulation in complying with the principle. Therefore, in our analyses we control for the fact that the proportionality principle might be more observable for Swiss insurers by

[105] See for the US Section 2 (A) of NAIC (2012) and for Europe Article 29 (3) of the European Parliament and European Council (2009).

[106] In this paper we focus on the proportionality principle in the context of insurance. A more general discussion of the proportionality principle from a juridical perspective is given by Harbo (2010). The European Court of Justice, for example, applies the principle by testing if a certain legislative or administrative action is (a) suitable to achieve the stated goals, (b) is necessary to achieve the goals and (c) the measure is appropriate, that is, the burden for affected parties is reasonable in a given context.

considering interaction effects. The results do not offer additional insights and are available upon request.

Academic papers also mention that regulation needs to take the individual risk profile of an insurer into account. For example, Cummins, Harrington and Niehaus (1994) and Holzmüller (2009) recommend the implementation of firm-specific risk-based capital requirements in order to incentivize insurers to reduce their insolvency risk. Risk-based capital requirements help regulators to identify financially weak companies and to take regulatory action before a bankruptcy occurs.

Our first step is to test the proportionality principle by comparing the costs of regulation for diversified and specialist insurers (*diversified vs. specialists*). According to Hypothesis 1a the regulatory costs for a composite insurer should be higher than for an insurer active in life or non-life only. According to the proportionality principle, there should be different regulatory requirements for life and non-life, because of differences in the nature and complexity of risk in these branches. For example, longevity is a major risk in life insurance, but not so much in non-life insurance. Consequently, composite insurers should have to comply with more regulations and therefore have to incur higher costs than insurers focusing only on life or non-life. If this hypothesis is supported, this would indicate that the scope of regulation indeed varies according to the nature and complexity of risk.

The second step is to test the proportionality principle by comparing the regulatory costs of *international vs. national* insurers. Hypothesis 1b states that costs of regulation for an insurance company are higher if the insurer is active in several countries. The reasoning behind this hypothesis is twofold. First, global activities incorporate more kinds of risks than only local ones and therefore according to the proportionality principle the regulatory requirements for international insurers should be higher.[107] An example is the current development of the Common Framework for the Supervision of Internationally Active Insurance Groups (ComFrame) by the IAIS (2013b). This regulation is

[107] One could argue that diversification effects reduce the overall risk, but the nature and complexity of the risks should be higher. Furthermore, economies of scale should be realizable by implementing regulations from several jurisdictions.

exclusively relevant for internationally active insurers, not for ones only with a national scope. Second, international insurers have to comply with different regulatory frameworks and therefore have to endure higher costs than national insurers which have only to comply with one framework.

The third and final step is to test the proportionality principle by comparing *primary vs. reinsurance* companies. Hypothesis 1c states that the costs of regulation are higher for primary insurers than for reinsurers since many regulatory requirements are applicable for primary insurers, but not for reinsurers.[108] The assumed reason for this pattern is that the policyholder in personal lines of insurance needs more protection by regulation than in commercial lines, since individuals are considered to have fewer capabilities and less resources to implement effective monitoring than companies. For example, Epermanis and Harrington (2006) show for the US that premium growth in commercial lines very much depend on the financial strength of the insurance company, but not so much in personal lines. Therefore, the market discipline in commercial lines can indeed be regarded as higher than in personal lines. Following this line of reasoning, in reinsurance there should be less need for regulation, since both counterparties are companies.[109] Consequently, also the costs of regulation should be less for reinsurers than for primary insurers.

With Hypothesis 2 we want to add a new empirical test to the discussion about the organizational forms of insurance companies: *stocks vs. mutuals*. Previous studies (e.g., Harrington and Niehaus, 2002; Viswanathan and

108 An example is Article 2 (1a) of the directive on markets in financial instruments by the European Parliament and European Council (2004) which is only relevant for primary insurers and not for reinsurers. In addition, rate regulation in personal lines of property-liability insurance in the U.S. can be mentioned as described by Cummins (2001). In Switzerland, Article 35(1) of the insurance supervision act by the Federal Assembly of the Swiss Confederation (2013) shows that reinsurers are less regulated than primary insures. It specifies that several articles of the legislative act are relevant for primary insurers, but not for reinsurers. For example, generally a Swiss insurance portfolio can only be transferred to a third party if the regulator approves the transaction. An exception is the transaction of a pure reinsurance portfolio which needs not to be approved.

109 This argument is in line with Skipper and Klein (2000, p. 493) who write: “Governments regulate insurance purchased by individuals more stringently than insurance purchased by businesses and other organizations because of the greater information problems for individuals. Reinsurance historically has been subject to minimal regulatory oversight because both buyers and sellers are usually well informed.”

Cummins, 2003) explained the decreasing number of mutuals in the insurance industry mainly by their limited access to capital markets and do not consider differences in regulation. Hypothesis 2 states that costs and benefits of regulation for insurance companies differ among organizational forms. Eling and Pankoke (2013a) compare the requirements for supervisory board members between Germany and Switzerland and illustrate that they vary according to the organizational form of a company. However, if stocks or mutuals are favored by regulation is not clear.

On the one hand, an argument for higher regulation costs of stock market companies is that listed companies are subject to much more transparency and disclosure requirements, which do not apply to mutual companies (see, e.g., internal control weakness reporting under the Sarbanes-Oxley Act as described by Su, Zhao and Zhou, 2014). This argument is in line with the entrenchment hypothesis by He and Sommer (2011) which states that for mutuals there are fewer control mechanisms available than for stock companies. On the other hand, for the US, Zanjani (2007) shows that the historical decline of the number of life insurance mutuals in the 20th century was significantly influenced by regulation. He shows that the stringency of regulation itself has no impact on the choice of organizational form. Rather initial capital requirements define the popularity of mutuals as the preferred organizational form. If high levels of capital are required by regulation to found a life insurer it can be observed that a stock company is the preferred organizational form. This finding follows economic intuition since raising capital is easier for stocks than for mutuals.

In addition to the two main hypotheses regarding the proportionality principle and the organizational form, we control for the size of the insurer, its business focus and its country of origin. We control for *size* since certain regulations – as reporting requirements – have to be fulfilled by all insurers regardless of their size, so the relative burden for small insures should be higher than for large ones. Consequently, the relation between costs and benefits should be seen more positively by large insurers.[110] In addition, we control if the insurer is mainly active in *life or non-life* insurance. We expect that life and non-life insurers face different costs of regulation given that different regulations need to be followed. In addition, there are different levels of market discipline in life and non-life insurance as shown by Eling and Schmit (2012), which should also be considered by regulation. An example in which these differences are indeed considered are the guidance papers about technical provisions for life and non-life insurance (FINMA, 2008a, 2008b) in Switzerland.

Lastly, we control if the insurer has its headquarters in *Switzerland or Austria/Germany*. The Swiss Solvency Test (SST) has already been introduced and implemented in the Swiss insurance industry, but its European counterpart, Solvency II, will not be in force before 2016. Therefore, Austrian and German companies are still busy with implementation efforts and therefore might have higher costs. As reported by CEA (2007), PwC (2010) and Ernst & Young (2011) (see Table 30) costs for the implementation of Solvency II can be quite substantial. Furthermore, according to international statistics there is in general more economic freedom for businesses in Switzerland and the regulatory framework is considered to be of higher quality than in Austria and Germany.[111] We thus expect to see country differences between Switzerland vs. Austria/Germany, both in the evaluation of costs and benefits.

4 Data and Methodology

The empirical data used in this study was created from an industry study which was conducted on behalf of the Swiss Insurance Association. In order to estimate regulatory costs and benefits, a survey was sent to the CFOs of all

[110] A common misunderstanding is to relate size to the proportionality principle. However, the proportionality principle solely relates to the risk of an insurer and size is not necessarily an indicator of risk. See, for example, IAIS (2011, p. 9) and Kessler (2013, p. 9).

[111] For a comparison of the business environments in several countries see Heritage Foundation (2014). Our assessment is based on the Index of Economic Freedom for 2013. For a comparison of the quality of the regulatory frameworks in several countries, see World Bank (2013). Our evaluation is based on the information about regulatory quality used to generate the Worldwide Governance Indicator. The latest information is from 2012.

insurance companies registered at the national regulator in Austria, Germany and Switzerland in October 2013. The survey was sent to 543 companies, of which 76 participated. The questionnaire is provided in Figure 10 in the Appendix.[112]

In the market survey, regulation comprises all laws, directives and guidelines which must be met by insurers due to government requirements. Costs and benefits of regulation for insurers are defined as all consequences of regulation – either direct or indirect. Government costs and non-economic costs and benefits are not covered. Furthermore, implementation costs are distinguished from compliance costs. On the benefits side, the benefits for policyholder protection, for financial stability and the impact on the attractiveness of the business location are evaluated.

The questionnaire starts with general questions about the insurance company.[113] The major part consists of questions about the perceived costs and benefits of insurance regulation. In this context, *perceived* means that costs and benefits can be rated on a scale with five options: high, rather high, medium, rather low or low. We ask for the situation today, five years ago and the situation that is expected in five years. Based on this section we create ordinal variables about costs and benefits over time. Perceived costs and benefits are based on the subjective view of the respondent; we also ask the respondents to report the actual costs, which might be seen as a second more objective measure. We thus ask for the actual number of full-time employees committed to existing regulation and the implementing of new requirements. Moreover, we asked the participants to report their actual external costs for compliance with existing regulation and for implementing new requirements. Based on this

[112] The results thus represent the perspective of the industry, which might raise questions about data bias and industry influence. In order to avoid this potential data bias, different measures for costs of regulation are considered (actual and perceived costs). Moreover, the cross-country setting allows us to compare the evaluation among different countries. The industry was involved to gather the analyzed data, but not in preparation of this paper.

[113] The chosen categories regarding costs and benefits that have to be assessed by the survey participants are based on Skipper and Kwon (2007, p. 627). The general design of the questionnaire follows loosely the one by SECO (2012).

information, we generate an aggregate cost measure, where we combine the different cost measures.[114] An overview of the variables is shown in Table 32.

[114] In order to calculate the variables $Costs_{Aggregated}$, $Costs_{Implementation}$, and $Costs_{Compliance}$ we consider the external costs as reported in the survey and add the internal costs. Since the internal costs are measured in numbers of employees we calculate first the equivalent labor costs. The monthly labor costs are based on the number of employees (full-time equivalents) and calculated as follows. Per country we multiply the "mean nominal hourly labour cost per employee" with the "mean weekly hours actually worked per employee" as reported by the International Labour Organization (ILO) as of 2010 for Austria, Germany and Switzerland. In order to derive the monthly costs we multiply the resulting figure with 4.34. As the CHF/EUR conversion rate we use 1.38 which is the average in 2010 according to DataStream.

Variable	Type	Description
Dependent Variables		
Actual:		
$Costs_{Aggregated}$	Continuous	Natural logarithm of monthly total costs in €; includes external and internal costs as well as implementation and compliance costs.
$Costs_{Implementation}$	Continuous	Natural logarithm of monthly costs in € for implementing new regulation; includes external and internal costs.
$Costs_{Compliance}$	Continuous	Natural logarithm of monthly costs in € for compliance with existing regulation; includes external and internal costs.
Perceived:		
Costs Current/Past/Future	Ordinal	$Costs_{Current}$ indicates perceived current costs. $Costs_{Historical}$ indicates perceived cost developments within the last five years. $Costs_{Future}$ indicates expected cost developments within the next five years. Each variable is scaled from 1 to 5, whereas 1 means low costs and 5 high costs.
Benefits Public/Policyholders/ FinancialCenter	Ordinal	$Benefits_{Public}$ indicates perceived public benefits. $Benefits_{Policyholders}$ indicates perceived benefits for policyholders. $Benefits_{FinancialCenter}$ indicates the perceived benefits on the attractiveness of the business location. Each variable is scaled from 1 to 5, whereas 1 means low benefits and 5 high benefits.
Independent Variables		
Diversified	Dichotomous	One, if the insurer is active in the life and non-life segment, otherwise 0.
International	Dichotomous	One, if the insurer is active internationally, otherwise 0.
Primary	Dichotomous	Primary is 1, if the insurer is a primary insurer otherwise 0.
Size	Continuous	Size indicates the natural logarithm of yearly gross premium income in million €.
Life	Dichotomous	Life is 1, if the insurer is a life-insurance company, otherwise 0.
Stock	Dichotomous	Stock is 1, if the insurer is a stock company, otherwise 0.
Swiss	Dichotomous	Swiss is 1, if insurer is a Swiss company, otherwise 0.

Table 32: Variables used in the analysis.

In addition to the variables shown in Table 32, we apply another variable in robustness tests. $Risk_{Proportionality}$ combines the Diversified, International and Primary into one ordinal variable. According to the proportionality hypothesis this should represent the risk exposure of the insurer's business activities. The weights of the composing variables are determined by a factor analysis.[115] In

[115] As a further robustness test we also calculated the variable $Risk_{Proportionality}$ with equal weights of the composing variables. The results do not reveal further insights.

this way we control for the possibility that an overall proportionality effect might be present, but which is not strong enough to provide significant results for Diversified, International and Primary individually. Descriptive statistics and general information about the participating insurers are presented in Table 33.

	No. of Survey Participants		No. of Survey Participants		No. of Survey Participants
Type of insurer		**Main region**		**Organizational form**	
Primary Insurer	63	National	49	Stock company	54
Reinsurer	13	International	25	Mutual company	15
				Insurance company under public law/branch	6
Country of origin		**Main segment**			
Austria	11	Life	4		
Germany	16	Non-life	50		
Switzerland	49	Life & non-life	22		

	Mean	Std. Deviation	Minimum	Maximum
Premium income (Mio. €)	1'594	3'835	0.33	18'904
Technical reserves (Mio. €)	6'625	19'454	0.33	112'195
Implementation costs (€ per month)[116]	94'671	180'060	325	813'008
Compliance costs (€ per month)	192'916	512'157	1'258	3'182'922
Aggregated costs (€ per month)	269'632	622'475	1'888	3'520'710
$\text{Costs}_{\text{Aggregated}}$	10.92	1.81	7.54	15.07

[116] It is tempting to estimate the total implementation costs for Austria and Germany in order to compare them with the estimates of CEA (2007) and Ernst & Young (2011) which try to estimate the implementation costs associated with Solvency II. We think that the insights are limited since the sample and the understandings of implementation costs differ. If we do so, nevertheless, total implementation costs per year for Austria are 31 million € and for Germany 76 million €. CEA (2007) estimates implementation costs between 4 and 6 billion € for the whole European Union during the whole project. Ernst & Young (2011) estimates 474 million € alone for the UK per year. However, they report as well that the UK Department of Treasury considered in 2008 implementation costs for the UK 97 million € for the whole project. We conclude that the figures by Ernst & Young (2011) might be overestimated and are more likely to represent an upper bound. Further information about our estimation can be received upon request.

$Costs_{Implementation}$	9.88	1.90	5.78	13.61
$Costs_{Compliance}$	10.42	1.83	7.14	14.97
$Costs_{Current}$	3.83	0.97	1	5
$Costs_{Past}$	4.48	0.62	1	5
$Costs_{Future}$	4.39	0.68	3	5
$Benefits_{Public}$	3.44	0.89	1	5
$Benefits_{Policyholders}$	3.45	0.83	1	4
$Benefits_{FinancialCenter}$	2.92	1.04	1	5
Diversified	0.29	0.46	0	1
International	0.33	0.47	0	1
Primary	0.83	0.38	0	1
Size	5.01	2.48	-1.12	9.85
Life	0.05	0.23	0	1
Stock	0.71	0.46	0	1
Swiss	0.64	0.48	0	1

Table 33: Summary statistics.

Regarding actual costs, we apply the following multivariate regression model:

$$Y^i = a + \beta_1 \text{Diversified}^i + \beta_2 \text{International}^i + \beta_3 \text{Primary}^i + \beta_4 \text{Size}^i + \beta_5 \text{Life}^i + \beta_6 \text{Stock}^i + \beta_7 \text{Swiss}^i + \varepsilon^i \quad (1)$$

Y is a vector of the dependent variables $\text{Costs}_{\text{Aggregated}}$, $\text{Costs}_{\text{Implementation}}$, and $\text{Costs}_{\text{Compliance}}$ as shown in Table 32. a is the regression constant which is the same for all insurance companies. β_1 to β_7 are the regression coefficients; i indicates the company. We employ the Newey-West estimator since for some model specifications autocorrelated error terms cannot be rejected at the 5% confidence level.[117] In addition, we check for multicollinearity among the independent variables, but do not consider the issue further since the Variance Inflation Factors are in the 1.1-2.2 range.[118]

For the perceived costs and benefits we use the following ordered probit model:

$$\Phi^{-1}(w^{ij}) = T^j - (\beta_1 \text{Diversified}^i + \beta_2 \text{International}^i + \beta_3 \text{Primary}^i + \beta_4 \text{Size}^i + \beta_5 \text{Life}^i + \beta_6 \text{Stock}^i + \beta_7 \text{Swiss}^i) \quad (2)$$

w^{ij} is a vector and indicates the cumulative probabilities of the dependent variables $\text{Costs}_{\text{Current}}$, $\text{Costs}_{\text{Past}}$, $\text{Costs}_{\text{Future}}$, $\text{Benefits}_{\text{Public}}$, $\text{Benefits}_{\text{Policyholders}}$ and $\text{Benefits}_{\text{FinancialCenter}}$ as shown in Table 32. The company is indicated by i and the category by j. The category is determined by the value of the dependent variable and is indicated by an integer between 1 and 5. Φ^{-1} is the inverse of the cumulative distribution function and is used as the linking function.[119] T^j

117 We use least square regressions to estimate the model since other regression methods do not provide additional benefits. We do not use stepwise regressions since our model is based on theoretical reasoning and we only consider a few independent variables. Furthermore, we do not consider fixed effects since there are no intra-group differences. One could argue that the data is censored and a tobit regression might be useful. However, initial tests show that no estimated dependent variables are censored and therefore we do not further employed the methodology.

118 Literature does not agree on the largest acceptable value of the variance inflation factor under the assumption that multicollinearity is not a concern. Kleinbaum et al. (2008, p. 310) suggest 10 as an upper limit and therefore we believe a maximum variance inflation factor of 2.2, as in our case, is commonly acceptable.

119 As a further robustness test we also employed a logit function as linking function. The results do not provide any further insights and can be provided upon request.

represents the threshold for category j. β_1 to β_7 are the regression coefficients. In the analysis the maximum likelihood method is used for the model estimation.

Finally, we take perceived costs and benefits combined into account and employ a latent class model with covariates. This methodology allows us to generate participant profiles regarding perceived costs and benefits. We estimate latent classes considering the variables $\text{Costs}_{\text{Current}}$, $\text{Costs}_{\text{Past}}$, $\text{Costs}_{\text{Future}}$, $\text{Benefits}_{\text{Public}}$, $\text{Benefits}_{\text{Policyholders}}$ and $\text{Benefits}_{\text{FinancialCenter}}$ and estimate the likelihood of a certain class composition. In a second step we then analyze the impact of different characteristics on the probability of an insurer to be assigned to a certain class.[120] In order to do so, we estimate the explanatory power of the independent variables on the class affiliation. For the analysis we employ the following log-likelihood function:

$$\ln L = \sum_{i=1}^{N} ln \sum_{r=1}^{R} \frac{e^{X_i \beta_r}}{\sum_{q=1}^{R} e^{X_i \beta_q}} \prod_{d=1}^{D} \prod_{k=1}^{K_d} (\pi_{drk})^{Z_{idk}} \tag{3}$$

The log-likelihood term $\ln L$ is maximized with respect to the class-conditional outcome probabilities π_{drk} and the class conditional coefficients $\beta_{r/q}$. i indicates the company, r/q the latent class, d the dependent variable and k the response. Z_{idk} is an indicator variable and equal to one if the i$^{\text{th}}$ individual gives the k$^{\text{th}}$ response to the d$^{\text{th}}$ dependent variable. X_i is a vector of the dependent variables of individual i. By definition, $\beta_1$is set to zero. For the maximization the expectation-maximization algorithm by Dempster, Laird and Rubin (1977) is used.

120 Since the latent class analysis is applicable only to categorical data we transform the size variable into a categorical variable form 1 to 3 according to the insurers' quantile in the sample. In addition, we transformed the other independent variables from a scale from 1 to 5 to a scale from 1 to 3. This is necessary since otherwise the number of potential latent classes would be limited to two considering our data. We perform the latent regression model using the poLCA package in R. For further information about the methodology see Linzer and Lewis (2011) and for an example of its application to finance, see Guerrero, Egea and González (2007).

5 Empirical Results

5.1 Actual Costs

We first discuss the results for the actual costs, that is Equation (1) for the compliance, the implementation and the aggregated costs. In Table 34 the costs numbers include both internal and external costs. Results where internal and external costs are separated are available upon request.

Dependent Variable:	**Costs** Aggregated	**Costs** Compliance	**Costs** Implementation	**Costs** Aggregated	**Costs** Compliance	**Costs** Implementation
	1	2	3	4	5	6
Constant	9.28***	9.14***	9.60***	8.60***	8.02***	8.37***
	(12.01)	(13.57)	(8.05)	(15.21)	(14.21)	(11.93)
Div-ersified	0.27 (0.50)	0.59 (1.01)	0.31 (0.51)	-	-	-
Inter-national	-0.74 (-1.42)	-0.84* (-1.84)	-0.80 (-0.89)	-	-	-
Primary	-0.31	-0.72	-0.93	-	-	-
	(-0.49)	(-1.32)	(-0.96)			
Risk Proportionality	-	-	-	0.32 (1.10)	0.25 (0.89)	0.11 (0.33)
Size	0.57***	0.53***	0.53***	0.58***	0.59***	0.57***
	(6.35)	(6.04)	(3.90)	(7.98)	(7.46)	(5.08)
Life	0.16	0.62	-0.09	0.17	0.53	0.03
	(0.27)	(0.24)	(-0.11)	(0.31)	(1.03)	(0.04)
Stock	-0.69*	-0.79**	-0.92	-0.66*	-0.75*	-0.83
	(-1.77)	(-2.19)	(0.23)	(-1.70)	(-1.89)	(-1.14)
Swiss	-0.01	0.26	-0.78	-0.02	0.22	-0.83
	(-0.03)	(0.54)	(-1.21)	(-0.05)	(0.44)	(-1.25)
R2 adjusted	0.51	0.49	0.38	0.52	0.49	0.39
N	54	54	43	54	54	43

Table 34: Multivariate least-square regression results. The dependent variables represent internal and external total costs. ***,** and * indicate, respectively,

the 1%, 5% and 10% confidence levels. T-statistics are reported in parentheses. N stands for the sample size.

Against our initial expectation, the variables Diversified, International, Primary and $Risk_{Proportionality}$ have no significant explanatory power in any model with the exception of International in model 2. Robustness tests (available upon request) with other model specifications show similar results. Therefore, according to Table 34 the proportionality hypotheses can be rejected. An insurer's risk seems not to have any influence on its regulatory costs. One explanation for the significant negative coefficient of the International variable in model 2 might be that the regulatory costs are lower outside Europe than within Europe.[121]

The variable Size is significant in all models at a 1% confidence level. The algebraic sign of the coefficient of the size variable is positive and less than 1.[122] This indicates that costs increase underproportionally compared with the size of the company, which suggests that there are economies of scale regarding costs of regulation for insurance companies.[123] Big insurance companies have in total higher regulation costs than small insurers, but in relation to their size regulatory costs are lower. These findings are in line with economic intuition and with Grace and Klein (1999), Deloitte (2006) as well as Europe Economics (2010). As mentioned in Table 30, Grace and Klein (1999) evaluate the explanatory

121 This interpretation is in line with recent developments. Between 2007 and 2012 the costs of the regulators in Austria, Germany and Switzerland increased by 20.9%, 7.9% and 14.2% annually. In comparison the costs of the regulator of New York, USA increased only by 4.0% annually in the same time period. See Eling and Kilgus (2014, Table 8), Insurance Department (2008) and Department of Financial Services (2013). Further analyses which are available upon request support the interpretation that regulator costs outside Europe are lower than within Europe. If costs are differentiated according to internal and external costs, International is only significant in the external costs model. This is consistent with our interpretation since higher fees for insurance companies would only affect external compliance costs. Implementation costs and internal costs do not include fees issued by the regulator.

122 If the costs model is transformed into a "costs-relative-to-size-model" only the constant changes and the coefficient for the size variable turns negative. The reason for this pattern is that both dependent variables are logarithmized and therefore both regression models are very similar. As a robustness test we performed the analysis nevertheless and found that size has a strongly significant negative impact on costs relative to premium income as well. Results are available upon request.

123 Since both the dependent variable and the variable Size are logarithmized the coefficient of the Size variable determines the non-linear relationship between the companies' size and regulatory costs. Model specifications which assume a linear relationship result in a worse model fit.

impact of the stringency of the regulatory environment on different expense ratios (total expenses/premiums written, claims costs/premiums written, licenses & fees/premiums written and salary expenses/premiums written). In addition they control for size and report a significantly negative impact of size on each expense ratio. Deloitte (2006) also reports economies of scale regarding costs of regulation for investment banking & corporate finance companies and institutional fund management firms. Investment & pension advice companies are an exception; their size seems not to affect the costs of regulations. Finally, Europe Economics (2010) report that relative to their size, large insurers have to bear lower compliance and implementation costs than small insurers regarding MiFID regulation.

The hypothesis regarding the organizational form is supported by the results shown in Table 34. The variable Stock is at least significant at a 10% confidence level in models 1 and 4 regarding aggregated costs and in models 2 and 5 regarding compliance costs. In addition, the coefficients are negative. This suggests that stock companies have lower regulatory costs to bear than mutual companies. In models 3 and 6 regarding implementation costs the coefficients for the Stock variables are not significant. That could imply that past regulation discriminated against mutuals but not against current regulatory initiatives. The control variables Life and Swiss are not significant in any model.

5.2 Perceived Costs

Results regarding the perceived costs of regulation are shown in Table 35. The perception of current costs (models 1 and 4), the perception of the costs development over the last five years (models 2 and 5) as well as the expected development of costs within the next five years (models 3 and 7) are analyzed.

Dependent Variable:	**Costs** Current	**Costs** Past	**Costs** Future	**Costs** Current	**Costs** Past	**Costs** Future
	1	2	3	4	5	6
Diversified	0.55	-0.03	0.06	-	-	-
	(1.54)	(0.00)	(0.02)			
International	0.15	0.04	0.25	-	-	-
	(0.12)	(0.00)	(0.29)			
Primary	0.10	0.27	0.08	-	-	-
	(0.04)	(0.20)	(0.02)			
$Risk_{Proportionality}$	-	-	-	0.07	0.10	-0.10
				(0.10)	(0.20)	(0.19)
Size	0.04	0.08	0.07	0.10	0.08	0.09
	(0.27)	(0.88)	(073)	(2.23)	(1.08)	(1.50)
Life	-0.25	-1.07	-1.35**	-0.40	-1.03	-1.36**
	(0.17)	(2.65)	(4.28)	(0.46)	(2.62)	(4.67)
Stock	-0.97***	-0.92**	-0.02	-1.01***	-0.91**	-0.03
	(7.44)	(5.24)	(0.00)	(8.14)	(5.29)	(0.00)
Swiss	0.17	-0.19	-0.61*	0.12	-0.17	-0.62*
	(0.24)	(0.23)	(2.71)	(0.14)	(0.20)	(2.80)
Pseudo-R2	0.18	0.18	0.21	0.16	0.18	0.21
N	58	58	60	58	58	60

Table 35: Ordered probit regression results (costs). Dependent variables consist of the perceived costs. ***,** and * indicate respectively the 1%, 5% and 10% confidence level. Wald-statistics are reported in parentheses. N stands for the sample size.

No variable regarding the proportionality principle is significant in any model. This can be interpreted as further evidence that the proportionality hypothesis has to be rejected. Insurers conducting risky business activities do not perceive costs as higher than their peers – neither current, nor past or future costs.

In models 1, 2, 4 and 5, only the coefficients for the variable Stock are significant at a 1% respectively 5% confidence level and are negative. These results indicate that stock companies are less likely than mutuals to perceive the costs of regulation as high. These results could be interpreted as evidence for the hypothesis regarding the organizational form, since stock insurers seem to perceive current costs and the costs development in the last five years as less onerous than mutuals. An alternative explanation could be that stocks are already accustomed to high regulatory requirements (e.g., Corporate Governance Codices, laws which apply only to stocks[124] and several requirements by stock exchanges). In contrast, for mutuals the large number and high intensity of regulation is relatively new (e.g., in Switzerland Corporate Governance was not an issue for mutuals before FINMA RS 2008/32 was implemented in 2008) and therefore in a relative comparison perceive the cost development as higher burden. Basically, this line of thought would follow the entrenchment hypothesis by He and Sommer (2011) that there are currently fewer control mechanisms for mutuals than for stocks.[125]

Swiss insurers perceive the future costs developments as less burdensome than Austrian and German insurers do. This might be because the Swiss risk-based capital requirements (SST) have already been implemented, whereas its European equivalent Solvency II will not be introduced until 2016. German and Austrian insurers thus expect an increase in costs, while Swiss insurers expect the costs to remain at a relative high level. In this context, we also see that non-life insurers expect more severe costs developments in the future than life insurers. An explanation could be that especially in credit insurance, more stringent regulation is expected. The expected increase in stringency of regulation is also given as an explanation for the currently high percentage of

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124 An example of a law only applicable to stocks is the German Gesetz zur Kontrolle und Transparenz im Unternehmensbereich (KonTraG). Its goal is to enhance corporate governance in German companies. It requires the establishment of a risk management system and the disclosure of certain information in annual reports.

125 The results have to be interpreted with caution since the pseudo-R2 figures are low and therefore the goodness of fit of the models can be doubted. Models 3 and 6 which are acceptable according to pseudo-R2 figures show no significant explanatory power of the variable Stock. In these models the variables Life and Swiss are negative and significant at a confidence level of 5% and 10% respectively. As pseudo-R2 we report the Nagelkerke information criterion. Figures above 0.2 indicate that the goodness of fit of the model is acceptable. See, for example, Backhaus et al. (2006, p. 456).

run-off portfolios in this line of business, as reported by Eling and Pankoke (2013b).

A comparison of the analyses regarding the actual and perceived costs shows that the results are consistent. Table 34 and Table 35 both indicate that the proportionality hypothesis can be rejected and provide evidence for the hypothesis regarding the organizational form. The main difference in the results is that the actual costs analysis reveals economies of scale regarding costs of regulation. In contrast, the Size variable in the perceived costs analysis has no explanatory power on the perception of costs. Given the lack of proportionality and the concerns about the amount of regulation which is especially often raised by the smaller insurers, we expected a negative link; smaller insurers perceive the burden of regulation as higher. This expectation is, however, not confirmed by our data.[126]

5.3 Perceived Benefits

Results regarding the perceived benefits of insurance regulation are shown in Table 36. We analyze the explanatory power of insurer characteristics on the perceived benefits regarding the general public (models 1 and 4), policyholders (models 2 and 5) as well as on the attractiveness of the business location (models 3 and 6).

[126] Further analyses of the differences between actual and perceived costs reveal that for most insurers the perception of costs is in proportion to actual costs. We find that deviations between actual and perceived costs can be explained by the companies' size. Large companies tend to perceive their regulatory costs as high, although, their actual costs relative to premium income are in comparison with other insurers rather low. We think this result is due to the fact that large insurers benchmark themselves only with their peers regarding size and do not consider smaller insurers. When thinking about regulatory costs, very small insurers and their regulatory burden are simply not the focus. Results can be provided upon request.

Dependent Variable:	**Benefits** **Public**	**Benefits** **Policyholders**	**Benefits** **FinancialCenter**	**Benefits** **Public**	**Benefits** **Policyholders**	**Benefits** **FinancialCenter**
	1	2	3	4	5	6
Diversified	-0.49	-0.69	-0.63	-	-	-
	(0.92)	(1.59)	(1.67)			
International	-0.65	-0.02	-1.59***	-	-	-
	(1.76)	(0.00)	(9.01)			
Primary	-0.34	0.33	-1.33**	-	-	-
	(0.36)	(0.27)	(5.34)			
$Risk_{Proportionality}$	-	-	-	0.09	-0.01	0.13
				(0.19)	(0.00)	(0.39)
Size	0.02	0.16	0.09	-0.06	0.07	0.00
	(0.01)	(2.62)	(1.11)	(0.74)	(0.97)	(0.00)
Life	0.51	-0.46	-0.39	0.67	-0.07	-0.29
	(0.42)	(0.29)	(0.29)	(0.83)	(0.01)	(0.19)
Stock	0.54	-0.18	0.05	0.56	-0.14	0.10
	(2.26)	(0.23)	(0.02)	(2.49)	(0.15)	(0.89)
Swiss	0.93**	0.67*	1.12***	0.88**	0.64*	0.95***
	(6.41)	(3.01)	(9.62)	(5.87)	(2.84)	(7.32)
Pseudo-R2	0.25	0.10	0.30	0.22	0.07	0.15
N	59	59	59	59	59	59

Table 36: Ordered probit regression results (benefits). Dependent variables consist of the perceived benefits. ***,** and * indicate respectively the 1%, 5% and 10% confidence level. Wald-statistics are reported in parentheses. N stands for the sample size.

The results provide no further support for the hypothesis regarding the organizational form. In all models the Stock variable has no significant explanatory power. The variables Diversified, International, Primary, $Risk_{Proportionality,}$ Size and Life are not significant in most models. Only the coefficients in model 3 for International and Primary are significant at a 1% respectively 5% level and negative. In case of the International variable in model 3 we interpret the result as follows. As mentioned in Section 5.1, costs of the regulator seem to be higher in Europe than elsewhere. In contrast to national insurers, international active insurers realize this[127] and report that the attractiveness of the business location is suffering because of costly regulation. In model 3 the variable Primary also has significant negative explanatory power. This means reinsurers have a more positive view of the impact of regulation on the attractiveness of the business location than primary insurers do. This finding is consistent with economic reality that regulatory concerns are especially important for reinsurers. For example, Bermuda turned into a reinsurance hub next to the USA, the UK, Germany and Switzerland mainly because of tax advantages and pragmatic regulation (see, e.g. Holzheu and Lechner, 2007).

The variable Swiss is significant at least at a 10% confidence level in all models. However, the interpretation should focus mainly on models 1, 3 and 4 since in all other models the pseudo-R2 figures are below 0.2. In general, Swiss insurers evaluate the benefits of regulation for the public and the business location more highly than do their Austrian and German peers. On the one hand, this can be attributed to a higher quality of the Swiss regulatory framework as reported by the World Bank (2013) and Heritage Foundation (2014). On the other hand, the ongoing discussion about Solvency II and its delayed introduction could cause the benefits of regulation to be considered as lower at the moment by the insurance industry in the European Union.

5.4 Perceived Costs and Benefits

We take costs and benefits combined into account by employing a latent class regression with covariates. In a first step the insurers have to be clustered along latent classes. Table 37 shows the Bayesian and the Akaike Information Criterion regarding the number of classes in the model. The goodness of fit is best for the model with two latent classes.[128] Models with more than four classes are not possible if all perceived costs and benefits variables should be

[127] Alternatively, one could argue that national insurers do realize the differences in costs of regulation for insurance companies among different jurisdictions as well, but are not so much concerned about this fact, since these differences do not pose a competitive disadvantage for them.

[128] For a further discussion of the selection of the number of classes in a latent class analysis, see Linzer and Lewis (2006).

considered because the number of estimated parameters exceeds the number of observations.

No. Classes	**BIC**	**AIC**
1	515.18	490.45
2	514.01	462.50
3	546.48	468.18
4	584.37	479.29

Table 37: Goodness of fit criteria regarding latent class selection.

Figure 9 shows the class-conditional probabilities for insurers to have a certain variable manifestation given they belong to class one or two. In this way, the composition of each class is illustrated. For example, an insurer assigned to class one has a 10% probability to rate current costs as *very low* (represented by 1), a 20% probability to rate them *medium* (represented by 2) and a 70% probability for a *high* rating (represented by 3).

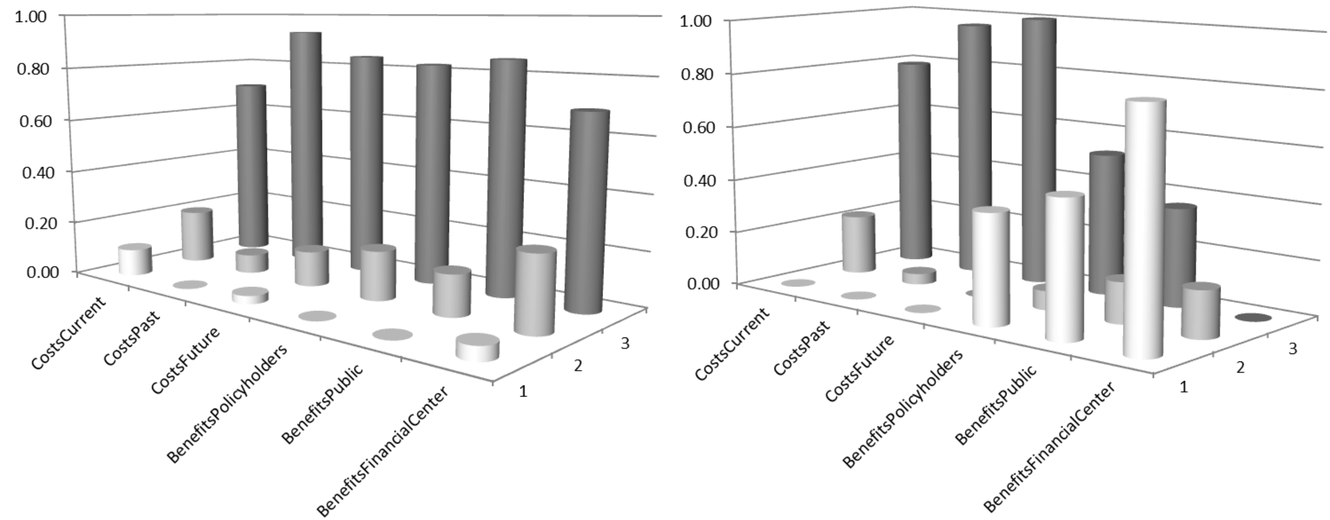

Figure 9: Class-conditional response probabilities. The left figure illustrates class 1 and the right figure illustrates class 2. The variable manifestation 1 represents low perceived costs with respect to benefits and the manifestation 3 high costs with respect to benefits.

Figure 9 reveals that to both classes a high percentage of insurers is attributed which rates the perceived costs for regulation as rather high. However, insurers which rate the perceived costs as low or medium fall mainly into class one: 30% of the insurers in class one rate current costs as low or medium in contrast to 22% in class two. Regarding past costs the figures are 7% for class one, 4% for class two, and 16% and 0% with respect to future costs. For perceived benefits the class compositions are clearer. In class one over 90% of the insurers rate the benefits regarding the public, policyholders and the business location as medium or high. In contrast, in class two over 40% of the insurers rate the benefits as low or medium.

The class assignments can thus be interpreted as information about the insurer's profile. Class one insurers in general have a positive view of regulation. The costs for regulation are rather high, but provide many benefits for a variety of stakeholders. We call companies belonging to class one "balanced" insurers. In contrast, class two seems two represent insurers with a negative view of regulation. The costs for regulation are very high and the benefits rather low. Especially they have a very unfavorable view of regulation with respect to the business location. These companies we call "pessimistic" insurers. In our sample 58% would be balanced "insurers" and 42% "pessimistic" ones. This result seems reasonable, since the Practitioner Panel (2013) reports for the UK that 37% of all financial services companies consider the regulator as ineffective.

After clustering the insurers in two latent classes and interpreting these clusters in a second step, the impact of independent variables on class assignments can be analyzed. Table 38 shows the model coefficients for class two of the independent variables because by default the coefficients for class one are set to zero. In addition, goodness of fit criteria are shown.[129] It can be seen that the model fit indeed increases when additional variables are used. BIC decreases from 514 to 490 and AIC from 463 to 427. Furthermore, the variable Swiss reduces the probability of an insurer being assigned to class two at a

[129] In order to illustrate the explanatory effect of the variables, we also calculated the conditional predicted probabilities for latent classes which are available upon request.

significant level of 1%. No other variables have significant impact on the probabilities for class assignments of the insurers.

	Independent Variables							
	Constant	Diversified	International	Primary	Size	Life	Stock	Swiss
Coef-ficient	-6.88	2.80	4.68	2.87	-1.40	1.47	0.33	-4.79***
	(-0.61)	(1.24)	(1.53)	(0.84)	(-0.72)	(0.26)	(0.14)	(-3.16)
AIC	427							
BIC	490							

Table 38: Parameter and goodness of fit criteria estimation of latent class model with covariates for class 2. By default the coefficients for class one are set to zero. ***,** and * indicate, respectively, the 1%, 5% and 10% confidence levels. T-statistics are reported in parentheses.

Taking perceived costs and benefits combined into account gives neither reason to support nor to reject the proportionality hypothesis or the hypothesis regarding the organizational form. Insurers can be clustered according to their overall view of regulation, but variables regarding the risk profile and the organizational form have no impact on this general view. In addition, the hypotheses focus on costs, but the clustering of the insurers is based mainly on the perception of benefits – the distribution of costs is similar in both classes.

An interesting finding of the latent class regression is that the country of origin plays a crucial role. Swiss companies seem to have a much better view of regulation than their Austrian and German peers. It seems that costs are perceived in both jurisdictions as rather high, but in Switzerland the high regulation is justified by high benefits for all stakeholders. This is in line with our initial reasoning that the business environment in Switzerland is more open than in Austria and Germany.

6 Conclusion and Policy Implications

Cost-benefit analyses of financial regulation, if at all, are conducted mostly for the banking industry (e.g., Elliehausen, 1998). The little material that exists on insurance typically analyzes the cost side without discussing the benefits of regulation. This paper targets this gap in the literature and evaluates both costs and benefits of insurance regulation. In addition, this paper focuses not only on costs and benefits individually, but takes costs and benefits combined into account by employing a latent class regression with covariates. The analysis is based on data from 76 insurance companies in Austria, Germany and Switzerland. Table 39 summarizes the main results.

Hypothesis/ Dependent variable	**Independen t variable**	**Our result**	**Comparison with literature**
Prop- ortionality/ Costs	Diversified, International and Primary	An insurer's risk profile has no impact on costs of regulation.	Result is in contrast to international guidelines and country-specific regulations (Insurance Core Principal (ICP) 2.5 of IAIS, 2013a; Article 7 (2c) of Federal Assembly of the Swiss Confederation, 2007 and Article 29 (3) of European Parliament and European Council, 2009).
Organ- izational form/ Costs and benefits	Stock	Stock insurers have lower regulatory costs than mutual companies.	Result is consistent with Zanjani (2007) and extends, for example, Harrington and Niehaus (2002) as well as Viswanathan and Cummins (2003).

Table 39: Summary of main results and comparison with existing literature

The proportionality hypothesis (regulation intensity increases with risk and complexity of the insurer) must be rejected. Neither the analysis regarding actual costs nor the one about perceived costs provides any evidence that the proportionality principle has been implemented in current regulation. In contrast, the size of an insurer has a significant impact on costs of regulation. Small insurers incur higher costs relative to yearly premium income than their larger peers.

These results are interesting since the regulators in Austria, Germany and Switzerland claim that the stringency of regulations is based on the riskiness and complexity of an insurer, not necessarily on its size. Our results suggest that the opposite might be true and at the very least the proportionality principle has not yet been properly implemented. Therefore, it might be worthwhile to revise existing regulation with respect to the risk sensitivity and, more importantly, to make sure that future regulation as Solvency II takes the proportionality principle into account. This recommendation is in line, for example, with the Practitioner Panel (2013) which reports that financial companies in the UK ask for more thorough implementation of the proportionality principle.

Regarding the second hypothesis, results show that actual and perceived costs of regulation are lower for stock insurers than for mutuals. In this regard our results support the findings by Zanjani (2007). The limited access to capital seems not to be the only disadvantage of mutuals but also the regulatory framework might deter insurance companies from choosing the organizational structure of a mutual. Further research should evaluate which specific regulations in addition to initial capital requirements are heavier burdens for mutuals than for stock companies. Similarly, regulators should review if some requirements cause competitive distortions between mutuals and stocks and if any organizational structure is preferable from a regulatory point of view.

Finally, the results show that Swiss insurers rate the perceived benefits of insurance regulation higher than their Austrian and German peers. Especially, when perceived costs and benefits are taken together into account Swiss insurers have a more positive view of regulation than Austrian and German insurers. Swiss insurers tend to be "balanced" in their perception and Austrian and German ones more "pessimistic". We attribute this to two reasons. First, the preparation process for Solvency II in the insurance sector in the European Union creates uncertainty and may lead to more pessimistic views on regulation. Second, the Swiss regulatory framework might be better than the one in the European Union in general.[130] These findings should alert regulators in the European Union not to create competitive disadvantages for insures due to regulatory requirements. Furthermore, after the implementation of Solvency II it would be worthwhile to analyze if the difference in perception of benefits

[130] International comparisons of regulatory frameworks by the World Bank (2013) and the Heritage Foundation (2014) rate Switzerland better than the European Union. Moreover, there is a recent trend in the European Union towards economically questionable regulations as unisex tariffs (see, e.g., Sass and Seifried, 2014) or simple solutions to systemic risk (see, e.g. Ashby, Peters and Devlin, 2014).

between Swiss and European insurers remains. Theoretically, Solvency II should further increase the benefits of regulation for the public and the policyholders in Europe.[131]

[131] See, for example, Holzmüller (2009) finds that Solvency II fulfills the criteria for capital requirements as stated by Cummins, Harrington and Niehaus (1994). Furthermore, according to Ernst & Young (2011) it is likely that Solvency II leads to a reduced default probability of insurers, improved risk management and more transparency. In addition, economic growth is supported due to higher confidence in the insurance sector.

Appendix

Marktbefragung zur Wirksamkeit der Regulierung in Deutschland, Österreich und der Schweiz

Unter Regulierung fassen wir alle Gesetze, Verordnungen und Richtlinien zusammen, welche aufgrund staatlicher Vorgaben erfüllt werden müssen. Der Fragebogen umfasst 10 Frageblöcke auf 4 Seiten. Sie können den Bogen postalisch oder online unter http://www.unipark.de/uc/ivw/ ausfüllen.

1. Bitte ordnen Sie Ihr Unternehmen / Geschäftstätigkeit nach folgenden Charakteristika ein
(Bitte beschränken Sie sich im Fall einer internationalen Versicherungsgruppe auf ihren Heimatmarkt):

a. Art Ihres Unternehmens:
☐ Erstversicherung ☐ Rückversicherung

b. Sitz Ihres Unternehmens:
☐ Deutschland ☐ Österreich ☐ Schweiz

c. Haupt-Versicherungssparte (mehr als 80% der Prämien):
☐ Leben ☐ Nichtleben ☐ Beide Sparten

d. Haupt-Kundensegment (mehr als 80% der Prämien):
☐ Privatkunden ☐ Firmenkunden ☐ Beide Segmente

e. Haupt-Tätigkeitsbereich (mehr als 80% der Prämien):
☐ National ☐ Europa ☐ Weltweit

f. Welche Rechtsform hat Ihr Unternehmen?

☐ Aktiengesellschaft ☐ Versicherungsverein auf Gegenseitigkeit / Genossenschaft
☐ Öffentlich-rechtliches VU ☐ Niederlassung

g. Wie gross ist Ihr Unternehmen?

Gebuchte Prämien: Mio. € …… oder Mio. CHF ……
Versicherungstechnische Rückstellungen (brutto): Mio. € …… oder Mio. CHF ……

2. Bewerten Sie bitte die Qualität der Regulierung und deren Umsetzung durch die Aufsicht.
1 = stimme überhaupt nicht zu, 5 = stimme voll zu

	1	2	3	4	5
a. Die Qualität der Regulierung (Gesetze, Verordnungen etc.) ist gut:					
… Heute.	☐	☐	☐	☐	☐
… Vor fünf Jahren.	☐	☐	☐	☐	☐
b. Die Qualität der Umsetzung (Umsetzung der Regulierung im Rahmen der Aufsichtstätigkeit) ist gut:					
… Heute.	☐	☐	☐	☐	☐
… Vor fünf Jahren.	☐	☐	☐	☐	☐

Anmerkungen dazu:

____

____

____

1

3. **Belastung aufgrund von Regulierung** (Kosten, Mehrarbeit, entgangenes Geschäft aufgrund von Regulierung)

	Wie gross ist die **durchschnittliche Belastung** für Ihr Unternehmen?						Wie hat sich die Belastung durch die Regulierung in den **letzten 5 Jahren** entwickelt?					Wie denken Sie wird sich die Belastung in den **nächsten 5 Jahren** entwickeln?				
Regulierung in Bezug auf:	Nicht betroffen	Gering	Eher gering	Mittel	Eher hoch	Hoch	Gefallen	Eher gefallen	Unverändert	Eher gestiegen	Gestiegen	Fallen	Eher fallen	Unverändert	Eher Steigen	Steigen
Versicherungsgeschäft																
Risk Management / Aktuarielle Anforderungen	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Corporate Governance / IKS	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Vermittlerrecht / Distribution	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Solvenz Anforderungen (SST / Solvency II)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Informationspflichten gegenüber der Aufsicht	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Veröffentlichungspflichten gegenüber der Öffentlichkeit	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Anti-Diskriminierung	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Qualifikation (Fit and Proper)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Insolvenz / Garantiefonds	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Allgemeine Regulierung																
Steuern / FATCA	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Geldwäsche	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Vergütungssysteme	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Datenschutz	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Wettbewerbsrecht	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Regulierung insgesamt	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

4. **Effektivität von Regulierung im Versicherungsbereich** (Nutzen der Regulierung)

	Hilft Regulierung die **Interessen der Versicherten** zu schützen?					Hilft Regulierung die **Interessen der Allgemeinheit** zu schützen (z.B. Finanzstabilität)?					Hilft Regulierung die **Attraktivität des Finanzplatzes** zu fördern?				
Regulierung in Bezug auf:	Nein	Eher nein	Weiss nicht	Eher ja	Ja	Nein	Eher nein	Weiss nicht	Eher ja	Ja	Nein	Eher nein	Weiss nicht	Eher ja	Ja
Versicherungsgeschäft															
Risk Management / Aktuarielle Anforderungen	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Corporate Governance / IKS	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Vermittlerrecht / Distribution	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Solvenz Anforderungen (SST / Solvency II)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Informationspflichten gegenüber der Aufsicht	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Veröffentlichungspflichten gegenüber der Öffentlichkeit	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Anti-Diskriminierung	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Qualifikation (Fit and Proper)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Insolvenz / Garantiefonds	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Allgemeine Regulierung															
Steuern / FATCA	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Geldwäsche	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Vergütungssysteme	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Datenschutz	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Wettbewerbsrecht	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Regulierung insgesamt	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

5. Wie gross ist der **Aufwand pro Monat**, um in Ihrem Unternehmen alle Tätigkeiten, die auf regulatorische Vorschriften basieren, auszuüben? Unterscheiden Sie bitte den internen Aufwand von demjenigen, den Sie an externe Personen vergeben (inkl. Gebühren für Wirtschaftsprüfung und Aufsicht). Versuchen Sie eine möglichst gesamthafte Betrachtung (inklusive Zentralbereiche wie Risk Management, Legal, Compliance etc.) vorzunehmen.

Laufender Aufwand für bestehende Regulierung:

a. Interner Aufwand (Anzahl Stellen in Vollzeitäquivalenz pro Monat): _______Vollzeitstellen

b. Externer Aufwand (Euro / CHF pro Monat): ____________€ oder ____________CHF

Implementierung neuer Regulierung in 2013:

a. Interner Aufwand (Anzahl Stellen in Vollzeitäquivalenz pro Monat): _______Vollzeitstellen

b. Externer Aufwand (Euro / CHF pro Monat): ____________€ oder ____________CHF

6. Wenn Sie die Möglichkeit hätten, eine konkrete gesetzliche Vorschrift / Regulierungsverordnung zu verändern, welche wäre das?

a. Gesetzliche Vorschrift ____

b. Haben Sie für diese Vorschrift konkrete Verbesserungsvorschläge?

____

____

____

Wie könnte man generell den mit der Regulierung einher gehenden Aufwand reduzieren?

____

____

____

7. Wie beeinflusst die derzeitige Regulierung den Wettbewerb in der Assekuranz?

☐ Weiss nicht ☐ Negativ (wettbewerbsverzerrend) ☐ Eher negativ ☐ Eher positiv ☐ Positiv (wettbewerbsfördernd)

8. Wie beeinflusst die derzeitige Regulierung die Innovationsfähigkeit der Assekuranz?

☐ Weiss nicht ☐ Negativ (innovationshemmend) ☐ Eher positiv ☐ Eher negativ ☐ Positiv (innovationsfördernd

9. Ländervergleich

a. Wie schätzen Sie den Umfang der Regulierung im Vergleich zu ihrem Heimatmarkt ein?

Deutschland:	☐Weiss nicht	☐ Geringer	☐Eher geringer	☐Vergleichbar	☐Eher mehr	☐ Mehr
Österreich:	☐Weiss nicht	☐ Geringer	☐Eher geringer	☐Vergleichbar	☐Eher mehr	☐ Mehr
Schweiz:	☐Weiss nicht	☐ Geringer	☐Eher geringer	☐Vergleichbar	☐Eher mehr	☐ Mehr

b. Wie schätzen Sie die Wirksamkeit der Regulierung im Vergleich zu ihrem Heimatmarkt ein?

Deutschland:	☐Weiss nicht	☐ Schlechter	☐Eher schlechter	☐Vergleichbar	☐Eher besser	☐Besser
Österreich:	☐Weiss nicht	☐ Schlechter	☐Eher schlechter	☐Vergleichbar	☐Eher besser	☐Besser
Schweiz:	☐Weiss nicht	☐ Schlechter	☐Eher schlechter	☐Vergleichbar	☐Eher besser	☐Besser

10. Zuletzt möchten wir Sie fragen, in wieweit Sie folgenden Aussagen zustimmen:

	1 = stimme überhaupt nicht zu, 5 = stimme voll zu	1	2	3	4	5
a.	Eine Alternative zu einer regelbasierten Regulierung kann in einer Ausweitung der Haftung für Manager liegen.	☐	☐	☐	☐	☐
b.	Eine Alternative zur Aufsichtskontrolle kann in einer Verlagerung der Kontrolle auf Ratingagenturen liegen.	☐	☐	☐	☐	☐
c.	Eine Alternative zur Aufsichtskontrolle kann in einer Verlagerung der Kontrolle auf Wirtschaftsprüfer liegen.	☐	☐	☐	☐	☐
d.	Die Komplexität der Regulierung ist zu hoch.	☐	☐	☐	☐	☐
e.	Regulierung schränkt den Handlungsraum des Managements ein und führt zu ökonomisch nicht sinnvollen Entscheidungen.	☐	☐	☐	☐	☐
f.	Die momentane Regulierung schafft gleiche Rahmenbedingungen für alle…					
	… Versicherer im lokalen Markt.	☐	☐	☐	☐	☐
	… Finanzdienstleister im lokalen Markt (Banken, Versicherer, Pens.kassen)	☐	☐	☐	☐	☐
	… für alle Versicherer im Vergleich Deutschland, Österreich, Schweiz.	☐	☐	☐	☐	☐
	Anmerkungen / Verbesserungsvorschläge / Was muss sich ändern? ________					
g.	Der Entstehungsprozess von Regulierung ist effizient und transparent.	☐	☐	☐	☐	☐
	Anmerkungen / Verbesserungsvorschläge / Was muss sich ändern? ________					
h.	Es wäre attraktiv das Solvency II / SST–Modell gegen eine einfache Kennzahl (z.B. Equity zu Total Assets) einzutauschen.	☐	☐	☐	☐	☐
	Anmerkungen / Verbesserungsvorschläge / Was muss sich ändern? ________					
i.	Im Rahmen der Finanzregulierung wird nicht ausreichend zwischen Versicherern und Banken differenziert.	☐	☐	☐	☐	☐
	Anmerkungen / Verbesserungsvorschläge / Was muss sich ändern? ________					
j.	Die Aufsicht verfügt über die notwendigen Ressourcen, um ihrer Aufgabe nachkommen zu können.	☐	☐	☐	☐	☐
	Anmerkungen / Verbesserungsvorschläge / Was muss sich ändern? ________					

Bitte senden Sie uns – sofern gewünscht – ihre Email Adresse oder Postanschrift auf einem separaten Blatt, so dass wir den Befragungsbogen anonym ablegen und Ihnen ein Exemplar der Resultate zuschicken können. Herzlichen Dank für Ihre Teilnahme!

4

Figure 10: Survey about the effectiveness of financial regulation in Austria, Germany and Switzerland.

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V Discontinued Business in Non-Life Insurance—An Empirical Test of the Market Development in the German-Speaking Countries[132]

Although every company has discontinued business, its active management is a relatively new topic in practice and an entirely new field of study in academia. Based on a survey of 85 non-life insurers from Germany, Switzerland, Austria, and Luxembourg, we empirically test the market development and find indication that Swiss insurers seem to have more experience with the active management of discontinued business than insurers in other countries. We explain this phenomenon by that country's more advanced solvency capital requirements that better reflect the risk of discontinued business activities. We thus conclude that with the introduction of Solvency II, active management of discontinued business will become more important since insurers will have to hold higher equity capital for discontinued business portfolios. We illustrate this fact within a numerical example which shows that 23% of the Solvency II non-life premiums and reserve risk can be traced back to discontinued business.

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1 Introduction

Current market studies estimate that 20–30% of the technical provisions in European property/casualty insurance are related to portfolios in discontinued business (see KPMG, 2010 and PwC, 2013). In the insurance context, 'discontinued business' refers to business for which there are still obligations from previous years, but no new business is being written and thus no premium income is being generated. Virtually every insurer has such 'inactive business', also known as 'run-off' or 'discontinued business'.[133]

In the past, most insurance companies in the German-speaking countries did not pay too much attention to their discontinued business portfolios. Unlike in the U.K. or U.S. insurance markets, where various instruments for actively managing discontinued business (e.g., portfolio transfer, commutation) are used, this issue has only recently become important in the German-speaking countries. One potential driver for the increasing importance of discontinued business is the planned introduction of Solvency II in 2016 (See, e.g., Financial Times, 2013). Under Solvency I, in general, discontinued business was not important for capital requirements. However, as we show in this paper, this situation will change significantly with the introduction of Solvency II.

To our knowledge, the issue of discontinued business is virtually absent from the existing academic literature. A number of consulting firms and other practitioners analyse the market from time to time (see KPMG, 2007, 2010; PwC, 2010, 2013 and Quane et al., 2002). The only on-topic academic paper we are aware of is by Kwon et al. 2015, who analyse market exit strategies from an international perspective, i.e., how insurers go about stopping their business in an entire country. Our focus is on the active reduction of discontinued business within a country, i.e., without leaving the whole market.

We present results of a market survey on discontinued business which was conducted in continental Europe. Specifically, we focus on the German-

[133] Run-off in the sense of discontinued business should not be confused with the so called run-off-triangle in the chain ladder procedure indicating the expected claims in the future (see Pater 1989 and Salzmann and Wüthrich, 2012

speaking countries of Germany, Austria, Switzerland, and Luxembourg. Using multivariate regression models, we empirically test four hypotheses that relate the company characteristics of insurance type (primary vs. reinsurance), legal form, domiciliary country, and size to the portion of business in run-off and experience with active management of discontinued business. Moreover, the impact of Solvency II on the future importance of discontinued business is analysed. To this end, we present a numerical analysis which shows the amount of the solvency capital requirements (SCR) in the 'non-life premium and reserve risk' attributable to discontinued business.

Our results based on the market survey show that Swiss insurers seem to have more experience with discontinued business than insurers in other German-speaking countries. This result might be attributable to the fact that Switzerland introduced risk-based capital standards in 2006. Germany, Austria, and Luxembourg still rely on the old Solvency I rules, under which discontinued business typically is unimportant. We also document that reinsurers and stock insurers are likely to have more experience with discontinued business, whereas the topic seems not to be on the agenda of most mutual companies.

One of the major conclusions from the analysis is that discontinued business is likely to become a much more important topic when Solvency II is introduced. We underline this result with a numerical example in which we compare an insurer with and without discontinued business. In this example, nearly one-quarter of the Solvency II 'non-life premium and reserve risk' is due to discontinued business. This finding emphasizes the increasing importance of discontinued business in the context of Solvency II. Every insurer must critically review inactive business as part of a value-based management system. Our findings are thus especially important for insurance managers and regulators, but also relevant to academics and policymakers interested in this new management topic.

The remainder of the paper is organised as follows. In Section 2 we examine the definition of discontinued business and provide a classification scheme for various management techniques. In Section 3 we provide an overview of the discontinued business market, discuss its development based on our market survey, and present regression results that empirically test our hypothesis. In Section 4 we discuss the possible implications of the new Solvency II regulation on the future management of discontinued business. We conclude and discuss directions for future research in Section 5.

2 Definition and classification of discontinued business

2.1 Definition of discontinued business

Discontinued business is still a relatively new field, and thus characterized by a variety of terms and varying definitions. Thus it is important to first clarify which definition we use in the following analysis. We define discontinued business as business for which there are still obligations from previous years, but for which no new premiums are written. Other terms for the concept of ‘discontinued business’ include ‘run-off’, ‘legacy business’, and ‘inactive business’, and we use these four terms as synonyms in this paper.

Discontinued business can be managed either actively or passively. By passive management, we mean that no focused attempts are made to decrease the amount of discontinued business. In contrast, active management involves proactively trying to reduce discontinued business. Active management can be further differentiated into internal and external solutions. Internal solutions are when the business is actively reduced, but no third party is involved (i.e., commutation or portfolio transfer within the group). External solutions occur when a third party is involved in the active reduction of the reserves (i.e., share deal, portfolio transfer or retrospective reinsurance). Figure 11 summarizes the definition of discontinued business and its management.

Discontinued business
= “inactive business” = “legacy business”= “run-off”

Active management of discontinued business:		**Passive management of discontinued business:** No special attention is paid to the discontinued business
Internal solutions: • Commutation • Portfolio transfer within the group	**External solutions:** • Share deal • Portfolio transfer • Retrospective reinsurance	

Figure 11: Definition of discontinued business.

2.2 Motivation for active management of discontinued business

As indicated above, there are many reasons for actively managing discontinued business and these are discussed in more detail and systematized below. In Figure 12 we differentiate between potential motives for internal and external solutions; i.e., commutation and the intragroup portfolio transfer versus the retrospective insurance, the share deal and the portfolio transfer. For a further discussion of discontinued business portfolio transfers see Quane et al. (2002).

Internal Solutions:		**External Solutions:**		
Motives for commutation: • Reputational risks • Run-off is core business	**Motives for intragroup portfolio transfers:** • Reduction of complexity • Profit enhancement • Tax advantages • Ring-fencing	**Motives for retrospective reinsurance:** • Reputational risks • Solvency improvement • Freeing up resources • Speed of execution	**Motives to cede portfolios/share deal:** • Reduction of complexity • Solvency improvement • Freeing up resources • Saving administrative costs	**Motives to buy discontinued business :** • Profit seeking • Specialization • Expertise in claims handling • Negotiating advantage towards third party • Improvement of diversification

Figure 12: Motives for active management of discontinued business.

The main motive for handling discontinued business portfolios in-house is reputational risk. Externalising discontinued business could be interpreted as a distress signal by the market since doing so makes it clear that certain lines of businesses are actively abandoned. Hence, it could distract business partners, customers, and investors. Furthermore, such behaviour could have the effect of undermining customer trust in the insurance company. There is no study which analyses these reputational risks so that the empirical relevance of these aspects is unclear. Nevertheless, reputational risks can be seen as a major argument for handling discontinued business without the help of a third party. Of course, there are also companies who actually specialize in managing discontinued business and thus see run-off as their core business. These companies not only have an interest in retaining their existing discontinued business portfolios, but even want to extend them.

Another aspect relevant to internal management of discontinued business is the intra-group transfer. Empirically, a major fraction of portfolio transfers is within a group, e.g., in Germany it accounts for about 50% of all discontinued business transfers. In general, there are three motives for intra-group transfer. The so-called ring-fencing of existing liabilities means that particular businesses (e.g., asbestos) are outsourced to a third company within the group so as to relieve other group companies of these liabilities. At the group level, complexity reduction could be a second reason for a transfer. And finally, tax considerations can be important.

From the perspective of a ceding company, there are five main arguments for externalising discontinued business: reducing risk, improving solvency, freeing up resources, saving administrative costs, and reducing complexity. Furthermore, being able to reduce the discontinued business portfolio in a short period of time is especially a motive for retrospective reinsurance. All these motives reflect the increasing importance of value-based management. For example, a portfolio transfer and the subsequent transfer of insurance contracts result in a reduction of risk, which in turn may lead to a more solvent company. Under Solvency I, this line of reasoning is not considered in determining capital requirements. Most cases of discontinued business under Solvency I have no impact as long as the premium index is higher than the claims index (the maximum of the two gives the capital requirement). This will change significantly with Solvency II, as we show in Section 4. In addition, for the management of discontinued business, the release of resources and, consequently, administrative savings can be important considerations. Another argument for the externalisation of discontinued business is reduction in complexity of the business structure and, therefore, simplification of management.

What are potential motives to buy portfolios in run-off? In fact, accepting old business might be profitable. For example, in continental Europe inactive portfolios are typically conservatively reserved so that settlement gains between buyer and seller can be distributed. Other benefits can be achieved if the acquiring company has the necessary specialization and know-how to better manage and assess the risk of the business than the ceding company. Also, the buyer may have a number of comparable portfolios, which can lead to synergies, better risk pooling, or diversification.

2.3 Techniques for active management of discontinued business

Table 40 sets out the four main techniques for actively managing discontinued business: sale of the company (share deal), transfer of a portfolio (portfolio transfer), retrospective reinsurance, and commutation.[134]

Method	**Definition**	**Economic finality**	**Judicial finality**	**Regulatory approval**
Share deal	A whole company with discontinued business is sold.	Yes	Yes	Yes
Portfolio transfer	A portfolio with discontinued business is transferred to another company.	Yes	Yes	Yes
Retrospective reinsurance	A retrospective reinsurance contract is set up for the portfolio with discontinued business which covers all underwriting liabilities arising from the portfolio.	Contingent*	No	No

[134] For another comparison of management techniques, see DARAG (2013).

Method	Definition	Economic finality	Judicial finality	Regulatory approval
Commutation	Insurer and policyholder(s) agree to cancel insurance coverage for a single payment.	Yes	Yes	No

Table 40: Four techniques for active management of discontinued business. *Economic finality is contingent on the reinsurer's solvency.

Under the first method, sale of the company (share deal), an entire company which has stopped writing new business is sold. Legally, the sold company can no longer be prosecuted. Thus, the transfer is final (so-called finality). The sale of the company is subject to regulatory approval.

In the second method, a portfolio consisting of discontinued business is transferred to another company within or outside an insurance group. Thus, portfolio transfers can be either an internal or an external solution to discontinued business. This process is also subject to regulatory approval. Most jurisdictions within the European Union have a uniform regulation for this procedure (see the European Parliament and Council of the European Union, 2005). This method is also 'final'.

Retrospective reinsurance is a third way to actively manage discontinued business. A retrospective reinsurance contract is set up for the discontinued business portfolio which covers all underwriting liabilities (i.e., claim payments). In this case, the transferring company continues to be liable, so the transfer is not final. The reinsurer's default risk is of importance and often can be secured via a letter of credit. Compared with the share deal and the portfolio transfer, the retrospective reinsurance method is faster and more inconspicuous, neither does it require regulatory approval. In practice, the reinsurance solution frequently is realized by the combination of a loss portfolio transfer and an adverse development cover.

The fourth implementation method—commutation—involves a company reaching an agreement with the policyholder to cancel the insurance cover against a payment. Generally, such an agreement is employed only between primary insurers and reinsurers or between reinsurers. In individual cases, however, such an agreement may also be made between an insurer and a customer, especially with large-volume industrial insurance policies. Legally, the transferring company is no longer liable (finality), and no regulatory approval is necessary.[135]

In evaluating the different options for active management, relevant criteria are finality (from both an economic and legal perspective), effects on risk, capital, and costs, default risk and reputational risk. With regard to finality, any form of active management, except retrospective reinsurance, leads to finality from an economic perspective. If this solution is chosen, default risk might be a problem which will need to be secured by instruments such as a letter of credit. For the other management options, default risk of the ceding company is not relevant. From a legal perspective, however, finality can be achieved only with the share deal, portfolio transfer, or commutation. Retrospective reinsurance does not change the legal responsibility of the ceding insurer. Risk reduction and reduction of capital requirements are accomplished directly and immediately by the reinsurance solution, whereas the share deal and portfolio transfer have to await regulatory approval. Reputational risk is not a problem in the reinsurance solution or for commutation, since there is no public action. However, in a portfolio transfer and for the share deal it should be noted, since the risks taken are settled by the acquiring company. Settlement and claims processing standards are important then.

3 Market development in the German-speaking countries

3.1 Market overview

The discontinued business market has evolved significantly in recent years. An important milestone in Germany was the implementation of the Insurance

[135] In the United Kingdom, there is a special type of commutation, the so-called scheme of arrangement. Within rules predefined by the U.K. legislator, an insurer offers to waive the insurance coverage by paying a fee to the policyholder. Once 75% of the policyholders agree, the repeal is made compulsory for all policyholders. The legality of this approach in Germany is questionable (see Bundesgerichtshof [BGH], 2012a, 2012b and 2012c). For a further discussion of scheme of arrangements in Germany, see, e.g., Schaloske 2009 and Schröder and Fischer 2012.

Supervision Act amendment in July 2007, particularly § 121f VAG, which regulates portfolio transfers in Germany (See Parliament of the Federal Republic of Germany, 2007). As a result, some companies now specialize in actively managing discontinued business portfolios, as is the case in other countries.

In Table 41 we present an overview of some main players in the global discontinued business market. The table includes both discontinued business specialists (risk carriers only focusing on discontinued business) as well as discontinued business consulting firms and is not meant to be a complete list. For example, in the UK there are a number of smaller discontinued business consulting firms, some of which also might be risk carriers. In addition to these specialized companies, reinsurers are counterparties in discontinued business transactions. Moreover, according to PwC (2013), new entrants, such as private equity firms, can be expected in the future.

Company	**Gross technical reserves in 1000€ (December 2011)**	**Headquarters**
Berkshire Hathaway Reinsurance Group (BHRG)*	≈ 24,266,399	Stamford, USA
Enstar	≈ 3,300,543	Hamilton, Bermuda
Axa Liability Managers	≈ 3,000,000	Paris, France
Catalina Holdings	≈ 446,735	Hamilton, Bermuda
Randall & Quilter	433,693	London, United Kingdom
Riverstone Group	244,732**	Manchester, USA
Inceptum Insurance Company/Syndicate Holding Corp	214,900	London, United Kingdom
Tawa	136,402	London, United Kingdom
DARAG	66,393	Wedel, Germany
Compre	47,201	London, United Kingdom
Hochrhein Internationale Rückversicherung***	31,617	Büsingen, Germany
HIR / Chiltington***	21,434	Hamburg, Germany
Ruxley Group	0****	London, United Kingdom
Amour Group Holdings	n.a.	Hamilton, Bermuda

Table 41: Players in the discontinued business market. Data are from annual reports and company web pages. Currency conversion rates are based on December 30, 2011. *Strictly speaking, BHRG is not a discontinued business specialist, but it is the biggest player in the market and therefore included in the list. **Reserves only for the European market. ***Hochrhein Internationale Rückversicherung is a subsidy of Axa Liability Managers and HIR/Chiltington was acquired by Tawa in 2012. ****Annual reports from 2011 show no technical reserves for the Ruxley Group.

Not only has the number of firms in this market been increasing, but there have been some very significant transactions in recent years. Just a few examples are the sale of BF Rückversicherung Anstalt to AXA Liability Managers (December 2009), the transfer of Hamburger Versicherungs-AG to DARAG (March 2010), the acquisition of the reinsurance portfolio of Alte Leipziger Versicherung by the Hochrhein Internationale Rückversicherung (October 2010), the acquisition of the Swiss reinsurer Glacier Re by Catalina Holdings (May 2011), and the acquisition of the inactive insurance business of Quantum Insurance Belgium

SA by DARAG (September 2011). Recently, the Zurich Insurance Company sold its Eagle Star discontinued business portfolio to the Riverstone Group (January 2013).

Perhaps not surprisingly, the current environment of increasing value orientation in corporate management, the implementation of Solvency II, and the current interest rate environment, has led to the stopping of writing new business. In Germany, companies now regularly announce that they are stopping new business in certain areas. Examples include Hamburg Versicherungs-AG (December 2008), Victoria Versicherung (November 2009), Delta Lloyd Life Insurance (March 2010), and Zurich Leben (February 2013).

Recent figures estimate the discontinued business market in Europe at € 220 billion (see PwC, 2013). In the German-speaking area, 29.6% of technical provisions (property/casualty insurance and reinsurance business) are assigned to discontinued business (see KPMG, 2010). Even assuming that only a portion of this volume is amenable to external solutions such as portfolio transfer, there is great potential for external discontinued business solutions in the next years. Data on portfolio transfers in Germany can be found in the BaFin journal that is published monthly (see BaFin, 2013). Figure 13 shows the number of portfolio transfers that occurred between January 2003 and April 2013.

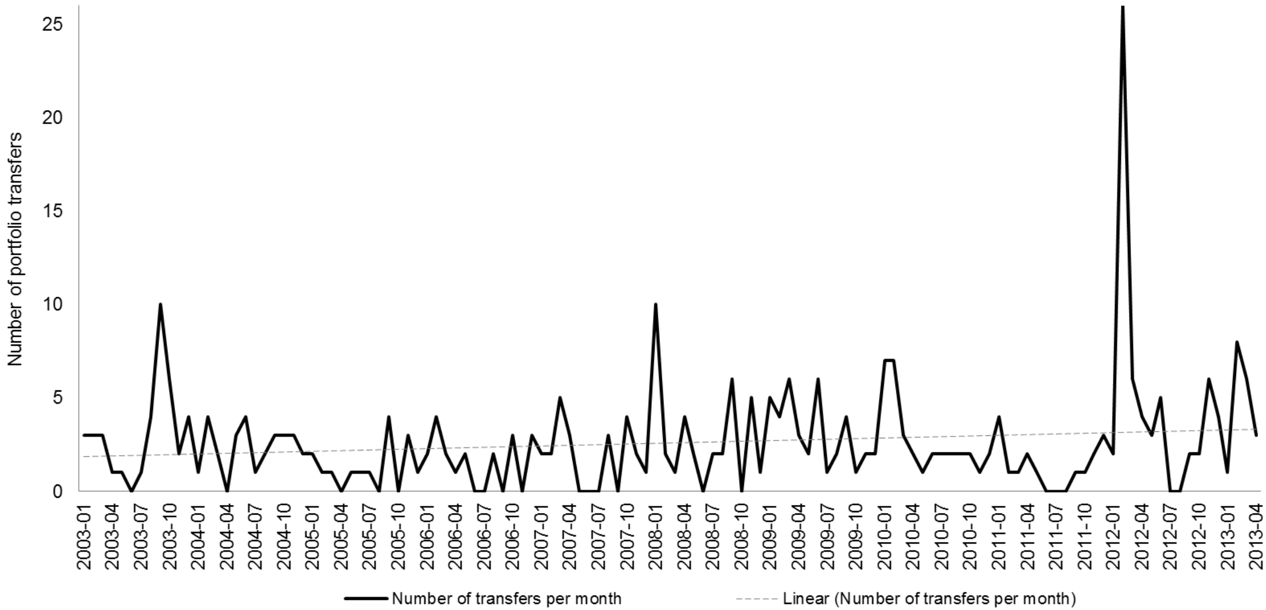

Figure 13: Number of portfolio transfers in Germany according to the BaFin journal.

Figure 13 reveals a slight upward trend over time, although there is an outlier in February 2012. It is estimated that about half the transactions are intra-group transfers.[136] The introduction of Solvency II is expected to significantly increase interest in this topic and it is thus likely that a significant increase in the frequency of transactions will be observed.

3.2 Market Survey

To analyse the status quo and potential of discontinued business in the German-speaking countries we conducted a market survey and designed a questionnaire focusing on (a) motives for discontinuing business and its relevance in different insurance lines, (b) the relevance of active discontinued business management and the experience of insurers in this field, and (c) the implications of Solvency II/Swiss Solvency Test on discontinued business. We invited 527 property/casualty insurers from Germany, Switzerland, Austria, and Luxembourg to participate online or by mail. We received answers from 85 companies. Descriptive statistics for the participating insurers are shown in Table 42 and the questionnaire can be found in Figure 15 in the Appendix.

Insurance type		**Legal form**		**Domiciliary country**		**Average size of insurer**	
Primary insurer	72%	Stock	65%	Germany	39%	Premiums	0.7 bn €
Reinsurer	26%	Mutual	26%	Switzerland	44%	Gross tech. reserves	2.9 bn €
Captive	2%	Other	9%	Austria	10%	Share premiums ceded	22%
				Luxembourg	7%		

Table 42: Survey participants.

[136] British insurers were involved in almost every transfers during February 2012. This was the month in which a decision regarding the legal treatment of the U.K. schemes of arrangement in Germany was made. The so-called Equitable Life judgement of the BGH rejected the legality of the schemes, but it also clarified other issues in dealing with them. It is likely that this ruling had implications for the recognition of transfers by the BaFin and therefore influenced the number of transfers in this month.

The concept of discontinued business and, especially, its active management is still new in German-speaking countries. We believe that the utilization of discontinued business as a management instrument is at different stages across the insurance industry. Table 43 summarizes our four main hypotheses. The first hypothesis is that stock companies generate more discontinued business than mutual insurers or companies with other legal forms. Furthermore, we believe stocks, compared to other insurers, more often actively reduce discontinued business portfolios. The rationale behind this hypothesis is the assumption that stock companies are, on average, more profit oriented than other insurers and therefore are more likely to wind up nonperforming business lines.

The second hypothesis is that discontinued business is more relevant in Switzerland and that Swiss insurers have more experience in the active management of discontinued business portfolios than insurers in Germany, Austria, or Luxembourg. The underlying reason is that Switzerland introduced a risk-based regulatory regime in 2006 which has been mandatory since 2011. Therefore, Swiss insurance companies had to adapt to new requirements which might have triggered portfolio reconstructions. In contrast, Solvency II will not be introduced before 2016 and its final design is still not clear.

The third hypothesis is that discontinued business is more relevant to reinsurers than it is to primary insurers and that they have more experience in actively managing it than do primary insurers or captives. The rationale is that the core business of reinsurance companies and the active management of discontinued business overlap, e.g., in the case of retrospective reinsurance. Furthermore, by actively buying discontinued business portfolios, reinsurers can further diversify existing insurance portfolios.

The fourth hypothesis is that the relevance of discontinued business and experience with its active management increases with the size of the insurance company. The rationale is that an insurer has to have different business lines in order to have discontinued business. Thus, under a going concern assumption, an insurer has to be of a certain size before it will have discontinued business portfolios on its balance sheet. Also, the active management of discontinued business portfolios requires resources which might not be available in small insurance companies. Moreover, complexity reduction is one of the motives for active management of discontinued business, and this is more likely to be necessary or desired in large companies.[137]

Hypothesis		Rationale
H_1	Stocks generate more discontinued business than insurers with other legal forms and have more experience in its active management.	Stocks are profit oriented and abandon businesses not meeting with their profit targets.
H_2	Discontinued business is more relevant in Switzerland than in the other German-speaking countries and Swiss insurers have more experience in its active management.	Switzerland already has a risk-based regulatory regime with capital requirements for discontinued business. In the rest of Europe, this will only be the case after the introduction of Solvency II.
H_3	Discontinued business is more relevant for reinsurers and they have more experience in actively reducing discontinued business than do primary insurers and captives.	The active management of run-off and the core business of reinsurers overlap.
H_4	The relevance of discontinued business and experience with its active management increases with the size of the insurance company.	Comparatively, larger companies have more resources for active management than do smaller ones. The larger the company, the more lines and products it provides, which increases the likelihood for discontinued business. Also, complexity is higher in larger companies.

Table 43: Decomposition of hypotheses.

To test the hypotheses, we build linear multivariate regression models based on several variables generated by the survey. An overview and explanation of the variables used in the models are given in Table 44.

137 Next to these four hypotheses we also determine the relevance of run-off for different lines of business. The results show that long tail lines such as liability insurance are more pronounced than other lines of business. Furthermore, we find that the main motives for stopping writing new premiums are that the insurer is leaving a specific line of business, is confronted with an unexpected claims experience and/or plans to concentrate on its core business.

Survey variable	Model variable	Scale	Explanation
Dependent variables			
Amount of discontinued business	RO	Cardinal	Participants were asked if their company has discontinued business and, if yes, what its share of technical reserves is. RO indicates the proportion of reserves relating to discontinued business.
Amount of active discontinued business	ARO	Cardinal	Participants were asked if their company has discontinued business which is actively managed and, if yes, what its share of technical reserves is. ARO indicates the proportion of reserves relating to discontinued business which is actively managed.
Independent variables			
Legal form (H1)	STOCK	Binary	Participants were asked which legal form their company has. STOCK is 1 if the company is a stock company; 0 otherwise.
Domiciliary country (H2)	CH	Binary	Participants were asked in which country their company is located: Germany, Switzerland, Austria, or Luxembourg. CH is 1 if the company is located in Switzerland; 0 otherwise.
Insurance type (H3)	RE	Binary	Participants were asked if their company is a primary insurer, reinsurer, or captive. RE is 1 if the company is a reinsurance company; 0 otherwise.
Size (H4)	SIZE	Cardinal	Participants were asked for the size of their company. SIZE indicates the natural logarithm of gross technical reserves of the insurer.
Discontinued business specialist (Control)	SPEC	Binary	Participants were asked if discontinued business is their core business. SPEC is 1 if the active management of discontinued business is the core business of the company; 0 otherwise.

Table 44: Survey variables used in the multivariate linear regression models.

The regression models are shown in Equations (1)–(4). Dependent variables are the amount of discontinued business and amount of actively managed discontinued business.[138] We interpret the amount of discontinued business as an indicator of the *relevance* of discontinued business and the amount of actively managed discontinued business as an indicator of *experience* with discontinued business. Moreover, we control for the effect of companies

[138] We also employ logistic regression models which are the same as the ones presented in Equations (1)–(4) with the difference that we use dummy variables as dependent variables. The dependent variable is 1 if the company has discontinued business/actively managed discontinued business; 0 otherwise. Results are presented in Table 47 in the Appendix.

specialized in discontinued business by adding a dummy variable for companies that denote discontinued business as their key business.

$$\mathrm{RO} = \alpha + \beta_1 STOCK + \beta_2 CH + \beta_3 RE + \beta_4 SIZE + \varepsilon \quad (1)$$

$$\mathrm{ARO} = \alpha + \beta_1 STOCK + \beta_2 CH + \beta_3 RE + \beta_4 SIZE + \varepsilon \quad (2)$$

$$\mathrm{RO} = \alpha + \beta_1 STOCK + \beta_2 CH + \beta_3 RE + \beta_4 SIZE + \beta_5 SPEC + \varepsilon \quad (3)$$

$$\mathrm{ARO} = \alpha + \beta_1 STOCK + \beta_2 CH + \beta_3 RE + \beta_4 SIZE + \beta_5 SPEC + \varepsilon \quad (4)$$

where α is a constant, $\beta_1, \beta_2, \beta_3, \beta_4$, and β_5 are the regression coefficients for the independent variables, and ε the error term. The estimation results are presented in Table 45.

Linear multivariate regression models (without control variable)					
Dependent variable	Independent variable	Estimated β_i	Standard error	T-statistic	Adjusted R^2
Model (1)					
RO	STOCK	16.92	8.45	2.00**	0.23
	CH	14.63	7.16	2.04**	
	RE	25.05	8.43	2.97***	
	SIZE	-1.49	1.37	-1.09	
Model (2)					
ARO	STOCK	18.00	8.40	2.14**	0.22
	CH	16.36	7.16	2.29**	
	RE	22.55	8.45	2.67***	
	SIZE	-1.82	1.44	-1.27	
Linear multivariate regression models (with control variable)					
Dependent variable	Independent variable	Estimated β_i	Standard error	T-statistic	Adjusted R^2
Model (3)					
RO	STOCK	4.53	9.23	0.49	0.68
	CH	21.36	7.46	2.87***	
	RE	11.43	10.39	1.10	
	SIZE	2.60	1.51	1.72*	
	SPEC	62.88	10.89	5.78***	

Linear multivariate regression models (without control variable)					
Model (4)					
ARO	STOCK	11.54	8.54	1.35	0.71
	CH	19.60	6.97	2.81***	
	RE	7.73	9.88	0.78	
	SIZE	1.82	1.43	1.27	
	SPEC	68.51	10.34	6.62***	

Table 45: Linear multivariate regression results.*, **, and *** indicate a significance level of 10%, 5%, and 1%, respectively.

In Table 45 the results for Models (1) and (2) show that the variable STOCK explains the relevance of discontinued business and experience at a significance level of 5%. This could be due to the higher profit orientation of stock companies in comparison with mutuals. However, if we control for discontinued business specialists, the variable is not significant (see Models (3) and (4)). Thus, the results regarding our first hypothesis are mixed. The variable CH explains the relevance of discontinued business and experience of the insurer in active discontinued business management at a significance level of 5%. In this case, controlling for discontinued business specialists increases the significance levels to 1% (see Models (3) and (4)). We conclude that these findings are support for our second hypothesis. For Swiss insurance companies, discontinued business seems to be more relevant and they are likely to have more experience in dealing with it than other European insurers. The variable RE explains the relevance and experience of discontinued business at a confidence level of 1% in Models (1) and (2). However, after controlling for companies specialized in discontinued business (Models (3) and (4)), RE also is no longer significant, but SPEC is significant at a 1% level.[139] Thus, the third hypothesis receives ambiguous support. Reinsurance companies are not more engaged in discontinued business or its active management than are primary insurers when we control for discontinued business specialists; rather, it seems that there is a certain group of reinsurers which focusses on this segment and is driving these results. SIZE is only significant in one of the presented regression models, i.e.,

139 For both RE and SPEC the variance inflation factor is below 5 and we assume there is no multicollinearity.

Model (3). There is thus only little evidence for the relevance of the forth hypothesis.

4 Implications of Solvency II for discontinued business

As indicated by the empirical tests, the development of risk-based capital standards seems to be an important driver of run-off activity. How does discontinued business affect the solvency capital requirements (SCR) under Solvency II?

To analyse the importance of discontinued business in the context of Solvency II, we first look at the results of the fifth Quantitative Impact Study (QIS 5). This shows that for a property/casualty insurance company, the 'non-life underwriting risk' module is, at 70%, the main driver of the SCR. Within this module, 68% of the capital requirement is due to the premium and reserve risk (P&R) (see Figure 14).[140] The P&R module contains capital requirements for premiums from the current fiscal year and for reserves from the current fiscal year and fiscal years before. Through the SCR for reserves, discontinued business becomes a relevant element.

[140] See BaFin (2011, p. 21).

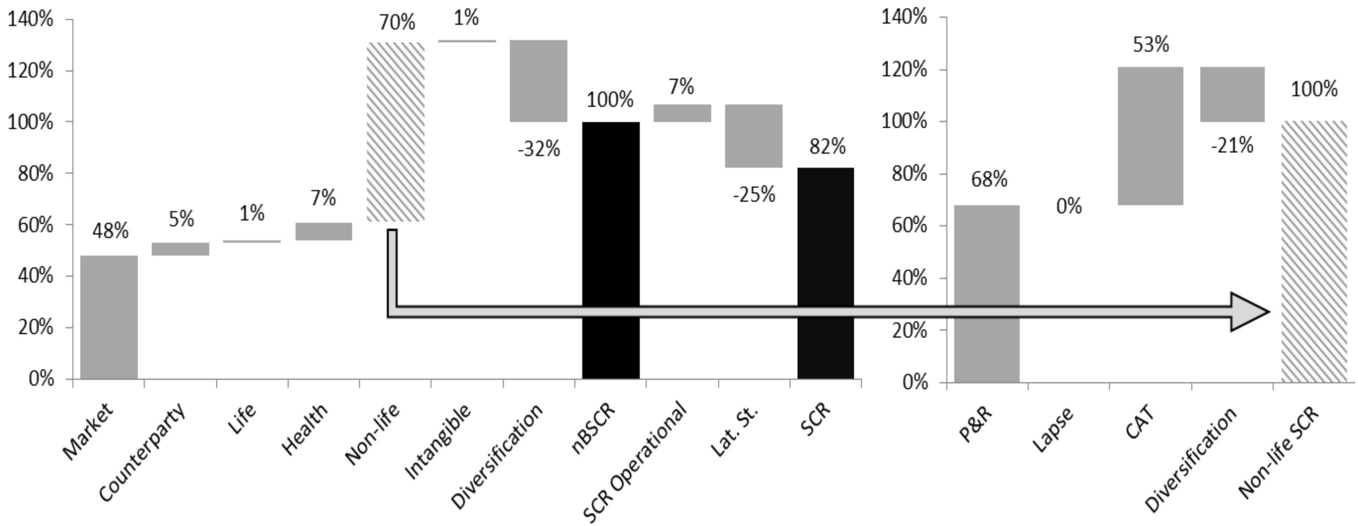

Figure 14: Risk reserve within Solvency II model.

In the following we analyse a numerical example to illustrate the importance of discontinued business in the context of Solvency II. We consider a sample company with three lines of business: motor liability, motor, and other third-party liability. We assume that the line of third-party liability is the discontinued business. For simplicity, we consider only the SCR from the non-life premium and reserve risk (P&R) and abstract from the diversification effects, which may yet arise at the upper levels. Our sample company is active in only one geographical area and the example is without reinsurance. The company generates a premium volume of 1,000€ in the two active lines and has reserves of 2,000€ in all three lines.[141] Table 46shows the necessary inputs, together with references to the Technical Specifications (TS) of QIS 5 and the results of our calculations.

	Lines of business			
	Motor liability	Motor other	3rd-party liability (in run-off)	References
Premiums	1,000€	1,000€	0	
Reserves	2,000€	2,000€	2,000€	
QIS 5 inputs				
Premium risk	10%	7%	15%	QIS 5, TS, SCR.9.25.
Reserve risk	9.50%	10%	11%	QIS 5, TS, SCR.9.29.
Proposed correlations				
Motor liability	1	0.5	0.5	QIS 5, TS, SCR 9.34.
Motor other	0.5	1	0.25	
3rd-party liability	0.5	0.25	1	
QIS 5 results				
σ_{lob}	8.50%	8.09%	11.00%	QIS 5, TS, SCR.9.31.

141 The share of discontinued business of total reserves here approximately corresponds to the proportion which KPMG (2010) has estimated for the total market (where it is 29.6%). Calibration of the premium vs. reserve volume could also be based on the market average for Germany or an actual company. An Excel spreadsheet with the corresponding calculations is available from the authors upon request.

V_{lob}	3,000€	3,000€	2,000€	QIS 5, TS, SCR.9.33.
σ_{total} $\sigma_{without\ discontinued\ business}$	7.04% 10.00%			QIS 5, TS, SCR.9.32.
NL P&R $_{total}$	1,565€			QIS 5, TS, SCR.9.16.
NL P&R $_{without\ discontinued\ business}$	1,200€			
Total difference	-365€			
Relative difference	-23.30%			

Table 46: Numerical example on the importance of discontinued business. σ indicates the standard deviation. Lob means line of business and V is the volume measure which incorporates the best estimate for claims outstanding. NL P&R stands for the capital requirement for 'non-life premium and reserve risk'. QIS 5, TS indicates the technical specifications of the fifth quantitative impact study (see CEIOPS, 2010).The results in Table 46 can be interpreted as follows. The SCR for all three lines of business totals 1,565€. Excluding discontinued business would result in an SCR of 1,200€. The proportion of discontinued business on the SCR is thus 23.3%. In other words, the necessary capital for the non-life premium and reserve risk (P&R) can be lowered from 1,565€ to 1,200€, i.e. by 23.3%, if the discontinued business is actively reduced.[142/143]

The non-life premium and reserve risk (P&R) is only one part of the total capital requirements and the present calculation is restricted to core elements for simplicity. It thus must be noted that the capital requirements in reality will be lower due to additional diversification effects. Furthermore, in the numerical

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142 The capital requirement for the 'non-life premium and reserve risk' is calculated as follows. First, for each line of business (lob) the standard deviation (σ) and volume measure/best estimate for claims outstanding (V) is calculated. In our case: 8.50%, 8.09%, and 11.00% for σ and 3,000€, 3,000€, and 2,000€ for V. Second, overall σ and V are derived including all lob. In our case: 7.04% and 8,000€. Third, a function f(σ) is multiplied with V and results in the capital requirement. In our case: 1,565€ for all lob and 1,200€ if just motor liability and motor other are considered. The transformation of σ ensures that the capital requirement is calibrated corresponding to a value-at-risk level of 99.5%. For the exact formulas of the calculation, see CEIOPS (2010, pp. 197–203).

143 Note that the Solvency I SCR using the premium index would be 321€ (57.5 * 18% + (2,000 – 57.5 * 16.0%)). So we also see in this example a significant increase in capital requirements under Solvency II compared to Solvency I. See Sandström (2005) for details regarding the calculation of the Solvency I SCR.

example we neglect the impact of discontinued business on the Own Risk and Solvency Assement (ORSA) of the second pillar which might expose a significant burden on insurance companies as well (see Planchet et al., 2012). However, the results clearly highlight the increasing relevance of discontinued business in the context of Solvency II.

5 Conclusions and directions for future research

The active management of discontinued business is a relatively new topic in the insurance sector in continental Europe and an entirely new field of study in academia. Until recently, it was only on the agenda of U.S. and U.K. insurers. However, lately there has been an upswing of interest in this issue in continental Europe. Our regression results show that the country variable for Swiss insurers can explain the amount of discontinued business as well as the amount of discontinued business which is actively reduced. Therefore we conclude that within the German-speaking countries the relevance of discontinued business is especially realized in Switzerland. Furthermore, Swiss insurers also seem to have more experience with actively managing discontinued business. We assume that this is because Switzerland already has a risk-based solvency regime since 2006. Hence, in Switzerland, capital requirements can be decreased by reducing discontinued business, which is not yet the case in the other countries.

In the European Union, we believe Solvency II will make the cost of discontinued business explicitly visible. By means of a simple numerical example, we show in this paper that capital requirements can be significantly lower if discontinued business is actively reduced—whether by internal or external approaches. Thus, managing discontinued business is likely to attract more management attention in the future and therefore one can expect that the market for discontinued business solutions will increase. How to deal effectively with discontinued business will become significantly more important over the next years.

Thus, future research should focus on the advantages and disadvantages of each method for actively reducing discontinued business. For example, at this point in time it is assumed that there is a reputational risk to publicly abandoning business, but whether this is indeed the case and, if so, its relevance and magnitude have not been empirically tested. A second research topic is additional investigation of how Solvency II will impact discontinued business. We illustrate the theoretical impact in this paper, but left the practical impact for future empirical work. For example, which lines of business will be affected most or which insurers will benefit or lose from the new regulation? Finally, research should take a global look at the topic and expand the focus beyond the western hemisphere.

Appendix

Marktbefragung „Run-off und Solvency II / SST"

In diesem Fragebogen wird „Run-off" wie folgt definiert:

- **Run-off**: nicht mehr gezeichnetes Geschäft, bei dem keine Prämien mehr generiert werden, aber noch versicherungstechnische Rückstellungen und Verpflichtungen bestehen.
- **Aktiver Umgang mit Run-off-Beständen:** Run-off-Bestände, die mithilfe nachfolgender Methoden aktiv reduziert werden:
  - Übertragung der Gesellschaft (Share Deal): Eine ganze Gesellschaft mit einem Bestand an nicht mehr gezeichnetem Geschäft wird verkauft.
  - Bestandsübertragung (Insurance Portfolio Transfer): Ein Bestand an nicht mehr gezeichnetem Geschäft wird auf eine andere Gesellschaft übertragen (z. B. in Deutschland nach § 121 f VAG).
  - Retrospektive Rückversicherung: Für den Bestand an nicht mehr gezeichnetem Geschäft wird ein Rückversicherungsvertrag geschlossen, der sämtliche Forderungen abdeckt, die durch den Run-off-Bestand entstehen (i. d. R. Kombination aus Adverse Development Cover und Loss Portfolio Transfer).
  - Commutation (Ablösung / Rückabwicklung): Eine Gesellschaft einigt sich mit dem Versicherungsnehmer, den Versicherungsschutz aufzuheben (i. d. R. nur zwischen Erst- und Rückversicherer bzw. zwischen Rückversicherern anzutreffen).

A. Allgemeine Fragen zum Unternehmen

1. Bezeichnen Sie bitte die Art Ihres Unternehmens:

☐ Erstversicherung ☐ Rückversicherung ☐ Captive

2. Welche rechtliche Form hat Ihr Unternehmen?

☐ Aktiengesellschaft ☐ Versicherungsverein auf Gegenseitigkeit

☐ Öffentlich-rechtliches VU ☐ Niederlassung ☐ Genossenschaft

3. Bitte geben Sie den Sitz Ihrer Gesellschaft an:

a. Sitzland:

☐ Deutschland ☐ Schweiz ☐ Österreich ☐ Luxemburg

b. Sitzland der Muttergesellschaft: ....

4. Wie groß ist Ihr Unternehmen?

a. Gebuchte Prämien: Mio. € .... oder Mio. CHF ....

b. Versicherungstechnische Rückstellungen brutto: Mio. € .... oder Mio. CHF ....

Welchen Anteil der gesamten Prämien zediert Ihr Unternehmen in etwa weiter? .... %

1

B. Run-off

5. **Kommt in Ihrem Unternehmen** „inaktives Geschäft" im Sinne von nicht mehr gezeichnetem Geschäft (**Run-off**) **vor,** für das noch Rückstellungen bestehen oder keine Rückstellungen mehr existieren, aber noch Spätschäden möglich sind?

☐ Ja ☐ Nein

Wenn ja, beschreiben Sie bitte nachfolgend die **Struktur der bestehenden Schadenreserven** im Run-off:

a. Wie hoch schätzen Sie den **Anteil der Rückstellungen für noch nicht abgewickelte Versicherungsfälle,** die nicht mehr gezeichnetes Geschäft betreffen? .... %

b. Bitte geben Sie an, in welchem **Umfang Run-off-Bestände** sich in den verschiedenen Sparten Ihres Unternehmens befinden. (Bitte bewerten Sie jede Sparte.)

		0%-20%	20%-40%	40%-60%	60%-80%	80%-100%
a.	Kraftfahrzeugversicherung und Kfz-Haftpflicht	☐	☐	☐	☐	☐
b.	Allgemeine Haftpflicht	☐	☐	☐	☐	☐
c.	Unfall	☐	☐	☐	☐	☐
d.	Rechtsschutz	☐	☐	☐	☐	☐
e.	Transport	☐	☐	☐	☐	☐
f.	Übrige Sachversicherung	☐	☐	☐	☐	☐
g.	Kreditversicherung	☐	☐	☐	☐	☐
h.	Weitere: (bitte nennen)	☐	☐	☐	☐	☐

c. Bitte geben Sie je nach Sparte an, **wann das Geschäft gezeichnet wurde**, das sich jetzt im Run-off befindet. (Bitte bewerten Sie jede Sparte. Mehrfachantworten sind möglich.)

		vor 1970	1970 - 1993	1994 - 2000	2001 - 2007	seit 2008
a.	Kraftfahrzeugversicherung und Kfz-Haftpflicht	☐	☐	☐	☐	☐
b.	Allgemeine Haftpflicht	☐	☐	☐	☐	☐
c.	Unfall	☐	☐	☐	☐	☐
d.	Rechtsschutz	☐	☐	☐	☐	☐
e.	Transport	☐	☐	☐	☐	☐
f.	Übrige Sachversicherung	☐	☐	☐	☐	☐
g.	Kreditversicherung	☐	☐	☐	☐	☐
h.	Weitere: (bitte nennen)	☐	☐	☐	☐	☐

6. Welche **Bedeutung** kommt Ihrer Ansicht nach den nachfolgenden Aspekten bei der (i. d. R. in der Vergangenheit getroffenen) **Entscheidung zur Einstellung** von Zeichnungsaktivitäten zu? (Bitte geben Sie für jeden Aspekt Ihre Einschätzung an.)

1 = große Bedeutung, 5 = keine Bedeutung

		1	2	3	4	5
a.	Aufgabe eines Geschäftsfeldes	☐	☐	☐	☐	☐
b.	Außerplanmäßiger Schadenverlauf	☐	☐	☐	☐	☐
c.	Konzentration auf das Kerngeschäft	☐	☐	☐	☐	☐
d.	Verbesserung der Finanzkraft des eigenen Unternehmens	☐	☐	☐	☐	☐
e.	Verbesserung des Ratings	☐	☐	☐	☐	☐
f.	Einstellung von Sparten nach Übernahmen von Gesellschaften	☐	☐	☐	☐	☐
g.	Solvency II / SST:					
-	Freisetzung von Kapital	☐	☐	☐	☐	☐
-	Optimierung Diversifikation (Glättung)	☐	☐	☐	☐	☐
-	Kostenreduktion / Offenlegungspflichten	☐	☐	☐	☐	☐
h.	Weitere: (bitte nennen)...	☐	☐	☐	☐	☐

7. Mit welchen **Methoden** konnten Sie schon **Erfahrungen** sammeln, um den Run-off-Bestand aktiv zu reduzieren? (Bitte wählen Sie in jedem Punkt eine Möglichkeit.)

1 = große Erfahrung, 5 = keine Erfahrung

		1	2	3	4	5
a.	Verkauf der Gesellschaft mit dem betreffenden Run-off-Bestand	☐	☐	☐	☐	☐
b.	Bestandsübertragung	☐	☐	☐	☐	☐
c.	Retrospektive Rückversicherung	☐	☐	☐	☐	☐
d.	Commutation (Ablösung)	☐	☐	☐	☐	☐
e.	Scheme of Arrangement	☐	☐	☐	☐	☐
f.	Weitere: (bitte nennen)...	☐	☐	☐	☐	☐

C. Aktiver Umgang mit Run-off

Beispiel: Versicherung A hat sich aus dem Bereich Produkthaftung für Konsumgüter zurückgezogen und Neugeschäft wird nicht mehr gezeichnet. Verpflichtungen aus Altverträgen und versicherungstechnische Rückstellungen bestehen jedoch weiter. Um diesen Run-off-Bestand abzubauen, könnte dieser z. B. mitsamt den bedeckenden Vermögenswerten an Versicherung B übertragen werden. (Für verschiedene Run-off-Methoden siehe Seite 1.)

8. Gibt es in Ihrem Unternehmen nicht mehr gezeichnetes Geschäft (**Run-off**), das aktiv reduziert wird?

☐ Ja ☐ Nein

Wenn ja, welcher Anteil der Reserven befindet sich im **Run-off** und **wird aktiv reduziert**? ....%

9. In welchem Umfang (Anteil Reserven) in den jeweiligen Sparten der Schaden- und Unfallversicherung gibt es in Ihrem Unternehmen **Run-off-Bestände,** die **aktiv reduziert** werden? (Bitte bewerten Sie jede Sparte.)

		0%-20%	20%-40%	40%-60%	60%-80%	80%-100%
a.	Kraftfahrzeugversicherung und Kfz-Haftpflicht	☐	☐	☐	☐	☐
b.	Allgemeine Haftpflicht	☐	☐	☐	☐	☐
c.	Unfall	☐	☐	☐	☐	☐
d.	Rechtsschutz	☐	☐	☐	☐	☐
e.	Transport	☐	☐	☐	☐	☐
f.	Übrige Sachversicherung	☐	☐	☐	☐	☐
g.	Kreditversicherung	☐	☐	☐	☐	☐
h.	Weitere: (bitte nennen)...	☐	☐	☐	☐	☐

10. Welche **Gründe** könnten Ihrer Meinung nach dafür sprechen, Run-off-Bestände **aktiv zu reduzieren** (entweder durch Externalisierung oder durch interne Maßnahmen)? (Bitte machen Sie zu jedem Aspekt Angaben.)

	1 = sehr wichtig, 5 = unwichtig	1	2	3	4	5
a.	Inter-Gruppen-Konzentration von Run-off-Beständen	☐	☐	☐	☐	☐
b.	Unsicherheit bzgl. der zukünftigen Schadenentwicklung	☐	☐	☐	☐	☐
c.	Sinkende Finanzkraft eines Geschäftspartners / Stabilität des Rückversicherers	☐	☐	☐	☐	☐
d.	Verbessertes Rating	☐	☐	☐	☐	☐
e.	Steuerliche Implikationen	☐	☐	☐	☐	☐
f.	Administrative Kosten	☐	☐	☐	☐	☐
g.	Vorbereitung von M&A-Transaktionen	☐	☐	☐	☐	☐
h.	Solvency II / SST:					
-	Freisetzung von Kapital	☐	☐	☐	☐	☐
-	Optimierung Diversifikation (Glättung)	☐	☐	☐	☐	☐
-	Kostenreduktion / Offenlegungspflichten	☐	☐	☐	☐	☐
i.	Weitere: (bitte nennen)...	☐	☐	☐	☐	☐

Beispiel: Versicherung A stellt das Zeichnen neuer Verträge im Geschäftsbereich Produkthaftung für Konsumgüter ein, weil dieser nicht zum Kerngeschäft zählt. Um das Rating zu verbessern, soll der eingestellte Geschäftsbereich (jetzt Run-off-Bestand) aktiv reduziert werden. Eine Lösung hierfür könnte die Externalisierung darstellen.

11. Soweit Sie aktiven Umgang für sinnvoll erachten, aus welchen **Gründen** würden Sie über eine **Externalisierung** des eingestellten Geschäfts (Run-off-Bestand) nachdenken? (Bitte machen Sie zu jedem Aspekt Angaben.)

1 = sehr wichtig, 5 = unwichtig

		1	2	3	4	5
a.	Reduktion von Komplexität	☐	☐	☐	☐	☐
b.	Verkürzung des Abwicklungszeitraums	☐	☐	☐	☐	☐
c.	Freisetzung von Eigenkapital / Bilanzentlastung / Kurzfristige Kapitalfreisetzung	☐	☐	☐	☐	☐
d.	Verbessertes Rating	☐	☐	☐	☐	☐
e.	Direkte Reduktion der Kosten	☐	☐	☐	☐	☐
f.	Fehlende Ressourcen (Mitarbeiter, Run-off-Expertise, Zeit) für eine optimale Verwaltung des Run-off-Bestands	☐	☐	☐	☐	☐
g.	Konzentration auf das Kerngeschäft	☐	☐	☐	☐	☐
l.	Weitere: (bitte nennen)..	☐	☐	☐	☐	☐

D. Implikationen von Solvency II / Schweizer Solvenztest (SST) und Ausblick

Unter Solvency II und SST werden Run-off-Bestände in der Kapitalunterlegung berücksichtigt. Somit werden eingestellte Geschäftsbereiche in jedem Unternehmen im Risikoidentifizierungsprozess und in der Risikostrategie grundsätzlich mit in Betracht bezogen.

12. Berücksichtigt Ihr Unternehmen im Risikoidentifizierungsprozess und in der Risikostrategie bzgl. Solvency II und SST folgende Risiken bzgl. **Run-off**? (Bitte machen Sie zu jedem Aspekt Angaben.)

1 = stark berücksichtigt, 5 = nicht berücksichtigt

		1	2	3	4	5
a.	Neubewertung des Bestands an nicht mehr gezeichnetem Geschäft	☐	☐	☐	☐	☐
b.	Höhere Eigenmittelunterlegung	☐	☐	☐	☐	☐
c.	Auslöser von Transaktionen	☐	☐	☐	☐	☐
d.	Unternehmen nicht betroffen, da Run-off-Kerngeschäft	☐	☐	☐	☐	☐
e.	Weitere: (bitte nennen)	☐	☐	☐	☐	☐

13. Welchen **Haupttreiber** sehen Sie, der in Zukunft die **Run-off**-Aktivitäten in Ihrem Unternehmen beeinflusst? (Bitte machen Sie zu jedem Aspekt Angaben.)

1 = große Bedeutung, 5 = keine Bedeutung

		1	2	3	4	5
a.	Komplexität	☐	☐	☐	☐	☐
b.	Verwaltungskosten	☐	☐	☐	☐	☐
c.	Operational Excellence / wertorientierte Steuerung	☐	☐	☐	☐	☐
d.	Risikoreduktion	☐	☐	☐	☐	☐
e.	Transparenz	☐	☐	☐	☐	☐
f.	Konzentration auf das Kerngeschäft	☐	☐	☐	☐	☐
g.	Solvency II / SST:					
-	Freisetzung von Kapital	☐	☐	☐	☐	☐
-	Optimierung Diversifikation (Glättung)	☐	☐	☐	☐	☐
-	Kostenreduktion / Offenlegungspflichten	☐	☐	☐	☐	☐
h.	Weitere: (bitte nennen)	☐	☐	☐	☐	☐

erne schicken wir Ihnen ein Exemplar der Studienresultate. Füllen Sie dazu bitte das separate Adressblatt aus, das wir nabhängig von Ihrem ausgefüllten und anonymisierten Fragebogen ablegen. Herzlichen Dank für Ihre Unterstützung.

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Figure 15: Market survey regarding discontinued business.

Logistic regression models (without control variable)					
Dependent variable	Independent variable	Estimated β_i	Standard error	Wald statistic	Nagelkerke R^2
Model (5)					
RO_L	STOCK	0.56	0.64	0.78	0.19
	CH	1.25	0.54	5.37**	
	RE	0.76	0.62	1.49	
	SIZE	0.06	0.11	0.30	
Model (6)					
ARO_L	STOCK	0.30	0.74	0.16	0.18
	CH	0.75	0.61	1.55	
	RE	0.90	0.65	1.92	
	SIZE	0.16	0.13	1.49	
Logistic regression models (with control variable)					
Dependent variable	Independent variable	Estimated β_i	Standard error	Wald statistic	Nagelkerke R^2
Model (7)					
RO_L	STOCK	-2.70	1.45	3.45*	0.65
	CH	4.14	1.66	6.23**	
	RE	1.79	1.57	1.30	
	SIZE	0.69	0.33	4.23**	
	SPEC	3.42	2.39	2.05	
Model (8)					
ARO_L	STOCK	-4.58	3.26	1.97	-
	CH	7.41	4.12	3.24*	
	RE	-1.56	1.73	0.81	
	SIZE	2.43	1.35	3.22*	
	SPEC	-	-	-	

Table 47: Logistic regression results.

RO_L and ARO_L are 1 if the company has discontinued business / actively managed discontinued business; otherwise 0. Due to the sample structure in Model (8) there is no observation where ARO_L = 0 and SPEC = 1, thus quasicomplete separation occurs and the maximum likelihood estimate for

SPEC does not exist. However, results for the other variables in the model are still valid.[144]

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Curriculum Vitae

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