Università
Ca'Foscari
Venezia

Corso di Dottorato di ricerca

in Economia

ciclo 29

Tesi di Ricerca
in cotutela con Johann Wolfgang Goethe-Universität

Essays on insurance regulation

SSD: SECS-P/02

Coordinatore del Dottorato
ch. prof. Giacomo Pasini

Supervisore
ch. prof. Loriana Pelizzon

Supervisore cotutela
ch. prof. Monica Billio

Dottorando
Matteo Sottocornola
Matricola 956325

Erstgutachter - First Supervisor: Prof. Loriana Pelizzon, Ph.D.

Zweitgutachter - Second Supervisor: Prof. Dr. Monica Billio, Ph.D.

Tag der Promotion - Day of Disputation: 1. März 2018

List of Original Articles

1 Elia Berdin and Matteo Sottocornola (2015):
"Insurance Activities and Systemic Risk", *CIR Working Paper Series No. 19/15, SAFE Working Paper No. 121.*

2 Loriana Pelizzon nd Matteo Sottocornola (2017):
"The impact of the Monetary Policy Interventions on the Insurance Industry", *SAFE Working Paper Series (forthcoming)*

3 Matteo Sottocornola (2016):
"Compliance Risk in the European Insurance Industry: Setting a Common Playing Field", *SAFE Working Paper Series (forthcoming)*

Abstract

The recently enforced Solvency II regime introduced relevant improvements in the insurance micro-prudential supervision including the move from a book based to a consistent market based valuation of the assets and the liabilities of insurance undertakings. Like other market based micro-prudential regulation Solvency II suffers of well known drawbacks such as the procyclicality of the valuation and the potential incentive for undertakings to commonly behave against specific circumstances. The latter element in particular, even if it is not of a concern by a micro-prudential perspective, could generate unintended detrimental effects at system level emphasizing the conflict between micro and macro-prudential regimes. Being (re)insurances provider of long-term funding to the economy, a potential misalignment in the macro- and micro- supervision might generate material externalities to the whole economy. As Solvency II applies to long term investors, it encompasses since its first enforcement qualitative and quantitative elements with macro-prudential effects aimed at smoothing the divergences between the goals of micro- and macro-prudential regimes. This work contributes to understanding of the systemic implication of the (re)insurers with specific reference to the undertaken activities and their sensitivity to monetary policy actions implemented by the Central Banks. Furthermore, it analyses the level of enforcement of the current regulatory regimes. Moreover, this thesis aims at providing a conceptual contribution to the improvements of the micro- and macro-prudential supervision in insurance.

The first chapter investigates systemic risk in the insurance industry. The contribution is twofold: at first a cross sectional analysis based on 3 market based measures (linear Granger causality test, conditional value at risk and marginal expected shortfall) on the systemic contribution of the insurance industry vis-à-vis banks and non-financial industry is provided. Secondly we investigate the determinants of the systemic risk contribution within the insurance industry by using balance sheet level data. Evidence suggests that *i)* the insurance industry shows a persistent systemic relevance over time and plays a subordinate role in causing systemic risk compared to banks, and that *ii)* within the industry, those insurers which engage more in non-insurance-related activities tend to pose more systemic risk. These results shed new light on the role of insurers in posing systemic risk and on the main determinants therein. This is a particularly relevant contribution on the debate on macro-prudential supervision in insurance.

The second chapter investigates the effect of the conventional and unconventional (e.g. Quantitative Easing) monetary policy intervention on the insurance industry. The work at first measures

whether and to what extent the last Quantitative Easing programme launched by the European Central Bank - ECB affected the stock performances of a large sample of (re)insurers by constructing an event study around the announcement date. Then, we enlarge the time frame by looking at the monetary policy surprise effects over a period of 12 years. In the second part of the paper we build a set of balance sheet based indices, aimed at identifying the characteristics of (re)insurers which determine their sensitivity to the monetary policy actions. Evidences suggest that a single intervention extrapolated from the comprehensive strategy cannot be utilized to estimate the effect of the central banks' actions on the markets. The extended analysis on the monetary policy surprises shows how impact of the monetary interventions on the (re)insurers change over time. The expansionary monetary policy interventions, when generating an instantaneous reduction of interest rates, impinge a movement in the stock prices in the same direction till September 2010. This effect turns to positive during the European sovereign debt crisis and it fades away in 2014-2015. The analysis of the balance sheet indices suggests that the sensitivity of (re)insurers to the monetary policy actions is mainly driven by the asset allocation and in particular by the exposures to fixed income assets. This work provides further contribution to the literature on the analyses of the monetary policy enriching it with a specific focus on the insurance industry.

The third chapter elaborates over the concept of compliance risk in the European insurance industry. In the absence of a common definition and subsequent blurred perimeter at European and national level, the work propose a shared definition and a clear indication on which risks have to be included under the umbrella of the compliance risk. The topic is approached via a survey extended to insurance companies based in Germany and Austria by posing a set of questions on the perception, materiality, approaches, models and foreseen evolution on the compliance risk. Within the limitation of the approach and of the sample, the survey spots the lower priority assigned by the companies to the compliance risk in the year of enforcement of Solvency II and the subsequent initial stage of evolution of the models and the approaches in place to manage it. The survey allows inferring a clear and shared definition of the compliance risk among the insurers and provides valuable indication for setting its perimeter. The increased clearness would ease the convergence to a common standard the enforcement by insurance undertakings of Solvency II in its completeness including the qualitative and quantitative aspects aimed at reducing its unintended potential negative effects at macro-prudential level.

Contents

List of Figures

List of Tables

Acknowledgments

My gratitude goes at first to my supervisor Professor Loriana Pelizzon. She was able to reintroduce a professional to academia and to initiate him to researches in finance. Supporting her as a research and teaching assistant was a unique chance of learning *on-the-job* the different aspects of the empirical research. Most of all she taught me how to approach data and how to infer robust conclusions via econometric models.

I wish also to thank my co-authors Elia Berdin, a talented researcher and a wonderful person. My journey would definitely be tougher without you.

I also would like to thank the Goethe University and the Research Center SAFE for providing me with a great research environment. I am also grateful to the members of the Risks and Financial Stability Department at the European Insurance and Occupational Pensions Authority for being a continuous source of inspiration.

My special thanks go also to my fellow students - Mario Bellia and Roberto Panzica - with whom I shared part of my stay in Frankfurt. I treasure thoughtful and pleasant discussions inside and outside the office. I would also like to include among my fellows Silvia Dalla Fontana and Nicola Mano thanking them for their excellent research support.

Above all, my deepest gratitude is devoted to my family. To my wife Elena who always supported me with here constant presence and encouragement. You represent in each and every moment the light driving me out of darker times. To my children Emma and Liam, pleasant distractions from work to keep me in contact with what really matters.

This dissertation is dedicated to the three of them.

Summary

Introduction

Solvency II, the 2016 enforced European micro-prudential regime (European Parliament and of the Council of 25, 2009), introduced a consistent and homogeneous market-based evaluation of the European insurance and reinsurance undertakings. The regulation is structured on three pillars dealing respectively with capital requirements, governance and disclosure. The novelties introduced by the Solvency II regime can be summarized without any claim to completeness in three main points: *i)* an holistic market based balance sheet evaluation; *ii)* a risk based capital charges;[1] *iii)* the introduction of the concept of proportionality.[2]

As other micro-prudential market based regimes such as banking regulations starting from Basel II onward,[3] Solvency II encompasses elements which may conflict with general macro-prudential principles, with the latter aiming at safeguarding the financial stability of a system rather than the resilience of a single institutions against adverse scenarios.[4] The mark-to-market valuation of the assets and of the liabilities accompanied with capital surcharges against excess of concentration on the asset allocations of individual undertakings [5] should grant a sound and proper approach by an entity perspective, but could generate potential unintended negative effects by a macro-prudential point of view such as excess of similarity in the asset allocation and common / procyclical behavior among (re)insurers.[6]

Before elaborating further on the macro-prudential implications stemming from the enforcement

[1] According to the first pillar of Solvency II, regulatory capital is calculated as function of the embedded risk in both assets and liabilities: based on a Value-at-Risk (VaR) approach to risk, regulation imposes a maximum expected probability of default with one year horizon (0.5%) which implies that the amount of regulatory capital is positively correlated to the overall level of risk of the insurer at a certain point in time.

[2] Undertakings, consistently with their level of complexity and upon approval of the National Competent Authority, are allowed to apply different approaches: simplified approach to the standard formula, standard formula, the Undertaking Specific Parameters, partial internal model or full internal model.

[3] The Basel Committee on Banking Supervision - BCBS and the Bank of International Settlement - BIS issued the Basel II regulatory framework in 2004 followed, after several revision, by the Basel III in 2015 that introduced macro-prudential elements into the reference framework.

[4] For a precise definition of financial stability refer to the definition provided by the ECB: *https://www.ecb.europa.eu/ecb/tasks/stability/html/index.en.html* .

[5] A thorough description of the underlying assumptions in the standard formula is provided by EIOPA (2014b).

[6] The linkage between similarity in the asset allocation and the common behaviour in the asset liquidation has been empirically shown in the US insurance market by Getmansky et al. (2017).

of Solvency II, it worth to briefly digress on the distinction between micro- and macro-prudential regulations and on the concept of systemic risk with specific reference to the insurance industry.

Macro regulations Vs Micro regulations

The recent financial crises[7] exposed important shortcomings in financial regulations and supervision, in particular concerning supervision and oversight of the financial system as a whole. The micro-prudential regimes somehow failed in those circumstances not preventing the built-up of externalities stemming from the distresses of specific entities. The reason behind that failure is twofold and lies at first in the approach of the supervisors and secondly in the different objectives of the micro- and macro-prudential regimes.

Before the crises, as highlighted by the European Commission (2009), supervisors' actions were mainly driven by micro-prudential intents rather than focusing on the wider implications affecting and stemming from a financial system. As a matter of fact, the concept of systemic risk and the identification of the Globally Systemically Important Financial Institutions were defined by the Financial Stability Board (2009) only in the 2009 as a first reaction to the 2007-2009 crisis.

The second element is the intrinsic differences in the goal and the perimeter of the macro- and micro-prudential supervision clearly depicted by Borio (2003) (see Table 1).

Table 1: Micro-prudential vs Macro-prudential supervision

	Macroprudential	**Microprudential**
Proximate objective	limit financial system-wide distress	limit distress of individual institutions
Ultimate objective	avoid economic output costs	consumer (investor/depositor) protection
Model of risk	(in part) endogenous	exogenous
Calibration of prudential controls	in terms of system-wide distress (top-down)	in terms of risks of individual institutions (bottom-up)

Micro-prudential supervision pursues the proper and sound solvency position of single entities to eventually avoid potential negative implications for consumers, whereas the macro-prudential supervision aims at containing the likelihood and the impact of a system-wide distress to eventually reduce externalities, therefore output costs. The other constituents of both frameworks are designed subsequently with micro-prudential model being more based on exogenous shocks hitting the single institutions according to their risk profile and macro-prudential models focused on the assessment of endogenous shocks from the system's perspective, namely looking at correlation and common behaviors. Borio (2003), beside highlighting the differences of the two approaches, also advocates the fact that the extension of the traditional micro-prudential frameworks towards a more macro-

[7] *Financial crises* shall be intended both the 2007-2009 crisis triggered in the U.S. by the subprime mortgage market and the 2010-2012 European sovereign debt crisis.

prudential approach can substantially improve the mitigation of financial instability.[8] Along the same line Crocket (2000), argues that financial stability can be most productively achieved if a better "*marriage* between the micro-prudential and the macro-prudential dimensions" is achieved.

Against this background the strong interplay and complementarity between the micro-prudential and the macro-prudential aspects of supervision are key for a sound framework. In insurance Christophersen and Zschiesche (2015) argue that such interplay and complementarity need to be fully understood and embraced by supervisors in order to avoid a situation in which the macro-prudential approach becomes a simple add-on to the micro-prudential approach and not its natural complement.

To complete the picture some considerations on the concept of systemic risk and its application to the insurance industry are provided.

The systemic relevance of the insurers

In the aftermath of the 2008-2009 subprime crisis the attention on the systemic implication of the financial service industry surged and supervisors traditionally focused on the solvency of the single institutions were asked to include in their radar also system-wide implications Group of Twenty (2009). Being the subprime crisis a credit-triggered event[9] the immediate elective target for analysis, discussions and actions was the banking sector with the systemic relevance of the insurance industry largely neglected till 2010 when the Financial Stability Board requested the International Association of Insurance Supervisors - IAIS to develop a process to identify globally active insurance-dominated financial conglomerates whose distress or disorderly failure, because of their *size, complexity and interconnectedness* would cause significant disruption to the global financial system and economic activity (IAIS, 2016). Contextually a vast literature on the measurement of the systemic risk emerged.[10]

According to relevant sources, the systemic relevance of an industry is mainly based on its relative weight or importance in the economy and on the role played by the industry in former crises.[11] Elaborating on those criteria, (re)insurers can be considered as major players in the financial system: in the EU, they hold an investment portfolio of EUR 9,897 billion which represent 61% of the EU GDP (Insurance Europe, 2016). Life insurers in particular, being long-term investors, provide an essential funding to the economy and thereby enhance economic growth also through a more efficient capital allocation (IAIS, 2011). Furthermore, insurers contribute to economic growth by allowing individuals to take risks, which in turn help innovation to take place (Kessler et al.,

[8] An extensive analysis on the definition of financial stability can be found in Allen and Wood (2006) and Garry (2004).

[9] The origin of the crisis is commonly traced back to the distresses of the Government Sponsored Enterprises Fannie Mae, Freddie Mac.

[10] See Bisias et al. (2012) for an exhaustive survey on available measures of systemic risk.

[11] In support of this statement please refer to IAIS (2016) where the concepts of *size* and of the role played by an entity in the system, namely the substitutability, are included in the criteria for the definition of the Globally Systemically Important Insurers (G-SIIs).

2004). On the involvement of the insurance industry in the 2007-2008 crisis it is enough to recall the bail-out of American International Group by the US Administration.[12]

Against this background, the common understanding among academia, practitioners and regulators is that the insurance industry is not systemically relevant as a whole but with some distinctions based on the undertaken activities. Macro-prudential framework for insurers is evolving along this line with the IAIS (2017) moving from a pure entity based assessment (based on the G-SIIs concept) to an activity based assessment.

The Solvency II regime

Insurance in general and life insurance in specific is a long-term liability driven business where obligations towards policyholders are backed by asset portfolios that tend to replicate the duration/return profile of the liabilities. To that aim, (re)insurers are traditionally investing in long-term securities providing certain returns, i.e. fixed-income assets such as sovereign and corporate bonds.[13]

A pure market based regulatory approach transfers without any filter the idiosyncratic movements of the markets directly to the balance sheets of the undertakings which might procyclically react in order to maintain their solvency ratio at a comfortable level.[14] Those regulatory-driven reactions are not justified neither beneficial to the long term nature of the undertakings' investments and might generate common movements in the asset allocation which are potentially creating a footprint on the market with effects to the rest of the financial system and eventually to the real economy.

Despite its micro-prudential nature, Solvency II already embeds several elements with macro-prudential effects aimed at pre-empting systemic implications for the insurance industry such as the concept of Ultimate Forward Rate (EIOPA, 2017a), the full set of *Long Term Guarantees* (LTG) measures such as the *Matching adjustment*, the *Volatility adjustment* and the *Symmetric adjustment mechanism*.[15] The elements therein aim at smoothing the effects on the short term market fluctuation on the valuation of assets and liabilities of an undertaking both in case of boom and bust cycles or distortion in market prices. Among the different price movements, key for the (re)insurers subject to the Solvency II regime is the level of the *risk free rate* which has a twofold effect on the balance sheet. Beside influencing the valuation of the assets, it has an impact on the valuation of the liabilities whose main part, the technical provisions, is computed by discounting the best estimate of the future cash flows according to the risk free rate term structure. The reference risk free rate curve defined by EIOPA (2017c) is built on the swap rates of a panel of

[12]Ref. to Harrington (2009) for a dissertation on the role of AIG in the subprime crisis.

[13]Overviews of the asset allocations of insurers in different years can be retrieved from the EIOPA Financial stability reports available at: https://eiopa.europa.eu/Pages/Financial-stability-and-crisis-prevention/Financial-Stability-Reports.aspx .

[14]Solvency ratio is calculated dividing the Eligible Own Funds by the Solvency Capital Requirement.

[15]For a thorough analysis of the LTG measures and their application refer to EIOPA (2016).

sovereign bonds, whose values are also driven by the conventional and unconventional monetary policy interventions of the Central Banks. Moreover, unconventional expansionary monetary policy interventions might have the additional side effects of reducing the availability of the assets included in the purchase programs of the Central Banks on the markets potentially creating a situation where the market fundamentals might not properly reflect the underlying credit risk (EIOPA (2017b) and Joint Committee of the European Supervisory Authorities (2017)). The impact on the (re)insurers is twofold: *i)* the potential mispricing of the assets might lead to an overvaluation of the asset side of the balance sheets and *ii)* the lack of sufficiently remunerable high quality assets on the market might create search for yield behavior in the industry worsening its exposure to the credit risk.

Beside the above mentioned quantitative tools with macro-prudential implications, the Solvency II framework encompasses qualitative elements such as the extension of the recovery period upon declaration of exceptional adverse situation,[16] the prohibition of certain type of activities (European Parliament and the Council of 25, 2014) and the Prudent Person Principles (European Parliament and of the Council of 25, 2009). All those elements move in the direction of avoiding the generation of externalities stemming from distresses in the insurance industry. Those principles shall be included in the overall risk management framework prescribed by the compliance regulations of each jurisdiction. However, as undertakings are still struggling with the full implementation of the Solvency II capital standards and reporting, the application of the rules and principles contained in the other parts of the framework, i.e. the compliance approach, is lagging behind.

Concluding, the aim of this dissertation is to contribute to the conceptual and analytic work necessary to better understand the systemic relevance of the insurance industry and the vulnerability to macro-economic changes with specific reference to the monetary policy actions enforced by the ECB. Furthermore, in the light of the macro-prudential qualitative elements contained in the Solvency II regime, the essay approaches the concept of the *compliance risk*. The following sections briefly describe the contribution of each chapter.

Chapter 1

Following the 2007-2009 financial crisis and the 2010-2012 European sovereign debt crisis, the concept of systemic risk has become increasingly relevant. After the collapse of Lehman Brothers in particular, the debate on systemic risk has been primarily focused on banks. However, recent empirical evidences suggest that institutions not traditionally associated with systemic risk, such as insurance companies, also play a prominent role in posing systemic risk. Thus in the paper we investigate the relative systemic risk contribution of insurance companies vis-à-vis other industries and the determinants of systemic risk within the insurance industry. In the first part we conduct

[16] According to the Guidelines on the extension of the recovery period in exceptional adverse situations it is in the EIOPA capacity to declare exceptional adverse situation when a significant share of insurers are affected by unforeseen, sharp and steep fall in financial markets, persistent low interest rate environment, or high-impact catastrophic event (EIOPA, 2015).

an aggregated industry analysis based on 3 measures of systemic risk, namely CoVaR, DMES and the linear Granger causality test, on 3 groups, namely insurers, banks and non-financials. In the second part we investigate the relation between the systemic risk contribution and different balance sheet positions. Our evidence suggests that in the aftermath of the recent crises financial institutions tend to cause more systemic risk than non-financial institutions; among financial institutions, banks pose more systemic risk than insurers, especially after the Lehman bankruptcy. Insurers do cause systemic risk, especially when they engage in non-insurance activities, e.g. banking activities. Furthermore, we find that systemic risk in the insurance industry is mainly driven by the liability side rather than the asset side. However, on the asset side we find that the level of diversification is also a strong determinant of systemic risk, although further investigation is needed. In addition, traditional variables associated with systemic risk in financial institutions, such as size is of importance, whereas price-to-book and leverage seem to play a counterintuitive role. This is however in line with previous findings, which confirm for instance that leverage in insurance is fundamentally different compared to leverage in banking. Results are robust to a set of different specifications, different panels and different econometric methods. Finally, the choice of the time span should shelter the analysis from biases stemming from sample (time-dependency) selection.

In this paper, we provide new evidence on the role of insurers in posing systemic risk, in particular on the role of insurance activities compared to non-insurance activities. Also, we are among the first to provide empirical evidence on the role of diversification in posing systemic risk, which should be further analyzed in future research. Moreover, we are the first to use a European set of companies and to use variables of stock rather than flow: the latter is particularly relevant to show how the stock of the outstanding business drives systemic risk contribution in the insurance industry.

Concluding, the research has the potential to provide a significant contribution to shed additional light on the debate on systemic risk in the insurance industry as well as insightful indications on how to assess the systemic relevance of insurance companies. This is particularly relevant in the light of the ongoing discussion on the role of the G-SIIs and on the specific regulations they might be subjected in the future. Furthermore, the paper could serve as a basis for a theoretical treatment of the systemic risk contribution of the insurance industry, and thereby contribute to deepening the understanding of the underlying economic forces driving systemic risk.

Chapter 2

Since 2008 Europe is facing a low and heterogeneous economic growth with peripheral countries still struggling to recover from pre-crisis periods. The prolonged low growth environment has been complemented by a contextual period of low inflation and ultra-low yields with the latter fostered by the expansionary monetary policy interventions adopted by Central Banks. The ECB is enforcing since 2013 a series of conventional and unconventional expansionary monetary intervention, including Quantitative Easing (last QE announced in January 2015). These expansionary interventions, beside the welcomed stimulus to the economy, result in extremely low interest rates exacerbating the problems arising from the low interest rates. The persistent low yield environment is heavily affecting the EU financial services industry and it is becoming a severe threat for the life insurers in terms of solvency and sustainability of their business models. Concerns are specifically addressed towards companies with a relevant outstanding portfolio of products entailing guaranteed rates of return and profit participation features. The lack of sufficiently remunerable rated assets on the market substantially reduce the capability for (re)insurers to match by a return and duration perspective the outstanding portfolio of guaranteed policies underwritten in high-yield years. The ECB's assets purchase programme tends to exacerbate the scarcity of valuable assets on the market.

Academia investigated both the effects of the low yields on (re)insurers and the effects of the momentary policy interventions on the markets. However, if on the one hand there is a common understanding on the relation between monetary interventions, interest rate term structure, on the other hand the effect of unconventional expansionary monetary policy on the market in general and on insurers in particular does not provide conclusive elements, especially in a low or negative yields environment. With this work we aim at filling this gap by investigating the effect of the conventional and unconventional monetary policy intervention on the insurance industry with a twofold approach.

At first we run an event study on the announcement date of the last ECB Quantitative Easing program. We scrutinize the cumulative abnormal return of a sample of 166 (re)insurers split into different subsamples according to size and geographical criteria comparing it with the behaviour of the other market participants. Then, with the aim of understanding the impact of the general enforced monetary policy strategy and not of a single extrapolated event, we enlarge the scope of our analysis by investigating the effects on the markets in general and on insurers in particular, of a series of announcements made by the ECB and the Fed. To do so we replicate the approach proposed by Rogers et al. (2014) and Pericoli and Veronese (2016) analysing how and to what extent the Central Banks announcements are signalled by the stock markets via changes in the term structure of the risk free rate. We apply the model on the same sample of (re)insures over a timeframe of 8 years split into 5 periods according to the economic cycles.[17]

The second part of the work scrutinises whether the asset and liability structure might explain the higher or lower sensitivity of a (re)insurance undertaking to the monetary policy interventions. The analysis elaborates on a set of balance sheet based indices aimed at approximating the asset allocation of the (re)insurers and their exposure to different business lines.

The event study suggests a moderate negative effect of the QE on the insurance industry. The different specifications we tested show how the outcomes of the event study are strongly dependent

[17] We define the following economic cycles: *i)* tranquil period (06.09.2004 to 15.06.2008); *ii)* US sub-prime crisis (01.09.2008 to 31.08.2010); *iii)* EU sovereign debt crisis (01.09.2010 to 30.06.2012); *iv)* transition to the low yield environment (01.07.2012 to 31.12.2013); and *v)* the low yield environment (01.01.2014 to 20.02.2017).

to the observation periods. By applying the monetary policy surprise based model, we document how the effect of monetary policy interventions on the market in general and on the insurance industry in particular change over time. For the two periods from 2008 till 2013 we find that when the monetary policy announcement generates an immediate reduction in the interest rates, the stock market returns move in the same directions and the effect on the insurance industry is even stronger. However, in the fourth period, when ECB started the QE program, the impact of monetary policy announcements on stock returns is not statistically significant. The two applied models return consistent results. Nevertheless this work shows how a single intervention extrapolated from the comprehensive strategy should be utilized with caution to estimate the effect of the monetary policy intervention on the market. The analysis of the sensitivity's determinants confirms that the exposure to fixed income assets makes (re)insurers more prone to the change in the interest rates triggered by the monetary policy actions. However, against our expectation, the different exposures towards life business and to non-insurance business do not condition the sensitivity thereof.

This work provides an initial contribution to the analysis of the monetary policy intervention enriching the literature focused on the insurance industry.

Chapter 3

The European financial services industry in general and the insurance industry in particular are highly regulated environments with legal frameworks defined both at the EU level (EU directives) and the local level (national legislation). Additionally, the supervision in many countries is fragmented with different authorities supervising specific business lines. Operating in such a heavily regulated markets implies that companies are exposed to the risk of not fulfilling all the requirements encompassed in those regulations, and thus exposing them to a compliance risk. This paper investigates the concept of compliance risk in the European insurance industry.

Although EU end local regulators devote parts of their directives and laws to the compliance risk, there is a general lack of consensus on its definition, classification and on the elements that have to be included in the perimeter. The fragmented understanding on the compliance risk, beside opening the door for regulatory arbitrages, undermines the attempt of building a level playing field in the EU financial market by defining a set of common rules (European Commission, 2005). Despite the compliance risk might have significant implication to the solvency and profitability position of the insurers, neither a theoretical approach aimed at measuring the compliance risk nor an empirical study assessing the materiality of the exposures have been produced to date by scholars. Also, consultancy companies operating in the financial service industry developed several distinct and incomplete approaches to assess and quantify the exposure of a company to the compliance risk.

Against this background I developed a survey-based research targeting the German and Austrian insurance industry with two main objectives. The first objective is to investigate the awareness about the compliance risk of the insurance companies operating in the targeted markets also analyzing the most utilized approaches. The second objective is to infer a shared definition of compliance risk and a subsequent clearly defined perimeter that allows *i)* a proper identification of the compliance risk and *ii)* avoids the mis-classification of the compliance-related events.

Within the limitation of the approach and of the sample, the result of the survey shows that most of the (re)insurers do not explicitly include the compliance risk in their risk profile and do not fully scrutinize the materiality of such risk. Moreover, the answers provided by the insurers show that the assessment and management of compliance risk are usually embedded into the wider operational risk approach neglecting the specificity of the risk thereof. Furthermore, the survey highlights the lower priority assigned by the companies to the compliance risk in the year of enforcement of Solvency II and the subsequent initial stage of evolution of models and approaches in place to manage it. Eventually, the survey serves as a foundation for a clear and shared definition of compliance risk:

Compliance risk encompasses all and only the risks arising from missing or partial adequacy to EU directives, local rules or internal rules in the defined deadlines and changes in the regulatory framework or unfavorable changes in the jurisprudence track records.

Also it provides valuable indication for setting its perimeter based on two dimensions: the *risk factors* and the *time*. The first dimension allows to dissect between pure operational risk and compliance risk, the time dimension serves as discriminant between compliance risk and reputational risk.

This work provides to regulators the theoretical basis for a better understanding and evolution of the compliance and its related risks in the insurance industry. Additionally the findings contained in the paper might serve as a basis for the enhancement of the models and the development of the tools aimed at managing the compliance risk by the (re)insurers.

Chapter 1

Insurance Activities and Systemic Risk

1.1 Introduction

Following the 2007-2009 financial crisis and the 2010-2012 European sovereign debt crisis, the concept of systemic risk has become increasingly relevant.[1] After the collapse of Lehman Brothers in particular, the debate on systemic risk has been primarily focused on banks.[2] However, recent empirical evidence suggests that institutions not traditionally associated with systemic risk, such as insurance companies, also play a prominent role in posing systemic risk. In particular, some authors find that the insurance industry has become a non-negligible source of systemic risk (e.g. Billio et al. (2012) and Weiß and Mühlnickel (2014)). This is partially in contrast to other authors, who do not find evidence of systemic relevance for the industry as a whole (e.g. Harrington (2009), Bell and Keller (2009) and Geneva Association (2010)). Finally, other authors take a more granular perspective and argue that insurance companies might be systemically relevant, but that such risk stems from non-traditional (banking-related) activities (Baluch et al. (2011) and Cummins and Weiss (2014)) and that in general, the systemic relevance of the insurance industry as a whole is still subordinated with respect to the banking industry (Chen et al., 2014).

As the current literature does not provide a common understanding and clear evidence regarding the systemic relevance of the insurance industry and the activities connected thereto, we thus aim with this paper to fill this gap. In particular, we investigate *i)* the systemic relevance of the insurance industry vis-à-vis other industries and *ii)* the key drivers of systemic risk within the

Part of the results presented in this paper were published in the Financial Stability Report - Thematic Article: Assessing the Systemic Relevance of the European Insurance Industry (Berdin, Sottocornola), EIOPA - December 2015.

[1] Throughout this paper, we rely on the definition of systemic risk given by the Group of Ten (2001): *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 high probability.*

[2] Lehman Brothers Holdings Inc. filed for Chapter 11 bankruptcy protection on September 15, 2008.

insurance industry.

To do so, we test 3 equity return-based measures of systemic risk, namely *1)* the indexes based on linear Granger causality tests proposed by Billio et al. (2012) (Granger test), *2)* the conditional value at risk proposed by Adrian and Brunnermeier (2011) (ΔCoVaR) and *3)* the dynamic marginal expected shortfall proposed by Brownlees and Engle (2012) (DMES), on 3 groups, namely banks, insurers and non-financial companies, all listed in Europe. We test the systemic relevance of each institution with respect to its own industry (*intra-industry*), with respect to *other industries* and with respect to the *total system*. Based on these estimations, we rank financial institutions according to their average systemic risk contribution over time and create an *industry composition index*. Finally, we investigate the drivers of systemic risk within the insurance industry by focusing on the asset and liability composition of insurers' balance sheets.

Our evidence suggests that the insurance industry tends to persistently pose systemic risk over time and to play a subordinate role with respect to the banking industry, with some distinction in specific periods when the insurance industry becomes more systemic than the banking industry. Furthermore, we show that insurers with a relatively larger proportion of non-insurance-related activities tend to pose more systemic risk. In addition, we are among the first to provide evidence on the role of diversification of the asset portfolio with respect to systemic risk. We also find and confirm previous evidence that price-to-book and size do matter, whereas leverage seems to play an ambiguous role. Finally, our results are robust across different specifications and different samples.

The paper is organized as follows: section 2.2 provides a comprehensive literature review, section 1.3 describes the methodology and the data; section 1.4 describes the results and section 1.5 concludes the analysis.

1.2 Literature review

The literature on systemic risk has been steadily growing following the crises.[3] In particular, a wide range of new empirical methods for testing the systemic risk contribution of financial institutions has been proposed. Moreover, both academia and regulators have dedicated more attention to the role of non-banking financial institutions: among these institutions, insurance companies emerged as a potential source of systemic risk.[4]

Before the crises, there was substantial agreement among scholars in considering the insurance industry to be not systemically relevant. However, in the literature that emerged in the aftermath of the crises, although many studies still consider the insurance industry non-systemically relevant as a whole, some authors argued that the insurance industry might have become systemically relevant, particularly in a number of specific activities. Many agree in ranking non-core life insurance activities as the most systemically relevant, whereas core non-life insurance activities are consid-

[3] By crises we mean both the 2007-2009 financial crisis and the 2010-2012 European sovereign crisis.

[4] A comprehensive review of the literature on systemic risk in the insurance industry is provided by Eling and Pankoke (2012).

ered the least systemically relevant. In addition, an ambiguous position is attributed to reinsurance activities.[5]

Cummins and Weiss (2014) argue that according to primary indicators and contributing factors, such as leverage, interconnectedness and size of exposure to credit, market and liquidity risk, the most systemically relevant activities are non-core activities conducted mainly by life insurers. Moreover, Harrington (2009) concludes that systemic risk is potentially higher for life insurers due to the higher leverage, sensitivity to asset value decline and potential policyholder withdrawals during a financial crisis, whereas systemic relevance is relatively low in property and casualty (P&C) insurance due to low leverage ratios. Furthermore, by analyzing the takeover of AIG by the Federal Government in the United States, the author suggests that the AIG crisis was heavily influenced by the credit default swaps (CDS) written by AIG financial products and not by more traditional insurance products written by AIG's regulated insurance subsidiaries. The Geneva Association (2010) conducted an analysis on the role played by insurers during the 2008 crisis and argues that the substantial differences between banks and insurance companies, namely the long-term liability structure of insurers compared to banks and the strong cash flow granted by the inversion of the cycle, is sufficient to rule out systemically any implications of the insurance industry during the financial crises aside from the companies highly exposed towards non-core insurance activities. Bell and Keller (2009) analyze the relevant risk factors stemming from an insurance company and conclude that traditional insurers do not pose systemic risk and, as a consequence, are neither too big nor too interconnected to fail, and that insurers engaging in non-traditional activities, such as CDS, can pose substantial systemic risk. Baluch et al. (2011) provide further arguments for the lower relevance of P&C activities and the higher relevance of non-traditional life activities: the authors argue that the fundamental reason lies in the bank-like business type and the massive amount of interconnectedness needed to run these kinds of activities.

The concept of interconnection, as expressed, among others, in Baluch et al. (2011), represents the link between analyses focused on industry-specific characteristics and more general equity-based analyses in which prices reflect all the necessary information.[6] Equity-based measures aim to measure the effect of one institution on the system or vice versa and the level of interconnectedness of the system. These measures include the ΔCoVaR (Adrian and Brunnermeier, 2011), the MES and DMES (Acharya et al., 2010), (Brownlees and Engle, 2012), the Distressed Insurance Premium (DIP) (Huang et al., 2012), Contingent Claims Analysis (CCA) (Gray and Jobst, 2011) and the linear and non-linear Granger causality test proposed by Billio et al. (2012). According to such measures, the insurance industry displays different degrees of systemic relevance. For instance, Acharya et al. (2010) argue that insurance companies are overall the least systemically relevant financial institutions. The authors provide estimations of the spillover effects through a measure

[5] Studies by Swiss Re (2003) and by The Group of Thirty (2006) tend to exclude any systemic relevance for the reinsurance business. On the other hand, Cummins and Weiss (2014) claim that, despite historical evidence, both life and P&C insurers are exposed to reinsurance crises.

[6] A comprehensive review of the models applied to systemic risk is provided by Bisias et al. (2012).

of conditional capital shortfall, i.e. Systemic Expected Shortfall (SES) and MES for the U.S. financial industry during the 2007-2009 crisis. The contribution of Adrian and Brunnermeier (2011) extends the traditional value at risk concept to the entire financial system conditional on institutions being in distress. The authors apply the measure to a set of institutions, including banks and thrifts, investment banks, government sponsored enterprises and insurance companies, finding no distinction among the systemic relevance of different types of institutions. In contrast, Billio et al. (2012) apply the linear and non linear Granger causality test to a sample of banks, insurers, hedge funds and broker dealers operating in the U.S. in order to establish pairwise Granger causality among equity returns of financial institutions. Their evidence suggests that during the 2008 financial crisis, besides banks, insurance companies were a major source of systemic risk. This conclusion is partially in contrast to Chen et al. (2014): the authors agree that the linear Granger causality test attributes a systemic relevance to insurance companies comparable to the systemic relevance of banks. However, they argue that when applying a linear and non-linear Granger causality test to the same series corrected for heteroscedasticity, banks tend to cause more systemic risk and for longer periods of time then insurance companies. Weiß and Mühlnickel (2014) and Bierth et al. (2015) focus directly on the link between equity-based systemic risk measures and industry-specific fundamentals. Weiß and Mühlnickel (2014) estimate the systemic risk contribution based on ΔCoVaR and MES for a sample of U.S. insurers during the 2007-2008 crisis, inferring that insurers that were most exposed to systemic risk were on average larger, relied more heavily on non-policyholder liabilities and had higher ratios of investment income to net revenues. Bierth et al. (2015) analyze a much broader sample of insurers over a longer time horizon and find that the systemic risk contribution of the insurance sector is relatively small. However, they also argue that the contribution of insurers to systemic risk peaked during the 2007-2008 financial crisis and find that the interconnectedness of large insurers with the insurance industry is a significant driver of the insurers exposure to systemic risk. Finally, they argue that the contribution of insurers to systemic risk appears to be primarily driven by leverage, loss ratios and funding fragility.

Concluding, the existing literature provides a diversified and controversial picture of the systemic relevance of the insurance industry. In particular, there is a lack of empirical evidence on the link between industry-specific activities and their contribution to systemic risk measured by equity prices. On the one hand, some studies argue that due to its nature, the insurance industry does not pose systemic risk, and therefore measures based on equity values might be misled by spurious effects (e.g. increased risk aversion vis-à-vis the financial industry); on the other hand, some studies provide evidence on the role of the insurance industry in posing systemic risk and its growing importance in recent years. Yet, few studies attempt to analyze empirically the relative position of the insurance industry vis-à-vis other industries and the key drivers within the insurance industry. This contribution thus aims at bridging this gap by investigating the systemic risk contribution of the insurance industry relative to other industries and the key determinants on the balance sheet of insurers. Moreover, this is the first study that focuses on European insurers.

1.3 Methodology & Data

Our analysis consists of 2 steps:

i) we conduct an analysis of the systemic risk contribution of the insurance industry vis-à-vis other industries using equity-based measures of system risk (*industry analysis*);

ii) we then conduct an empirical analysis at balance sheet level of a broader sample of European insurers based on their systemic risk contribution (*analysis of fundamentals*).

1.3.1 Systemic Risk Measures and Rankings of Systemic Risk Contributions

For the industry analysis, we apply 3 widely used equity-based measures of systemic risk: *1)* **the Granger causality test** proposed by Billio et al. (2012), *2)* the **ΔCoVaR** proposed by Adrian and Brunnermeier (2011) and *3)* the **DMES** proposed by Brownlees and Engle (2012).[7] We identify 3 groups, namely banks, insurers and non-financials. In addition, for each systemic risk measure and for each group, we distinguish between 3 cases: the average contribution of the individual institution belonging to a single group *a)* within its group (*intra-industry*), *b)* towards the other 2 groups (*other industries*) and *c)* towards all 3 groups (*total system*).[8] We then calculate the average contribution of each industry by taking the median of the month (for the ΔCoVaR and the DMES, whereas the Granger causality test is calculated on a monthly basis) and the average through the institutions of the same industry. Finally, at each point in time, we rank the institutions of the total system from the *most* to the *least* systemically relevant according to each systemic risk measure. We then select the top 10 institutions at each point in time and calculate the relative weight of each industry within the top 10 over time, thereby creating an index. More formally, the group of selected institutions at each point in time is defined as

$$S_t^k = \{i_{1,t} > ... > i_{n,t} > ... > i_{10,t}\} \tag{1.1}$$

in which i_n represents an institution ranked from the most to the least systemic (with $n = 1 \rightarrow$ *most systemic*) according to the k measure, with $k =$ Granger, ΔCoVaR, DMES. Then, the index for each systemic risk measure k is obtained as follows

$$I_t^k = \begin{cases} \frac{\sum_{n=1}^{10} \mathbb{1}_{i_{n,t}=Bank}}{10} \\ \frac{\sum_{n=1}^{10} \mathbb{1}_{i_{n,t}=Insurer}}{10} \\ \frac{\sum_{n=1}^{10} \mathbb{1}_{i_{n,t}=Non-Financial}}{10} \end{cases} \tag{1.2}$$

in which $\mathbb{1}$ is an indicator function that takes value 1 if the condition (e.g. if $i_n = Bank$) is met and 0 otherwise. Sums are then scaled between 0 and 1. Finally, we group all 3 indexes and form

[7] An extensive mathematical treatment of the 3 measures is provided in Appendix 1.6.

[8] An extensive mathematical explanation of how the 3 cases are calculated is provided in Appendix 1.6.

the total index, which is given by

$$I_t^{tot} = \begin{cases} \frac{\sum_k \sum_{n=1}^{10} \mathbb{1}_{i_{n,k,t}=Bank}}{3 \cdot 10} \\ \frac{\sum_k \sum_{n=1}^{10} \mathbb{1}_{i_{n,k,t}=Insurer}}{3 \cdot 10} \\ \frac{\sum_k \sum_{n=1}^{10} \mathbb{1}_{i_{n,k,t}=Non-Financial}}{3 \cdot 10} \end{cases} \tag{1.3}$$

It is worth remarking that the 3 systemic risk measures that we test in the analysis tend to represent different phenomena and therefore need to be correctly interpreted. The Granger causality test is a measure that allows us to quantify the degree of connectedness of an institution vis-à-vis a system of institutions. By creating a network of pairwise statistical relations, we can observe not only the degree of interdependence, but also the direction thereof. The measure is thus a good proxy for an analysis at an aggregate level (for example industry or other clusters), but its estimation could become cumbersome when the objective is to test the individual interconnection with respect to a system of institutions as proxy for the market.[9] The ΔCoVaR measures the difference between the CoVaR conditional on the distress of an institution, i.e. the value-at-risk of the system conditional on an institution being in distress and the CoVaR conditional on the normal state of the institution. It is therefore able to capture the marginal contribution of a particular institution to the overall systemic risk. One of the main advantages of such a measure is its ability to capture the individual contribution of each institution to the system. Finally, the DMES measures, in a dynamic setting, the expected drop in equity value of an institution when the system is in distress. It is worth mentioning that this is not a direct measure of systemic risk, but is highly related to it. The contribution of Brownlees and Engle (2012) originates from the proposal of Acharya et al. (2010), in which the marginal expected shortfall of an institution coupled with its leverage, originate the systemic expected shortfall (SES), i.e. the expected capital shortage of an individual firm conditional on a substantial reduction in the capitalization of the system. The authors propose a similar measure called SRISK, which is based on a dynamic estimation of the MES and leverage ratios. A major advantage of such a contribution is its ability to capture time-varying effects, effects which are not observable following Acharya et al. (2010). However, both Brownlees and Engle (2012) and Acharya et al. (2010) estimate such systemic risk measures relying on the estimation of the marginal expected shortfall (MES) and of pre-determined leverage ratios: in order to avoid additional assumptions that might cast doubts on the reliability of the estimation,[10] we simply rely on the directly observable part of the measure, i.e. the DMES, which is sufficient to provide information on the individual fragility of the individual institution with

[9]By market, we essentially mean a broad measure and proxy for the (real) economic activity such as a major stock index. Throughout the paper, we therefore interchangeably use the terms system and market as (almost) perfect substitutes.

[10]However, it is worth noting that Brownlees and Engle (2012) provide a series of robustness checks on the stability of the parametrization of the SRISK measure.

respect to market tail events, which in turn have potential systemic implications.[11]

Data

The data set for the industry analysis consists of equity returns of 60 companies listed in Europe over a time window of 14 years, from January 1999 to December 2013, which becomes 17 years (i.e. from January 1996 to December 2013) for the Granger causality test due to the lag on the series.[12] For each group, we select the top 20 institutions in terms of capitalization from STOXX® Euro 600 Banks, STOXX® Euro 600 Insurance and STOXX® Europe 600 for banks, insurers and non-financials respectively.[13] Table 1.1 reports the list of the selected institutions, while table 1.2 reports the industry distribution of non-financial institutions. Data were collected both at daily and monthly frequencies. Table 2.5 reports the summary statistics of the 3 groups. To calculate the ΔCoVaR, we rely on a set of state variables as proposed in Adrian and Brunnermeier (2011), namely *i)* Market volatility (VIX for Europe), *ii)* Liquidity spread (3M Repo - 3M Bubill), *iii)* change in the short-term interest rate (3M Bubill), *iv)* the slope of the yield curve (10Y Bund - 3M Bubill), *v)* credit spread (BAA 5-7Y Corporate (Bank of America) - EURO Sovereign 5-7Y (Barclays)), *vi)* market returns (STOXX EURO 600 All shares). Table 2.7 reports the summary statistics for the state variables. Finally, tables 2.8, 1.6 and 1.7 report the summary statistics of monthly and daily returns for banks, insurers and non-financials respectively.

1.3.2 Systemic Risk Measures and Insurers' Fundamentals

For the analysis of fundamentals, we investigate the relation between asset and liability compositions and systemic risk measures. In particular, we focus on items on the balance sheet rather than on the income statement, i.e. measures of *stock* rather than *flow*. This is justified by the fact that the insurance industry is a liability-driven business which often entails a long-term horizon in which the ability to maintain outstanding financial promises might change over time.[14] The outstanding stocks, and therefore the underlying past and current capital allocation decisions, i.e. underwriting decisions and consequent asset allocation, thus have a profound impact on the dynamics of the value of the institution, especially when sudden changes in market conditions, such as the 2007-2009 financial crisis, occur.[15] Thus, it is worth dissecting the different components of the insurance balance sheet in order to understand where potential sources of systemic risk are.

[11] Another major issue we face regarding the estimation of the SRISK is the frequency of the accounting data: since we focus on European insurers, we do not possess sufficiently long quarterly series of balance sheet data.

[12] Data were downloaded from Datastream®.

[13] Within each group, companies are ranked according to the yearly average market capitalization over the 14-year time frame. We selected those companies which were continuously listed over the period.

[14] This is particularly true in the life and health business segment.

[15] In a public speech, the President of the European Central Bank (ECB) Mario Draghi emphasized this point and stated that "(...) *The models were built on flows, with little or no attention paid to stocks. But it was precisely from stocks that the irregularities and hence the crisis arose. Non linearities arise on a balance sheet when capital falls to zero and the agent goes into default* (...)" (Draghi, 2012). For a much broader perspective on stocks vs. flows, see for instance Borio and Disyatat (2011).

In addition, the analysis focuses on the business conducted at shareholders' risk, namely excluding items for which risk is borne by policyholders.[16] In this part of the analysis, we are thus able to test which features drive the contribution of insurers to systemic risk.

In order to test the relation between relevant balance sheet items and systemic relevance, we run OLS regressions with yearly fixed effects of the lagged individual insurer balance sheet characteristics on the individual systemic risk measure.[17] We specify a model that includes both asset and liability based indicators. This model allows on the one hand to separately analyze the systemic implications stemming from underwriting and investment decision[18] and on the other hand to avoid potential biases, such as omitted variables.

The baseline model for the i^{th} insurer is given by the following:

$$SR_t^i = \beta_0 + \beta_1 \cdot Price-to-book_{t-1}^i + \beta_2 \cdot Leverage_{t-1}^{i,A/L} + \beta_3 \cdot Size_{t-1}^{i,A/L} + \sum_j \beta_j \cdot X_{j,t-1}^i + \epsilon_t^i \quad (1.4)$$

in which *Price-to-book* is the market value to book value ratio, $Leverage^A$ is the ratio between tangible assets and tangible equity and $Leverage^L$ the ratio between liabilities and tangible equity, $Size^A$ is the logarithm of tangible assets and $Size^L$ is the logarithm of liabilities.[19] We specify both *Leverage* and *Size* in 2 different (but analogous) ways in order to avoid multicollinearity problems when regressing on the relevant balance sheet items and proxies.

X_j includes a set of balance sheet items and proxies for specific factors which may influence the systemic risk contribution of an insurance company. These include *Concentration*, *Investment Quality*, *Fixed Income Assets*, *Equity Assets*, *Cash*, *Insurance Activities*, *Total Debt* and *Separate Accounts*. More specifically, *Concentration* is the Herfindahl-Hirschman index (H-H) with respect to asset classes of the portfolio's holdings which broadly captures the degree of diversification of the portfolio[20]; *Investment Quality* is the amount of at least A-rated assets which proxies the quality of the asset allocation with respect to credit risk[21] and *Fixed Income Assets*, *Equity Assets* and *Cash* are the amount of fixed income, equity and cash assets classes respectively. Finally, *Insurance Activities* is the amount of insurance activities among total activities, *Total Debt* is the amount of debt which includes senior debt, i.e. mainly deposits for banking activities, and subordinated debt, *Separate Accounts* is the amount of business which is not at shareholder risk.[22]

[16]This business is usually categorized as unit-linked or separate account business.

[17]We introduce the lag as to avoid endogeneity issues.

[18]It is worth noticing how underwriting decisions tend to shape investment decisions consistently with the typical liability-driven business approach of the insurance industry, but decisions on the asset allocation might be also influenced by other factors, such as the need to deliver investment performances, and not being limited to the replication of the liability portfolio.

[19]*Price-to-book*, *Leverage* and *Size* are usually identified as key drivers of systemic risk in financial institutions, see for instance Weiß and Mühlnickel (2014).

[20]The H-H index is a widely applied measure of concentration: it is computed as follows $\frac{\sum_i x_i^2}{(\sum_i x_i)^2}$. For its original applications, see Albert O. Hirschman (1964).

[21]This typically includes fixed income assets as the rating mainly refers to credit risk.

[22]Table 1.8 reports a detailed overview of the variables used throughout the analyses.

Hypotheses and Expected Contributions

It is worth clarifying beforehand the expectations with respect to the marginal contribution of single factors on systemic risk. To this purpose, we formulate 2 ex-ante hypotheses: the first one is the following

H.1) The Systemic Risk contribution of insurers is mainly driven by the liability side, i.e. its capital structure.

In particular, we expect *Insurance Activities* as a proxy for traditional insurance business, to exert a negative contribution to systemic risk, i.e. $\frac{\partial SR}{\partial I.A.} < 0$; by contrast *Total Debt* is expected to positively contribute to systemic risk, i.e. $\frac{\partial SR}{\partial T.D.} > 0$: this could be loosely interpreted as proxy for banking activities, since deposits are classified as senior debt, but also more broadly as non-insurance activities. Finally, *Separate Accounts* (or unit-linked business) is expected to be insignificant as most of the risk connected to such business are transferred to policyholders.

An implication of such hypothesis is that the asset side tends to play a subordinated role in posing systemic risk in insurance, although its level of diversification and its credit quality might turn out to be relevant factors since underwriting decisions tend to be replicated in the asset side.[23] More formally, *Concentration* is a proxy for the degree of diversification of the asset portfolio. By a micro perspective, a higher degree of diversification could have a positive impact on the single institution in terms of risk diversification. However, by a macro perspective a higher degree of diversification could have a negative impact on the overall system due to the higher degree of interconnectedness among institutions. [24] Hence, as interconnectedness is a potential source of systemic risk (Billio et al., 2012), we formulate a second hypothesis:

H.2) A higher diversification of investments is associated with a higher contribution to systemic risk.

More specifically we expect *Concentration* to negatively contribute to the systemic relevance of an institution, i.e. $\frac{\partial SR}{\partial C.} < 0$. In addition, also *Fixed Income Assets*, *Equity Assets* and *Cash* might be significant contributors to systemic risk, in particular bonds might be expected to display a negative sign due to the generally lower degree of risk compared to equity, which in turn we expect to be a positive contributor and cash can be expected to display a negative sign as it could be loosely interpreted as a proxy for liquidity.

Finally, *Price-to-book*, $Leverage^{A/L}$ and $Size^{A/L}$ are in general positive contributor to systemic risk in financial institutions, although in the insurance context it might not always be the case.[25]

[23] In other words, (re)insurers focused on traditional insurance activities adopt asset and liability management strategies through which risks undertaken on the liability side are hedged (replicated) through the asset side.

[24] An extensive treatment of the argument is provided among others by Das and Uppal (2004), Wagner (2010), Ibragimov et al. (2011) and Raffestin (2014).

[25] See for instance Bierth et al. (2015).

Data

For the analysis of fundamentals, we rely on a larger data set of insurers listed in Europe. We were able to collect both market data and balance sheet data for 61 European insurers from SNL Financials. Tables 1.9 and 1.10 report summary statistics for equity returns of the insurers and balance sheet variables. Table 1.11 displays the correlation matrix of balance sheet variables. Data for balance sheet variables is available from 2005 onwards, therefore the analysis of fundamentals can only cover the period between 2005 and 2013.

To test the relation between balance sheet composition and systemic risk contributions, we rely on 2 of the 3 measures that we estimated in the industry analysis, namely the ΔCoVaR and the DMES. This is due to the fact that while we can estimate these 2 measures using a representative index, this is no longer possible for the Granger causality test. In fact, for the purpose of the analysis, it is convenient to measure the marginal effect of each institution vis-à-vis the system, which can be proxied through a broad equity index.[26] Due to data availability, we use the FTSE All shares as proxy for the system.[27] For the analysis of fundamentals, we thus focus on the ΔCoVaR and the DMES. To match the yearly frequency of the balance sheet data, we estimate daily ΔCoVaR and DMES, then take the median of the month and average through the year.[28]

1.4 Empirical Results

1.4.1 Systemic Risk Measures and Rankings of Systemic Risk Contributions

The Granger causality test (Billio et al., 2012)

Figure 1.1 reports the evolution over time of the total number of causing (Granger-causal) significant connections over the total number of possible connections from a single institution belonging to each group towards its own industry (*intra-industry*). During the pre-crisis period, a generalized decrease in the connectivity level can be observed across the 3 groups: particularly in the period from 1999 to the end of 2004, the level of connectivity goes from roughly 20-25% to 10-15%; starting from 2005 onwards, the level of intra-industry connectivity among banks and insurers increases rapidly, spiking at 35-40% around the time of Lehman filing for bankruptcy and the subsequent AIG bailout. For non-financials, although the index signals an increase of the connectivity level, a Lehamn effect is much less visible. The filing for bankruptcy and the subsequent AIG bailout thus represent more of a shock to the financial industry than to the non-financial industry. The aftermath of Lehman in fact signals a clear increase in the connectivity level among banks: non-

[26] A similar approach is proposed in Bierth et al. (2015) and Brunnermeier et al. (2012).

[27] For the sake of consistency, we would have employed the Euro STOXX total market, but unfortunately the total return index is only available from 2002 onwards. Therefore, we use the FTSE All shares as a substitute and proxy for the European market as a whole.

[28] The systemic risk measures were re-estimated using the FTSE All shares as a system: not all of the 61 insurers were continuously listed between January 1999 and December 2013, therefore we calculated the measures with the available time series.

financials continue to display relatively lower levels of connectivity, whereas insurers tend to span halfway between banks and non-financials.

Figure 1.2 reports the evolution over time of the total number of Granger-causal significant connections over the total number of possible connections from each group towards *other industries*. The upper graph displays the average number of receiving (Granger-causal) connections for a single institution in each group from other industries. We can observe a clear pre- and post-Lehman trend which is consistent with the shock to the financial system as recorded in figure 1.1: before the filing for bankruptcy of Lehman, financial institutions tended to act as receivers more than non-financials; after Lehman the opposite occurs, with non-financials being net receivers. The lower graph displays the number of causing (Granger-causal) connections for each group from other industries. Clearly, the trend now follows opposite directions, with financial institutions becoming the net causer after Lehamn: in particular, banks from 2006 up to Lehman play a much stronger role compared to insurers, and the same tendency can be observed from 2009 to 2012. Once again, we can observe a subordinated role of insurers compared to banks as a cause of systemic risk, with a consequent role of net receiver played by non-financials.

Finally, figure 1.3 reports the evolution over time of the total number of causing and receiving (Granger-causal) significant connections over the total number of possible connections from each group towards the *total system*. Once again, insurers tend to be subordinated compared to banks in causing as well as receiving systemic risk: even though a unique trend over time does not emerge, we can still observe how from 2007 through to 2013, insurers persistently pose less systemic risk compared to banks, with an increase in this difference from 2009 onwards.

In summary, the outcome provided by the Granger causality test provides a fairly clear picture over time of receivers and causers of systemic risk: non-financials behave as causers during tranquil periods and as net receivers during crises, whereas banks appear to be the most prominent causers of systemic risk in the aftermath of a crisis. In particular, among financial institutions, insurers display a more ambiguous behavior compared to banks and on average play a subordinated role compared to banks, especially during the 2007-2009 financial crisis and its aftermath. This is in line with existing findings for American insurance companies.[29]

ΔCoVaR (Adrian and Brunnermeier, 2011)

Figure 1.4 reports estimations of the average individual institutions' ΔCoVaR within its industry (*intra-industry*). The figure displays a strong differentiation between financial and non-financial institutions. Banks and insurers present the lowest values, with the 2 curves almost perfectly co-moving over the whole time window. Nevertheless, differences between banks and insurers do exist, especially in the aftermath of the crisis, where banks persistently tend to register lower values compared to insurers, with differences of up to 1 percentage point around the European sovereign crisis, i.e. between 2011 and 2012. Furthermore, a striking difference emerges when comparing non-

[29] See, among others, Chen et al. (2014).

financials with banks and insurers: with the Granger causality test, non-financials are consistently less interconnected within themselves and display persistently much higher values.[30]

Figure 1.5 reports results for the average individual institutions' ΔCoVaR towards *other industries*: pre-crises periods are clearly dominated by non-financials, whereas during and after the Lehman bankruptcy, banks and insurers become systemically more relevant, with non-financial companies still displaying a relatively higher contribution to systemic risk. It is clear that by changing the composition of the reference system towards which we estimate the measure, effects differ quite substantially: by considering the marginal effects of an institution towards other industries, we can observe the spillover effects that one industry has onto other industries, and not surprisingly, non-financials had a higher influence on banks and insurers before the financial crisis occurred. This is mainly due to the exposure of the financial sector towards all other sectors rather than vice-versa.[31] This once again provides evidence on the financial nature of the crisis.

Finally, figure 1.6 reports the results of the average individual institutions' ΔCoVaR towards the *total system*. Here, it is worth noting that before the bankruptcy of Lehman, financials and non-financials display small differences in values, whereas after the crisis, the contribution to systemic risk of financial institutions increases dramatically, with banks once more dominating insurers in terms of marginal contribution. Even though the differences appear modest, we should stress the fact that the measure is estimated on daily returns and averaged through many institutions, therefore the average marginal contribution of banks after 2008 can be estimated as being roughly 20% higher compared to insurers, which makes it considerably higher.

In summary, ΔCoVaR provides a fairly clear indication of the behavior of financial and non-financial institutions, which is in line with the Granger causality test. Furthermore, if we consider the estimations of the *total system* to be more representative of the role of each group in posing systemic risk, insurers again tend to play a subordinated role compared to banks.

DMES (Brownlees and Engle, 2012)

Figure 1.7 reports the results for the average marginal contribution of the individual institution within its industry (*intra-industry*). The pattern of each group is comparable with the one obtained with the other 2 measures, and in particular with the ΔCoVaR. The 2 measures present the same peaks during the financial crises and report a higher level of systemic riskiness after the crises compared to the pre-crises period. Differences from the previous measures can be found in the spikes at the end of 2001 and 2003 reported by DMES: these spikes are mainly driven by the insurance industry and can be traced back to industry-specific events such as 9/11 and severe natural catastrophes occurring in Europe in 2003. Consistent with the design of the measure, these peaks are well captured by DMES due to its focus on tails of the distributions, i.e. severe events.

[30]Please note that we consider lower values to be a sign of higher systemic relevance, since the measure estimates market value losses.

[31]In the public debate, this is sometimes referred to as "Wall Street" vs "Main Street".

In general, financial institutions report lower average DMES values than non-financial institutions, with some differences between banks and insurers depending on the period: in the aftermath of the crises, banks pose more risk than insurers.

Figure 1.8 reports results for the average marginal contribution of the individual institution towards *other industries*: on the one hand, the measure indicates once more the distinction between financial and non-financial institutions, with the latter being overall less exposed to the financial sector; on the other hand, banks and insurers appear to be substantially equal in terms of contribution, with banks dominating in the aftermath of Lehman.

Finally, figure 1.9 reports the results for the average marginal contribution of the individual institution towards the *total system*. There is no significant difference from the results presented in both the Granger causality test and in the ΔCoVaR, which in turn confirms our results.

In summary, DMES confirms the outcome of the 2 other measures, attributing the higher systemic relevance to financial institutions, among which insurers prevail before Lehman and banks in its aftermath.

Systemically Important Financial Institutions (SIFIs)

We also report the average results towards the *total system* for those insurers labeled as SIFIs: this distinction is particularly relevant, since regulators indicated some common characteristics among these institutions which should make them more systemically relevant compared to the median insurer. It is thus worth analyzing their individual behavior vis-à-vis the *total system*. Figure 1.10 shows a higher average degree of causality compared to the full insurance group with significant peaks which can be observed during the Lehman bankruptcy. In general, we can observe that despite a higher causality compared to non-SIFIs, this sub-group of institutions still tends to play a minor role compared to banks in the aftermath of the Lehman crisis. Figure 1.11 reports a widespread increase of systemic contribution of SIFI insurers measured by ΔCoVaR in comparison to the full insurance sample and even compared to banks. The contribution towards the *total system* is the highest among the 3 groups throughout the period. Finally, figure 1.12 reports the result for the DMES: among the 3 measures, the DMES displays the smallest differences between SIFI insurers and non-SIFI insurers, with the period following the Lehman bankruptcy recording the systemic contribution of SIFIs as being significantly inferior to the contribution of banks.

Rankings

In order to provide a straightforward representation of the systemic relevance of the 3 groups according to the 3 measures, we display in figure 1.13 the 10 most systemically relevant institutions grouped by industry at each point in time. The Granger causality test and the ΔCoVaR alternatively rank banks during crises and non-financials during tranquil periods as the most systemically relevant companies with a key distinction: banks are always present throughout the period, whereas non-financials disappear after the Lehman crisis. Insurers, despite always being present in the top

10 sub-group throughout the period, still play a subordinated role compared to banks. The DMES attributes a predominant role to insurance companies before the Lehman bankruptcy and to banks afterwards. The measure associates to non-financials an ancillary role only in tranquil periods. The systemic relevance of the 3 groups is finally summarized into a synthetic indicator that displays at each point in time the industry composition of the top 10 most systemic institutions according to the 3 measures.[32] The index clearly shows that non-financials dominate the index before Lehman, whereas banks dominate it thereafter. In contrast, insurers always tend to play a subordinated role both before and after the Legman bankruptcy.

In conclusion, we can summarize our findings as follows: *i)* the 3 measures make a clear distinction between financial and non-financial institutions; *ii)* among financial institutions, banks dominate insurers in terms of contribution to systemic risk in the aftermath of the financial crises, with insurers nevertheless displaying a persistent contribution to systemic risk over time; *iii)* there is no clear-cut evidence on higher systemic relevance of SIFI insurers; *iv)* trends in systemic risk contributions are time-dependent and tend to change rapidly, making the choice of the time span of analysis a crucial variable. Moreover, it is worth mentioning that the 3 measures were developed to capture different features of the systemic risk contribution of institutions, therefore inconsistencies over time should not be seen as lack of accuracy, but rather as emphasis on different factors that contribute to systemic risk.

In the next section, we analyze the determinants behind the systemic contribution of insurers: we attempt to shed further light on which activities within the insurance industry make some insurers more systemic than others. To do so and to overcome sample biases, particularly with respect to the choice of the time window to analyze, we collect a broader sample of data on European insurers over a longer period of time (than previously done in the literature).

1.4.2 Systemic Risk Measures and Insurers' Fundamentals

Table 1.12 reports the results of the panel regressions run on the ΔCoVaR and on the DMES.[33] The model described in equation (1.4), has 2 specifications: an asset oriented specification and a liability oriented specification, which differ for the definition of *Leverage* and *Size*. In addition, both specifications are tested on 3 different panels, namely *i) Full Sample*, *ii) Sample without Reinsurers* and *iii) Sample without Reinsurers and SIFIs*. We opt for 2 different specifications in order to avoid multicollinearity issues as some of the regressors present a relatively high level of correlation.[34] Finally, the 3 different panels aim to exclude potential biases induced by institutions with specific characteristics, such as reinsurers and SIFIs compared to the median insurer.

The results on the *Full Sample* of both the ΔCoVaR and the DMES suggest a statistically and

[32]See equation (1.3).

[33]In order to ease the interpretation of coefficients, ΔCoVaR and DMES values are reported with inverted signs ad scaled by 100, e.g. a higher systemic relevance is associated with a higher (positive) value displayed by the 2 measures.

[34]Table 1.11 reports the correlations among regressors.

economic significant positive contribution of *Size*, both if computed as total assets or total liabilities, although the magnitude of the coefficient is relatively moderate. By contrast, both *Price-to-book* and *Leverage* seem to be statistically significant when regressed on the ΔCoVaR, whereas they lose significance when regressed on the DMES. However the economic significance, both in terms of sign and magnitude suggest a controversial and minor effect on systemic risk, in line with the findings of Bierth et al. (2015). A potential interpretation could be that *Leverage* as measured among others in banking, does not properly fit insurers as measure of financial fragility, whereas *Price-to-book* could be a better indicator at a higher frequency, e.g. quarterly frequency, as it tends to reflect market sentiment in the relatively shorter term.

Striking results come from the effects of *Concentration*: in line with our second hypothesis ($H.2$) the degree of diversification of the asset allocation have a very strong statistically and economic significant negative impact on the systemic risk contribution of insurers, which implies that the more diversified a portfolio of assets is, the higher the propensity to pose systemic risk. Results remain strong under the 2 different specifications and the 2 different systemic risk measures. This is consistent with the theoretical argument outlaid among others by Das and Uppal (2004), Wagner (2010), Ibragimov et al. (2011) and Raffestin (2014), which has so far lacked empirical evidence. Also the *Investment Quality* of the asset portfolio seems to atter for the DMES, even though its statistical and economic significance appear rather small. In addition, the relative positions taken in major asset classes such as *Fixed Income Assets* and *Cash* appear to be statistically significant only for a sub-set of the specifications, although significance becomes weaker for the DMES, thereby highlighting potential biases in the sample. Also, the sign of the coefficients is always positive, thus making the economic interpretation difficult as both assets classes should (theoretically) be negatively linked to systemic risk. By contrast *Equity Assets* does not display statistical significance.

Insurance Activities display a strong economic and statistically significant coefficient across the 2 specifications and the 2 measures: as we per our conjecture ($H.1$), there exists a strong negative relation between the amount of insurance activities held in portfolio (with respect to all activities of the insurer) and the systemic risk contribution of the insurer. This evidence is consistent with the idea expressed in Cummins and Weiss (2014) that non-core activities are potentially more systemic than the traditional insurance activities, and in line with the evidence from U.S. insurers provided by Weiß and Mühlnickel (2014), in which non-policy holders' activities did cause systemic risk during the financial crisis.

Total Debt displays a statistically significant coefficient only for the DMES: the economic significance is robust and suggests that insurers with a capital structure more exposed to non policy holders' liabilities or more in general exposed to non-insurance (banking) activities, tend to pose more systemic risk. Finally, *Separate Accounts* appear to be weakly statistically significant in only one specification, i.e. asset oriented specification, of the ΔCoVaR and of the DMES, whereas they display statistically insignificant coefficients if specified with liability oriented variables.

Moving from the *Full Sample* to *Sample without Reinsurers* we note how for the ΔCoVaR, *Fixed Income Assets* becomes insignificant, whereas *Cash* remains unchanged. For the DMES we note how both *Concentration* and *Investment Quality* increase their significance, both economic and statistical. By contrast *Total Debt* loses some statistical significance, although its p value is still below 10%. *Price-to-book*, *Leverage* and *Size* remain mainly unchanged. Finally, moving to the reduced and potentially more robust sample, as it excludes potential biases both from reinsurers and SIFIs, we observe that the key drivers across the different specifications and for both measures are indeed *Concentration*, *Insurance Activities* and *Total Debt*. All other variables lose significance, except for few outliers. Such result strongly confirms that net of reinsurers and SIFIs, i.e. mostly big insurance groups, the key drivers of systemic risk in insurance are non-insurance activities and the level of diversification of its asset portfolio.

To summarize, we can conclude that *i) Insurance Activities* are a strongly economic and statistically significant factor for systemic risk in insurance, as well as *Total Debt*, which together strongly determine the capital structure of firms, *ii) Concentration*, i.e. diversification, if it can be considered optimal at single institution level, it may turn out to be deleterious at an aggregate (systemic) level. In addition we confirm that *Size* does matter, whereas *Leverage* appears to be a potentially misleading measure in insurance companies.

Robustness of Results

In addition to the robustness check that we conducted by testing the different specifications across 3 different panels we conduct a difference-in-differences (DiD) analysis to check for potential endogeneity issues.[35] Similar to Brunnermeier et al. (2012), we test the robustness of our findings around Lehman's filing for bankruptcy and subsequent AIG bailout.[36] Since Lehman's failure came as an exogenous shock, it represents a good candidate for a natural experiment.[37]

We adopt the following strategy for the DiD analysis: we run regressions using the same specifications as in equation (1.4) and we test single variables around the Lehman shock, i.e. systemic risk contribution in 2007 vs 2008, balance sheet items and proxies in 2006 vs 2007. In particular, we construct dummy variables for each of the relevant variable, i.e. *Concentration*, *Investment Quality*, *Fixed Income Assets*, *Equity Assets*, *Cash*, *Insurance Activities*, *Total Debt* and *Separate Accounts*.[38] The model is the following:

[35] In the panel regressions we use a time lag between dependent and independent variables: theoretically such temporal mis-match should shelter our analysis from endogeneity or reverse causality issues.

[36] For further details on the applied DiD methodology, see, for instance, Meyer (1995) and Angrist and Krueger (1999). For a more didactic contribution, see Wooldridge (2010).

[37] AIG was bailed out by the U.S. Government a day after Lehman's bankruptcy filing.

[38] We neglect *Price-to-book*, *Leverage* and *Size* not because we neglect their importance, but because they have been substantially analyzed in previous work, see for instance Brunnermeier et al. (2012) for banks and (Bierth et al., 2015) for insurers.

$$SR^i = \beta_0 + \beta_1 \cdot Price - to - book^i + \beta_2 \cdot Leverage^{i,A/L} + \beta_3 \cdot Size^{i,A/L} + \sum_{j \neq z} \beta_j \cdot X_j^i + \quad (1.5)$$

$$\delta_0 \cdot d.shock + \delta_1 \cdot d.X_z + \widehat{\delta} \cdot d.shock \cdot d.X_z + \epsilon^i \quad (1.6)$$

in which the $d.shock$ is a dummy variable which takes value 0 for 2007 and value 1 for 2008 (pre- and post-shock period) and the $d.X_z$ is a dummy that represents the control (or non-treated group) and the treatment group respectively. We specify 8 treatment groups, 1 for each relevant variable: we divide the observations into 2 groups, above and below the median and assign value 0 and 1 depending on the expected sign of the variable. Table 1.13 provides an overview of the treatment variables.

Tables 1.14 - 1.17 report the results of the DiD around the Lehman bankruptcy and AIG bailout: the coefficient of interest is of course the interaction term ($\widehat{\delta}$) between the shock dummy and the control group. The striking result of such robustness check is that, *Insurance Activities*, *Total Debt* and *Separate Accounts* appear to be statistically and economically significant determinants of systemic risk, although not uniformly for the 2 measures: in fact, *Separate Accounts* are statistically insignificant for the ΔCoVaR. This confirms our hypothesis that the capital structure, i.e. the liability side, is the key driver of systemic risk in insurance. By contrast *Concentration* does not display significant coefficients: however, this shall not be taken as a rejection *in toto*, rather it deserves further investigation, since *Concentration* is just a proxy and by definition it is an imperfect measure and therefore, measurement errors might be a potential explanation for its insignificance.

1.5 Conclusion

In the present paper, we propose an analysis of the role of the insurance industry in posing systemic risk and the determinants therein. We divide the analysis into 2 parts: first, we conduct an aggregated industry analysis based on 3 measures of systemic risk on 3 different groups. By doing so, we aim to test the relative systemic risk contribution of the insurance industry vis-à-vis other industries. In the second part of the analysis, we investigate what are the potential determinants of systemic risk within the insurance industry by focusing on the asset and liability composition of insurers.

Our evidence suggests that financial institutions tend to cause more systemic risk than non-financial institutions; among financial institutions, banks pose more systemic risk than insurers, especially after the Lehman bankruptcy. Insurers do cause systemic risk, especially when they engage in non-insurance activities, e.g. banking activities. Furthermore, we find that systemic risk in the insurance industry is mainly driven by the liability side, i.e. the capital structure rather than the asset side: however, on the asset side we find that the level of diversification is also a strong determinant of systemic risk, although further investigation is needed. In addition, traditional variables associated with systemic risk in financial institutions, such as size is of importance, whereas price-to-book and leverage seem to play a counterintuitive role. This is however in line with previous findings, which confirm for instance that leverage in insurance is fundamentally different compared to leverage in banking. Results are robust to a set of different specifications, different panels and different econometric methods. Finally, the choice of the time span should shelter the analysis from biases stemming from sample (time-dependency) selection.

In conclusion, we provide new evidence on the role of insurers in posing systemic risk, in particular on the role of insurance activities compared to non-insurance activities. Also, we are among the first to provide empirical evidence on the role of diversification in posing systemic risk, which should be further analyzed in future research. Moreover, we are the first to use a European set of companies and to use variables of *stock* rather than *flow*: the latter is particularly relevant to show how the stock of the outstanding business drives systemic risk contribution in the insurance industry.

Thus, our research has the potential to provide a significant contribution to shedding additional light on the debate on systemic risk in the insurance industry as well as insightful indications on how to assess the systemic relevance of insurance companies. This is particularly relevant in the light of the ongoing discussion on the role of SIFIs and on the specific regulations they might be subjected in the future. Furthermore, the present paper could serve as a basis for a theoretical treatment of the systemic risk contribution of the insurance industry, and thereby contribute to deepening the understanding of the underlying economic forces driving systemic risk.

1.6 Appendix

1.6.1 The Granger causality test (Billio et al., 2012)

We measure the systemic importance of an institution in terms of the total number of statistically significant pairwise connections based on linear Granger causality tests. This approach allows us to infer when equity price movements of an institution influence price movements of another institution over a given period of time. The Granger causality test measures the ability of 2 time series to forecast each other. We can write the system of equations as follows

$$y^i_{t+1} = \alpha^i y^i_t + \beta^{ij} y^j_t + \epsilon^i_{t+1} \tag{1.7}$$

$$y^j_{t+1} = \alpha^j y^j_t + \beta^{ji} y^i_t + \epsilon^j_{t+1} \tag{1.8}$$

in which coefficients α^i, β^{ij}, α^j, β^{ji} are estimated via linear regression and in which time series j is said to "Granger-cause" times series i if lagged values of j contain statistically significant information that helps in predicting i.

The *causality indicator* is defined as follow:

$$j \to i = \begin{cases} 1, & \text{if } j \text{ Granger causes } i \\ 0, & otherwise \\ 0, & \text{for } j \to j \end{cases} \tag{1.9}$$

Equation (1.9) allows us to calculate a series of indexes based on the total number of significant relations among institutions at a specific point in time.[39]The *Degree of Granger Causality* thus represents the fraction of statistically significant relationships over the total number of possible connections among the full sample,

$$DGC = \frac{1}{N(N-1)} \sum_{i=1}^{n} \sum_{j \neq i} (j \to i) \tag{1.10}$$

Moreover, we can differentiate between *causing* and *receiving* connections which are defined as follows

$$Out : (j \to S)|_{DGC \geq K} = \frac{1}{N-1} \sum_{i \neq j} (j \to i)|_{DGC \geq K} \tag{1.11}$$

$$In : (S \to j)|_{DGC \geq K} = \frac{1}{N-1} \sum_{i \neq j} (i \to j)|_{DGC \geq K} \tag{1.12}$$

We then distinguish between 3 cases:

[39] The level of significance K is set at 0.05.

1) *intra-industry*:

$$(j \to ind^{-j})|_{DGC \geq K} = \frac{1}{(N-1)} \sum_{i \neq j} (j \to ind^{-j})|_{DGC \geq K} \tag{1.13}$$

$$(ind^{-j} \to j)|_{DGC \geq K} = \frac{1}{(N-1)} \sum_{j \neq i} (ind^{-j} \to j)|_{DGC \geq K} \tag{1.14}$$

2) *other industries*:

$$\left(j \to S^{-ind}\right)|_{DGC \geq K} = \frac{1}{2N} \sum_{i \neq j} (j \to S^{-ind})|_{DGC \geq K} \tag{1.15}$$

$$\left(S^{-ind} \to j\right)|_{DGC \geq K} = \frac{1}{2N} \sum_{i \neq j} (S^{-ind} \to j)|_{DGC \geq K} \tag{1.16}$$

3) *total system*:

$$(j \to S^{-j})|_{DGC \geq K} \frac{1}{3N-1} \sum_{i \neq j} (j \to S^{-j})|_{DGC \geq K} \tag{1.17}$$

$$(S^{-j} \to j)|_{DGC \geq K} \frac{1}{3N-1} \sum_{i \neq j} (S^{-j} \to j)|_{DGC \geq K}. \tag{1.18}$$

Each index represents the contribution of each individual institution. We then calculate industry averages by summing the total number of institutions' connections across each industry group.

1.6.2 ΔCoVaR (Adrian and Brunnermeier, 2011)

The measure extends the concept of *Value at Risk* (VaR) designed for individual institutions to the system as a whole. The CoVaR represent the VaR of a system conditional on institutions being in distress. The systemic contribution of an individual institution to the system is computed as the difference between the CoVaR of the institution in distress and the CoVaR in the median state, hence ΔCoVaR. Following Adrian and Brunnermeier (2011), we calculate the ΔCoVaR using quantile regressions by setting the median state at the 50 percentile and the distress situation at the 95 percentile. We also include in the regressions a set of 6 state variables M_{t-1}, namely market volatility, liquidity spread, changes in the short-term interest rates, the slope of the yield curve, credit spreads and total equity returns, using 1 week lag.

Estimations are based on the following equations

$$X_t^i = \alpha^i + \gamma^i M_{t-1} + \varepsilon_t^i \tag{1.19}$$

$$X_t^S = \alpha^{S|i} + \beta^{S|i} X_t^i + \gamma^{S|i} M_{t-1} + \varepsilon_t^{S|i} \tag{1.20}$$

where i represents the individual institution and S is the index representing the set of institutions under consideration. The predicted value from the regressions are then plugged into the following equation to obtain both the VaR of the individual institution and consequently the CoVaR

$$VaR_t^i(q) = \hat{\alpha}_q^i + \hat{\gamma}_q^i M_{t-1} \tag{1.21}$$

$$CoVaR_t^i(q) = \hat{\alpha}^{S|i} + \hat{\beta}^{S|i} VaR_t^i(q) + \hat{\gamma}^{S|i} M_{t-1}. \tag{1.22}$$

Finally, the contribution of each institution to the system is calculated as follows:

$$\Delta CoVaR_t^i(q) = CoVaR_t^i(5\%) - CoVaR_t^i(50\%) = \hat{\beta}^{S|i}(VaR_t^i(5\%) - VaR_t^i(50\%)) \tag{1.23}$$

We then distinguish between 3 cases:

1) *intra-industry*:

$$X_t^S = \frac{\sum_{j \neq i} w_{t-1}^j \cdot r_t^j}{\sum_{j \neq i} w_{t-1}^j} \tag{1.24}$$

with *w=market capitalization*, *r= return*, *j= i's industry group*,

$$\Delta\overline{CoVaR}_t^{intra\text{-}industry|i} = \frac{1}{N}\sum_{i}^{N} \Phi^{-1}(0.5)\Delta CoVaR_{t\to t+h}^{intra\text{-}industry|i} \tag{1.25}$$

where $t \to t+h$ indicates 1 calendar month of daily ΔCoVaR.

2) *other industries*:

$$X_t^S = \frac{\sum_{j} w_{t-1}^j \cdot r_t^j}{\sum_{j} w_{t-1}^j} \tag{1.26}$$

with *w=market capitalization*, *r= return*, *j= excluding i's industry group*,

$$\Delta\overline{CoVaR}_t^{other\ industries|i} = \frac{1}{N}\sum_{i}^{N} \Phi^{-1}(0.5)\Delta CoVaR_{t\to t+h}^{other\ industries|i} \tag{1.27}$$

where $t \to t+h$ indicates 1 calendar month of daily ΔCoVaR.

3) *total system*:

$$X_t^S = \frac{\sum_{j \neq i} w_{t-1}^j \cdot r_t^j}{\sum_{j \neq i} w_{t-1}^j} \tag{1.28}$$

with *w=market capitalization*, *r= return*, *j= total system*,

$$\Delta \overline{CoVaR}_t^{total\ system|i} = \frac{1}{N}\sum_i^N \Phi^{-1}(0.5)\Delta CoVaR_{t\to t+h}^{total\ system|i} \tag{1.29}$$

where $t \to t+h$ indicates 1 calendar month of daily ΔCoVaR.

Where N represents the number of institutions for each of the 3 groups. In order to avoid correlation biases, i.e. under case 1) and 3), we always exclude institution i from the index representing the reference group.

1.6.3 DMES (Brownlees and Engle, 2012)

The measure is based on the expected loss conditional to a distressed situation (eg. returns being less than a certain quantile): Brownlees and Engle (2012) extend the measure proposed by (Acharya et al., 2010) by introducing a dynamic model characterized by time varying volatility and correlation as well a nonlinear tail dependence. The market model is defined as follows

$$\begin{gathered} r_{mt} = \sigma_{mt}\epsilon_{mt} \\ r_{it} = \sigma_{it}\rho_{it}\epsilon_{mt} + \sigma_{it}\sqrt{1-\rho_{it}^2\xi_{it}} \\ (\epsilon_{mt}, \xi_{it}) \sim F \end{gathered} \tag{1.30}$$

where r_i is the market return of the i^{th} institution and σ_{it} is its conditional standard deviation, r_m is the market return of the system considered and σ_{mt} is its conditional standard deviation, ϵ and ξ are the shocks that drive the system and ρ_{it} is the conditional correlation between i and m. The one period ahead DMES can be expressed as follows

$$DMES_{it-1}^1(C) = \sigma_{it}\rho_{it}E_{t-1}(\epsilon_{mt}|\epsilon_{mt} < \frac{C}{\sigma_{mt}}) + \sigma_{it}\sqrt{1-\rho_{it}^2}E_{t-1}(\xi_{it}|\epsilon_{mt} < \frac{C}{\sigma_{mt}}) \tag{1.31}$$

where C is the conditioning systemic event which we assume to be equal to the 95^{th} percentile of the total period market return, i.e. $C = \Phi^{-1}(0.95)r_m$.[40] The conditional standard deviations and the conditional correlation are estimated by means of a TARCH and a DCC model respectively.[41] The tail expectations $E_{t-1}(\epsilon_{mt}|\epsilon_{mt} < \frac{C}{\sigma_{mt}})$ and $E_{t-1}(\xi_{it}|\epsilon_{mt} < \frac{C}{\sigma_{mt}})$ are calculated by means of a non-parametric kernel estimator and are given by the following equations

$$\hat{E}_h(\epsilon_{mt}|\epsilon_{mt} < k) = \frac{\sum_{i=1}^n \epsilon_{mt}K_h(\epsilon_{mt}-k)}{(n\hat{p}_h)} \tag{1.32}$$

[40] The choice over the $VaR_{0.95}$ of the market allows for a more direct comparison with the estimations of the ΔCoVaR.

[41] For further mathematical details, see Brownlees and Engle (2012).

$$\hat{E}_h(\xi_{it}|\epsilon_{mt} < k) = \frac{\sum_{i=1}^{n} \xi_{it} K_h(\epsilon_{mt} - k)}{(n\hat{p}_h)} \tag{1.33}$$

with

$$\hat{p}_h = \frac{\sum_{i=1}^{n} K_h(\epsilon_{mt} - k)}{n}$$

We then distinguish between 3 cases:

1) *intra-industry*:

$$r_{mt} = \frac{\sum_{j \neq i} w_{t-1}^{j} \cdot r_t^{j}}{\sum_{j \neq i} w_{t-1}^{j}} \tag{1.34}$$

with *w=market capitalization*, *r= return*, *j= i's industry group*,

$$\overline{DMES}_t^{intra\text{-}industry|i} = \frac{1}{N} \sum_{i}^{N} \Phi^{-1}(0.5) DMES_{t \to t+h}^{intra\text{-}industry|i} \tag{1.35}$$

where $t \to t+h$ indicates 1 calendar month of daily DMES.

2) *other industries*:

$$r_{mt} = \frac{\sum_{j} w_{t-1}^{j} \cdot r_t^{j}}{\sum_{j} w_{t-1}^{j}} \tag{1.36}$$

with *w=market capitalization*, *r= return*, *j= excluding i's industry group*,

$$\overline{DMES}_t^{other\ industries|i} = \frac{1}{N} \sum_{i}^{N} \Phi^{-1}(0.5) DMES_{t \to t+h}^{other\ industries|i} \tag{1.37}$$

where $t \to t+h$ indicates 1 calendar month of daily DMES.

3) *total system*:

$$r_{mt} = \frac{\sum_{j \neq i} w_{t-1}^{j} \cdot r_t^{j}}{\sum_{j \neq i} w_{t-1}^{j}} \tag{1.38}$$

with *w=market capitalization*, *r= return*, *j= total system*,

$$\overline{DMES}_t^{total\ system|i} = \frac{1}{N} \sum_{i}^{N} \Phi^{-1}(0.5) DMES_{t \to t+h}^{total\ system|i} \tag{1.39}$$

where $t \to t+h$ indicates 1 calendar month of daily DMES.

Where N represents the number of institutions for each of the 3 groups. In order to avoid correlation biases, i.e. under case 1) and 3), we always exclude institution i from the index representing the reference group.

1.7 Figures

Figure 1.1: Total Cause Intra-Industry. The figure displays for each group the number of significant cause and receive linear Granger causality connections over the total number of possible cause and receive connections. Statistical significance level is set at 5%. Results are calculated using Newey West standard errors.

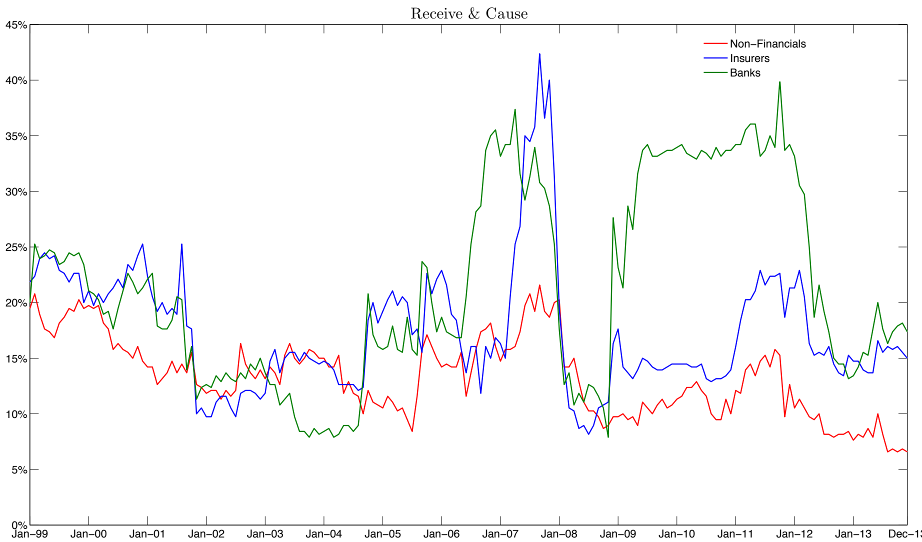


Figure 1.2: Total Cause/Receive towards Other Industries. The figure displays for each group the number of significant cause and receive linear Granger causality connections over the total number of possible cause and receive connections. Statistical significance level is set at 5%. Results are calculated using Newey West standard errors.

Figure 1.3: Total Cause/Receive towards Total System. The figure displays for each group the number of significant cause and receive linear Granger causality connections over the total number of possible cause and receive connections. Statistical significance level is set at 5%. Results are calculated using Newey West standard errors.

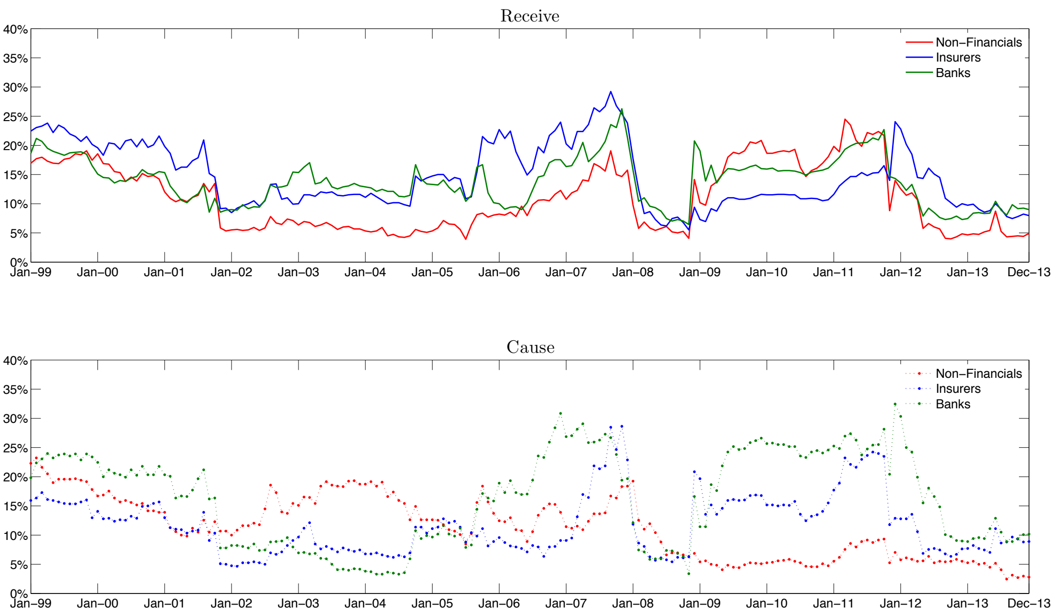


Figure 1.4: Average Institutions' ΔCoVaR Intra-Industry. The figure displays the industry monthly average calculated on the single institution's monthly median value.

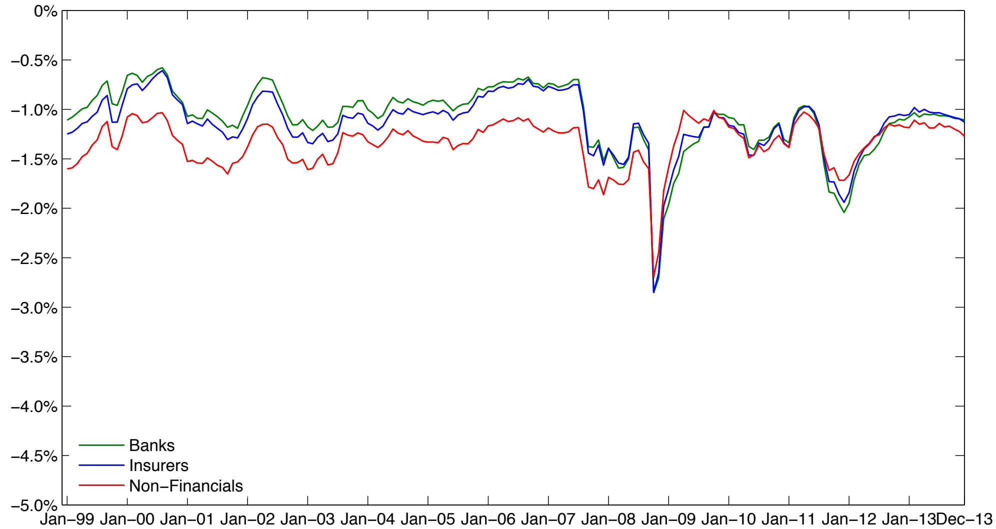


Figure 1.5: Average Institutions' ΔCoVaR towards Other Industries. The figure displays the industry monthly average calculated on the single institution's monthly median value.

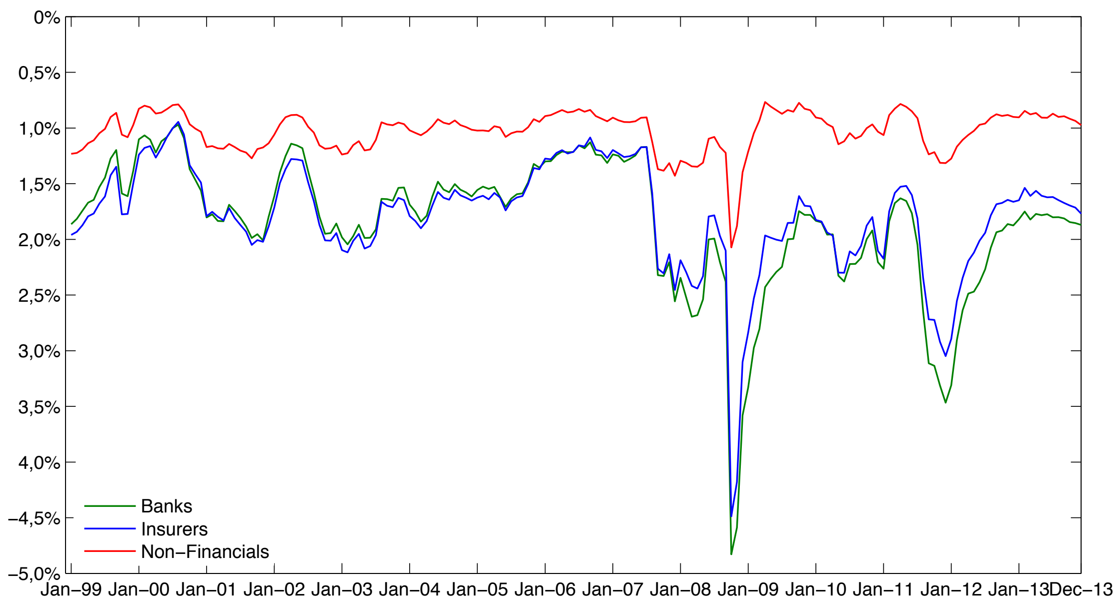


Figure 1.6: Average Institutions' ΔCoVaR towards Total System. The figure displays the industry monthly average calculated on the single institution's monthly median value.

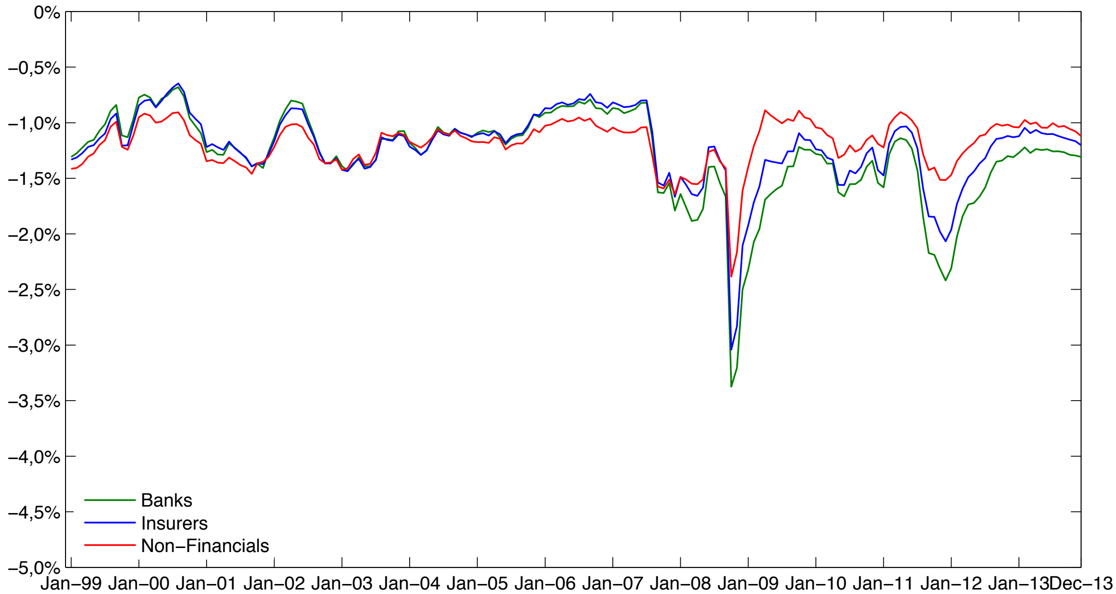


Figure 1.7: Average Institutions' DMES Intra-Industry. The figure displays the industry monthly average calculated on the single institution's monthly median value.

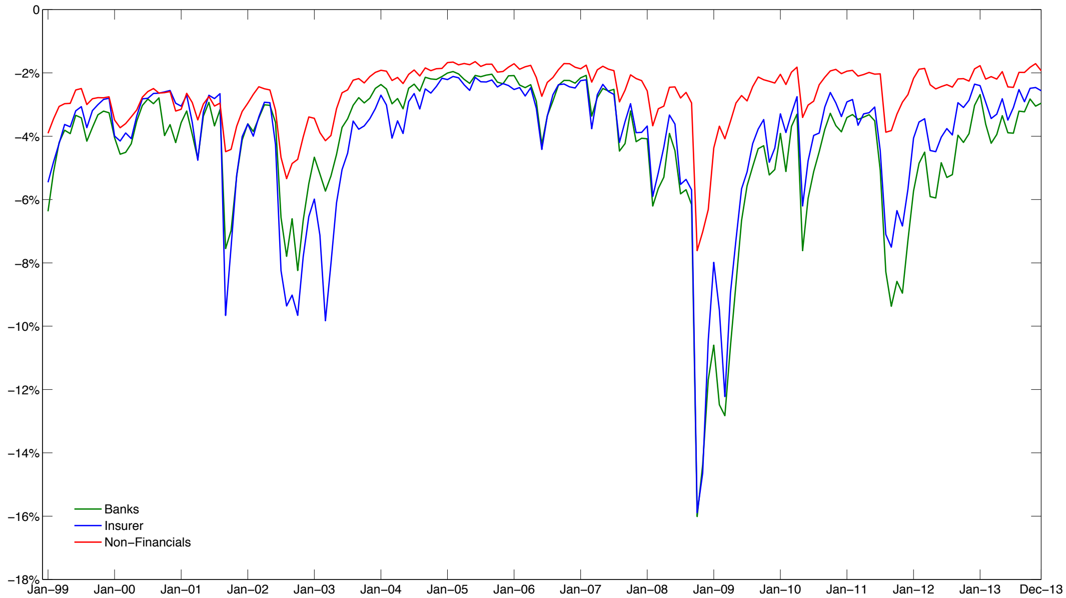


Figure 1.8: Average Institutions' DMES towards Other Industries. The figure displays the industry monthly average calculated on the single institution's monthly median value.

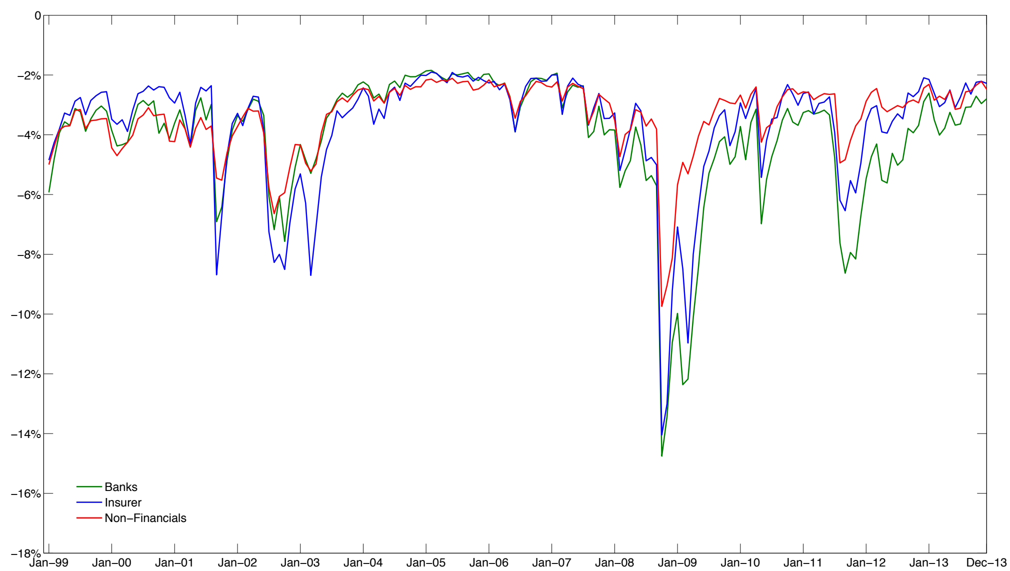


Figure 1.9: Average Institutions' DMES towards Total System. The figure displays the industry monthly average calculated on the single institution's monthly median value.

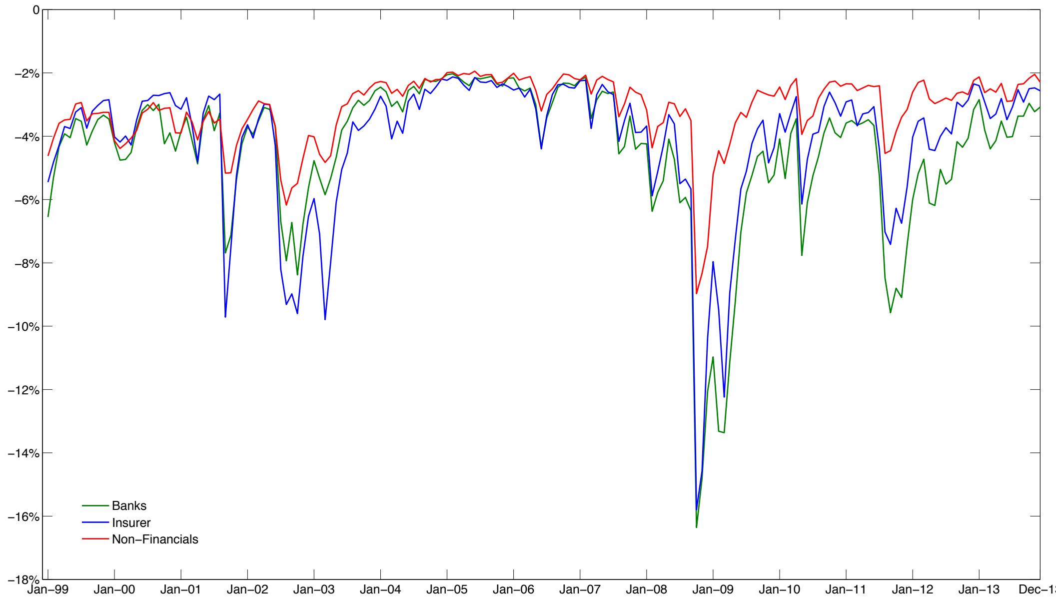


Figure 1.10: Total Cause towards Total System - Focus on SIFI Insurance Companies. The figure displays for each group the number of significant cause and receive linear Granger causality connections over the total number of possible cause and receive connections. Statistical significance level is set at 5%. Results are calculated using Newey West standard errors.

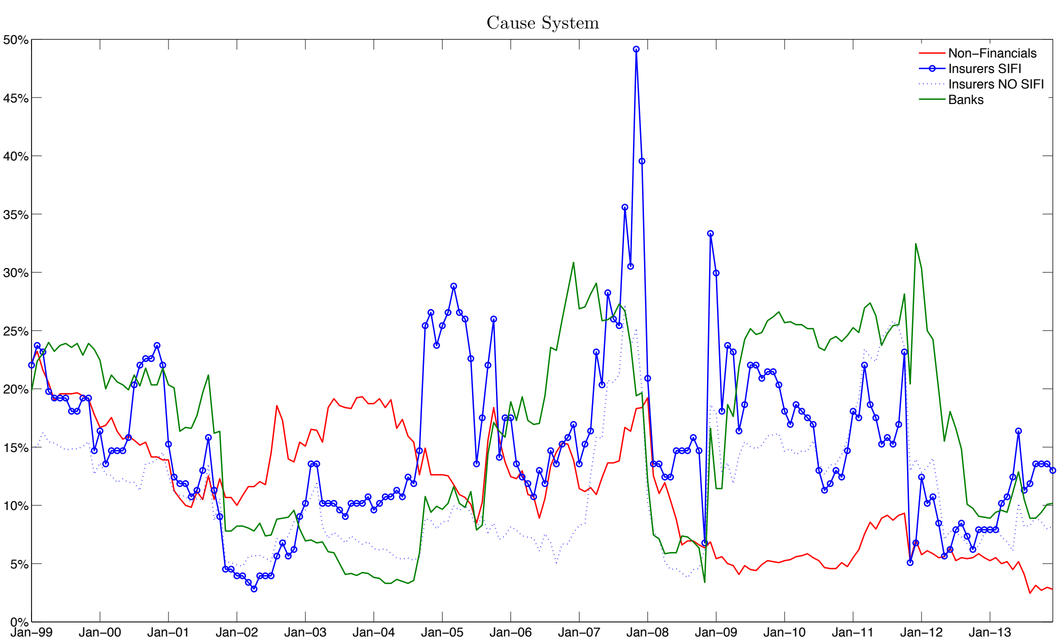


Figure 1.11: Average Institutions' ΔCoVaR towards Total System - Focus on SIFI Insurance Companies. The figure displays the industry monthly average calculated on the single institution's monthly median value.

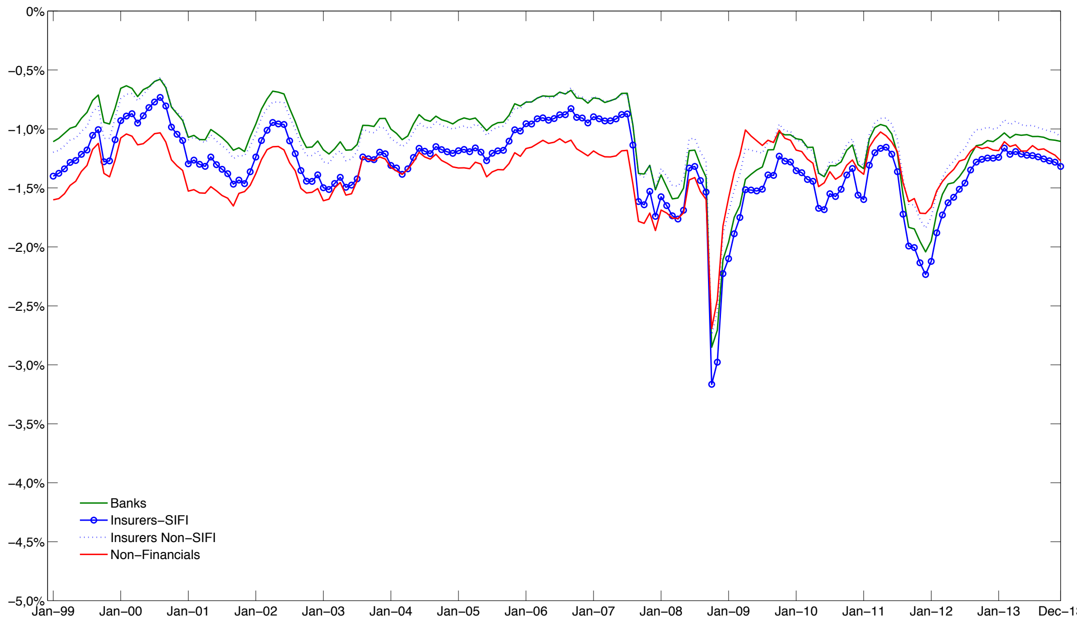


Figure 1.12: Average Institutions' DMES towards Total System - Focus on SIFI Insurance Companies. The figure displays the industry monthly average calculated on the single institution's monthly median value.

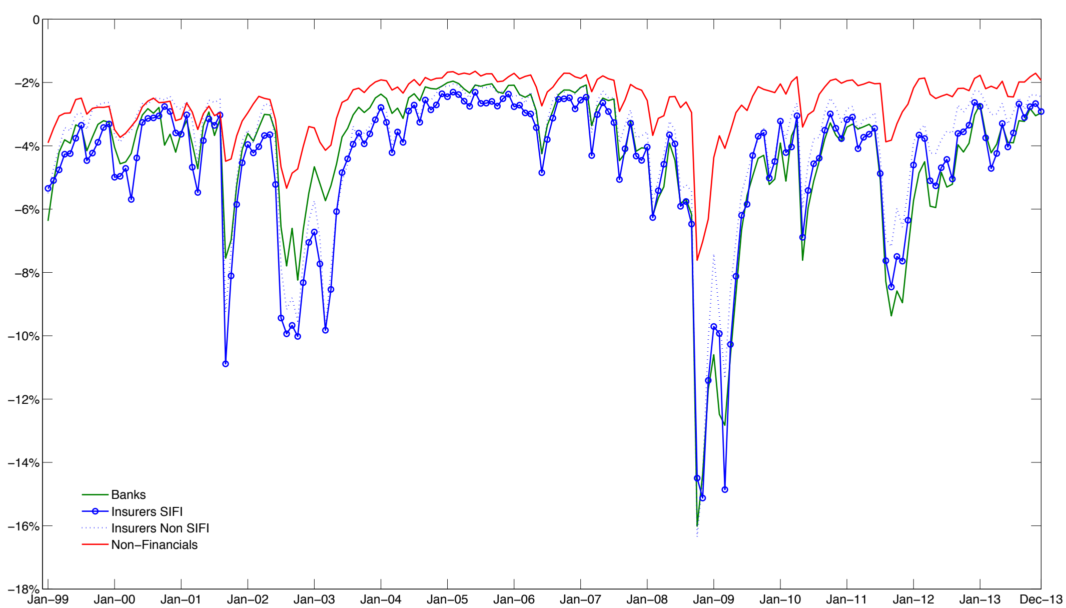


Figure 1.13: Most Systemically Relevant Institutions. The 3 graphs report the industry composition of the 10 most systemically relevant institutions at each point in time.

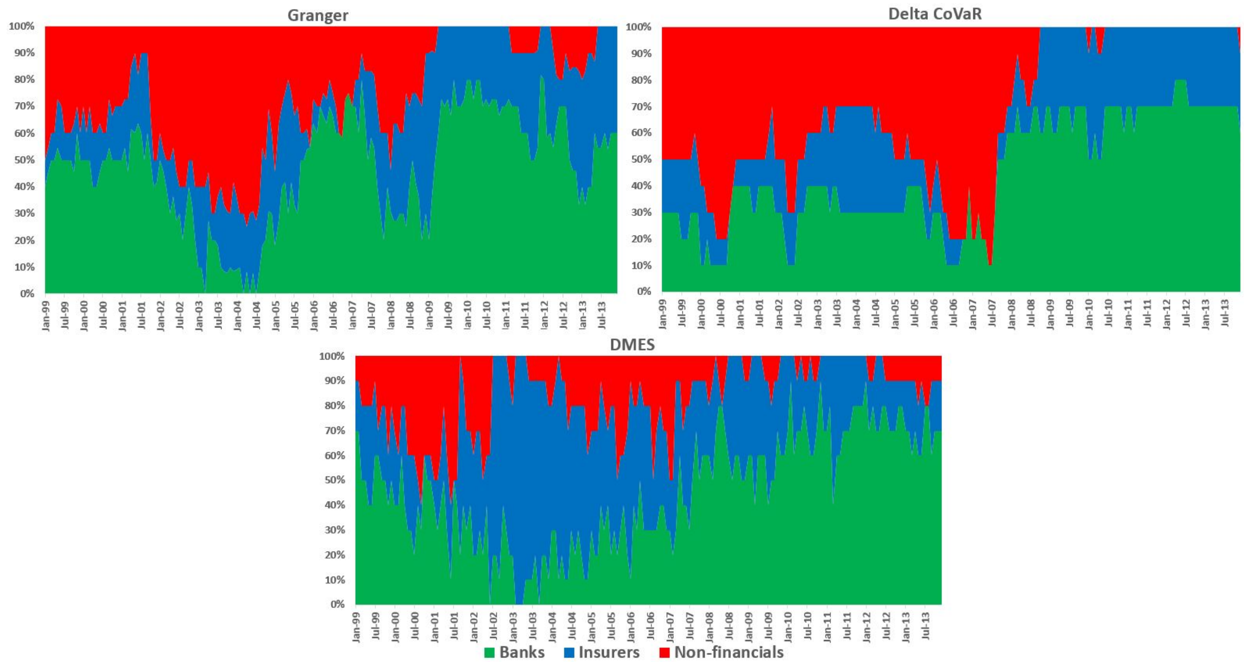
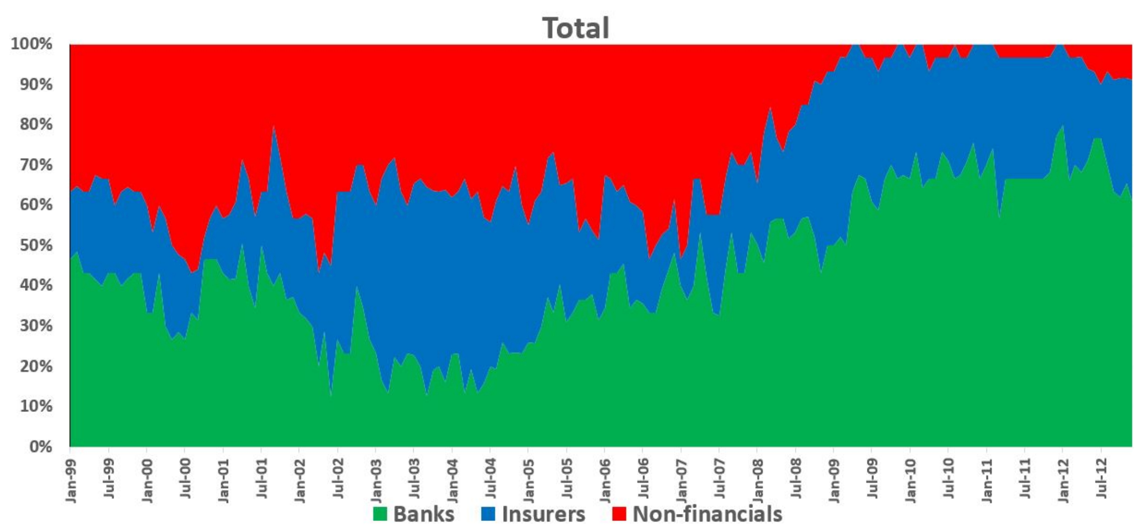


Figure 1.14: Cumulative Index. The graph reports the average industry composition of the 3 indices at each point in time.



1.8 Tables

Table 1.1: List of the institutions included in the 3 groups.

Name	Ticker	Country
Banks		
HSBC	HSBA	UK
BANCO SANTANDER	E:SCH	ES
UBS	S:UBSN	CH
BNP PARIBAS	F:BNP	FR
LLOYDS BANKING GROUP	LLOY	UK
ROYAL BANK OF SCOTLAND	RBS	UK
BARCLAYS	BARC	UK
CREDIT SUISSE GROUP	S:CSGN	CH
BBV. ARGENTARIA	E:BBVA	ES
DEUTSCHE BANK	D:DBKX	DE
UNICREDIT	I:UCG	IT
SOCIETE GENERALE	F:SGE	FR
STANDARD CHARTERED	STAN	UK
INTESA SANPAOLO	I:ISP	IT
NORDEA BANK	W:NDA	SE
KBC	B:KB	BE
DANSKE BANK	DK:DAB	DK
COMMERZBANK	D:CBKX	DE
SVENSKA HANDBKN.	W:SVK	SE
SEB	W:SEA	SE
Insurers		
ALLIANZ	D:ALV	DE
PRUDENTIAL	PRU	UK
AXA	F:MIDI	FR
ZURICH INSURANCE GROUP	S:ZURN	CH
MUNICH RE	D:MUV2	DE
SWISS RE	S:SREN	CH
ING	H:ING	NL
ASSICURAZIONI GENERALI	I:G	IT
SAMPO	M:SAMA	FI
LEGAL & GENERAL	LGEN	UK
AVIVA	AV.	UK
AEGON	H:AGN	ND
MAPFRE	E:MAP	ES
HANNOVER RE	D:HNR1	DE
AGEAS	B:AGS	BE
RSA INSURANCE GROUP	RSA	UK
VIENNA INSURANCE GROUP	O:WNST	AT
SCOR SE	F:SCO	FR
SWISS LIFE	S:SLHN	CH
BÂLOISE	S:BALN	CH
Non-Financials		
BRITISH PETROLEUM	BP.	UK
VODAFONE	VOD	UK
NOVARTIS	S:NOVN	CH
NESTLE	S:NESN	CH
GLAXOSMITHKLINE	GSK	UK
ROYAL DUTCH SHELL	H:RDSA	UK
TOTAL	F:TAL	FR
ROCHE	S:ROG	CH
ENI	I:ENI	IT
TELEFONICA	E:TEF	ES
SANOFI	F:SQ@F	FR
NOKIA	M:NOK1	FI
SIEMENS	D:SIEX	DE
ASTRAZENECA	AZN	UK
L'OREAL	F:OR@F	FR
E ON	D:EONX	DE
BRITISH AMERICAN TOBACCO	BATS	UK
RIO TINTO	RIO	UK
LVMH	F:LVMH	FR
DIAGEO	DGE	UK

Table 1.2: List of the Non-Financial institutions included in the analysis classified according to GICI classification.

Name	**Sector**	**Industry Group**
BRITISH PETROLEUM	Energy	Energy
VODAFONE	Telecommunication	Telecommunication
NOVARTIS	Health Care	Pharmaceuticals & Biotechnology
NESTLE	Consumer Staples	Food & staples retailing
GLAXOSMITHKLINE	Health Care	Pharmaceuticals & Biotechnology
ROYAL DUTCH SHELL	Energy	Energy
TOTAL	Energy	Energy
ROCHE	Health Care	Pharmaceuticals & Biotechnology
ENI	Energy	Energy
TELEFONICA	Telecommunication	Telecommunication
SANOFI	Health Care	Pharmaceuticals & Biotechnology
NOKIA	Information technology	Technology hardware & Equipment
SIEMENS	Industrials	Capital Goods
ASTRAZENECA	Health Care	Pharmaceuticals & Biotechnology
L'OREAL	Consumer Staples	Households and Personal Products
E ON	Utilities	Utilities
BRITISH AMERICAN TOBACCO	Consumer Staples	House Beverage & Tobacco
RIO TINTO	Materials	Materials
LVMH	Consumer Staples	Households & Personal Products
DIAGEO	Consumer Staples	Food & staples retailing

Table 1.3: Descriptive Statistics of Total Return Indeces. Descriptive statistics of the Total Return Indexes of the 60 institutions on the time period between January 1996 to December 2013. The upper part reports values at monthly frequency, whereas the lower part reports values at daily frequency.

Monthly Data	**#**	**Obs.**	**Average**	**Median**	**St.Dev.**	**Min**	**Max**
Banks	**20**	4,319	0.0048	0.0119	0.1189	-1.2447	0.6602
Non-Financial	**20**	4,320	0.0086	0.0125	0.0808	-0.6628	0.5099
Insurers	**20**	4,304	0.0046	0.0117	0.1137	-2.0293	0.6745
Full Sample	**60**	12,943	0.0060	0.0121	0.1058	-2.0293	0.6745

Daily Data	**#**	**Obs.**	**Average**	**Median**	**St.Dev.**	**Min**	**Max**
Banks	**20**	92,160	0.0002	0.0000	0.0256	-1.0957	0.5495
Non-Financial	**20**	92,160	0.0004	0.0000	0.0192	-0.4578	0.3226
Insurers	**20**	92,160	0.0002	0.0000	0.0245	-1.4949	0.3022
Full Sample	**60**	276,480	0.0003	0.0000	0.0232	-1.4949	0.5495

Table 1.4: Descriptive Statistics of State Variables. Descriptive statistics of daily data observed on the period between January 1999 to December 2013.

	Obs.	**Average**	**Median**	**St.Dev.**	**Min**	**Max**
VIX	4,608	-0.0001	-0.0020	0.0614	-0.3506	0.4960
3M Repo-3M Bubill	4,608	-0.0167	-0.0091	0.6118	-2.0781	2.8463
3M Bubill	4,608	-0.0004	0.0000	0.1037	-1.3863	1.9459
10Y Bund - 3M Bubill	4,608	0.0145	0.0147	0.0076	-0.0022	0.0324
BAA 5-7Y Corp. - Euro Sov. 5-7Y	4,608	0.0118	0.0093	0.0075	-0.0080	0.0358
STOXX Euro 600 All shares	4,608	0.0002	0.0007	0.0124	-0.0793	0.0941

Table 1.5: Descriptive Statistics of Banks. Log returns are observed both at *a)* monthly frequency and *b)* daily frequency. Observation period between January 1996 to December 2013.

***a)* Name**	**Ticker**	**Obs.**	**Average**	**Median**	**St.Dev.**	**Min**	**Max**
HSBC	HSBA	216	0.0074	0.0086	0.0850	-0.3051	0.3178
BANCO SANTANDER	E:SCH	216	0.0075	0.0133	0.1051	-0.5183	0.3095
UBS	S:UBSN	216	0.0008	0.0047	0.1022	-0.4722	0.2654
BNP PARIBAS	F:BNP	216	0.0086	0.0092	0.1087	-0.4946	0.3052
LLOYDS BANKING GROUP	LLOY	215	-0.0001	0.0087	0.1375	-1.0936	0.5410
ROYAL BANK OF SCOTLAND	RBS	216	-0.0048	0.0104	0.1631	-1.2447	0.4344
BARCLAYS	BARC	216	0.0051	0.0196	0.1395	-0.8081	0.6393
CREDIT SUISSE	S:CSGN	216	0.0020	0.0140	0.1152	-0.6667	0.2333
BBV. ARGENTARIA	E:BBVA	216	0.0081	0.0155	0.1084	-0.5886	0.3150
DEUTSCHE BANK	D:DBKX	216	0.0023	0.0098	0.1206	-0.6229	0.4333
UNICREDIT	I:UCG	216	0.0023	0.0052	0.1215	-0.4667	0.3338
SOCIETE GENERALE	F:SGE	216	0.0060	0.0130	0.1342	-0.6053	0.2943
STANDARD CHARTERED	STAN	216	0.0075	0.0125	0.1104	-0.4134	0.4616
INTESA SANPAOLO	I:ISP	216	0.0060	0.0133	0.1214	-0.4655	0.6602
NORDEA BANK	W:NDA	216	0.0121	0.0173	0.0859	-0.2902	0.2820
KBC GROUP	B:KB	216	0.0048	0.0194	0.1530	-1.1424	0.6334
DANSKE BANK	DK:DAB	216	0.0080	0.0134	0.0987	-0.5550	0.4769
COMMERZBANK	D:CBKX	216	-0.0088	-0.0027	0.1465	-0.7785	0.5445
SVENSKA HANDBKN.	W:SVK	216	0.0122	0.0115	0.0703	-0.2447	0.2031
SEB	W:SEA	216	0.0089	0.0184	0.1037	-0.4589	0.3787

***b)* Name**	**Ticker**	**Obs.**	**Average**	**Median**	**St.Dev.**	**Min**	**Max**
HSBC	HSBA	4,608	0.0004	0.0000	0.0187	-0.2080	0.1442
BANCO SANTANDER	E:SCH	4,608	0.0004	0.0000	0.0225	-0.1603	0.2088
UBS	S:UBSN	4,608	0.0000	0.0000	0.0236	-0.1889	0.2751
BNP PARIBAS	F:BNP	4,608	0.0004	0.0000	0.0253	-0.1893	0.1898
LLOYDS BANKING GROUP	LLOY	4,608	0.0000	0.0000	0.0300	-0.4148	0.4078
ROYAL BANK OF SCOTLAND	RBS	4,608	-0.0002	0.0000	0.0340	-1.0957	0.3050
BARCLAYS	BARC	4,608	0.0003	0.0000	0.0292	-0.2856	0.5495
CREDIT SUISSE	S:CSGN	4,608	0.0001	0.0000	0.0252	-0.1767	0.2461
BBV.ARGENTARIA	E:BBVA	4,608	0.0004	0.0000	0.0219	-0.1454	0.1991
DEUTSCHE BANK	D:DBKX	4,608	0.0001	0.0001	0.0252	-0.1753	0.2124
UNICREDIT	I:UCG	4,608	0.0001	0.0000	0.0264	-0.1896	0.1901
SOCIETE GENERALE	F:SGE	4,608	0.0003	0.0000	0.0272	-0.1771	0.2143
STANDARD CHARTERED	STAN	4,608	0.0004	0.0000	0.0252	-0.1795	0.2624
INTESA SANPAOLO	I:ISP	4,608	0.0003	0.0000	0.0265	-0.1846	0.1796
NORDEA BANK	W:NDA	4,608	0.0006	0.0000	0.0219	-0.1221	0.1492
KBC GROUP	B:KB	4,608	0.0002	0.0000	0.0301	-0.2866	0.4048
DANSKE BANK	DK:DAB	4,608	0.0004	0.0000	0.0201	-0.1719	0.1398
COMMERZBANK	D:CBKX	4,608	-0.0004	0.0000	0.0285	-0.2746	0.2048
SVENSKA HANDBKN.	W:SVK	4,608	0.0006	0.0000	0.0186	-0.1074	0.1329
SEB	W:SEA	4,608	0.0004	0.0000	0.0250	-0.2231	0.2322

Table 1.6: Descriptive Statistics of Insurers. Log returns are observed both at *a)* monthly frequency and *b)* daily frequency. Observation period between January 1996 to December 2013.

***a)* Name**	**Ticker**	**Obs.**	**Average**	**Median**	**St.Dev.**	**Min**	**Max**
ALLIANZ	D:ALV	216	0.0019	0.0119	0.1049	-0.4538	0.4230
PRUDENTIAL	PRU	216	0.0085	0.0214	0.1073	-0.5433	0.4310
AXA	F:MIDI	216	0.0055	0.0138	0.1214	-0.6390	0.3478
ZURICH INSURANCE GROUP	S:ZURN	216	0.0024	0.0115	0.1113	-0.7533	0.2935
MUNICH RE	D:MUV2	214	0.0057	0.0106	0.0884	-0.3837	0.3084
SWISS RE	S:SREN	216	0.0031	0.0158	0.1160	-0.8553	0.4279
ING GROEP	H:ING	216	0.0036	0.0118	0.1310	-0.7791	0.3262
ASSICURAZIONI GENERALI	I:G	216	0.0019	0.0080	0.0886	-0.4041	0.2532
SAMPO	M:SAMA	216	0.0183	0.0196	0.0892	-0.4501	0.2562
LEGAL & GENERAL	LGEN	216	0.0094	0.0187	0.1004	-0.5431	0.2776
AVIVA	AV.	216	0.0029	0.0098	0.1082	-0.5951	0.3514
AEGON	H:AGN	216	0.0018	0.0181	0.1319	-0.5931	0.6236
MAPFRE	E:MAP	216	0.0065	0.0096	0.0957	-0.4189	0.2777
HANNOVER RE	D:HNR1	202	0.0100	0.0140	0.0999	-0.6683	0.3550
AGEAS	B:AGS	216	-0.0022	0.0132	0.1844	-2.0293	0.6745
RSA INSURANCE GROUP	RSA	216	-0.0007	0.0077	0.1037	-0.5306	0.2485
VIENNA INSURANCE GROUP	O:WNST	216	0.0077	0.0008	0.0885	-0.6419	0.4381
SCOR SE	F:SCO	216	-0.0007	0.0131	0.1114	-0.6743	0.3231
SWISS LIFE	S:SLHN	216	-0.0005	0.0104	0.1456	-0.7104	0.6159
BÂLOISE	S:BALN	216	0.0070	0.0157	0.0967	-0.4777	0.2488

***b)* Name**	**Ticker**	**Obs.**	**Average**	**Median**	**St.Dev.**	**Min**	**Max**
ALLIANZ	D:ALV	4,608	0.0000	0.0000	0.0227	-0.1568	0.1781
PRUDENTIAL	PRU	4,608	0.0004	0.0000	0.0262	-0.2231	0.2107
AXA	F:MIDI	4,608	0.0002	0.0005	0.0262	-0.2035	0.1978
ZURICH INSURANCE GROUP	S:ZURN	4,608	0.0001	0.0000	0.0229	-0.2257	0.1920
MUNICH RE	D:MUV2	4,608	0.0002	0.0000	0.0212	-0.1719	0.1653
SWISS RE	S:SREN	4,608	0.0002	0.0000	0.0230	-0.3292	0.1957
ING GROEP	H:ING	4,608	0.0002	0.0006	0.0297	-0.3213	0.2565
ASSICURAZIONI GENERALI	I:G	4,608	0.0000	0.0000	0.0182	-0.1612	0.1739
SAMPO	M:SAMA	4,608	0.0009	0.0000	0.0206	-0.1823	0.1367
LEGAL & GENERAL	LGEN	4,608	0.0005	0.0000	0.0252	-0.3408	0.2430
AVIVA	AV.	4,608	0.0002	0.0000	0.0259	-0.4060	0.2239
AEGON	H:AGN	4,608	0.0000	0.0000	0.0289	-0.2768	0.3022
MAPFRE	E:MAP	4,608	0.0003	0.0000	0.0222	-0.1508	0.1618
HANNOVER RE	D:HNR1	4,608	0.0005	0.0000	0.0218	-0.1989	0.1538
AGEAS	B:AGS	4,608	0.0001	0.0005	0.0353	-1.4949	0.2589
RSA INSURANCE GROUP	RSA	4,608	0.0000	0.0000	0.0238	-0.2426	0.1425
VIENNA INSURANCE GROUP	O:WNST	4,608	0.0004	0.0000	0.0179	-0.1974	0.1529
SCOR SE	F:SCO	4,608	0.0000	0.0000	0.0257	-0.3622	0.1907
SWISS LIFE	S:SLHN	4,608	0.0000	0.0000	0.0248	-0.2240	0.1877
BÂLOISE	S:BALN	4,608	0.0004	0.0000	0.0203	-0.1662	0.1891

Table 1.7: Descriptive Statistics of Non-Financials. Log returns are observed both at *a)* monthly frequency and *b)* daily frequency. Observation period between January 1996 to December 2013.

***a)* Name**	**Ticker**	**Obs.**	**Average**	**Median**	**St.Dev.**	**Min**	**Max**
BRITISH PETROLEUM	BP.	216	0.0058	0.0110	0.0742	-0.3714	0.1982
VODAFONE	VOD	216	0.0105	0.0176	0.0847	-0.2530	0.2669
NOVARTIS	S:NOVN	216	0.0070	0.0069	0.0609	-0.1707	0.2594
NESTLE	S:NESN	216	0.0094	0.0173	0.0523	-0.2074	0.1246
GLAXOSMITHKLINE	GSK	216	0.0058	0.0051	0.0627	-0.2058	0.2659
ROYAL DUTCH SHELL	H:RDSA	216	0.0067	0.0024	0.0697	-0.2999	0.2608
TOTAL	F:TAL	216	0.0094	0.0098	0.0680	-0.2370	0.2101
ROCHE	S:ROG	216	0.0064	0.0068	0.0644	-0.2654	0.1922
ENI	I:ENI	216	0.0091	0.0115	0.0672	-0.2365	0.2219
TELEFONICA	E:TEF	216	0.0093	0.0135	0.0884	-0.3293	0.3580
SANOFI	F:SQ@F	216	0.0110	0.0103	0.0686	-0.1901	0.1985
NOKIA	M:NOK1	216	0.0077	0.0155	0.1437	-0.4512	0.5099
SIEMENS	D:SIEX	216	0.0079	0.0181	0.1046	-0.3699	0.2960
ASTRAZENECA	AZN	216	0.0078	0.0100	0.0704	-0.2218	0.2523
L'OREAL	F:OR@F	216	0.0102	0.0133	0.0654	-0.2592	0.1606
E ON	D:EONX	216	0.0045	0.0161	0.0752	-0.3212	0.1880
BAT	BATS	216	0.0148	0.0174	0.0682	-0.2396	0.2173
RIO TINTO	RIO	216	0.0093	0.0189	0.1054	-0.4874	0.3274
LVMH	F:LVMH	216	0.0089	0.0151	0.1039	-0.6628	0.3172
DIAGEO	DGE	216	0.0096	0.0137	0.0618	-0.2476	0.1780

***a)* Name**	**Ticker**	**Obs.**	**Average**	**Median**	**St.Dev.**	**Min**	**Max**
BRITISH PETROLEUM	BP.	4,608	0.0003	0.0000	0.0173	-0.1404	0.1058
VODAFONE	VOD	4,608	0.0005	0.0000	0.0218	-0.1458	0.1371
NOVARTIS	S:NOVN	4,608	0.0003	0.0000	0.0138	-0.0989	0.1824
NESTLE	S:NESN	4,608	0.0004	0.0000	0.0127	-0.0798	0.0926
GLAXOSMITHKLINE	GSK	4,608	0.0003	0.0000	0.0164	-0.1389	0.1881
ROYAL DUTCH SHELL	H:RDSA	4.608	0.0003	0.0004	0.0162	-0.1032	0.1310
TOTAL	F:TAL	4,608	0.0004	0.0006	0.0179	-0.1317	0.1279
ROCHE	S:ROG	4,608	0.0003	0.0000	0.0144	-0.1101	0.0987
ENI	I:ENI	4,608	0.0004	0.0005	0.0174	-0.1012	0.1614
TELEFONICA	E:TEF	4,608	0.0005	0.0003	0.0188	-0.0989	0.1326
SANOFI	F:SQ@F	4,608	0.0005	0.0000	0.0193	-0.1401	0.1368
NOKIA	M:NOK1	4,608	0.0003	0.0000	0.0304	-0.2599	0.2922
SIEMENS	D:SIEX	4,608	0.0004	0.0001	0.0225	-0.1873	0.2157
ASTRAZENECA	AZN	4,608	0.0004	0.0000	0.0169	-0.1257	0.1236
L'OREAL	F:OR@F	4,608	0.0005	0.0002	0.0185	-0.1179	0.1375
E ON	D:EONX	4,608	0.0002	0.0000	0.0191	-0.1223	0.1813
BAT	BATS	4,608	0.0007	0.0000	0.0184	-0.1220	0.3226
RIO TINTO	RIO	4,608	0.0004	0.0000	0.0260	-0.4578	0.1968
LVMH	F:LVMH	4,608	0.0004	0.0000	0.0209	-0.1308	0.1562
DIAGEO	DGE	4,608	0.0005	0.0000	0.0159	-0.0978	0.1540

Table 1.8: Balance Sheet Variables. The table provides details on the list of variables used in the panel. Balance sheet items are named according to SNL Financial definition.

Variable	**Definition**
$Price-to-book$	$\frac{Equity\ Market\ Value}{Equity\ Book\ Value}$
$Leverage^A$	$\frac{Tangible\ Assets - Separate\ Account\ Assets}{Tangible\ Equity}$
$Size^A$	$ln(Tangible\ Assets)$
$Leverage^L$	$\frac{Total\ Liabilities - Separate\ Account\ Liabilities}{Tangible\ Equity}$
$Size^L$	$ln(Total\ Liabilities - Separate\ Account\ Liabilities)$
$Concentration^{\dagger}$	$\frac{\sum_i Asset\ Class_i^2}{(\sum_i Asset\ Class_i)^2}$
$Investment\ Quality$	$\frac{Total\ Investment\ Grade\ Assets}{Tangible\ Assets - Separate\ Account\ Assets}$
$Fixed\ Income\ Assets$	$\frac{Total\ Debt\ Instruments}{Tangible\ Assets - Separate\ Account\ Assets}$
$Equity\ Assets$	$\frac{Total\ Equity\ Instruments}{Tangible\ Assets - Separate\ Account\ Assets}$
$Cash$	$\frac{Cash\ \&\ Cash\ Equivalents}{Tangible\ Assets - Separate\ Account\ Assets}$
$Insurance\ Activities$	$\frac{Reserves\ for\ Insurance\ Contracts - Unit\ Linked\ Insurance}{Total\ Liabilities - Separate\ Account\ Liabilities}$
$Total\ Debt^{\ddagger}$	$\frac{Senior;Debt + Subordinated\ Debt}{Total\ Liabilities - Separate\ Account\ Liabilities}$
$Separate\ Accounts$	$\frac{Separate\ Account\ Liabilities}{Total\ Liabilities}$

†: $Asset\ Class_i$= Cash & Cash Equivalents; Funds Withheld & Deposits; Primary Insurance Receivables; Reinsurance Receivables; Insurance Receivables; Other Loans; Total Debt Instruments; Total Equity Instruments; Securities Owned: Derivative Financial Instruments; Securities Owned: Other Investments; Total Investment in Real Estate; Investment in Partnerships; Reinsurance Recoverable on Loss & LAE Reserves; Fixed Assets; Total Other Assets.

‡: *Senior Debt* includes deposits from banking activities, whereas *Subordinated Debt* includes hybrid securities and other subordinated debt.

Table 1.9: Descriptive statistics of Insurance Companies Extended Panel. Descriptive statistics of daily log returns observed between January 2005 to December 2013.

Name	Obs.	Average	Median	St.Dev.	Min	Max
Admiral	2,406	0.0008	0.0000	0.0207	-0.2958	0.2272
Aegon	3,892	-0.0004	0.0000	0.0302	-0.2768	0.3022
Ageas	3,892	-0.0005	0.0000	0.0377	-1.4949	0.2589
Aksigorta	3,892	0.0012	0.0000	0.0322	-0.2187	0.3176
Allianz	3,892	-0.0001	0.0000	0.0230	-0.1568	0.1781
Alm. Brand	3,892	-0.0001	0.0000	0.0229	-0.2378	0.2492
Amlin	3,892	0.0006	0.0000	0.0188	-0.3491	0.1659
Anadolu Anonim Türk Sigorta Sirketi	3,892	0.0010	0.0000	0.0301	-0.2336	0.1886
Anadolu Hayat Emeklilik	3,595	0.0007	0.0000	0.0313	-0.1707	0.1861
Generali	3,892	-0.0001	0.0000	0.0176	-0.0923	0.1231
Aviva	3,892	0.0000	0.0000	0.0266	-0.4060	0.2239
Aviva Sigorta	3,892	0.0014	0.0000	0.0343	-0.2267	0.2116
AXA	3,892	0.0000	0.0000	0.0274	-0.2035	0.1978
Bâloise	3,892	0.0001	0.0000	0.0202	-0.1662	0.1891
Beazley	2,889	0.0007	0.0000	0.0180	-0.1404	0.1361
Chesnara	2,496	0.0007	0.0000	0.0202	-0.1075	0.1052
CNP Assurances	3,892	0.0004	0.0000	0.0189	-0.1444	0.1043
Delta Lloyd	1,080	0.0004	0.0006	0.0206	-0.0861	0.1088
Direct Line Insurance Group	315	0.0014	0.0014	0.0115	-0.0396	0.0717
Euler Hermes	3,548	0.0004	0.0000	0.0214	-0.1641	0.1462
European Reliance General Insurance Company	3,892	-0.0002	0.0000	0.0374	-0.2176	0.1815
FBD Holdings	3,892	0.0004	0.0001	0.0487	-1.9376	1.9386
Friends Life Group	1,315	0.0002	0.0000	0.0182	-0.1580	0.1108
Globos osiguranje a.d.o. Beograd	1,227	-0.0012	0.0000	0.0479	-0.2235	0.1823
Grupo Catalana Occidente	3,310	-0.0028	0.0000	0.0608	-1.4674	0.8362
Gunes Sigorta	3,892	0.0009	0.0000	0.0331	-0.2356	0.1765
Hannover Re	3,892	0.0003	0.0000	0.0220	-0.1989	0.1538
Hansard Global	1,828	-0.0002	0.0003	0.0219	-0.1550	0.1831
Helios Underwriting	1,641	0.0003	0.0000	0.0223	-0.5216	0.3909
ING Groep	3,892	-0.0001	0.0000	0.0308	-0.3213	0.2565
Jadransko Osiguranje	1,734	-0.0005	0.0000	0.0290	-0.2653	0.1856
Lancashire Holdings Limited	2,088	0.0009	0.0000	0.0136	-0.0627	0.1162
Legal & General Group	3,892	0.0002	0.0000	0.0258	-0.3408	0.2430
Liberty Life Insurance	3,892	-0.0008	0.0000	0.0489	-0.4158	0.4196
Mapfre	3,892	0.0003	0.0000	0.0219	-0.1344	0.1618
Mediolanum	3,892	0.0001	0.0000	0.0253	-0.1163	0.1710
Munich Re	3,892	0.0001	0.0000	0.0209	-0.1719	0.1653
Novae Group	3,892	-0.0001	0.0000	0.0269	-0.5556	0.3212
Nuernberger	3,892	0.0000	0.0000	0.0176	-0.2289	0.2263
Partnership Assurance Group	146	-0.0019	-0.0010	0.0307	-0.2374	0.1560
Personal Group Holdings	3,396	0.0007	0.0000	0.0114	-0.1144	0.1173
Phoenix Group	1,070	0.0002	0.0000	0.0170	-0.0853	0.1059
Pozavarovalnica Sava	1,440	-0.0008	0.0000	0.0258	-0.1389	0.1389
Protector Forsikring	1,712	0.0003	0.0000	0.0252	-0.1697	0.2230
Prudential	3,892	0.0002	0.0000	0.0272	-0.2231	0.2107
RSA Insurance Group	3,892	-0.0002	0.0000	0.0240	-0.2426	0.1321
Sampo Oyj	3,892	0.0007	0.0000	0.0197	-0.1823	0.1367
Scor	3,892	-0.0003	0.0000	0.0266	-0.3622	0.1907
St. James's Place	3,892	0.0003	0.0000	0.0253	-0.2329	0.2394
Standard Life	1,940	0.0004	0.0000	0.0239	-0.1604	0.1865
Storebrand	560	0.0026	0.0000	0.0147	-0.0666	0.0925
Swiss Life	3,892	-0.0002	0.0000	0.0249	-0.2240	0.1877
Swiss Re	3,892	-0.0001	0.0000	0.0237	-0.3292	0.1957
Talanx	322	0.0009	0.0000	0.0140	-0.0471	0.0399
Topdanmark	3,892	0.0006	0.0000	0.0180	-0.1133	0.1407
Tryg	2,130	0.0005	0.0000	0.0160	-0.1361	0.1032
Uniqa Insurance	3,670	0.0001	0.0000	0.0170	-0.1729	0.0965
Vaudoise Assurances	3,892	0.0003	0.0000	0.0198	-0.1801	0.1869
Vienna Insurance Group	3,892	0.0003	0.0000	0.0188	-0.1974	0.1529
Zavarovalnica Triglav.	1,377	-0.0005	0.0000	0.0217	-0.1076	0.0953
Zurich Insurance Group	3,892	-0.0002	0.0000	0.0233	-0.2257	0.1920

Table 1.10: Descriptive Statistics of Balance Sheet Variables. The table reports the summary statistics for 3 samples: full, without reinsurers and without reinsurers and SIFIs.

	Full Sample				
	Obs	Mean	Std. Dev.	Min	Max
Price to Book	445	2.8762	18.5761	-5.5000	382.5900
$Leverage^A$	443	12.9052	10.3963	2.0417	55.8480
$Size^A$	448	16.6411	2.5930	10.0355	21.0045
$Leverage^L$	428	13.3584	22.1188	1.0417	314.6381
$Size^L$	428	16.2179	2.6604	9.6472	20.9111
Concentration	449	0.3051	0.1017	0.1168	0.6099
Investment Quality	443	0.3752	0.2861	0.0000	1.0093
Fixed Income Assets	439	0.4136	0.1944	0.0000	0.7569
Equity Assets	436	0.0813	0.0858	0.0000	0.6269
Cash	443	0.0872	0.1215	0.0009	0.6619
Insurance Activities	427	0.6598	0.2383	0.0000	0.9635
Total Debt	420	0.1102	0.1660	0.0000	0.8099
Separate Accounts	428	0.1683	0.2398	0.0000	0.9280

	Sample w/o Reinsurers				
	Obs	Mean	Std. Dev.	Min	Max
Price to Book	409	3.0416	19.3694	-5.5000	382.5900
$Leverage^A$	411	13.0744	10.7641	2.0417	55.8480
$Size^A$	416	16.5293	2.6453	10.0355	21.0045
$Leverage^L$	396	13.6578	22.9653	1.0417	314.6381
$Size^L$	396	16.0770	2.7050	9.6472	20.9111
Concentration	417	0.3106	0.1031	0.1168	0.6099
Investment Quality	411	0.3723	0.2897	0.0000	1.0093
Fixed Income Assets	407	0.4114	0.2009	0.0000	0.7569
Equity Assets	404	0.0848	0.0877	0.0000	0.6269
Cash	411	0.0912	0.1249	0.0009	0.6619
Insurance Activities	395	0.6495	0.2440	0.0000	0.9635
Total Debt	388	0.1145	0.1716	0.0000	0.8099
Separate Accounts	396	0.1793	0.2454	0.0000	0.9280

	Sample w/o Reinsurers and SIFIs				
	Obs	Mean	Std. Dev.	Min	Max
Price to Book	364	3.2197	20.5261	-5.5000	382.5900
$Leverage^A$	368	11.2150	9.1015	2.0417	55.8480
$Size^A$	372	16.1192	2.4930	10.0355	21.0045
$Leverage^L$	356	12.0553	23.4185	1.0417	314.6381
$Size^L$	356	15.6598	2.5284	9.6472	20.9111
Concentration	372	0.3084	0.1073	0.1168	0.6099
Investment Quality	368	0.3612	0.2888	0.0000	1.0093
Fixed Income Assets	365	0.3996	0.2067	0.0000	0.7569
Equity Assets	365	0.0825	0.0894	0.0000	0.6269
Cash	368	0.0966	0.1306	0.0009	0.6619
Insurance Activities	355	0.6548	0.2543	0.0000	0.9635
Total Debt	348	0.1141	0.1784	0.0000	0.8099
Separate Accounts	356	0.1801	0.2579	0.0000	0.9280

Table 1.11: Correlation Matrix. The table reports the correlation among the variables for the 3 samples.

Full Sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) *Price-to-book*	1												
(2) $Leverage^A$	-0.0297	1											
(3) $Size^A$	-0.0320	0.6417	1										
(4) $Leverage^L$	-0.0305	0.9748	0.6426	1									
(5) $Size^L$	-0.0274	0.6523	0.9873	0.6583	1								
(6) *Concentration*	-0.0743	0.2249	0.3667	0.2164	0.3216	1							
(7) *Investment Quality*	-0.0060	0.1454	0.4283	0.1445	0.4312	0.2607	1						
(8) *Fixed Income Assets*	-0.0263	0.2166	0.4887	0.1961	0.5141	0.5070	0.6141	1					
(9) *Equity Assets*	0.0334	0.1340	-0.0135	0.0947	-0.0307	-0.0477	0.0153	-0.1044	1				
(10) *Cash*	0.0134	-0.2576	-0.3597	-0.2699	-0.4268	-0.0884	-0.3320	-0.4825	-0.2168	1			
(11) *Insurance Activities*	0.0401	-0.3401	-0.2737	-0.3102	-0.2172	-0.4177	0.1339	0.1492	0.0514	-0.0751	1		
(12) *Total Debt*	-0.0424	0.3339	0.3133	0.3414	0.3226	0.2573	-0.1403	-0.0105	-0.1535	-0.2108	-0.5911	1	
(13) *Separate Accounts*	-0.0313	0.1521	0.2678	0.1241	0.1209	0.3262	0.0796	-0.0363	0.1654	0.2757	-0.3713	0.0254	1

Sample w/o Reinsurers

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) *Price-to-book*	1												
(2) $Leverage^A$	-0.0317	1											
(3) $Size^A$	-0.0272	0.6675	1										
(4) $Leverage^L$	-0.0328	0.9747	0.6697	1									
(5) $Size^L$	-0.0219	0.6822	0.9871	0.6898	1								
(6) *Concentration*	-0.0835	0.218	0.4154	0.2082	0.3751	1							
(7) *Investment Quality*	-0.0062	0.1471	0.4401	0.1454	0.443	0.2661	1						
(8) *Fixed Income Assets*	-0.0259	0.2207	0.4901	0.2003	0.5181	0.5201	0.6274	1					
(9) *Equity Assets*	0.0289	0.1274	0.0128	0.0864	-0.0014	-0.0816	0.0184	-0.1005	1				
(10) *Cash*	0.0100	-0.2693	-0.3473	-0.2821	-0.4150	-0.1140	-0.3236	-0.4846	-0.2432	1			
(11) *Insurance Activities*	0.0459	-0.3387	-0.3109	-0.3078	-0.2576	-0.4009	0.1274	0.1528	0.0742	-0.0568	1		
(12) *Total Debt*	-0.0457	0.3326	0.3377	0.3402	0.3516	0.2467	-0.1279	-0.0094	-0.1708	-0.232	-0.5856	1	
(13) *Separate Accounts*	-0.0370	0.1462	0.3033	0.1172	0.1563	0.3038	0.1017	-0.0360	0.1461	0.2592	-0.3525	0.0037	1

Sample w/o Reinsurers and SIFIs

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) *Price-to-book*	1												
(2) $Leverage^A$	-0.0236	1											
(3) $Size^A$	-0.0155	0.6315	1										
(4) $Leverage^L$	-0.0248	0.9590	0.6322	1									
(5) $Size^L$	-0.0090	0.6466	0.9836	0.6552	1								
(6) *Concentration*	-0.0824	0.2922	0.4477	0.2781	0.4052	1							
(7) *Investment Quality*	-0.0016	0.2177	0.471	0.2093	0.4767	0.2665	1						
(8) *Fixed Income Assets*	-0.0212	0.212	0.4798	0.1843	0.5152	0.5156	0.6351	1					
(9) *Equity Assets*	0.0300	0.0474	-0.021	-0.0031	-0.0388	-0.0766	0.0706	-0.11	1				
(10) *Cash*	0.0067	-0.2599	-0.3276	-0.2768	-0.4063	-0.1093	-0.3429	-0.4841	-0.2377	1			
(11) *Insurance Activities*	0.0445	-0.3668	-0.3143	-0.3236	-0.2537	-0.4202	0.1216	0.1557	0.0871	-0.0637	1		
(12) *Total Debt*	-0.0465	0.4461	0.3892	0.453	0.4084	0.2578	-0.1212	0.0033	-0.1764	-0.2386	-0.5904	1	
(13) *Separate Accounts*	-0.0370	0.1817	0.3392	0.1440	0.1745	0.3034	0.1130	-0.0482	0.1442	0.2632	-0.3612	0.0088	1

Table 1.12: Panel Regressions. The table reports the panel regression for both asset and liability specifications across 3 different samples - fixed effect model. ΔCoVar and DMES are reported with positive sign and sclaed by 100. Robust t-statistic in parentheses. $***p < 0.01$, $**\ p < 0.05$, $*p < 0.1$.

	Full Sample				Sample w/o Reinsurers				Sample w/o Reinsurers and SIFIs			
Variables	**ΔCoVaR**	**ΔCoVaR**	**DMES**	**DMES**	**ΔCoVaR**	**ΔCoVaR**	**DMES**	**DMES**	**ΔCoVaR**	**ΔCoVaR**	**DMES**	**DMES**
Price − to − book	-0.00116***	-0.00116***	0.000719	0.000710	-0.00117***	-0.00117***	0.000286	0.000262	-0.00104***	-0.00103***	0.000381	0.000435
	(-5.068)	(-5.077)	(1.195)	(1.189)	(-5.076)	(-5.094)	(0.443)	(0.409)	(-5.169)	(-5.235)	(0.599)	(0.694)
$Leverage^A$	-0.00351*		-0.0113		-0.00334		-0.0194		-0.0101***		-0.0381**	
	(-1.790)		(-0.961)		(-1.615)		(-1.611)		(-4.143)		(-2.454)	
$Size^A$	0.146***		0.442***		0.147***		0.511***		0.135***		0.520***	
	(17.14)		(9.043)		(15.26)		(9.091)		(13.38)		(8.150)	
$Leverage^L$		-0.00556***		-0.0184		-0.00551**		-0.0277**		-0.0139***		-0.0527***
		(-2.638)		(-1.526)		(-2.488)		(-2.219)		(-5.423)		(-3.257)
$Size^L$		0.146***		0.443***		0.147***		0.514***		0.138***		0.527***
		(17.98)		(9.312)		(16.26)		(9.366)		(14.89)		(8.500)
Concentration	-0.844***	-0.773***	-3.090***	-2.876***	-0.759***	-0.696***	-3.652***	-3.403***	-0.537**	-0.400**	-3.208***	-2.682***
	(-4.102)	(-3.807)	(-3.199)	(-3.030)	(-3.554)	(-3.267)	(-3.669)	(-3.504)	(-2.475)	(-2.048)	(-3.081)	(-2.761)
Investment Quality	-0.0607	-0.0612	-0.704*	-0.707*	-0.0372	-0.0415	-1.018**	-1.026**	0.130	0.151*	-0.416	-0.327
	(-0.798)	(-0.789)	(-1.888)	(-1.845)	(-0.442)	(-0.480)	(-2.557)	(-2.507)	(1.425)	(1.716)	(-1.030)	(-0.816)
Equity Assets	-0.0863	-0.107	0.137	0.0844	-0.0711	-0.0926	-0.0999	-0.214	-0.239	-0.328**	-0.895	-1.234
	(-0.478)	(-0.580)	(0.156)	(0.0965)	(-0.388)	(-0.496)	(-0.108)	(-0.233)	(-1.380)	(-2.036)	(-1.012)	(-1.480)
Fixed Income Assets	0.312**	0.258*	1.221*	1.053	0.251	0.199	1.334*	1.113	0.0762	-0.0470	0.482	0.0209
	(2.169)	(1.842)	(1.681)	(1.475)	(1.626)	(1.330)	(1.746)	(1.500)	(0.445)	(-0.330)	(0.607)	(0.0298)
Cash	0.390**	0.417**	1.877*	1.948*	0.393**	0.419**	1.675	1.725*	0.287	0.257	1.288	1.167
	(2.096)	(2.239)	(1.859)	(1.948)	(2.066)	(2.213)	(1.600)	(1.669)	(1.502)	(1.387)	(1.239)	(1.152)
Insurance Activities	-0.499***	-0.513***	-1.595***	-1.642***	-0.465***	-0.480***	-1.630***	-1.666***	-0.434***	-0.415***	-1.664***	-1.596***
	(-4.794)	(-4.866)	(-3.630)	(-3.788)	(-4.424)	(-4.510)	(-3.656)	(-3.812)	(-4.486)	(-4.582)	(-3.830)	(-3.944)
Total Debt	-0.0189	-0.0375	1.527**	1.477**	-0.00982	-0.0303	1.276*	1.214*	0.213**	0.229**	1.670**	1.745***
	(-0.161)	(-0.321)	(2.305)	(2.217)	(-0.0845)	(-0.260)	(1.901)	(1.793)	(2.102)	(2.299)	(2.570)	(2.654)
Separate Accounts	-0.143*	0.0935	-0.783*	-0.0650	-0.156*	0.0832	-0.855*	-0.0256	-0.113	0.108	-0.976**	-0.119
	(-1.835)	(1.212)	(-1.666)	(-0.140)	(-1.963)	(1.054)	(-1.817)	(-0.0551)	(-1.541)	(1.496)	(-2.047)	(-0.252)
Observations	314	314	314	314	286	286	286	286	253	253	253	253
Adjusted R-squared	0.702	0.704	0.558	0.559	0.701	0.702	0.570	0.571	0.662	0.678	0.555	0.563
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F test	61.20	59.48	14.75	14.73	57.63	55.80	13.98	14.03	43.87	45.97	11.28	12.15

Table 1.13: DiD Variables and Expected Signs.

VARIABLES	**dummy=0**	**dummy=1**	$\frac{\partial SR}{\partial d.X_z}$
Concentration	B	T	> 0
Investment Quality	T	B	< 0
Fixed Income	T	B	< 0
Equity	B	T	> 0
Cash	T	B	< 0
Insurance Activities	T	B	< 0
Total Debt	B	T	> 0
Separate Account	B	T	> 0

T=$\Phi^{-1}X_z \geq 0.5$

B=$\Phi^{-1}X_z < 0.5$

Table 1.14: Robustness Check - DiD for ΔCoVaR, Asset Side Specification. Shock dummy computed around Lehman Brothers filing for bankruptcy and AIG bailout. Treatment groups defined in table 1.13.
Robust t-statistic in parentheses. $***\,p < 0.01$, $**\ p < 0.05$, $*\,p < 0.1$.

VARIABLES	ΔCoVaR	ΔCoVaR	ΔCoVaR	ΔCoVaR	ΔCoVaR	ΔCoVaR	ΔCoVaR	ΔCoVaR
Price − to − book	0.106***	0.0890***	0.0902***	0.0875***	0.0890***	0.0797***	0.0896***	0.0836***
	(7.594)	(7.235)	(6.793)	(6.359)	(5.932)	(6.651)	(6.713)	(5.935)
Leverage^A	-0.0210*	-0.0234***	-0.0126**	-0.0129**	-0.0111*	-0.0120**	-0.0124**	-0.0115*
	(-1.910)	(-4.296)	(-2.204)	(-2.398)	(-1.944)	(-2.337)	(-2.429)	(-1.781)
Size^A	0.238***	0.236***	0.207***	0.210***	0.213***	0.188***	0.199***	0.198***
	(7.089)	(6.665)	(7.813)	(7.769)	(8.059)	(8.480)	(7.885)	(7.974)
Concentration		-1.207*	-0.993**	-1.410**	-1.050	-1.033**	-1.276**	-1.602***
		(-1.806)	(-2.325)	(-2.340)	(-1.407)	(-2.246)	(-2.431)	(-2.980)
Investment Quality	-0.167		-0.177	-0.273	-0.221	-0.0916	-0.208	-0.254
	(-0.652)		(-0.927)	(-1.217)	(-0.950)	(-0.470)	(-1.124)	(-1.098)
Fixed Income Assets	-0.479	-0.214		0.306	0.207	0.0149	0.178	0.396
	(-1.205)	(-0.289)		(0.719)	(0.427)	(0.0443)	(0.425)	(0.911)
Equity Assets	-2.231**	-1.625*	-0.199		-0.105	-0.190	-0.0361	-0.399
	(-2.301)	(-1.953)	(-0.258)		(-0.152)	(-0.283)	(-0.0592)	(-0.531)
Cash	-1.278*	-0.949	-0.341	-0.228		-0.251	0.0197	-0.319
	(-1.783)	(-1.458)	(-0.651)	(-0.486)		(-0.595)	(0.0422)	(-0.673)
Insurance Activities	0.153	-0.315	-0.207	-0.366	-0.197		-0.110	-0.340
	(0.279)	(-1.100)	(-0.914)	(-1.199)	(-0.634)		(-0.545)	(-1.265)
Total Debt	-0.380	-0.166	-0.205	-0.274	-0.147	-0.0836		-0.183
	(-1.181)	(-0.785)	(-0.788)	(-0.908)	(-0.528)	(-0.439)		(-0.691)
Separate Accounts	0.151	0.170	-0.113	-0.139	-0.236	-0.224	-0.0763	
	(0.638)	(1.044)	(-0.684)	(-0.885)	(-1.535)	(-1.455)	(-0.528)	
d.shock	0.309*	0.471***	0.451***	0.361***	0.341***	0.255**	0.272***	0.312***
	(2.030)	(4.789)	(4.963)	(4.136)	(3.832)	(2.516)	(3.194)	(3.559)
d.Concentration	-0.0945							
	(-0.545)							
d.shock · d.Concentration	0.159							
	(0.874)							
d.Investment Quality		-0.0415						
		(-0.411)						
d.shock · d.Investment Quality		-0.150						
		(-1.027)						
d.Fixed Income Assets			0.0792					
			(0.757)					
d.shock · d.Fixed Income Assets			-0.0745					
			(-0.524)					
d.Equity Assets				-0.153				
				(-1.553)				
d.shock · d.Equity Assets				0.142				
				(1.004)				
d.Cash					-0.169			
					(-1.463)			
d.shock · d.Cash					0.144			
					(1.059)			
d.Insurance Activities						0.0604		
						(0.734)		
d.shock · d.Insurance Activities						0.299**		
						(2.355)		
d.Total Debt							-0.0545	
							(-0.616)	
d.shock · d.Total Debt							0.280**	
							(2.072)	
d.Separate Accounts								-0.127
								(-1.275)
d.shock · d.Separate Accounts								0.232*
								(1.674)
Observations	40	48	70	70	70	70	70	70
Adjusted R-squared	0.725	0.713	0.671	0.682	0.682	0.720	0.700	0.686
F test	16.86	22.10	15.74	16.47	15.16	19.35	15.82	18.29

Table 1.15: Robustness Check - DiD for ΔCoVaR, Liability Side Specification. Shock dummy computed around Lehman Brothers filing for bankruptcy and AIG bailout. Treatment groups defined in table 1.13.
Robust t-statistic in parentheses. $***\, p < 0.01$, $**\, p < 0.05$, $*\, p < 0.1$.

VARIABLES	ΔCoVaR	ΔCoVaR	ΔCoVaR	ΔCoVaR	ΔCoVaR	ΔCoVaR	ΔCoVaR	ΔCoVaR
Price − to − book	0.107***	0.0892***	0.0885***	0.0863***	0.0888***	0.0786***	0.0886***	0.0822***
	(7.845)	(7.579)	(6.321)	(5.892)	(5.670)	(6.320)	(6.319)	(5.364)
$Leverage^L$	-0.0234**	-0.0268***	-0.0141**	-0.0143**	-0.0127**	-0.0134**	-0.0140**	-0.0147**
	(-2.260)	(-4.557)	(-2.347)	(-2.441)	(-2.085)	(-2.455)	(-2.584)	(-2.097)
$Size^L$	0.237***	0.236***	0.200***	0.203***	0.206***	0.182***	0.193***	0.196***
	(7.736)	(6.713)	(7.543)	(7.433)	(7.847)	(8.281)	(7.579)	(7.434)
Concentration		-1.309**	-1.046**	-1.348**	-0.921	-0.973**	-1.184**	-1.474***
		(-2.089)	(-2.326)	(-2.255)	(-1.232)	(-2.071)	(-2.292)	(-2.763)
Investment Quality	-0.203		-0.192	-0.264	-0.207	-0.0843	-0.200	-0.232
	(-0.841)		(-0.986)	(-1.171)	(-0.882)	(-0.433)	(-1.085)	(-1.059)
Fixed Income Assets	-0.562	-0.263		0.220	0.0636	-0.0703	0.0742	0.289
	(-1.473)	(-0.371)		(0.524)	(0.132)	(-0.213)	(0.183)	(0.687)
Equity Assets	-2.204**	-1.648**	-0.137		-0.0207	-0.120	0.0244	-0.212
	(-2.222)	(-2.038)	(-0.176)		(-0.0299)	(-0.176)	(0.0395)	(-0.279)
Cash	-1.322*	-0.936	-0.196	-0.140		-0.166	0.110	0.0517
	(-1.905)	(-1.508)	(-0.358)	(-0.283)		(-0.376)	(0.223)	(0.102)
Insurance Activities	0.191	-0.264	-0.239	-0.368	-0.193		-0.103	-0.372
	(0.342)	(-0.940)	(-0.986)	(-1.138)	(-0.602)		(-0.502)	(-1.264)
Total Debt	-0.408	-0.0890	-0.194	-0.264	-0.148	-0.0776		-0.143
	(-1.184)	(-0.438)	(-0.726)	(-0.840)	(-0.526)	(-0.411)		(-0.502)
Separate Accounts	0.527**	0.537***	0.182	0.167	0.0783	0.0422	0.209	
	(2.209)	(3.734)	(1.087)	(1.031)	(0.501)	(0.271)	(1.396)	
d.shock	0.311**	0.477***	0.456***	0.370***	0.352***	0.255**	0.283***	0.313***
	(2.074)	(5.047)	(4.910)	(4.160)	(3.899)	(2.479)	(3.209)	(3.605)
d.Concentration	-0.0856							
	(-0.496)							
d.shock · d.Concentration	0.171							
	(0.943)							
d.Investment Quality		-0.0551						
		(-0.553)						
d.shock · d.Investment Quality		-0.162						
		(-1.149)						
d.Fixed Income Assets			0.0685					
			(0.656)					
d.shock · d.Fixed Income Assets			-0.0714					
			(-0.501)					
d.Equity Assets				-0.137				
				(-1.369)				
d.shock · d.Equity Assets				0.130				
				(0.902)				
d.Cash					-0.175			
					(-1.476)			
d.shock · d.Cash					0.130			
					(0.939)			
d.Insurance Activities						0.0627		
						(0.764)		
d.shock · d.Insurance Activities						0.304**		
						(2.363)		
d.Total Debt							-0.0312	
							(-0.353)	
d.shock · d.Total Debt							0.263*	
							(1.930)	
d.Separate Accounts								-0.0531
								(-0.529)
d.shock · d.Separate Accounts								0.243*
								(1.775)
Observations	40	48	70	70	70	70	70	70
Adjusted R-squared	0.732	0.732	0.666	0.674	0.677	0.716	0.693	0.682
F test	15.93	22.93	15.01	15.57	14.64	18.48	15.44	16.14

Table 1.16: Robustness Check - DiD for DMES, Asset Side Specificatio. Shock dummy computed around Lehman Brothers filing for bankruptcy and AIG bailout. Treatment groups defined in table 1.13.
Robust t-statistic in parentheses. $***\ p < 0.01$, $**\ p < 0.05$, $*\ p < 0.1$.

VARIABLES	DMES	DMES	DMES	DMES	DMES	DMES	DMES	DMES
Price − to − book	0.362***	0.207**	0.236***	0.206**	0.243***	0.217***	0.218***	0.204**
	(2.967)	(2.189)	(2.893)	(2.595)	(2.903)	(2.707)	(2.853)	(2.369)
$Leverage^A$	-0.201***	-0.111***	-0.0643**	-0.0559*	-0.0526*	-0.0614**	-0.0607**	-0.0459
	(-3.055)	(-3.165)	(-2.270)	(-1.924)	(-1.854)	(-2.380)	(-2.492)	(-1.484)
$Size^A$	1.162***	1.015***	0.740***	0.759***	0.764***	0.710***	0.720***	0.718***
	(4.334)	(4.184)	(3.907)	(4.207)	(4.298)	(3.795)	(4.080)	(3.924)
Concentration		-3.621	-7.211***	-9.316***	-5.766	-6.652**	-8.735***	-9.069***
		(-0.941)	(-2.930)	(-2.745)	(-1.584)	(-2.294)	(-2.879)	(-2.845)
Investment Quality	-1.690		-1.994*	-2.538*	-2.117	-1.502	-2.632**	-2.415*
	(-1.231)		(-1.775)	(-1.932)	(-1.671)	(-1.350)	(-2.533)	(-1.920)
Fixed Income Assets	-3.606	-0.620		2.260	0.472	0.286	1.422	2.471
	(-1.582)	(-0.164)		(1.001)	(0.187)	(0.136)	(0.756)	(1.101)
Equity Assets	-6.814	-5.292	2.106		2.893	3.333	1.608	2.367
	(-1.332)	(-1.239)	(0.506)		(0.824)	(0.945)	(0.559)	(0.601)
Cash	2.017	1.101	0.683	-0.180		1.862	0.763	1.003
	(0.403)	(0.227)	(0.220)	(-0.0664)		(0.684)	(0.302)	(0.376)
Insurance Activities	-0.808	-2.285*	-1.491	-2.395*	-1.127		-1.968	-1.743
	(-0.237)	(-1.731)	(-1.104)	(-1.818)	(-0.823)		(-1.626)	(-1.251)
Total Debt	1.518	1.937	1.074	-0.0952	1.026	2.182		1.020
	(0.644)	(0.880)	(0.649)	(-0.0568)	(0.683)	(1.453)		(0.604)
Separate Accounts	-1.225	-0.815	-1.218	-0.936	-1.601*	-1.495	-0.749	
	(-0.588)	(-0.476)	(-1.068)	(-0.866)	(-1.742)	(-1.457)	(-0.734)	
d.shock	2.059**	2.463***	2.599***	2.668***	2.339***	1.511***	1.674***	2.245***
	(2.690)	(4.669)	(4.520)	(4.495)	(4.553)	(3.026)	(3.817)	(3.901)
d.Concentration	-1.395							
	(-1.373)							
d.shock · d.Concentration	1.233							
	(1.025)							
d.Investment Quality		-0.435						
		(-0.610)						
d.shock · d.Investment Quality		0.581						
		(0.575)						
d.Fixed Income Assets			-0.143					
			(-0.271)					
d.shock · d.Fixed Income Assets			0.0240					
			(0.0285)					
d.Equity Assets				-0.502				
				(-0.975)				
d.shock · d.Equity Assets				0.0365				
				(0.0462)				
d.Cash					-1.106**			
					(-2.238)			
d.shock · d.Cash					0.536			
					(0.683)			
d.Insurance Activities						-0.561		
						(-1.104)		
d.shock · d.Insurance Activities						2.012**		
						(2.478)		
d.Total Debt							-0.400	
							(-0.852)	
d.shock · d.Total Debt							1.941**	
							(2.525)	
d.Separate Accounts								-1.140*
								(-1.943)
d.shock · d.Separate Accounts								0.773
								(0.974)
Observations	40	48	70	70	70	70	70	70
Adjusted R-squared	0.489	0.583	0.489	0.501	0.514	0.541	0.555	0.510
F test	5.232	4.059	5.964	5.150	6.218	5.180	4.995	5.854

Table 1.17: Robustness Check - DiD for DMES, Liability Side Specification. Shock dummy computed around Lehman Brothers filing for bankruptcy and AIG bailout. Treatment groups defined in table 1.13.
Robust t-statistic in parentheses. $***\, p < 0.01$, $**\; p < 0.05$, $*\, p < 0.1$.

VARIABLES	DMES	DMES	DMES	DMES	DMES	DMES	DMES	DMES
$Price-to-book$	0.358***	0.203**	0.232***	0.202**	0.242***	0.214***	0.214***	0.198**
	(2.971)	(2.085)	(2.821)	(2.493)	(2.853)	(2.683)	(2.789)	(2.246)
$Leverage^L$	-0.199***	-0.123***	-0.0715**	-0.0621*	-0.0594*	-0.0684**	-0.0669**	-0.0581*
	(-2.882)	(-3.156)	(-2.359)	(-1.968)	(-1.954)	(-2.451)	(-2.595)	(-1.707)
$Size^L$	1.102***	0.988***	0.718***	0.727***	0.736***	0.687***	0.692***	0.700***
	(4.062)	(4.129)	(3.825)	(4.050)	(4.198)	(3.745)	(4.030)	(3.739)
Concentration		-4.157	-7.459***	-9.124***	-5.397	-6.471**	-8.427***	-8.646***
		(-1.110)	(-3.025)	(-2.757)	(-1.513)	(-2.328)	(-2.864)	(-2.793)
Investment Quality	-1.818		-2.068*	-2.502*	-2.071	-1.484	-2.604**	-2.319*
	(-1.316)		(-1.807)	(-1.877)	(-1.620)	(-1.326)	(-2.482)	(-1.871)
Fixed Income Assets	-3.855	-0.790		1.962	0.000219	-0.0352	1.045	2.094
	(-1.649)	(-0.208)		(0.876)	(8.79e-05)	(-0.0168)	(0.562)	(0.947)
Equity Assets	-6.336	-5.469	2.320		3.217	3.613	1.776	3.063
	(-1.179)	(-1.259)	(0.552)		(0.911)	(1.010)	(0.612)	(0.750)
Cash	1.312	0.864	1.145	0.0494		2.087	0.980	2.247
	(0.264)	(0.178)	(0.363)	(0.0175)		(0.743)	(0.371)	(0.795)
Insurance Activities	-0.537	-2.118	-1.585	-2.418*	-1.115		-1.949	-1.888
	(-0.157)	(-1.558)	(-1.160)	(-1.793)	(-0.804)		(-1.613)	(-1.312)
Total Debt	1.425	2.260	1.164	-0.0157	1.072	2.238		1.194
	(0.581)	(1.022)	(0.700)	(-0.00917)	(0.703)	(1.486)		(0.709)
Separate Accounts	0.498	0.784	-0.170	0.172	-0.475	-0.492	0.280	
	(0.248)	(0.501)	(-0.148)	(0.155)	(-0.498)	(-0.482)	(0.269)	
d.shock	2.040**	2.482***	2.613***	2.700***	2.382***	1.514***	1.717***	2.245***
	(2.600)	(4.721)	(4.485)	(4.486)	(4.534)	(2.970)	(3.828)	(3.926)
d.Concentration	-1.314							
	(-1.262)							
$d.shock \cdot d.Concentration$	1.302							
	(1.053)							
d.Investment Quality		-0.513						
		(-0.712)						
$d.shock \cdot d.Investment\ Quality$		0.531						
		(0.524)						
d.Fixed Income Assets			-0.192					
			(-0.360)					
$d.shock \cdot d.Fixed\ Income\ Assets$			0.0400					
			(0.0474)					
d.Equity Assets				-0.433				
				(-0.835)				
$d.shock \cdot d.Equity\ Assets$				-0.00732				
				(-0.00911)				
d.Cash					-1.105**			
					(-2.184)			
$d.shock \cdot d.Cash$					0.477			
					(0.600)			
d.Insurance Activities						-0.550		
						(-1.092)		
$d.shock \cdot d.Insurance\ Activities$						2.028**		
						(2.471)		
d.Total Debt							-0.304	
							(-0.662)	
$d.shock \cdot d.Total\ Debt$							1.878**	
							(2.446)	
d.Separate Accounts								-0.859
								(-1.468)
$d.shock \cdot d.Separate\ Accounts$								0.814
								(1.023)
Observations	40	48	70	70	70	70	70	70
Adjusted R-squared	0.461	0.577	0.484	0.492	0.508	0.536	0.548	0.503
F test	4.598	4.030	5.679	5.089	6.134	5.014	4.934	5.818

Chapter 2

The Impact of the Monetary Policy Interventions on the Insurance Industry

2.1 Introduction and literature review

To contrast the economic stagnation affecting Europe, the European Central Bank (ECB) is enforcing since 2013 a series of conventional and unconventional expansionary monetary intervention, including Quantitative Easing (last QE announced in January 2015).[1] These expansionary interventions, in addition to the welcomed stimulus on the economy, result in extremely low interest rates exacerbating the problems arising from the low yield environment.

The persistent low yield environment is heavily affecting the EU financial services industry and it is becoming a severe threat for the life insurers in terms of solvency and sustainability of their business models. From a policymakers perspective an increasing attention on the stability and profitability of life insurers is expressed by EIOPA. These constantly rank the low yield environment as the major source of risk for the life insurers (EIOPA (2013), EIOPA (2014a), EIOPA (2015)). Concerns are specifically addressed towards companies with a relevant outstanding portfolio of products entailing guaranteed rates of return and profit participation features. The lack of sufficiently remunerable rated assets on the market substantially reduce the capability for (re)insurers to match by a return and duration perspective the outstanding portfolio of guaranteed policies underwritten in high-yield years. Concerns are shared by the national authorities overseeing markets traditionally active on saving products with minimum guaranteed returns such as Germany. For instance, Deutsche Bundesbank (2013), from the 2013 stress test exercise inferred that a persistent low yield environment would heavily affect the solvency situation of German insurers. Moreover, the report

A former version of this paper were published in the Financial Stability Report - Thematic Article: The impact of the monetary policy interventions on the insurance industry (Pelizzon, Sottocornola), EIOPA - December 2016.

[1] See: ECB (2015).

concluded that under particularly adverse conditions more than 30 per cent of the German life insurers won't meet Solvency II capital requirements by 2023. Comparable results are obtained by Berdin and Grndl (2015) in their model based analysis on a stylised German life insurers solvability under the Solvency II regime. Wedow and Kablau (2011) analyse the German market once more and reached less pessimistic conclusions. As a matter of fact they empirically conclude that given the outstanding stock of guaranteed products the solvency situation will be threatened only in extremely adverse scenarios. Nevertheless, the authors argue that a prolonged low yield scenario would progressively worsen the solvency capability of insurance companies offering minimum guaranteed products. In the literature there is a common understanding in considering these kinds of products as the most exposed to the drop in the interest rates. In particular duration mismatches between assets and liability are considered to be the vulnerable point of these products, as qualitatively shown by Holsboer (2000) and theoretically expressed by Li and Wei (2013). In addition to the minimum guaranteed benefits, the profit participation component seems to cause trouble to insurers as pointed out by Grosen and Lchte Jrgensen (2000) in their theoretical work. Profit distribution policies have been empirically investigated by Kling and Ru (2007a) both by a general and local perspective (Kling and Ru, 2007b). An additional element of vulnerability of the life insurers exposed to a persistent low yield environment comes from surrender options potentially embedded in the contracts. Gatzert (2008) and Albizzati and Geman (1994) explain how in periods of low profit sharing returns, policyholders can opt for more attractive investments enhancing the lapse risk. All these studies investigate the issue from a theoretical point of view of a numerical simulation; with this work we aim to shed light on the empirical evidence related to stock market evaluation of the impact of unconventional monetary policies on the insurance industry. In fact, if on the one hand there is a common understanding on the relation between monetary interventions and the interest rate term structure, on the other hand the effect on conventional and unconventional expansionary monetary policy on the market does not provide conclusive elements, especially in a low or negative yields environment. The impacts of the monetary policy on market valuations have been vastly investigated. Specifically, the role of monetary policy announcements on asset pricing is well documented (see Cook and Hahn (1998), Bernanke and Kuttner (2005), Ehrmann et al. (2011) and Ippolito et al. (2015), among others). However, the literature on Quantitative Easing and near-zero rates is still in its initial phase and has thus far mainly concentrated on measuring the effects of unconventional monetary policies on aggregates such as inflation and GDP (see Chen et al. (2012), Chung et al. (2010), Gambacorta and Peersman (2014) Gambacorta, Hofmann and Peersman (2014), and Kapetanios et al. (2012) amid others). A number of papers investigates the effect of unconventional policies on financial markets, with a focus on interest rates and equities in the U.S. and developed European countries. Instances for works in this area are Krishnamurthy and Vissing-Jorgensen (2011), D'Amico et al. (2012), King et al. (1991), Banerjee et al. (2014), Li and Wei (2013) and Pericoli and Veronese (2016). It is worth mentioning various studies that implement the event-study methodology in order to properly investigate the effects of unconventional monetary policies. Regarding the Eurozone, Briciu and Lisi (2015) have identified announcements that can be considered as complete surprises: they then simply added up the jumps in asset prices in short-time windows bracketing these announcements. Nevertheless, complete surprises do not account for market expectations. A way to bypass this issue is offered by Joyce et al. (2011), by normalising data looking at the surveys periodically conducted by financial institutions such as bank and insurances, with the purpose to measure in a more realistic manner the market surprise to monetary policy announcements. However, due to the limited availability of surveys, this measure does not represent a viable alternative for many fields. A more effective approach, proposed by Rogers et al. (2014), turned out to be helpful in order to measure the effects of monetary measures on different asset prices relatively to changes in government bond yields and relies on a particular definition of monetary policy surprise centred on the intraday changes in government bond yields right after the announcement. Despite the ample sources, no analysis has been specifically devoted to the insurance industry. We therefore focus our attention on how and to what extent the 2015 ECB QE and the convention and unconventional expansionary monetary policy strategy deployed by Central Banks impact the market performances of the (re)insurers. Our approach is twofold. The first part of the analyses identifies the effect of the monetary policy interventions on the (re)insurers scrutinizing the reaction of the stock prices to the central banks policy actions. Initially we elaborate over a simple event study bases on a market model (Mackinlay, 1997) around the last ECB QE announcement (22 January 2015). Subsequently, we extend the analysis to a broader sample of announcements by following the approach of Pericoli and Veronese (2016) who compare monetary policy announcement and non-announcements days in different sub-periods. In this second part, our paper builds on the latter intuition. The idea underlying this approach is that the periods are characterised by different "structural parameters", in the spirit of Rigobon (2003). Within these periods, estimates of impacts are obtained by separately pooling announcement and non-announcement days.

An additional step in the analysis of the impacts of the monetary policy announcements consists in the identification of the characteristics which drive the sensitivity of the companies to the events thereof. In the literature the linkage between the impact of the change in the interest rates upon monetary policy decisions and the banks' exposure to different asset classes and to different businesses has been explored both in the US and Europe. Arseneau (2017) shows that, in the US banking industry, the impact of the monetary policy transmitted by the change in the interest rates differs significantly and much of this heterogeneity can be explained by cross-bank differences in the provision of liquidity services. In Europe, Ampudia and Van-den Heuvel (2017) empirically found that the composition of the balance sheets is important in order to understand the effects of the monetary policy decisions on banks. In specific the two authors infer that banks with high deposit ratios are in general less sensitive to changes in interest rates, except when rates are low. To our knowledge, the analysis thereof are limited to the banking industry, therefore in the second part of this work we identify the determinants of the sensitivity of the (re)insurers to the ECB's monetary policy announcements looking at the asset and liability composition of their balance sheet. We base our analysis on a *logit* regression using as a dependent variable the sensitivity of the (re)insurers to the monetary policy interventions and as regressors a set of balance sheet based indices approximating the asset allocation and the liability exposures.

The paper is structured in five sections. At first this introduction provides a review of the main related researches and presents the overall content of the study. We devote section 2.2 and 2.3 to present the applied methodology and to describe the utilised market based and balance sheet based dataset respectively. Section 2.4 summarises the empirical evidences on the effect of monetary policies on the insurance industry and the determinants of the sensitivity of (re)insurers to the events thereof. The article concludes with the presentation of the main findings and of the further implications (Section 2.5).

2.2 Methodology

Our analysis encompasses 2 steps:

i we investigates the effects of the conventional and non-conventional monetary policy interventions on the stock prices of a set of listed companies from selected from different industries and different geographical areas *(monetary policy impact analysis)*;

ii we then empirically identifies the main determinants at balance sheet level of the sensitivity of the European (re)insures to the ECB's monetary policy actions *(analysis of the determinants)*

2.2.1 Monetary Policy Impact Analysis

To evaluate the effect of the non-conventional monetary policy interventions enforced by the ECB we focus on the QE program launched on the 22^{nd} of January 2015. More specifically we design an event study based on a market model around the announcement of the QE program. The Cumulative Abnormal Returns of insurers are computed against different samples in order to insulate the effect of the QE on the broad insurance market and on a set of subsamples defined according to geographical areas and sizes defined in term of total assets. In detail we split the full sample by a geographical perspective into: *i)* US (re)insurers, *ii)* EU (re)insurers, *iii)* EMU (re)insurers and *iv)* EU-non EMU (re)insurers. Size-wise we dissect the sample into big and small (re)insurers. It is worth noting that in this article we utilise the notation "big and small" in a relative extent. The sample includes large listed (re)insurers, nevertheless to understand whether and to what extent size acts as determinant of the impacts of monetary policy intervention on insurers. We use the following divide: threshold of EUR 50bn used by FMI and IAIS as a size criteria to identify G-SII insurers (IAIS (2016)). We compute for each group the Cumulative Abnormal Returns (CAR) around the announcement date using a two-day event window as in

Chen et al. (2012) as follow:[2]

$$CAR_{i,t} = \sum_{j=1}^{t} AR_{i,j} \tag{2.1}$$

where i represents the institution and j represents the time. The *Abnormal Return* (AR) of an institution i is computed according to equation (2.1).

$$AR_{i,t} = OR_{i,t} - IR_{i,t} \tag{2.2}$$

where the OR express the observed market return of the institution i, whereas IR expresses the implied return of the same institution. We compute implied returns on the (re)insurer i on an estimation windows spanning form 26 August, 2013 to 20 January, 2015 according to equation (2.3).

$$IR_{i,t} = \hat{\beta}_i \times OR_{i,t} \tag{2.3}$$

where $\hat{\beta}_i$ is derived via OLS according to equation (2.4):

$$Return_{i,t} = \alpha_i + \beta_i \times market_t + \epsilon_{i,t} \tag{2.4}$$

In the second part of the monetary policy impact analyses, in order to identify the causal relationship of the monetary policy, we estimate an ordinary least square regression of daily returns of the (re)insurance companies on monetary policy surprises. Based on the fact that at a first instance conventional and unconventional monetary policies affect the risk free rate term structure, we define, according to Bernanke and Kuttner (2005) and Rogers et al. (2014), the *monetary policy surprise* as the linear combination of the changes on the whole term structures of the interest rates. We then estimate the impact of the monetary policy surprise on the market returns of a panel of listed companies via OLS regressions according to equation (2.5).

$$\Delta y_t = \alpha + \beta \times \Delta RFR^{FED}_{t=t_{aFED}} + \gamma \times \Delta RFR^{ECB}_{t=t_{aECB}} + \sum_j \phi_j \times X_{t,j} + u_t \tag{2.5}$$

where Δy_t is the change in the market return, $\Delta RFR^{FED}_{t=t_{aFED}}$ and $\Delta RFR^{ECB}_{t=t_{aECB}}$ are the Fed and ECB monetary-policy surprises defined as the first principal component factor PCA of the changes in 1-year, 2-year, 5-year, 7-year and 10-year zero-coupon interest rates.[3] In line with Pericoli and Veronese (2016) we use a set of control variables represented by $X_{t,j}$, namely the US Citi Economic Surprise Index (CESI), the Euro-area CESI and the VIX. Equation (2.5) is estimated only around but close to $ECB(t = t_{aECB})$ or $Fed(t = t_aFED)$ announcement days split into five periods as follow.

[2] The use of a longer window does not allow to insulate the effect of the analyzed event as other elements may generate movements in the stock prices.

[3] For the EU we utilize the zero-coupon interest rate implied in government bonds irrespective of their rating (ECB computation). For the US we utilize the FED zero-coupon rate.

1^{st} from 6 September 2004 to 15 June 2008. We define it as a *tranquil* period characterized by conventional monetary policies conducted both by ECB and Fed. The interest rates in this period reported a general increasing trend however characterised by some sharp drops.

2^{nd} from 1 September 2008 to 31 August 2010. It is the period of the *US sub-prime crisis* and its subsequent global spillover. The Troubled Asset Relief Program (TARP) process and conventional and unconventional monetary policies (QE1 announced in November 2008 and ceased in March 2010) enforced by the Fed reduced the US at near-zero interest rate. The ECB stared in October 2008 the progressive reduction of the interest rates to a near-zero level complemented by unconventional policy as Long Term Refinancing Operations (LTRO) announced in May 2009 and Asset Purchases Programme (APP). Yield curves started a constant decrease more pronounced for the short maturities.

3^{rd} from 1 September 2010 to 30 June 2012. The focus moved from the US to Europe. The period is characterized by the severe tensions on the EURO originated by speculative attacks to the currency and by the sovereign debt crisis of the peripheral countries of the euro area. The nearly default of Greece represents the peak of this crisis. The ECB reaction was anticipated in the *Whatever it takes* speech of President Draghi and enforced by conventional monetary policy interventions (reduction of interest rate on deposit facilities to 0%) and unconventional monetary policy intervention (the launch of Outright Monetary Transactions - OMT). In order to contrast the US economy downturn, the Fed proceeded along the path of conventional expansionary monetary policy complemented by unconventional monetary policies launching in November 2010 the QE2 and in September 2012 the QE3. Yields reacted with a high volatile general decrease with the shorter maturities reaching for the first time the "zero level" in the period of observation.

4^{th} from 1 July 2012 to 31 December 2013. The Euro sovereign debt crises, also thanks to the ECB interventions, reached an end leaving the markets with yields somehow stable over the period and around the zero for the shortest maturities up to 2% for the 10-year.

5^{th} from 1 January 2014 to 20 February 2017: The *low yield environment* is the key topic to be mentioned. In order to contrast the prolonged stagnation of the economy in the euro area and to fulfill its mandate of keeping the inflation close to 2%, the ECB launched in April 2014 the Quantitative Easing program which was extended in 2015 further. TLTROs initiatives complemented the set of enforced unconventional monetary policies. Interest rate on deposit facilities turned to negative from June 2014 onwards. In the US, the recovery of the economy led to a first increase on the Fed Funds rate at the end of 2015 (outside our period of observation).

The five periods and the yield movements are reported in figure 2.1 which depicts the term structure of the Euro Area risk free rates for the maturities used to compute the PCA and the decomposition of the 5 periods (vertical lines).

INSERT FIGURE 2.1 HERE

In order to check potential *behavioral* implications driven by the attempt of the market to anticipate or delay potential reactions to the monetary policy announcements by the Central Banks we tested the the regression displayed in equation 2.5 not only in the announcements days but also on a 3-day window moving around the announcement day.[4]

This specification allows to investigate whether conventional and unconventional monetary policies have been effective over time in fostering favorable conditions for the (re)insurers when policy rates were stuck at the zero lower bound, and if their transmission operated through a decrease in term premia benefit the insurance industry.

2.2.2 Analysis of the determinants

In the analysis of the determinants we scrutinise whether the asset and liability structure might explain the higher or lower sensitivity of a (re)insurance undertaking to the monetary policy interventions. Changes in the yields in general and in the reference risk free rate in particular have impacts on both sides of the balance sheet of a (re)insurer. In fact, independently by the regulatory regime, the economic valuation of the assets and the best estimates backing the provisioning reflect the market yields regime. The impact of the change in the risk free rates is even more relevant in a full market based regulatory framework as Solvency II where the technical provisions are computed by discounting the future cash flows of the outstanding policy portfolio at the Risk Free Rate (European Parliament and of the Council of 25, 2009). Against this background we define a set of indicators aimed at representing the main characteristics of a company in term of undertaken business and asset allocation (ref. table 2.1).

INSERT TABLE 2.1 HERE

In order to test the relation between the defined balance based indicators and the sensitivity to the monetary policy intervention we run a panel regression on the set of European (re)insurers on the 5 periods of observations. Specifically we run a *Logit* regression for each European company using as dependent a dummy variable defined on the coefficient of the regressor $\Delta RFR^{ECB}_{t=t_{aECB}}$ obtained via equation 2.5 as follow:

$$SL[01]^i = \begin{cases} 1, & \text{if } p < 0.1\%. \\ 0, & otherwise \end{cases} \tag{2.6}$$

We use as regressor a set the set of defined balance sheet items.

[4]Specification tested: -2 days, announcement day; -1 day, announcement day, +1 day; announcement day, +2 days.

The baseline for the i^{th} (re)insurer follows:

$$SL[01]_t^i = \alpha + \sum_j \beta_j \times X_{j,t}^i + \epsilon_t^i \tag{2.7}$$

where X_j includes the set set of balance sheet indices reported in table 2.1.

The contributions we are expecting form the indices thereof is strictly related to the characteristics of the different activities undertaken by the (re)insurers. It worth noting that here we are using the word *activity* with a broad meaning, namely including both the type of underwritten contracts (eg. life, non-life, non-traditional insurance activities) and the investment strategy enforced to back the liabilities.

More specifically we expect that the sensitivity of a (re)insurer to the monetary policy intervention would be primarily driven by its asset allocation, therefore from the exposure to fixed income assets and equity assets. In particular we expect that a high exposure to fixed income assets whose value is directly influenced by the level of the risk free rate should be associated to a high sensitivity (*Hp.1*).

Given that insurance is a liability driven business where assets are primarily used to back the obligations of (re)insurers towards their policyholders we also expect that the composition of the portfolio of liability plays a role in the sensitivity to the monetary policy actions. A company more exposed to the life business traditionally characterised by long term liabilities shall be more prone to shocks to the yields than a company active in the non-life business usually based on yearly based contracts whose price is adjustable at the same frequency (*Hp.2*). We also expect that the engagement in non-traditional insurance activities which usually implies maturity transformation based products might play a role (*Hp.3*).

Well aware that the interactions between assets and liabilities is of utmost importance to determine the exposure if a (re)insurer to the fluctuations of the yields in the market we would be keen to test the contribution of the *duration mismatch* between assets and liabilities of (re)insurers. However *i)* the scarce availability of data at sufficient level of granularity and *ii)* the huge debate on how to calculate the duration of the (re)insurers portfolios encompassing optionalities embedded both on the assets (eg. derivatives used for hedging purpose) and liability side (eg. profit-participation related benefits), prevent us to use this metrics in this paper.

In order to cope with yearly the mismatching between the balance sheet reporting available on a yearly basis and the extension of the period we defined for the monetary policy surprise analysis we match each of the 5 periods with the average figures disclosed by (re)insurers in the balance sheets reported in the correspondent time frame as reported in table 2.2.

INSERT TABLE 2.2 HERE

2.3 Dataset

2.3.1 Monetary Policy Impact Analysis

We conduct the event study on a panel of 96 US and 70 European listed insurers selected among the largest in term of total assets.[5] Data consist of the total return index and market capitalisation retrieved via Thomson Reuters Datastream® of the (re)insurers over a time window of 370 trading days from August 26, 2013 to January 24, 2015. We use as an estimation panel a set of indices for each geographical area containing all relevant listed companies, namely excluding all the small caps and the (re)insurers encompassed in our panel (i.e. only the largest companies that jointly account for 80% of the total market capitalisation were used to compute the country level market indices). Additionally, we remove all insurance companies and all companies which had less than 120 active trading days in any year. Based on end year market capitalisation figures, we compute weighted country market returns. We then build a set of country based indices based on the market capitalization of the companies in order to scrutinize the effect of the QE *i)* at European and US level and *ii)* at a country level. Also we split the sample according to the size of the insurers to understand whether and to what extent size acts as a determinant of the impacts of monetary policy intervention on insurers. Table 2.3 provides a detail of the sample of the (re)insurers.

INSERT TABLE 2.3 HERE

For the second part of our analyses, we regress the stock returns of the (re)insurers on the change in the risk free rate term structure during the monetary policy days defined according to the scheduled and unscheduled central bank board meetings as well as on those days when relevant news on monetary policies were disclosed (Table 2.4 displays the summary statistics of the returns).[6] The comparison of the stock returns during the monetary policy days and the other days provides heterogeneous outcomes. In the first two periods, the average values of the stock returns in the ECB's and FED's monetary policy days are lower than the values observed in the "other days". The situation change in the third periods where the higher returns are associated to the monetary policy days. Values revert again in period 4 and period 5.

INSERT TABLE 2.4 HERE

Regressors, beside the already mentioned change in the risk free rates for Euro ($\Delta RFR^{ECB}_{t=t_{aECB}}$) and USD ($\Delta RFR^{FED}_{t=t_{aFED}}$), include also the VIX, the CESI EUR and the CESI USD indices as control variables. Table 2.5 displays the summary statistics of the independent variables for the five periods of observation.

[5]Total assets reference date: year-end 2014. Data retrieved via SNL Financial®.

[6]The full list of monetary policy days divided between US and EU is provided in Appendix 2.8.6 and extend the one from Pericoli and Veronese (2016) paper. The lists are divided into 2 periods of observation with the oldest slots that only reports scheduled meetings and the more recent ones that complement scheduled meetings with unscheduled meetings and relevant speeches.

INSERT TABLE 2.5 HERE

The ECB announcement days had a different impact on the interest rates according to the periods of observation. Periods 1, 2 and 4 display an average decrease of the rates in the announcement days with an average of interest rate changes of - 0.134%, - 0.517% and - 0.137% respectively with a significant variations from the "Other days" which reports a + 0.194% in period 1, + 0.463% in period 2 and + 0.231% in period 4. Period 3 and period 5 show the opposite reaction of the rates with on average a positive change in the interest rates (+ 0.055% and + 1.161%) with a variations from the "Other days" of + 0.835% in period 3 and - 0.005% in period 5. The change in the interest rates in response to the monetary policy actions can be explained by the fact that the intervention either was in the direction of a decrease of the interest rates or, despite being for a reduction of interest rates, did not match the expectation of the market that reacted in the opposite direction.

2.3.2 Analysis of the determinants

For the analysis of the determinants we retrieved from SNL Financials the year-end balance sheet data of the the panel of the 70 European (re)insurers used in the monetary policy impact analysis. By a time perspective, as SNL Financials displays sufficiently complete figures since 2003, we made base our analysis on a a set of 14 year-end balance sheets, from 2003 to 2016. Summary statistics on the utilized balance sheet indicators are provided in table 2.6.

INSERT TABLE 2.6 HERE

2.4 Empirical evidences

In this section we report the application of the approach explained in the section 2.2. We start form the analysis of the monetary policy impact and at first we show the results of the event study centered on the ECB announcement of the last QE (22/01/2015) on the defined samples of (re)insurers. Subsequently, with the aim of scrutinizing the general effect of a series of several interrelated monetary policy interventions, we display the outcome of the analysis on the *monetary policy surprise* effect by enlarging the timeframe of our analysis and the number of interventions announced by the Central Banks. In the second part we move to the analysis of the determinants. With the attempt to identify the characteristics that make (re)insurers more prone to the monetary policy interventions, we present the empirical evidences obtained via OLS regressions (ref. equation 2.7).

2.4.1 Monetary Policy Impact Analysis

Event study

We design the event study on a -2/+2 days event window (see shaded cells in Table 2.7).

INSERT TABLE 2.7 HERE

We select a 4-day event window because we want to capture the expectation effect that shall be reflected in prices in the few days before the announcement on the one hand the adjustments subsequent the announcement on the other hand. A longer event window would be prone to capture spurious effects originated by other events that may happen in the market. According to this specification the QE has a significant negative impact on the return of the full sample of (re)insurers (column Total). The same can be observed regarding the different geographical and size-based subsamples. In this respect, however, the level of significance is insufficient. The only exception is represented by the US subsample (column US). This subsample reports still small but higher significant impacts in comparison to the full sample. The result cannot be explained from the information available. It also cannot be connected to the ECB intervention. Therefore, it may be related to other concurrent events and hence deserves further analyses. The evolution of the Cumulative Abnormal Returns over time for the country based subsamples is provided in Appendix 2.8.1.

As a robustness check we tested other specifications of the event windows without obtaining statistically significant results. Furthermore, the direction and the significance of the impacts of the QE announcement are strongly dependent form the parameters of the event study, namely the size of the event window and of the estimation window (see Table 2.7 in the non-shaded cells). In fact, when restricting the event window to the day of the announcement (-0/+0), the empirical evidence offer the same picture although the sign is the other way round and the magnitude lower. The smaller coefficients, despite their significance, show how the market reflected the expected monetary action in the previous days leaving some adjustments for the day of the announcement. From the event study we are not able to infer a clear-cut indication on the impact of the last ECB QE announcement on the (re)insurers. The limited and somehow contradictory evidences suggest that the 2015 QE was not well received by the insurance market. However, the limited magnitude and the volatility of the sign of the impact claim for a wider approach that evaluates the general monetary policy strategy encompassing several interventions enforced by the Central Banks.

Monetary policy surprise

Monetary policy interventions cannot be considered on as standalone actions, they are at the same time the cause and consequence of complex and interrelated macroeconomic circumstances. The analysis of a standalone event (e.g. a QE announcement) excerpted from the larger set of monetary policy actions encompassed in the overall monetary policy strategy, may lead to partial and potentially misleading results. In order to overcome this, we propose an identification approach that takes direct inspiration from Rogers et al. (2014) and Pericoli and Veronese (2016). According to the authors, the monetary policy interventions are transmitted to the market through the variation in yields over the whole interest rate term structure. The effect of the Central Banks' announcements is signaled by a statistically significant higher monetary policy surprise during the event days compared to the non-event days. These evidences can be observed on each of the five periods (Table 2.8 Monetary Policy Surprise - Volatility of the first component of the interest rate term structure). Also market returns of (re)insurers and other listed institutions reflect the announcement events but with a statistically significant increase in the volatility limited to the first three periods.

INSERT TABLE 2.8 HERE

According to our results, monetary policy interventions have a statistically significant impact on the stock returns during the first 3 periods of analysis. In particular, interventions that generate an instantaneous reduction in interest rates tested via equation 2.5 seem to be negatively received by the markets (ref. periods 1 and 2) whereas a series of interventions generating an increase of the interest rates seems to have a positive effect (period 3). By a financial stability perspective periods 2 and 3 are the more interesting as they cover the two most recent crises: the sub-prime crisis (period 2) and the European sovereign debt crisis (period 3). During those periods both ECB and FED interventions point in the same direction with the impact of the ECB interventions being more effective over the 5 periods of observations. As a matter of fact, the coefficients associated to the monetary ECB and FED interventions when statistically significant are always positive (ref. Figure 2.2). Those positive coefficients transfer the movements of the interest rates triggered by the monetary policy interventions (positive/negative sign of the PCA on the risk free rate term structures for different maturities) to the movements in the stock returns of the targeted companies without any change in the direction.[7]

This is also in line with the comparison between the stock returns observed during the monetary policy days and during the "other days". As displayed in table 2.4 during the first two periods, when the monetary policy impacts are deemed to have negative impacts on the market, the stock returns observed during the monetary policy days are lower than the ones observed in the "other days" and period 3 shows the opposite behavior.

Also, it worth noting that even if a statistically significant impact can be also observed in the first period of observation, the values of the coefficient associated to the monetary policy surprise are smaller than during the crisis periods signaling a lower effectiveness of Central Banks' interventions during "tranquil" periods.

Figures 2.2 also shows that, the effect of expansionary monetary policy intervention on stock returns tend to fade away in the fourth and fifth periods. We find two potential explanations for this behavior. At first, the low level reached by the interest rates during those two periods (ref. 2.1). Indeed, starting from September 2012 and for 1 year the shortest maturities (1 and 2 years) fluctuated around the zero level and the mid term maturities (5 year) were below 1%. During the

[7]For a tabular representation of the interactions among monetary policy surprise (first principal component on the interest rates term structure), the sign of the coefficients associated to them via OLS regression (ref. 2.5) and the net impacts on the stock prices refer to Appendix 2.8.4.

5^{th} period the economy entered in the so-called low yield environment with all maturities below or close to zero. The second rationale lies in the definition of the stock prices: markets were at this stage somehow "addicted" to prolonged and, according to the statements of the Central Banks, expected to last for long, therefore stock prices might have already included all further conventional and unconventional expansionary monetary policy actions.

The dissection between (re)insurers and other companies shows a slightly lower impact of the monetary policy surprises in the insurance industry. This difference can be traced back to the insurance balance sheet structure. The effect of a reduction of the interest rates on the balance sheet of an insurers is in fact twofold: if on the one hand the increase of the price of the fixed-income assets have a positive effect to the capital position, on the other hand the reduction of the yields increase the present value of the technical provisions and make (re)insures potentially prone to mismatches in the future positive and negative cash flows.

INSERT FIGURE 2.2 HERE

The results are confirmed when we analyse geographical subsamples based on macro-areas but with some distinctions (ref. Figure 3.2). Beside the confirmation of the significance observed in the first three periods, the evidences show how during crisis periods the impact of ECB monetary policies on the EMU institutions is higher than the one on the other geographical subsamples. The relatively small difference in the coefficients can be explained by the cross-border nature of the business run by the institutions included in the analysis. Indeed we are investigating the impacts of monetary interventions on listed groups operating globally. Therefore, despite to some extent geographical criteria is respected (EMU and US subsamples for ECB and Fed interventions respectively), any action on specific currency only partially affects the returns and the capital positions of those institutions. Interestingly, the sign of the coefficients observed in the fifth period, even if non statistically significant, turn to negative confirming the negative impact both on the (re)insurers and on the other companies of the sample. In an ultra-low interest rates environment, even if the monetary interventions by ECB lead to an increase in the interest rates as observed in the announcement days, the movements are negatively reflected by the market. This finding is in line with the evidences obtained by the event study. The actions taken by FED and ECB tend to point in the same directions but with some specificity. According to our evidences, the impact of the FED monetary policy actions impacts is usually larger both to (re)insurers and non-insurers however appear to be limited to the US market (ref. Appendix 2.8.3).

Those considerations can be extended with some distinctions to both (re)insurers and other listed companies operating in different geographical areas as shown in Figure 2.3.

INSERT FIGURE 2.3 HERE

The local perspective at EU level confirms the general outcomes (Figure 2.4) where the statistically significant results are displayed in the first three periods and the larger impacts are concentrated in periods 2 and 3. ECB monetary policy actions have a heterogeneous effects across EU jurisdictions with larger impacts observed in Belgium, France, Netherlands and Spain followed by Italy. The traditionally large exposures to long term with-profit life contracts backed by fixed income assets of insurers based in those country could serve as an explanation to the high sensitivity to changes in the interest rates.

Coherently with the doubts about Greece's Euro-reversibility from the European Sovereign debt crisis onward and with the exclusion of Greece from the ECB QE programme, this jurisdiction seems to be only marginally affected by the monetary policy actions enforced by the ECB. Coefficients are indeed non statistically significant allover the periods of observation.

The comparison between industries shows how in the highly affected jurisdiction the impact of the monetary policy actions is larger in the insurance industry whereas in other countries such as Austria, Denmark and Norway the reactions is larger in the non-insurance industry. Again the asset and liability composition of the (re)insurers based in those jurisdictions could serve as rationale for this result.

INSERT FIGURE 2.4 HERE

The figures displayed so far stem form equation 2.5 calculated on a 3-day window - 2 days before and announcement day -. In order to test potential *behaviors* of the companies we run the regression moving the 3-day window around the announcement day. The different specifications show a moderate trend of the (re)insures to anticipate the announcements rather than reacting to them with some delay. Indeed, as shown in the appendix 2.8.5 the coefficients and the level of significance decrease when moving form the specification *-2 days, announcement day* to *announcement day, +2 days*

Summarizing, the expansionary monetary policy actions which lead to an immediate decrease of the interest rate have a negative effects on the stock returns of the companies included in our sample. On the contrary, when the interest rates increase we observe a positive reactions of the markets. Monetary policy actions produces a larger effect on the markets during crises periods. Additionally the effectiveness of the conventional and unconventional monetary policy actions seems to fade away after prolonged period of enforcement and in ultra-low yield environments. The asset and liability structure of (re)insurers seems to dampen the impact of the changes in the interest rates compared to the other sectors of the economy.

In the following section we try to understand what are the items in the balance sheet of a (re)insurer which determine the higher or lower response to the changes of the interest rates.

2.4.2 Analysis of the Determinants

Table 2.9 reports the results of the Logit regressions based on the indices built on the balance sheet assets.

INSERT TABLE 2.9 HERE

Empirical evidences show how the sensitivity of (re)insurers to the monetary policy surprises is driven by the asset side of the balance sheet. In line with our first hypothesis (*Hp.1*), the exposure of (re)insurers to fixed income assets acts as a main determinant of the sensitivity of (re)insurers to the sudden changes in the reference interest rate. The monetary policy announcements have indeed a direct impact on the prices of the fixed income assets and only an indirect effects on the other asset classes such as equity which indeed according to our evidences do not play a significant role. An expansionary monetary policy announcement that, as shown in the previous section leads to a reduction of the risk free rates across all the maturities, causes a contraction in the bond yields and a contextual increase in their market prices.

For a (re)insurer the effect of the reduction of the reference interest rates has also an impact on the liabilities with the values of the provisions moving in the opposite direction. This effect is expected to be more pronounced for those businesses entailing longer duration. Against it and according to our second hypothesis (*Hp.2*) we expected the exposure to the life business being a determinant of the sensitivity to the monetary policy surprises. The empirical evidences reject this hypothesis. Exposures to *Life business* and to *Non-insurance activities* traditionally based on maturity transformation are not associated to statistically significant coefficient.

Also we observe that against our expectations (*Hp.3*) the higher or lower engagement in *Non-insurance Activities* does not play a statistically significant role in determining the sensitivity of (re)insurers to the monetary policy surprises. Therefore our third hypothesis is rejected. Concluding, our empirical evidences show how *Size* acts as a main determinant.

2.5 Conclusions and way forward

In this paper we investigate the impact of conventional and unconventional monetary policies on the insurance industry by looking at the impact of the actions taken by the ECB on the market returns of (re)insurers. Additionally we analyse which are the characteristics of a (re)insurers that drive the sensitivities of the companies to changes in the interest rates.

We investigate the impact of the monetary policy via two approaches. At first we run an event study on the announcement date of the last ECB Quantitative Easing program. We scrutinize the cumulative abnormal return of a sample of 166 (re)insurers split into different subsamples according to size and geographical criteria comparing it with the behaviour of the other market participants. Subsequently, with the aim of understanding the impact of the general enforced monetary policy strategy and not of a single event, we enlarge the scope of our analysis by investigating the effects on the markets in general and on insurers in particular, of a series of announcements made by the ECB and the Fed. To do so we replicate the approach proposed by Rogers et al. (2014) and Pericoli and Veronese (2016) analysing how and to what extent the Central Banks announcements are signaled by the markets via changes in the term structure of the risk free rate.

The event study suggests a moderate negative effect of the QE on the insurance industry. The different specifications we tested show how the outcomes of the event study are strongly dependent to the observation periods. Furthermore, we do not obtain statistically significant results for the subsamples. By applying the monetary policy surprise based model, we document *i)* how the effect of monetary policy interventions on interest rates in the announcement days changes over time and *ii)* the subsequent impact of the expansionary monetary policy interventions on the market in general and on the insurance industry in particular.

Our empirical evidences suggest that when monetary policy actions generate an immediate reduction of the interest rates (periods 1 and 2) the effect on the stock returns is negative, whereas an increase in the interest rates (period 3) is positively received by the markets. The impact on the stock market is larger during crisis periods than in tranquil periods and the effectiveness of the monetary policy actions tend to fade away after a prolonged applications and in an ultra-low yield environment (periods 4 and 5). This applies both to the ECB and FED actions with one distinction: FED interventions affects larger geographical areas than the ECB ones with the latter having more concentrated but higher impacts. Monetary policy actions, when producing statistically significant results have more limited results on (re)insurers than to other companies, in particular for the ECB. The balance sheet structure of (re)insurers with assets and liabilities reacting in opposite directions to changes in the interest rates could serve as a rationale for those behaviours. Stock prices are defined by the discounted future profits therefore the potential negative impacts of the reduced interest rates on the long term obligations characterizing the life business overcome the short term benefits deriving from the mark to market valuation of the assets. This explanation is also in line with the results obtained at EU country level where jurisdictions traditionally exposed to long term obligations are higher affected than the others.

The two applied models return consistent results. Nevertheless this work shows how a single intervention extrapolated from the comprehensive strategy should be utilized with caution to estimate the effect of the monetary policy intervention on the market.

In the second part of the paper we investigate the characteristics of the (re)insurers based in Europe which drive the reaction to the ECB monetary policy actions. To do so we define a set of balance sheet based indicators aimed at capturing the asset allocation and the composition of the product portfolio of each entity. We then used those indices as regressors for the sensitivity of a (re)insurer to the monetary policy actions in a logit regression.

According to our evidences, only the size and the exposure to fixed income assets seems to drive the sensitivity of (re)insurers to the monetary policy interventions. Against our initial hypothesis none of the liability based indices provide statistically significant results.

Our balance sheet analysis is limited by the frequency and by the granularity of the information. This paper would benefit from the availability of complete and accurate quarterly balance sheet data and from a thorough knowledge of the interactions between the assets and liability sides of the insurers, i.e. duration mismatch. Additionally, we do not provide a clear-cut explanation to the documented scarce effectiveness of the ECB and FED interventions in the last two period of observation. We propose the prolonged enforcement of unidirectional monetary policy actions and the ultra-low yield environment as potential explanations, however at this stage we are not able to be more precise.

We believe that this work provides an initial valuable contribution to the literature on the analyses of the monetary policy enriching it with a specific focus on the insurance industry. Also, the evidence we provide can be of interest for policymakers offering them a wider perspective on the impacts that monetary policy actions have on a specific sector.

2.6 Figures

Figure 2.1: ECB risk free rate term structure 1, 2, 5, 7, 10-year maturity.
Yield curve spot rate - 1, 2, 5, 7, 10-year maturity - Government bond, nominal, all issuers whose rating is triple A - Euro area (changing composition). Vertical lines identify the periods. Source: ECB.

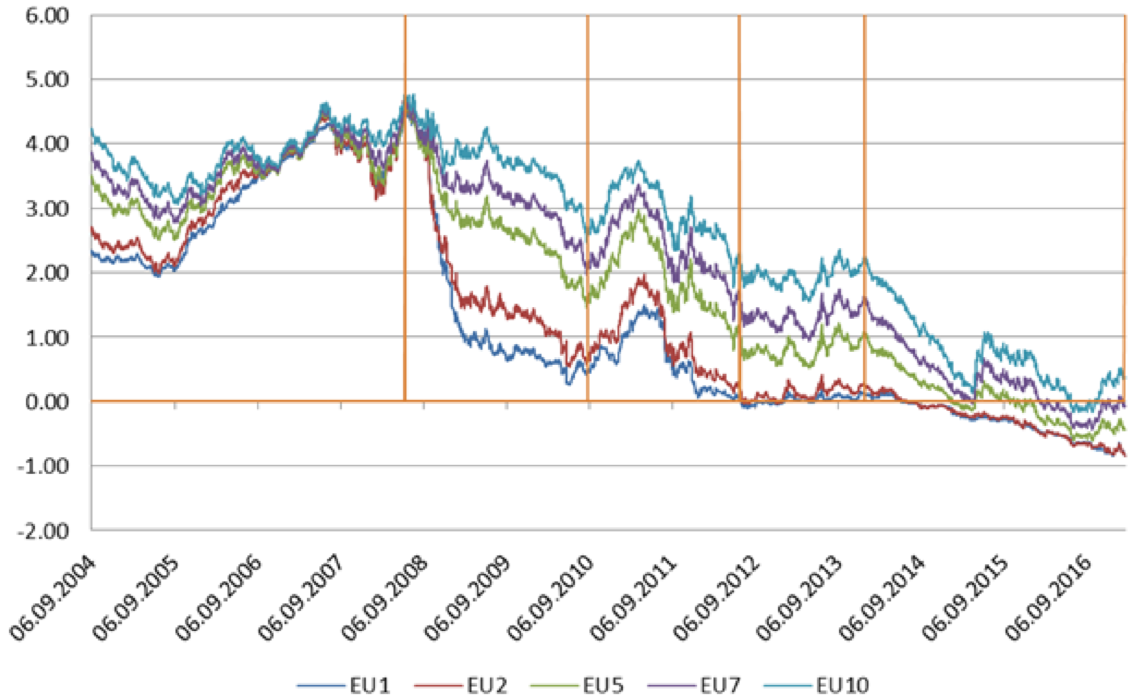
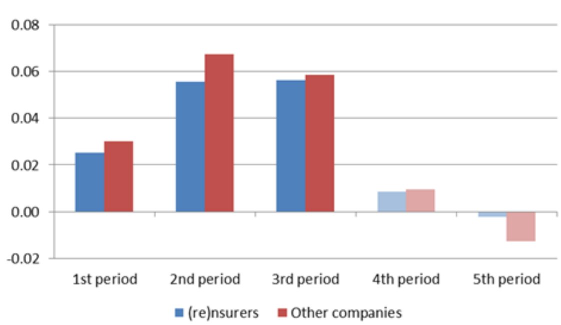


Figure 2.2: ECB and FED coefficient over time Full sample.
This figure graphically represents the coefficient of the monetary policy surprise explanatory variables as described in equation (2.5) and reported in Appendix A). Transparent bars represent non-significant coefficients (T-statistics > 10% level).

(a) ECB



(b) FED

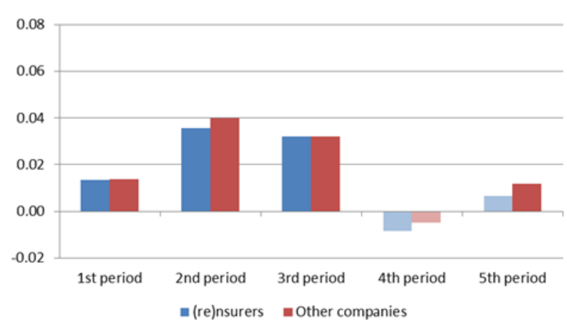
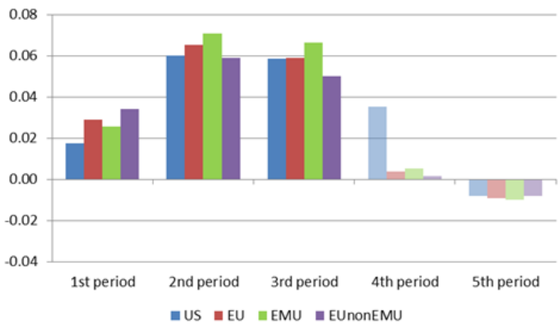


Figure 2.3: ECB coefficient over time Subsamples
This figure graphically represents the coefficient of the monetary policy surprise explanatory variables as described in equation (2.5) and reported in Appendix A). Transparent bars represent non-significant coefficients (T-statistics > 10% level).

(a) (re)insurers



(b) other listed companies

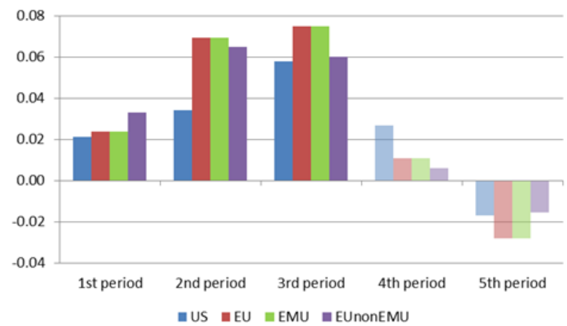
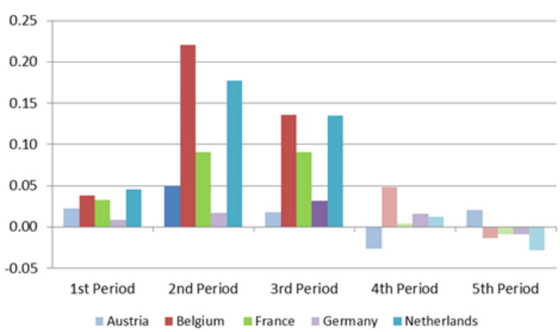
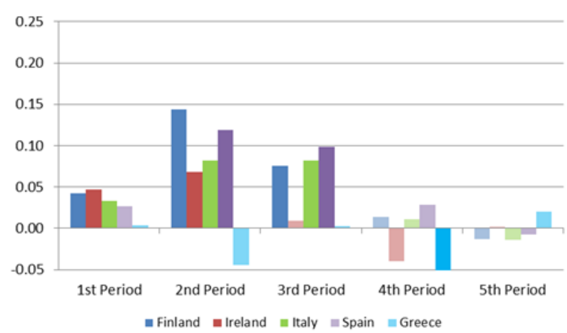


Figure 2.4: ECB intervention monetary policy surprise: country based impact on (re)insurers
This figure graphically represents the coefficient of the monetary policy surprise explanatory variables as described in equation (2.5) and reported in Appendix A). Transparent bars represent non-significant coefficients (T-statistics > 10% level).

(a) core Euro area



(b) peripheral Euro area



2.7 Tables

Table 2.1: Balance Sheet Variables:
the table provides details on the list of variables used as regressors in the Logit. Balance sheet items are named according to SNL Financial definition.

Variable	Definition
Size	$ln(Tangible\ Assets)$
Fixed Income Assets	$\frac{Total\ Debt\ Instruments}{Tangible\ Assets - Separate\ Account\ Assets}$
Equity Assets	$\frac{Total\ Equity\ Instruments}{Tangible\ Assets - Separate\ Account\ Assets}$
Cash and Equivalent	$\frac{Cash\ \&\ Cash\ Equivalents}{Tangible\ Assets - Separate\ Account\ Assets}$
Non-Insurance Activities	$1 - \frac{(Reserves\ for\ Insurance\ Contracts - Unit\ Linked\ Insurance)}{Total\ Liabilities - Separate\ Account\ Liabilities}$
$LifeBusiness^{EU}$	$\frac{Lifeandhealthinsurancereserves}{TotalPolicyReserves}$
$LifeBusiness^{US}$	$\frac{Lifeandhealthinsurancereserves}{TotalPolicyReserves}$
Unit-Linked Business	$\frac{Separate\ Account\ Liabilities}{Total\ Liabilities}$

Table 2.2: Balance Sheet aggregation:
the table provides the approach used to aggregate the balance sheets in oder to match the five periods used in the monetary policy impact analysis.

Period	Reference window	Balance sheet
1	6.9.04 to 15.6.08	2003 to 2007
2	16.6.08 to 31.8.10	2008 and 2009
3	1.9.10 to 30.6.12	2010 and 2011
4	1.7.12 to 31.12.13	2011 and 2012
5	1.1.14 to 20.2.17	2013 to 2016

Table 2.3: Descriptive Statistics (Event Study).
This table reports the summary statistics for the Total Return Index (TR) of the (re)insurers included in the different sample for the period from 26.08.2013 to 20.01.2015. Subsamples are created according to geography and size. Data are downloaded from Thomson Reuters Datastream® on 08 June 2015.

Sample	**Obs (#)**	**Mean (%)**	**Std. Dev. (%)**	**Min (%)**	**Max (%)**
All companies	166	-0.90	6.80	-71.20	19.30
US companies	96	-1.50	8.10	-71.20	19.30
EU companies	55	0.10	3.50	-8.70	12.70
EMU companies	29	-0.10	3.60	-8.70	9.80
EU non EMU companies	26	0.40	3.40	-3.80	12.70
Big companies	41	-1.00	3.40	-15.10	3.00
Small companies	125	-0.80	7.60	-71.20	1.73

Table 2.4: Descriptive Statistics (Market returns).
The table reports the summary statistics of the total return of the stocks of the insurance companies included in the sample. Statistics are reported for the ECB announcement days, the FED announcement days and the other days of the observation window.

Period 1 - 6.9.04 - 15.6.08

	ECB Announcement days					**Fed announcement days**					**Other days**				
Δy(%)	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
ALL	155	0.033	0.351	-1.364	1.842	155	0.238	0.457	-0.980	1.978	155	0.056	0.108	-0.284	0.942
EU	51	-0.089	0.306	-1.364	0.565	51	-0.001	0.341	-0.980	1.449	51	0.072	0.065	-0.027	0.296
EMU	29	-0.003	0.220	-0.433	0.565	29	0.034	0.352	-0.647	1.449	29	0.085	0.076	0.000	0.296
EU non EMU	22	-0.202	0.367	-1.364	0.374	22	-0.048	0.328	-0.980	0.539	22	0.055	0.041	-0.027	0.155
US	90	0.082	0.314	-0.771	0.935	90	0.376	0.473	-0.967	1.978	90	0.041	0.124	-0.284	0.942

Period 2 - 16.6.08 - 31.8.10

	ECB Announcement days					**Fed announcement days**					**Other days**				
Δy(%)	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
ALL	156	-0.621	0.772	-2.816	1.890	156	0.207	0.790	-2.536	3.349	156	0.079	0.228	-0.173	2.451
EU	49	-0.387	0.449	-1.209	1.144	49	0.065	0.509	-0.880	1.249	49	0.015	0.080	-0.173	0.162
EMU	27	-0.460	0.506	-1.209	1.144	27	-0.066	0.445	-0.817	0.818	27	-0.009	0.067	-0.162	0.094
EU non EMU	22	-0.297	0.360	-0.902	0.302	22	0.227	0.545	-0.880	1.249	22	0.045	0.087	-0.173	0.162
US	93	-0.754	0.878	-2.816	1.890	93	0.286	0.927	-2.536	3.349	93	0.116	0.283	-0.100	2.451

Period 3 - 1.9.10 - 30.6.12

	ECB Announcement days					**Fed announcement days**					**Other days**				
Δy(%)	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
ALL	160	0.225	0.464	-1.687	1.838	160	0.369	0.874	-2.787	8.275	160	0.054	0.115	-0.687	0.694
EU	52	0.311	0.489	-1.687	1.118	52	0.101	0.562	-2.787	0.852	52	-0.005	0.130	-0.687	0.148
EMU	30	0.273	0.552	-1.687	1.118	30	0.057	0.675	-2.787	0.852	30	-0.040	0.155	-0.687	0.100
EU non EMU	22	0.363	0.396	-0.515	1.032	22	0.160	0.365	-0.648	0.784	22	0.044	0.060	-0.099	0.148
US	93	0.126	0.430	-1.436	1.838	93	0.561	0.999	-1.274	8.275	93	0.090	0.100	-0.236	0.694

Period 4 - 1.7.12 - 31.12.13

	ECB Announcement days					**Fed announcement days**					**Other days**				
Δy(%)	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
ALL	169	0.168	0.587	-3.993	2.445	170	0.114	0.873	-6.358	4.912	170	0.158	0.281	-0.476	3.163
EU	56	0.110	0.510	-2.415	1.594	56	0.125	0.752	-1.175	4.912	56	0.118	0.113	-0.261	0.352
EMU	31	0.113	0.630	-2.415	1.594	31	0.167	0.959	-1.175	4.912	31	0.130	0.107	-0.148	0.352
EU non EMU	25	0.105	0.314	-0.724	0.617	25	0.073	0.373	-0.805	0.805	25	0.104	0.120	-0.261	0.224
US	98	0.216	0.658	-3.993	2.445	99	0.118	0.985	-6.358	4.382	99	0.187	0.356	-0.476	3.163

Period 5 - 1.1.14 - 20.2.17

	ECB Announcement days					**Fed announcement days**					**Other days**				
Δy(%)	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
ALL	184	0.173	0.577	-2.292	4.310	184	0.312	0.714	-1.621	6.646	184	0.507	5.703	-0.166	77.283
EU	61	0.271	0.403	-0.714	1.475	61	0.175	0.446	-1.621	1.884	61	0.050	0.063	-0.059	0.318
EMU	33	0.356	0.425	-0.524	1.475	33	0.075	0.463	-1.621	1.135	33	0.042	0.066	-0.059	0.318
EU non EMU	28	0.171	0.356	-0.714	1.023	28	0.293	0.403	-0.474	1.884	28	0.060	0.059	-0.054	0.269
US	106	0.121	0.681	-2.292	4.310	106	0.386	0.867	-0.444	6.646	106	0.844	7.511	-0.095	77.283

Table 2.5: Descriptive Statistics (Monetary Policy Surprise).
The table reports the summary statistics of: *i)* the control variables CEIS EUR, CEIS US and VIX; *ii)* the first principal component of the change in 1-year, 3-year, 5-year, 7-year and 10-year zero-coupon interest rate for the US and the EU. Statistics are reported for the ECB announcement days, the Fed announcement days and the other days of the observation window.

Period 1 - 6.9.04 - 15.6.08

	ECB Announcement days					Fed announcement days					Other days				
Variable	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
$\Delta RFR^{ECB}_{t=t_{aECB}}$	49	-0.134	9.003	-16.573	32.186	42	-0.776	6.989	-20.416	19.449	562	0.194	6.788	-18.351	25.996
$\Delta RFR^{FED}_{t=t_{aFED}}$	49	1.771	12.889	-35.041	35.109	42	-2.441	14.175	-51.698	28.151	562	0.143	12.181	-42.248	46.458
CESIUSDIndex	49	-1.339	43.912	-98.500	72.900	42	-0.498	42.068	-102.500	76.900	562	-4.455	39.125	-107.600	66.400
CESIEURIndex	49	23.308	61.417	-105.200	146.500	42	24.524	55.484	-100.400	147.300	562	25.729	59.310	-114.300	162.500
VIXIndex	49	16.086	5.189	10.440	27.660	42	16.252	6.024	10.230	30.830	562	14.886	4.276	9.890	29.080

Period 2 - 16.6.08 - 31.8.10

	ECB Announcement days					Fed announcement days					Other days				
Variable	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
$\Delta RFR^{ECB}_{t=t_{aECB}}$	27	-0.517	11.443	-21.619	24.329	32	-3.186	8.932	-24.745	11.753	302	0.463	8.953	-39.673	30.702
$\Delta RFR^{FED}_{t=t_{aFED}}$	27	-0.134	20.289	-35.919	50.249	32	-5.556	28.876	-86.940	50.249	302	-0.204	16.100	-43.225	89.631
CESIUSDIndex	27	-0.033	45.946	-120.300	73.600	32	-9.316	52.044	-136.100	59.800	302	5.370	48.074	-140.600	72.500
CESIEURIndex	27	-14.581	91.203	-188.600	121.200	32	-37.559	86.161	-186.500	110.300	302	-10.443	86.349	-185.300	131.000
VIXIndex	27	32.315	13.808	16.480	63.680	32	34.510	15.137	17.690	69.960	302	30.606	12.641	15.590	80.860

Period 3 - 1.9.10 - 30.6.12

	ECB Announcement days					Fed announcement days					Other days				
Variable	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
$\Delta RFR^{ECB}_{t=t_{aECB}}$	24	0.055	11.918	-19.863	34.756	22	-0.015	8.222	-18.761	14.484	267	0.835	8.956	-33.874	35.864
$\Delta RFR^{FED}_{t=t_{aFED}}$	24	0.866	13.071	-35.070	22.639	22	-0.359	12.512	-23.012	38.000	267	0.369	11.085	-30.759	42.212
CESIUSDIndex	24	8.196	54.739	-98.200	86.100	22	-1.523	58.295	-98.500	77.300	267	2.449	51.334	-117.200	91.900
CESIEURIndex	24	7.658	50.335	-91.700	114.900	22	2.927	49.961	-104.200	83.300	267	2.227	48.326	-103.300	104.000
VIXIndex	24	21.638	6.163	15.950	36.270	22	22.810	7.123	14.800	37.320	267	21.881	6.441	14.260	45.450

Period 4 - 1.7.12 - 31.12.13

	ECB Announcement days					Fed announcement days					Other days				
Variable	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
$\Delta RFR^{ECB}_{t=t_{aECB}}$	20	-0.137	9.071	-13.963	18.630	17	-0.881	6.631	-16.564	9.683	213	0.231	6.001	-15.131	27.528
$\Delta RFR^{FED}_{t=t_{aFED}}$	20	1.727	8.839	-10.742	21.538	17	0.334	15.014	-31.617	36.271	213	-0.369	6.399	-16.664	21.173
CESIUSDIndex	20	5.915	34.360	-60.200	59.600	17	5.106	32.667	-62.300	48.500	213	14.898	28.639	-64.900	60.700
CESIEURIndex	20	-7.455	46.096	-79.000	71.900	17	0.800	46.350	-77.900	69.100	213	-4.162	40.456	-83.000	69.200
VIXIndex	20	15.303	1.761	12.940	18.490	17	15.208	1.917	12.670	18.960	213	14.811	2.014	11.300	22.720

Period 5 - 1.1.14 - 20.2.17

	ECB Announcement days					Fed announcement days					Other days				
Variable	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
$\Delta RFR^{ECB}_{t=t_{aECB}}$	33	1.161	8.703	-20.767	26.883	29	-0.246	4.670	-9.935	14.603	511	-0.005	4.578	-22.545	20.976
$\Delta RFR^{FED}_{t=t_{aFED}}$	33	2.728	6.768	-8.899	16.123	29	-2.894	14.906	-35.043	26.710	511	-0.164	9.168	-41.082	35.474
CESIUSDIndex	33	-8.336	30.214	-55.000	63.900	29	-10.083	29.814	-71.900	50.700	511	-8.408	28.973	-73.300	72.700
CESIEURIndex	33	2.018	31.979	-55.000	66.100	29	-1.286	28.871	-50.600	57.600	511	5.014	31.385	-71.100	75.600
VIXIndex	33	14.713	3.447	10.320	26.690	29	15.019	3.224	10.610	23.110	511	15.641	4.152	10.580	40.740

Table 2.6: Balance Sheet Indices.
This table reports the summary statistics for the items utilized in the analysis of determinants. The indices are build on the balance sheet items reported by the (re)insurers from 2003 to 2016. Source: SNL Financials.

Indicator	**Obs.**	**Mean**	**Std. Dev.**	**Min**	**Max**
Total Assets (Ln)	520	2.784	0.178	2.217	3.033
Fixed Income Assets	486	0.620	0.281	0.000	1.000
Equity Assets	490	0.114	0.129	0.000	0.806
Cash & Equivalent	510	0.189	0.119	0.003	0.338
Non-Insurance Activities	472	0.375	0.223	0.082	0.998
Life Business	450	0.712	0.876	0.000	5.849
Unit Linked Business	466	0.384	0.412	0.000	0.376
Dividend Payout	492	-0.379	1.913	-11.621	18.868

Table 2.7: Event Study.
The table reports for the different combinations of event and estimation windows length the mean of the cumulative abnormal returns of the (re)insurers under the different samples. Significance of the parameter expressed via T-statistics *=10% level, **=5%level, ***2.5%level.

Parameters		**Cumulative Abnormal Return**									
		Total		**mean(small-big)**		**EU**		**EMU**		**US**	
event window (days)	estimation window (days)	value (%)	sig.	value (%)	sig.	value (%)	sig.	value (%)	sig.	value (%)	sig.
-2/+2	100	**-1.376**	*	-0.588	-	0.124	-	0.028	-	**-2.456**	*
-2/+2	250	**-0.854**	*	0.220	-	0.140	-	-0.075	-	**-1.530**	**
-2/+2	350	**-0.836**	**	0.386	-	-0.011	-	-0.223	-	**-1.397**	***
-1/+1	100	-0.017	-	0.752	-	-0.031	-	**-0.603**	*	-0.053	-
-1/+1	250	0.338	-	1.291	-	-0.016	-	**-0.683**	*	0.536	-
-1/+1	350	0.337	-	1.394	-	-0.140	-	**-0.770**	*	0.622	-
0/0	100	**0.460**	*	-0.299	-	0.245	-	0.420	-	0.494	-
0/0	250	**0.573**	*	-0.040	-	0.272	-	0.324	-	**0.656**	*
0/0	350	**0.551**	***	-0.017	-	0.213	-	0.290	-	**0.656**	*
0/+1	100	0.148	-	0.791	-	-0.014	-	-0.521	-	0.098	-
0/+1	250	0.382	-	1.151	-	-0.020	-	-0.639	-	0.495	-
0/+1	350	0.376	-	**1.208**	*	-0.110	-	-0.701	-	0.544	-
0/+2	100	-0.133	-	0.404	-	0.048	-	-0.240	-	-0.487	-
0/+2	250	0.199	-	0.930	-	0.011	-	-0.404	-	0.117	-
0/+2	350	0.197	-	**1.012**	*	-0.091	-	-0.495	-	0.179	-
0/+3	100	-0.025	-	0.146	-	-0.001	-	-0.278	-	-0.336	-
0/+3	250	0.457	-	0.797	-	-0.001	-	-0.380	-	0.515	-
0/+3	350	**0.496**	*	0.911	-	-0.120	-	-0.487	-	**0.665**	*

Table 2.8: Monetary Policy Surprise - Volatility of the first component of the interest rate term structure.

The table reports the volatility of *i)* the first PCA factor using the 1-year, 3-year, 5-year, 7-year and 10-year bond yield dissected for the Euro area and the US and for the different periods of observations; *ii)* the market returns of the (re)insurers included in the sample and *iii)* the market returns of the indices of the financial services deducted by the (re)insurers. Additionally the *P-value* for the one sided *F-test* of difference in variances is reported, namely $H_0 : \sigma_{event} > \sigma_{no-event}$.

Monetary Policy Surprise

	ECB			Fed		
Period	σ_{event}	$\sigma_{no-event}$	***p-val***	**sev**	**snev**	***p-val***
1	27.854	23.081	0.000	26.188	23.082	0.000
2	40.807	32.247	0.000	46.669	29.809	0.000
3	30.816	25.348	0.000	17.845	14.916	0.000
4	20.308	15.223	0.000	23.016	14.807	0.000
5	22.430	18.007	0.000	21.077	14.350	0.000

(re)insurers' returns

	ECB			Fed		
Period	σ_{event}	$\sigma_{no-event}$	***p-val***	**sev**	**snev**	***p-val***
1	0.239	0.118	0.000	0.234	1.988	0.118
2	0.376	0.181	0.084	0.406	3.511	0.181
3	0.376	0.174	0.000	0.373	2.131	0.174
4	0.285	0.440	0.685	0.464	1.487	0.440
5	0.281	0.862	0.685	0.467	1.487	0.862

Other returns

	ECB			Fed		
Period	σ_{event}	$\sigma_{no-event}$	***p-val***	**sev**	**snev**	***p-val***
1	0.481	0.337	0.000	0.251	0.347	0.125
2	0.859	0.771	0.094	0.958	0.764	0.174
3	0.584	0.455	0.001	0.344	0.467	0.162
4	0.383	0.300	0.633	0.618	0.390	0.370
5	0.420	0.623	0.546	0.618	0.390	0.562

Table 2.9: Logit regression (balance sheet indices).
The table reports the logit regresison for both asset and liability specifications according to equation 2.7. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	Asset side			Liability Side				
Variables	(1)	(2)	(3)	(1)	(2)	(3)	(4)	(5)
Total Assets (Ln)	4.381***	4.091***	4.014***					
	(1.014)	(1.177)	(1.192)					
Fixed Income Assets		1.206*	1.184*					
		(0.696)	(0.703)					
Equity Assets		1.805	1.911					
		(1.272)	(1.281)					
Cash and Equivalent			-0.0327					
			(0.0827)					
Life Business				0.155			0.122	0.261
				(0.151)			(0.184)	(0.255)
Non-Insurance Activities					0.567		0.233	0.322
					(0.601)		(0.760)	(0.759)
Unit Linked Business						0.00103		-0.00406
						(0.00325)		(0.00463)
Constant	-13.15***	-13.36***	-13.13***	-0.806***	-0.979***	-0.772***	-0.871***	-0.993***
	(2.876)	(3.481)	(3.519)	(0.178)	(0.269)	(0.143)	(0.278)	(0.297)
Observations	260	241	241	225	236	233	225	224

2.8 Appendix

2.8.1 Event Study

Figure 2.5: The impact of the announcement of Quantitative Easing on the insurance sector. The averaged cumulative abnormal return is plotted against time. The red vertical on 22.01.2015 indicates the event: The announcement of Quantitative Easing by the ECB. It was averaged for firms based in the US and in the European Monetary Union (EMU). The red vertical on 22.01.2015 indicates the event: The announcement of Quantitative Easing by the ECB.

(a) Full sample

(b) Subsamples

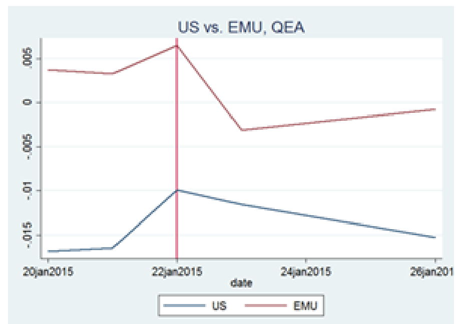
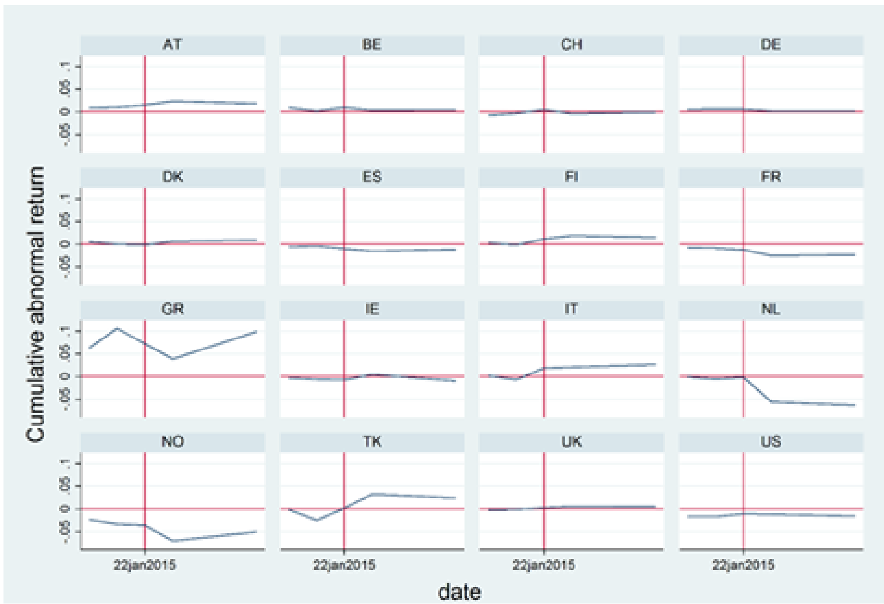


Figure 2.6: The impact of the announcement of Quantitative Easing on the insurance sector - Country analysis

The cumulative abnormal return is plotted against time. CAR of (re)insurers isaveraged for each country. Greece, as excluded from the QE program is reported as a check. The red vertical on 22.01.2015 indicates the event: The announcement of Quantitative Easing by the ECB.



2.8.2 Monetary policy days

Table 2.10: ECB Monetary Policy Days (August 2008 - February 2017).
The table reports a detailed list of the regular and extraordinary press releases from the ECB having potential monetary policy implications.

ECB Monetary Policy Days (Detailed - from 08.2008 onwards)			
Date	**Event**	**Date**	**Event**
2-Aug-07	GC meeting	12-Jan-12	GC meeting
09-Aug-07	Special fine tuning operations	9-Feb-12	GC meeting, ECB approved criteria for credit claims for 7 NCBs
22-Aug-07	Supplementary LTRO (announcement)	28-Feb-12	Results of second 3-year LTRO
23-Aug-07	Supplementary LTRO (allotment)	8-Mar-12	GC meeting
6-Sep-07	GC meeting	4-Apr-12	GC meeting
4-Oct-07	GC meeting	3-May-12	GC meeting
8-Nov-07	GC meeting	6-Jun-12	GC meeting
6-Dec-07	GC meeting	5-Jul-12	GC meeting, MRO rate decreased to 0.75%, deposit facility rate to 0
10-Jan-08	GC meeting	26-Jul-12	"Whatever it takes" London speech
7-Feb-08	GC meeting	2-Aug-12	GC meeting, OMT
6-Mar-08	GC meeting	6-Sep-12	GC meeting, OMT details
28-Mar-08	introduce 6-m LTROs	4-Oct-12	GC meeting
10-Apr-08	GC meeting	8-Nov-12	GC meeting
8-May-08	GC meeting	6-Dec-12	GC meeting
5-Jun-08	GC meeting	10-Jan-13	GC meeting
3-Jul-08	GC meeting, MRO increased to 4.25%	7-Feb-13	GC meeting
7-Aug-08	GC meeting	7-Mar-13	GC meeting
4-Sep-08	GC meeting	22-Mar-13	Collateral rule changes for some uncovered gov-guaranteed bank bonds
8-Oct-08	GC meeting, MRO decreased to 3.75%, , Fixed-rate full allotment (FRFA) on MRO	4-Apr-13	GC meeting
6-Nov-08	GC meeting, MRO decreased to 3.25%	2-May-13	GC meeting, MRO rate decreased to 0.5%, FRFA extended to July 2014
4-Dec-08	GC meeting, MRO decreased to 2.50%	6-Jun-13	GC meeting
15-Jan-09	GC meeting, MRO decreased to 2.00%	4-Jul-13	GC meeting, forward guidance: 'expects the key ECB interest rates to remain at present or lower levels for an extended period of time'
5-Feb-09	GC meeting	1-Aug-13	GC meeting
5-Mar-09	GC meeting, MRO decreased to 1.50%	5-Sep-13	GC meeting
2-Apr-09	GC meeting, MRO decreased to 1.25%	2-Oct-13	GC meeting
7-May-09	GC meeting, MRO decreased to 1.00%, 3year LTROs, CBPP	7-Nov-13	GC meeting, MRO rate decreased to 0.25%
4-Jun-09	GC meeting, CBPP details announced	5-Dec-13	GC meeting
2-Jul-09	GC meeting	9-Jan-14	GC meeting
6-Aug-09	GC meeting	6-Feb-14	GC meeting
3-Sep-09	GC meeting	6-Mar-14	GC meeting
8-Oct-09	GC meeting	25-Mar-14	QE announcement Draghi (Science Po - Paris): A consistent strategy for a sustained recovery
5-Nov-09	GC meeting	3-Apr-14	GC meeting
3-Dec-09	GC meeting, Phasing out of 6m LTROs, indexation of 1y LTROs	24-Apr-14	QE announcement Draghi (NDL Conf - Amsterdam): Monetary policy communication in turbulent times
14-Jan-10	GC meeting	8-May-14	GC meeting
4-Feb-10	GC meeting	5-Jun-14	GC meeting, MRO rate decreased to 0.15%, announcement of TLTROs
4-Mar-10	GC meeting, Phasing out of 3m LTROs, indexation of 6m LTROs	3-Jul-14	GC meeting, details of TLTROs
8-Apr-10	GC meeting	7-Aug-14	GC meeting
6-May-10	GC meeting	4-Sep-14	GC meeting, MRO rate decreased to 0.05%, announcement of CCBP3 & ABSPP
9-May-10	GC meeting, Securities Market Programme (SMP)	2-Oct-14	GC meeting, details of ABSPP CBPP3
10-Jun-10	GC meeting	6-Nov-14	GC meeting
8-Jul-10	GC meeting	4-Dec-14	GC meeting, introduction of the QE-PSPP - Draghi: 'More stimulus is likely on the way, but the final decision wont be taken until early next year'
28-Jul-10	Collateral rules tightened, revised haircuts	22-Jan-15	GC meeting, announcement of PSPP
5-Aug-10	GC meeting	9-Mar-15	start of the PSPP purchases
2-Sep-10	GC meeting	5-Mar-15	GC meeting
7-Oct-10	GC meeting	15-Apr-15	GC meeting
4-Nov-10	GC meeting	3-Jun-15	GC meeting
2-Dec-10	GC meeting	16-Jul-15	GC meeting
13-Jan-11	GC meeting	3-Sep-15	GC meeting, possible extension of QE program (Draghi)
3-Feb-11	GC meeting	22-Oct-15	GC meeting
3-Mar-11	GC meeting, FRFA extended to July 2011	03-Nov-15	Draghi: willing and able to act by using all instruments within its mandate
7-Apr-11	GC meeting, MRO increased to 1.25%	03-Dec-15	GC meeting
5-May-11	GC meeting	21-Jan-16	GC meeting
9-Jun-11	GC meeting	10-Mar-16	GC meeting
7-Jul-11	GC meeting, MRO increased to 1.50%	21-Apr-16	GC meeting
4-Aug-11	GC meeting, SMP covers Spain and Italy	2-Jun-16	GC meeting
7-Aug-11	SMP on Italy and Spain acknowledged by ECB	21-Jul-16	GC meeting
8-Sep-11	GC meeting	8-Sep-16	GC meeting
6-Oct-11	GC meeting, CBPP2 launched	20-Oct-16	GC meeting
3-Nov-11	GC meeting, MRO decreased to 1.25%	8-Dec-16	GC meeting
8-Dec-11	GC meeting, Two 3-year LTROs, reserve ratio to 1%, MRO rate decreased to 1%	19-Jan-17	GC meeting
21-Dec-11	Results of first 3-year LTRO		

Table 2.11: ECB Monetary Policy Days (January 1999 - July 2008).
The table reports a list of the press releases following the ECB GC meetings.

ECB Monetary Policy Days (Synntetic - from 01.1999 to 07.2007)			
Date	**Event**	**Date**	**Event**
14-Jan-99	GC meeting	08-May-03	GC meeting
04-Feb-99	GC meeting	05-Jun-03	GC meeting
04-Mar-99	GC meeting	10-Jul-03	GC meeting
08-Apr-99	GC meeting	31-Jul-03	GC meeting
06-May-99	GC meeting	04-Sep-03	GC meeting
02-Jun-99	GC meeting	02-Oct-03	GC meeting
01-Jul-99	GC meeting	06-Nov-03	GC meeting
29-Jul-99	GC meeting	04-Dec-03	GC meeting
09-Sep-99	GC meeting	08-Jan-04	GC meeting
07-Oct-99	GC meeting	05-Feb-04	GC meeting
04-Nov-99	GC meeting	04-Mar-04	GC meeting
02-Dec-99	GC meeting	01-Apr-04	GC meeting
05-Jan-00	GC meeting	06-May-04	GC meeting
03-Feb-00	GC meeting	03-Jun-04	GC meeting
02-Mar-00	GC meeting	01-Jul-04	GC meeting
30-Mar-00	GC meeting	05-Aug-04	GC meeting
05-May-00	GC meeting	02-Sep-04	GC meeting
08-Jun-00	GC meeting	07-Oct-04	GC meeting
06-Jul-00	GC meeting	04-Nov-04	GC meeting
03-Aug-00	GC meeting	02-Dec-04	GC meeting
31-Aug-00	GC meeting	13-Jan-05	GC meeting
05-Oct-00	GC meeting	03-Feb-05	GC meeting
02-Nov-00	GC meeting	03-Mar-05	GC meeting
30-Nov-00	GC meeting	07-Apr-05	GC meeting
04-Jan-01	GC meeting	05-May-05	GC meeting
01-Feb-01	GC meeting	02-Jun-05	GC meeting
01-Mar-01	GC meeting	07-Jul-05	GC meeting
11-Apr-01	GC meeting	04-Aug-05	GC meeting
10-May-01	GC meeting	01-Sep-05	GC meeting
07-Jun-01	GC meeting	06-Oct-05	GC meeting
05-Jul-01	GC meeting	03-Nov-05	GC meeting
02-Aug-01	GC meeting	01-Dec-05	GC meeting
30-Aug-01	GC meeting	12-Jan-06	GC meeting
11-Oct-01	GC meeting	02-Feb-06	GC meeting
08-Nov-01	GC meeting	02-Mar-06	GC meeting
06-Dec-01	GC meeting	06-Apr-06	GC meeting
03-Jan-02	GC meeting	04-May-06	GC meeting
07-Feb-02	GC meeting	08-Jun-06	GC meeting
07-Mar-02	GC meeting	06-Jul-06	GC meeting
04-Apr-02	GC meeting	03-Aug-06	GC meeting
02-May-02	GC meeting	31-Aug-06	GC meeting
06-Jun-02	GC meeting	05-Oct-06	GC meeting
04-Jul-02	GC meeting	02-Nov-06	GC meeting
01-Aug-02	GC meeting	07-Dec-06	GC meeting
12-Sep-02	GC meeting	11-Jan-07	GC meeting
10-Oct-02	GC meeting	08-Feb-07	GC meeting
07-Nov-02	GC meeting	08-Mar-07	GC meeting
05-Dec-02	GC meeting	12-Apr-07	GC meeting
09-Jan-03	GC meeting	10-May-07	GC meeting
06-Feb-03	GC meeting	06-Jun-07	GC meeting
06-Mar-03	GC meeting	05-Jul-07	GC meeting
03-Apr-03	GC meeting		

Table 2.12: FED Monetary Policy Days (August 2008 - February 2017). The table reports a detailed list of the regular and extraordinary press releases from the FED having potential monetary policy implications.

Fed Monetary Policy Days (Detailed - from 10.2008 onwards)			
Date	**Event**	**Date**	**Event**
8-Oct-08	Joint Statement by Central Banks, FOMC decrease fed funds rate by 0.5% pp to 1.50%	24-Oct-12	FOMC meeting
29-Oct-08	FOMC meeting	12-Dec-12	FOMC meeting
25-Nov-08	Fed announces results of auction of $150 billion in 13-day credit	30-Jan-13	FOMC meeting
1-Dec-08	Federal Reserve announces results of auction of $150 billion in 84-day credit	20-Mar-13	FOMC meeting - Bernanke warns of 'premature tightening' in monetary policy (taper tantrum)
16-Dec-08	FOMC meeting	1-May-13	FOMC meeting
28-Jan-09	FOMC meeting	22-May-13	Bernanke warns of 'premature tightening' in monetary policy (taper tantrum)
18-Mar-09	FOMC meeting	19-Jun-13	FOMC meeting - Bernanke warns of taper tantrum again
29-Apr-09	FOMC meeting	31-Jul-13	FOMC meeting
24-Jun-09	FOMC meeting	18-Sep-13	FOMC meeting
12-Aug-09	FOMC meeting	16-Oct-13	unscheduled FOMC meeting
23-Sep-09	FOMC meeting	30-Oct-13	FOMC meeting
4-Nov-09	FOMC meeting	18-Dec-13	FOMC meeting
16-Dec-09	FOMC meeting	29-Jan-14	FOMC meeting
27-Jan-10	FOMC meeting	4-Mar-14	unscheduled FOMC meeting
16-Mar-10	FOMC meeting	19-Mar-14	FOMC meeting
28-Apr-10	FOMC meeting	30-Apr-14	FOMC meeting
9-May-10	unscheduled FOMC meeting	18-Jun-14	FOMC meeting
23-Jun-10	FOMC meeting	15-Jul-14	Semiannual Monetary Policy Report to the Congress
10-Aug-10	FOMC meeting	30-Jul-14	FOMC meeting
27-Aug-10	Ben Bernanke Jackson Hole speech	22-Aug-14	Janet Yellen Jackson Hole speech
21-Sep-10	FOMC meeting	17-Sep-14	FOMC meeting
15-Oct-10	unscheduled FOMC meeting	29-Oct-14	FOMC meeting
3-Nov-10	FOMC meeting	17-Dec-14	FOMC meeting
14-Dec-10	FOMC meeting	28-Jan-15	FOMC meeting
26-Jan-11	FOMC meeting	24-Feb-15	Semiannual Monetary Policy Report to the Congress
15-Mar-11	FOMC meeting	18-Mar-15	FOMC meeting
27-Apr-11	FOMC meeting	29-Apr-15	FOMC meeting
22-Jun-11	FOMC meeting	17-Jun-15	FOMC meeting
1-Aug-11	unscheduled FOMC meeting	29-Jul-15	FOMC meeting
9-Aug-11	FOMC meeting	17-Sep-15	FOMC meeting
26-Aug-11	Ben Bernanke Jackson Hole speech	28-Oct-15	FOMC meeting
21-Sep-11	FOMC meeting	16-Dec-15	FOMC meeting
2-Nov-11	FOMC meeting	27-Jan-16	FOMC meeting
28-Nov-11	unscheduled FOMC meeting	16-Mar-16	Press Conference
13-Dec-11	FOMC meeting	27-Apr-16	FOMC meeting
25-Jan-12	FOMC meeting	15-Jun-16	Press Conference
13-Mar-12	FOMC meeting	27-Jul-16	FOMC meeting

Table 2.13: FED Monetary Policy Days (January 1999 - July 2008).
The table reports a list of the press releases following the FOMC meetings.

Fed Monetary Policy Days (Synntetic - from 05.1999 to 10.2008)			
Date	**Event**	**Date**	**Event**
30-Mar-99	FOMC meeting	28-Jan-04	FOMC meeting
18-May-99	FOMC meeting	11-Feb-04	FOMC meeting
30-Jun-99	FOMC meeting	16-Mar-04	FOMC meeting
22-Jul-99	FOMC meeting	04-May-04	FOMC meeting
24-Aug-99	FOMC meeting	30-Jun-04	FOMC meeting
05-Oct-99	FOMC meeting	20-Jul-04	FOMC meeting
16-Nov-99	FOMC meeting	10-Aug-04	FOMC meeting
21-Dec-99	FOMC meeting	21-Sep-04	FOMC meeting
02-Feb-00	FOMC meeting	10-Nov-04	FOMC meeting
17-Feb-00	FOMC meeting	14-Dec-04	FOMC meeting
21-Mar-00	FOMC meeting	02-Feb-05	FOMC meeting
16-May-00	FOMC meeting	16-Feb-05	FOMC meeting
28-Jun-00	FOMC meeting	22-Mar-05	FOMC meeting
20-Jul-00	FOMC meeting	03-May-05	FOMC meeting
22-Aug-00	FOMC meeting	30-Jun-05	FOMC meeting
03-Oct-00	FOMC meeting	20-Jul-05	FOMC meeting
15-Nov-00	FOMC meeting	09-Aug-05	FOMC meeting
19-Dec-00	FOMC meeting	20-Sep-05	FOMC meeting
03-Jan-01	FOMC meeting	01-Nov-05	FOMC meeting
31-Jan-01	FOMC meeting	13-Dec-05	FOMC meeting
13-Feb-01	FOMC meeting	31-Jan-06	FOMC meeting
20-Mar-01	FOMC meeting	15-Feb-06	FOMC meeting
11-Apr-01	FOMC meeting	28-Mar-06	FOMC meeting
18-Apr-01	FOMC meeting	10-May-06	FOMC meeting
15-May-01	FOMC meeting	29-Jun-06	FOMC meeting
27-Jun-01	FOMC meeting	19-Jul-06	FOMC meeting
18-Jul-01	FOMC meeting	08-Aug-06	FOMC meeting
21-Aug-01	FOMC meeting	20-Sep-06	FOMC meeting
13-Sep-01	FOMC meeting	25-Oct-06	FOMC meeting
17-Sep-01	FOMC meeting	12-Dec-06	FOMC meeting
02-Oct-01	FOMC meeting	31-Jan-07	FOMC meeting
06-Nov-01	FOMC meeting	14-Feb-07	FOMC meeting
11-Dec-01	FOMC meeting	21-Mar-07	FOMC meeting
30-Jan-02	FOMC meeting	09-May-07	FOMC meeting
27-Feb-02	FOMC meeting	28-Jun-07	FOMC meeting
19-Mar-02	FOMC meeting	18-Jul-07	FOMC meeting
07-May-02	FOMC meeting	07-Aug-07	FOMC meeting
26-Jun-02	FOMC meeting	10-Aug-07	FOMC meeting
16-Jul-02	FOMC meeting	16-Aug-07	FOMC meeting
13-Aug-02	FOMC meeting	18-Sep-07	FOMC meeting
24-Sep-02	FOMC meeting	31-Oct-07	FOMC meeting
06-Nov-02	FOMC meeting	06-Dec-07	FOMC meeting
10-Dec-02	FOMC meeting	11-Dec-07	FOMC meeting
29-Jan-03	FOMC meeting	09-Jan-08	FOMC meeting
11-Feb-03	FOMC meeting	21-Jan-08	FOMC meeting
18-Mar-03	FOMC meeting	30-Jan-08	FOMC meeting
25-Mar-03	FOMC meeting	27-Feb-08	FOMC meeting
01-Apr-03	FOMC meeting	10-Mar-08	FOMC meeting
08-Apr-03	FOMC meeting	18-Mar-08	FOMC meeting
16-Apr-03	FOMC meeting	30-Apr-08	FOMC meeting
06-May-03	FOMC meeting	25-Jun-08	FOMC meeting
25-Jun-03	FOMC meeting	15-Jul-08	FOMC meeting
15-Jul-03	FOMC meeting	24-Jul-08	FOMC meeting
12-Aug-03	FOMC meeting	05-Aug-08	FOMC meeting
15-Sep-03	FOMC meeting	16-Sep-08	FOMC meeting
16-Sep-03	FOMC meeting	29-Sep-08	FOMC meeting
28-Oct-03	FOMC meeting	07-Oct-08	FOMC meeting
09-Dec-03	FOMC meeting		

2.8.3 Monetary policy surprise

Table 2.14: Impact of monetary policy surprise.
The table reports the coefficients of equation 2.5.
Significance of the parameter expressed via T-statistics *=10% level, **=5%level, ***2.5%level.

		1st Period						2nd Period						3rd Period						4th Period						5th Period					
		ECB	sig	$R\hat{2}$	FED	sig	$R\hat{2}$	ECB	sig	$R\hat{2}$	FED	sig	$R\hat{2}$	ECB	sig	$R\hat{2}$	FED	sig	$R\hat{2}$	ECB	sig	$R\hat{2}$	FED	sig	$R\hat{2}$	ECB	sig	$R\hat{2}$	FED	sig	$R\hat{2}$
ALL	Ins.	0.025	***	0.132	0.013	**	0.183	0.056	***	0.108	0.036	***	0.180	0.056	***	0.178	0.032	***	0.172	0.008	-	0.065	-0.0084	-	0.04	-0.002	-	0.059	0.006	-	0.039
	No-Ins.	0.030	***	0.133	0.014	***	0.234	0.067	***	0.097	0.040	***	0.172	0.059	***	0.215	0.032	***	0.248	0.009	-	0.054	-0.0048	-	0.03	-0.013	-	0.062	0.012	**	0.038
EU	Ins.	0.029	***	0.193	0.003	-	0.232	0.065	***	0.160	0.028	***	0.171	0.059	***	0.227	0.025	***	0.160	0.004	-	0.062	-0.0088	***	0.06	-0.009	-	0.120	-0.006	**	0.029
	No-Ins.	0.028	**	0.140	0.007	-	0.248	0.067	***	0.120	0.034	**	0.146	0.067	***	0.249	0.035	**	0.200	0.008	-	0.052	0.0007	-	0.04	-0.022	-	0.065	0.007	-	0.014
EU FE	Ins.	0.028	***	0.187	0.040	***	0.303	0.065	***	0.160	0.084	***	0.212	0.058	***	0.220	0.079	***	0.397	0.004	-	0.062	0.0365	***	0.13	-0.009	*	0.120	0.010	*	0.027
	No-Ins.	0.027	***	0.134	0.006	***	0.245	0.067	***	0.120	0.034	***	0.146	0.067	***	0.245	0.035	***	0.201	0.008	-	0.052	0.0007	-	0.04	-0.021	***	0.065	0.007	**	0.014
NONEU	Ins.	0.029	*	0.118	0.000	-	0.212	0.076	***	0.132	0.028	**	0.154	0.051	***	0.184	0.031	-	0.213	-0.014	-	0.033	0.0006	-	0.01	0.013	-	0.105	0.006	-	0.078
	No-Ins.	0.041	***	0.147	0.010	-	0.163	0.066	***	0.150	0.034	***	0.231	0.051	***	0.190	0.029	-	0.111	-0.007	-	0.032	0.0027	-	0.01	0.002	-	0.046	0.014	-	0.079
EMU	Ins.	0.026	**	0.163	0.005	**	0.230	0.071	***	0.166	0.028	*	0.189	0.066	***	0.227	0.029	-	0.144	0.005	-	0.073	-0.0054	-	0.07	-0.010	-	0.135	-0.001	-	0.046
	No-Ins.	0.024	*	0.118	0.003	-	0.225	0.069	***	0.117	0.034	**	0.133	0.075	***	0.244	0.044	***	0.221	0.011	-	0.047	0.0018	-	0.02	-0.028	-	0.069	0.013	-	0.028
EU non EMU	Ins.	0.034	***	0.204	0.037	**	0.199	0.059	***	0.129	0.079	***	0.145	0.050	***	0.212	0.065	***	0.162	0.002	-	0.028	0.0276	*	0.07	-0.008	-	0.076	0.007	-	0.022
	No-Ins.	0.033	***	0.154	0.010	-	0.253	0.065	***	0.116	0.033	***	0.148	0.060	***	0.226	0.026	*	0.153	0.006	-	0.043	-0.0005	-	0.07	-0.016	-	0.055	0.001	-	0.011
US	Ins.	0.017	-	0.126	0.036	***	0.254	0.060	**	0.070	0.051	**	0.236	0.059	***	0.163	0.040	**	0.173	0.035	**	0.198	-0.0169	-	0.2	-0.008	-	0.050	0.019	*	0.068
	No-Ins.	0.021	*	0.122	0.026	***	0.238	0.034	*	0.050	0.051	***	0.295	0.058	***	0.212	0.035	**	0.207	0.027	*	0.193	-0.0177	*	0.17	-0.017	-	0.102	0.014	-	0.113
Austria	Ins.	0.022	-	0.059	0.004	-	0.172	0.049	**	0.030	0.018	-	0.078	0.017	-	0.022	0.013	-	0.147	-0.026	-	0.027	-0.018	-	0.12	0.021	-	0.164	0.000	-	0.096
	No-Ins.	0.046	***	0.107	0.002	-	0.194	0.100	***	0.121	0.027	-	0.113	0.046	*	0.105	0.043	*	0.153	0.000	-	0.024	0.0011	-	0.02	0.000	-	0.031	0.020	*	0.050
Belgium	Ins.	0.038	**	0.120	0.024	-	0.104	0.221	***	0.173	0.058	-	0.130	0.136	***	0.210	0.105	-	0.110	0.048	-	0.067	-0.0034	-	0.01	-0.013	-	0.087	0.001	-	0.008
	No-Ins.	0.035	***	0.152	0.005	-	0.197	0.060	***	0.101	0.017	-	0.089	0.042	***	0.113	0.019	*	0.130	0.036	-	0.068	-0.0022	-	0.03	-0.032	-	0.062	0.020	*	0.037
Denmark	Ins.	0.035	**	0.089	-0.015	*	0.154	0.053	**	0.093	0.015	-	0.080	0.030	**	0.096	0.019	-	0.116	-0.023	-	0.037	-0.0201	-	0.07	-0.009	-	0.009	-0.005	-	0.026
	No-Ins.	0.042	***	0.140	0.007	-	0.178	0.081	***	0.201	0.025	**	0.108	0.038	**	0.085	0.025	-	0.120	-0.022	-	0.065	-0.0175	*	0.08	-0.016	-	0.028	0.007	-	0.033
Finland	Ins.	0.042	*	0.114	0.003	-	0.117	0.144	***	0.201	0.051	**	0.175	0.075	***	0.159	0.041	**	0.098	0.014	-	0.009	-0.0015	-	0.07	-0.013	-	0.024	0.002	-	0.030
	No-Ins.	0.040	*	0.095	-0.010	-	0.238	0.064	*	0.073	0.028	**	0.108	0.089	***	0.199	0.045	**	0.098	0.013	-	0.065	0.0002	-	0.02	-0.010	-	0.030	-0.002	-	0.006
France	Ins.	0.033	**	0.156	0.005	-	0.225	0.091	***	0.204	0.023	*	0.121	0.090	***	0.249	0.041	**	0.139	0.003	-	0.007	-0.0052	-	0.02	-0.009	-	0.138	-0.001	-	0.047
	No-Ins.	0.027	*	0.116	0.005	-	0.236	0.065	***	0.105	0.030	**	0.108	0.078	***	0.228	0.048	***	0.202	0.017	-	0.056	0.0013	-	0.06	-0.029	-	0.056	0.009	-	0.012
Germany	Ins.	0.008	-	0.080	0.009	-	0.171	0.017	-	0.029	0.020	**	0.151	0.032	**	0.102	0.016	-	0.154	0.016	-	0.044	-0.0063	-	0.02	-0.009	-	0.044	0.005	-	0.016
	No-Ins.	0.009	-	0.070	0.008	-	0.166	0.062	**	0.090	0.048	**	0.113	0.070	***	0.184	0.054	***	0.259	0.005	-	0.072	0.0035	-	0.04	-0.042	-	0.102	0.014	-	0.021
Greece	Ins.	0.004	-	0.009	-0.007	-	0.011	-0.045	-	0.021	0.022	-	0.029	0.003	-	0.014	0.031	-	0.043	-0.096	*	0.038	-0.0087	-	0.06	0.021	-	0.019	-0.029	-	0.013
	No-Ins.	0.029	**	0.048	-0.005	-	0.080	0.064	-	0.062	0.037	***	0.096	0.120	***	0.247	-0.001	-	0.091	0.007	-	0.006	0.0389	*	0.1	0.018	-	0.017	0.070	-	0.073
Ireland	Ins.	0.047	**	0.091	0.011	-	0.050	0.068	**	0.104	0.021	-	0.032	0.009	-	0.019	0.025	*	0.127	-0.040	-	0.174	-0.0019	-	0.02	0.002	-	0.044	-0.013	-	0.032
	No-Ins.	0.048	***	0.210	0.012	-	0.204	0.088	**	0.111	0.039	**	0.135	0.049	***	0.131	0.002	-	0.092	-0.008	-	0.054	-0.0156	-	0.05	-0.028	-	0.067	0.002	-	0.006
Italy	Ins.	0.033	***	0.116	0.008	-	0.177	0.082	***	0.232	0.034	***	0.211	0.082	***	0.176	0.016	-	0.082	0.011	-	0.120	-0.0156	-	0.09	-0.014	-	0.103	0.009	-	0.057
	No-Ins.	0.028	**	0.108	0.006	-	0.229	0.075	***	0.121	0.027	*	0.089	0.097	***	0.250	0.052	***	0.172	0.013	-	0.056	-0.0032	-	0.02	-0.029	-	0.051	0.019	-	0.027
Netherlands	Ins.	0.046	**	0.126	0.008	-	0.136	0.177	***	0.107	0.081	**	0.184	0.135	***	0.244	0.061	**	0.122	0.012	-	0.085	-0.01	-	0.02	-0.029	-	0.140	-0.020	-	0.032
	No-Ins.	0.037	***	0.146	0.000	-	0.221	0.068	***	0.117	0.031	**	0.139	0.053	***	0.220	0.028	**	0.226	0.003	-	0.011	0.0016	-	0.09	-0.045	-	0.091	0.012	-	0.023
Norway	Ins.	0.021	-	0.037	-0.023	-	0.112	0.017	-	0.029	0.020	-	0.144	0.061	**	0.145	0.031	-	0.103	0.001	-	0.032	-0.0108	-	0.05	0.027	-	0.076	-0.016	-	0.031
	No-Ins.	0.031	-	0.028	0.000	-	0.138	0.099	***	0.137	0.049	***	0.189	0.072	***	0.185	0.036	*	0.106	-0.005	-	0.026	-0.0141	-	0.05	-0.003	-	0.031	-0.001	-	0.020
Spain	Ins.	0.027	-	0.038	-0.006	-	0.117	0.119	***	0.171	0.024	*	0.099	0.099	***	0.263	0.041	**	0.088	0.029	-	0.049	0.0219	-	0.04	-0.008	-	0.105	0.008	-	0.072
	No-Ins.	0.024	-	0.113	-0.005	-	0.154	0.086	***	0.120	0.031	**	0.107	0.092	***	0.268	0.044	***	0.164	0.023	-	0.065	-0.0145	-	0.02	-0.025	-	0.086	0.006	-	0.018
Turkey	Ins.	0.033	-	0.075	-0.007	-	0.139	0.055	-	0.049	0.034	**	0.110	0.011	-	0.014	0.015	-	0.155	-0.044	-	0.056	-0.0071	-	0.01	0.022	*	0.029	0.026	**	0.167
	No-Ins.	0.060	***	0.139	0.019	-	0.079	0.069	**	0.092	0.040	***	0.241	0.036	**	0.083	0.020	-	0.036	-0.017	-	0.038	0.0044	-	0	0.030	-	0.028	0.028	*	0.088
UK	Ins.	0.033	***	0.200	0.004	-	0.194	0.059	***	0.113	0.031	***	0.152	0.058	***	0.238	0.021	*	0.127	0.010	-	0.025	-0.0133	*	0.08	-0.009	-	0.078	-0.012	-	0.028
	No-Ins.	0.030	***	0.114	0.011	-	0.236	0.060	***	0.092	0.033	***	0.138	0.064	***	0.240	0.029	*	0.157	0.011	-	0.040	0.0037	-	0.06	-0.014	-	0.048	0.000	-	0.013

2.8.4 Monetary policy surprise - net effects on the stock prices

Table 2.15: Monetary policy surprise - net effects on the stock prices.
The table reports ttabular representation of the interactions among monetary policy surprise (first principal component on the interest rates term structure), the sign of the coefficients associated to them via OLS regression (ref. equation 2.5) and the net impacts on the stock prices. Significance of the parameter expressed via T-statistics *=10% level, **=5%level, ***2.5%level.

	PCA	OLS coefficient		Effect on the
Period	Sign	Sign	Significance	Stock Returns
1	-	+	***	-
2	-	+	***	-
3	+	+	***	+
4	+	+	.	.
5	-	-	.	.

2.8.5 Monetary policy surprise - sensitivity to different time windows

Table 2.16: Impact of ECB monetary policy surprise - sensitivity to time windows. The table reports the impact of the ECB monetary policy interventions estimated via equation 2.5 applying 3 time windows. Significance of the parameter expressed via T-statistics *=10% level, **=5%level, ***2.5%level.

Period 1 - 6.9.04 - 15.6.08						
	-2 days, announcement day		**-1 day, announcement day, +1 day**		**'announcement day, +2 days**	
Variable	**ECB**	**Sig**	**ECB**	**Sig**	**ECB**	**Sig**
EU	0.029	***	0.017	*	0.016	-
EMU	0.026	**	0.014	-	0.011	-
EU NON EMU	0.034	***	0.023	**	0.023	**
NO EU	0.029	*	0.022	-	0.019	-
US	0.017	-	0.010	-	0.014	-

Period 2 - 16.6.08 - 31.8.10						
	-2 days, announcement day		**-1 day, announcement day, +1 day**		**'announcement day, +2 days**	
Variable	**ECB**	**Sig**	**ECB**	**Sig**	**ECB**	**Sig**
EU	0.065	***	0.054	***	0.084	***
EMU	0.071	***	0.057	***	0.094	***
EU NON EMU	0.059	***	0.051	***	0.073	***
NO EU	0.076	***	0.072	***	0.102	***
US	0.060	**	0.055	*	0.086	***

Period 3 - 1.9.10 - 30.6.12						
	-2 days, announcement day		**-1 day, announcement day, +1 day**		**'announcement day, +2 days**	
Variable	**ECB**	**Sig**	**ECB**	**Sig**	**ECB**	**Sig**
EU	0.059	***	0.052	***	0.055	***
EMU	0.066	***	0.058	***	0.061	***
EU NON EMU	0.050	***	0.045	***	0.048	***
NO EU	0.051	***	0.056	***	0.061	***
US	0.059	***	0.056	***	0.062	***

Period 4 - 1.7.12 - 31.12.13						
	-2 days, announcement day		**-1 day, announcement day, +1 day**		**'announcement day, +2 days**	
Variable	**ECB**	**Sig**	**ECB**	**Sig**	**ECB**	**Sig**
EU	0.004	-	0.030	*	0.027	-
EMU	0.005	-	0.035	*	0.035	*
EU NON EMU	0.002	-	0.022	-	0.015	-
NO EU	-0.014	-	-0.005	-	-0.005	-
US	0.035	**	0.053	***	0.049	***

Period 5 - 1.1.14 - 20.2.17						
	-2 days, announcement day		**-1 day, announcement day, +1 day**		**'announcement day, +2 days**	
Variable	**ECB**	**Sig**	**ECB**	**Sig**	**ECB**	**Sig**
EU	-0.009	-	0.004	-	0.004	-
EMU	-0.010	-	0.014	-	0.010	-
EU NON EMU	-0.008	-	-0.006	-	-0.003	-
NO EU	0.013	-	0.013	-	0.012	-
US	-0.008	-	0.037	-	0.038	-

2.8.6 Analysis of the determinants - Correlation matrix

Table 2.17: Balance Sheet Indices - Correlation Matrix.
The table reports the correlations among the balance sheet indices used in the logit regression(ref. equation 2.7).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) Total Assets (Ln)	1.000							
(2) Fixed Income Assets	0.334	1.000						
(3) Equity Assets	-0.114	-0.450	1.000					
(4) Cash & Equivalent	-0.171	0.057	-0.007	1.000				
(5) Non-Insurance Activities	0.062	-0.434	0.321	0.134	1.000			
(6) Life Business	0.270	-0.325	0.616	0.010	0.589	1.000		
(7) Unit Linked Business	0.045	-0.330	0.530	0.072	0.452	0.754	1.000	
(8) Dividend Payout	-0.161	-0.171	0.102	0.134	-0.076	-0.015	-0.004	1.000

Chapter 3

Compliance Risk in the European Insurance Industry: Setting a Common Playing Field

3.1 Introduction and Approach

The financial services industry in general and the insurance industry in particular are highly regulated environments. Focusing on the European market, legal frameworks are defined both at the EU level (EU directives) and the local level (national legislation). Additionally, the supervision in many countries is fragmented with different authorities supervising specific business lines.[1] Operating in such a heavily regulated markets implies that companies are exposed to the risk of not fulfilling all the requirements encompassed in those regulations, and thus exposing them to a compliance risk.

The aim of this project is twofold: at first I investigate the awareness about the compliance risk of the insurance companies operating in the German and Austrian market also analyzing the most utilized approaches. Secondly, elaborating on the shared understanding of the insurers and on the regulatory framework I propose a new definition of compliance risk with a precise perimeter that allows a proper identification of the compliance risk avoiding the mis-classification of the events.

By a regulatory perspective the European Union and the member states show a heterogeneous picture of the concept of compliance risk. Despite it is mentioned in almost each local rule and communitarian directive, neither a shared standard definition nor a precise perimeter of the compliance risk can be inferred.

The compliance risk is mentioned by some extent in EU directives and guidelines. the Quantitative Impact Study 5 issued by EIOPA (EIOPA, 2011), for example, states that: *"Operational risk is*

Data collection was supported by ISS Software. The author is grateful to Andreas Penzel.

[1]For example in Italy insurance activities are supervised by IVASS (insurance products and operations), CONSOB (financial products and related consumer protection) and COVIP (pension funds and related products).

the risk of loss arising from inadequate or failed internal processes, or from personnel and systems, or from external events. Operational risk should include legal risks, and exclude risks arising from strategic decisions, as well as reputation risks. The operational risk module is designed to address operational risks to the extent that these have not been explicitly covered in other risk modules". From the statement a couple of elements can be excerpted: *i)* the persistent overlapping of the compliance risk with the operational risk, *ii)* the fact that reputational risks and legal risks shall be treated differently.

Despite the attempt of building a level playing field in the EU financial market by defining a set of common rules (European Commission, 2005), the conversion of EU directives into local regulations is not homogeneous, leading to different approaches to the compliance risk. A quick overview of some of the indications provided by National Competent Authorities on their own jurisdictions, without claiming for completeness, gives a clear understanding of this fragmentation.

For the Italian insurance market, IVASS (2008) defines the risk of non-compliance with regulations as *"the risk of incurring judicial or administrative sanctions, suffering losses or damage to reputation as a consequence of the failure to comply with laws, regulations or provisions issued by the National Supervisory Authorities or self-regulatory rules, such as articles, codes of conduct or self-disciplinary codes; risk arising from unfavorable changes in the law or judicial orientation"*. The Bank of England (2013) through its Prudential Supervision Authority includes, among the role of the compliance function of an insurance company the identification, the assessment, the monitoring and the reporting *"on a firms compliance risk exposure, tracking any changes in the environment that could affect compliance risk, "*. In Germany, at the end of 2013, BaFin (2013) issued a recommendation through two expert articles (*"Measures to protect policyholders"* and *"Incentive in Sales"*) stressing the *"potential damage in the reputation of undertakings deriving from sales practice and incentives"*). However, non-compliance risk is not mentioned.

Although regulators spend words on compliance risk, there is a general lack of consensus on its definition, classification and on what has to be included in the perimeter. In fact, some refer to legal risk, and some to the failure of complying with laws. In some cases, compliance risk is included in the broader perimeter of operational risks, in other cases they are treated as separate entities. Moreover, some regulators tend to strictly relate reputational risk to compliance risk.

Against this framework, most of the insurers and reinsurers have not explicitly included compliance risk in their risk profile so far and have not fully scrutinized the materiality of such risk. Moreover, the assessment and management of compliance risk are usually embedded into the wider operational risk approach. Such an approach neglects the specific risk factors of the compliance risk. In fact, the lack of complying with specific regulation is usually included into generic events encompassed in the operational risk framework and consequently traced back to the general operational risk factors personnel, process and systems.

Despite the compliance risk affects both the balance sheet and the income statement of the insurance companies, scarce attention has been devoted to this topic by scholars active in the fields of insurance and risk management. Neither a theoretical approach aimed at measuring the compliance risk nor an empirical study assessing the materiality of the exposures have been produced to date by academia. On the other hand, consultancy companies are active in this field. Almost all of those that are operating in the financial services industry propose a structured approach to assess and quantify the exposure of a company to the compliance risk. Deloitte Consulting (2014) offers a Governance Risk and Compliance approaches that include the evaluation of the reputational risk on a semi-quantitative base. The whole model is mainly driven by a forward-looking assessment based on the expert judgment of the exposure. IBM (2016) embeds the assessment of the compliance risk in the operational risks management tool. SAS (2012) offers a comprehensive suite to monitor and assess operational and compliance risk based the identifications and quantification of risk related events. Oliver Wyman (2015), by claiming an unclear scope and mandate for the compliance function, uncoordinated process and fragmented systems proposes a process based framework for the management of the compliance issues. List Group (2014) offers a specific module to manage within its Governance Risk and Compliance suite to manage the compliance risk. The compliance risk module besides exploiting the operational risks event catalog, provide a specific regulation based library.

Looking at the models proposed by the consultancy companies and at the patented models (e.g. Agle and Wolff (2013)), most of the approaches are based on the concept of the risk self-assessment. These approaches usually assess the risks by deriving them from guided but subjective evaluations of individuals' semi-quantitative estimations and expert judgments. Despite its forward-looking perspective, this approach presents several weaknesses as:

- it is biased by personal perceptions of individuals;
- it does not take into account current facts and figures of the assessed company;
- it gathers only semi-quantitative data usually organized in levels of RAG matrices; [2]
- it does not properly dissect between pure operational events and compliance driven events.

Given the above mentioned limitations, I believe that these approaches are not suitable to properly assess the materiality and the exposure of a company to the compliance risk. Moreover, the aggregation of data can lead to an incorrect estimation of the total exposure.

These limitations can obviously lead to an incomprehensive perception of the compliance risk and its boundaries. In order to achieve a common understanding of both definition and approach an unanimous perspective within the insurance companies and the among market participants needs to be developed. I therefore conduct a survey among insurers aimed at addressing a quantitative approach to compute the materiality of the exposure of the industry to the compliance risk. Capital is always the scarce resource in the financial service industry, hence, if insurance companies are

[2] RAG scale (Red-Amber-Green scale) is a commonly utilized graphical representation of quantitative or qualitative indicators based on a set of pre-defined thresholds.

nowadays focused on developing or calibrating their internal model on the key risks included in the first pillar of Solvency II, in a short time, even small and medium companies should improve the models by including operational and compliance risks. The state of the art of the semi-quantitative compliance risk models does not allow their inclusion in a full or partial internal model. Hence a step in this direction is needed and this project can deliver a major contribution in this respect.

In order to challenge my belief of the understanding and the awareness of the compliance risk among practitioners and the needs for clarifications and developments I designed a survey and elaborate on it.

The present contribution aims at providing a shared definition of compliance risk jointly with a clear perimeter that allows dissecting, despite inevitable overlapping, between compliance risk and operational risk. Therefore I address the following questions:

- How important do the insurance companies consider the compliance risk to be?
- Which are the most significant drivers of the compliance risk?
- Is there common understanding of the compliance risk within the insurance companies and the market?
- Does a widely-accepted precise definition of the compliance risk for the insurance business exist?

I developed the paper on 6 main sections including the introduction. At first (Section 3.2) I describe the structure of the survey and the process I followed for the data gathering and elaboration. Section 3.3 presents the structure of the sample. Then in section 3.4 I provide an overview of the collected information and I report on the empirical evidences. Section 3.5 presents the main elements inferred from the survey. The last section (Section 3.6) is devoted to the conclusions and provides suggestion to further proceed in the analysis of the compliance risk and its management.

3.2 Survey's Structure and Process

The goals of the survey is to reach a common understanding of the compliance risk among practitioners by investigating how it is perceived by the insurers and how they are approaching it. The survey is divided in six groups of questions. Group 1 collects a set of information instrumental to the treatment of the sample. Being the questionnaire anonymized, participants were required to provide data that allows to infer volumes and typology of the business and the reference markets. The second group aims at building a level playing field on the compliance risk. More specifically, I intend to reach a shared understanding on the perimeter of the compliance risk and an agreement on the key elements needed for its identification and measurement. The ultimate goal of the section is to propose a commonly accepted definition of compliance risk. Group 3 investigates the perception and the materiality that insurers have on the compliance risk. To that aim I scrutinize: *i)* the overall sentiment of insurers about being exposed to sanctions for misinterpretation of the law, *ii)* whether insurers have a clear idea of the quantification of their exposure to the compliance risk and if and to what extent they consider this specific risk relevant at this point in time and *iii)* the processes and the business lines (product categories) that are sources of concerns for the insurers. Group 4 is devoted to understand how the companies approach the compliance risk. To my knowledge, compliance risk is usually included in the operational risk management framework but with scarce evidences on the specificity of the risk factors. I was not able to find enforced approaches to measure and manage the compliance risk so far. For this reason, the section gathers detailed information on the applied methodologies to measure compliance risks, namely: *i)* if and to what extent compliance risk is measured, *ii)* if the compliance risk is included in operational risk framework and with which level of details and iii) if and how the potential losses are modeled. Subsequently, group 5 tries to understand if there are common current and future needs for models and software to manage the compliance risk among insurers. The last section slightly diverges from the compliance risk topic by gathering information on the reputational risk. Reputational risk is considered as an effect of second level, namely it stems, under specific circumstances, from events generated by other risks such as operational risks or compliance risks.[3] Group 6 aims at building a common understanding on reputational risks and at investigating how it is perceived by insurers.

Two workshops with insurance companies preceded the distribution of the survey. Both workshops were aimed at introducing the participants to the basic concept of the compliance risk by presenting the orientations included in different jurisdictions.

Additionally I devoted a relevant part of the presentation to the explanation of the basic constituents of the compliance risk, namely the definitions of entities and relations embedded in the compliance risk model.[4] These explanations were needed to ensure that all the participants were on the same page while approaching the survey (Statistics Canada (2003); Kelley, K., Clark, B., Brown, V., Sitzia, J. (2003)). The workshops ended with the presentation of the structure and the sections of the survey.

The web-based survey is composed by a combination of 55 multiple choice and open-response questions.[5] In case of the multiple choice questions I asked the participants to rank their response in order of relevance where applicable, or to express their agreements to statements in scale of 4 values (fully agree, agree, disagree and strongly disagree). Given the specificity and on some aspects the innovation of the approach of the qualitative questions, despite its potential negative implications on results (Sanchez and Morchio, 1992), I also included the option *I do not know* in the set of possible answers.

[3]The definition of reputational risk is retrieved by the year-report of large European Insurance companies.
[4]For the list of the definition refer to Appendix A
[5]I kept the number of questions at its minimum to reduce the burden on the participants (Bogen, 1996).

3.3 Data

The sample includes 39 insurance companies mainly operating in the German (61% of the sample) and Austrian (33% of the sample) market.[6] Only 2 companies declare other EU countries as reference markets. Insurers are almost equally distributed on the 7 size-based cohorts built on the underwritten premium (2014 data). Cohorts were subsequently grouped in 3 clusters: Small, Mid and Large. Business-wise, 17 companies are pure property and casualty insurers, 1 is running only life business and 13 are composite. Among composite, 6 companies offer pension products and 2 are active in non-traditional insurance activities. It is also worth noting that non-life insurers fully define the mid-small cohorts in terms of size, whether the life business is mainly run by the largest companies. Figure 3.1 provides a detailed overview of the sample.

INSERT FIGURE 3.1 HERE

3.4 Empirical Evidences

3.4.1 Definition and Perimeter

At a first glance, the companies included in the sample reflect a slightly positive picture of the enforced approach to the compliance risk. Most of them report to have a clear definition of compliance risk (Figure 3.2a) in place. Some differences emerge among the subsamples (Figure 3.2b) where mid and large insurers appear to be better organized than smaller ones. A thorough look at the reported definitions allows appreciating that: *i)* most of the companies generally refer to behavior in line with external law and regulation; *ii)* five definitions include the internal rules and codes of conducts; *iii)* one definition refer to reputational losses.

INSERT FIGURE 3.2 HERE

One of the most stressed elements in risk management frameworks and in the regulations is the concept of awareness of the risk across the organization, sometimes referred as *"risk culture"* (Power, M., Ashby, S., and Palermo, T, 2015).[7] According to Eling, M. and Schmeiser H. (2010) *"The best risk models are useless if the results are not understood by the people who make decisions"*. Furthermore the authors claim that in the insurance industry the interaction between risk models, risk management process and managerial decisions can be improved. I scrutinized the issue of misalignment between the declared approaches and the actual behavior of the insurers in the day to day activities by posing a simple question "Is the definition sheared and agreed across the whole organization?". The answers (Figure 3.3a) present some inconsistency if compared to

[6] I invited more than 100 insurers to the survey. 41 participated and 39 of the questionnaire were deemed as complete enough to be analyzed.

[7] For legal reference refer to European Commission (2013) EU directive 2013/36/EU, paragraph 54 *"Member States should introduce principles and standards to ensure effective oversight by the management body, promote a sound risk culture at all levels of credit institutions and investment firms..."*.

the previous question. As a matter of fact, companies with a definition of compliance risk in place, fail in sharing it with the full organization (share of positive answers drops from 67% to 49%). It goes without say that any non-enforced document or definition is ineffective by a risk management perspective. Following the assumption that for the specific question an *"I do not know"* answer implicitly corresponds to a *"Not shared"* answer, the subsample analysis does not provide meaningful differences.

INSERT FIGURE 3.3 HERE

Summarizing, the first set of answers returns a heterogeneous picture composed by different approaches to the compliance risk with a common ground: they are mainly based on a reactive need of complying legal requirements rather than to proactively manage it. This picture claims for a comprehensive reshape in the approach to the compliance risk starting from a common set of definitions.

Initial point is the clear definition of a perimeter for the compliance risk. I try to reach it by asking a set of questions regarding the risk categories that should be included under the umbrella of the compliance risk. The answers provided show a convergence (Figure 3.4a) on a specific perimeter. In detail, there is a common understanding that compliance risk should include the risks arising from missing or partial adequacy to communitarian directives or local rules in the defined deadlines and the risks arising from missing or partial adequacy to internal rules (ethical code, regulations, processes and procedures). A lower convergence, but still above level 3 *"Yes"*, can be found on the inclusion of risk of losses arising from changes in the regulatory framework or unfavorable changes in the jurisprudence track records. Furthermore, the risk of losses deriving from mistakes in contracts or legal binding documents that cannot be traced back to illegal actions tend to be excluded from the framework due to their "pure" operational nature. Reputational risk deserves specific evaluations. Limiting the analysis to this single question, it seems that reputational risks should be included in the perimeter of the compliance risk. However the answers provided in the last part of the questionnaire specifically devoted to investigate the reputational risk, show that it can be considered as a second level effect, hence it can be excluded from the narrow perimeter of the compliance risk.

The drill-down in the subsample (Figure 3.4b) does not show meaningful differences driven by geographical markets but it reports some distinction according the size of the company. Beside the general confirmation of the overall results, large insurers provide more clear-cut indications on their orientation than mid and small insurers. As a matter of fact extreme statements as *"Absolutely Yes/No"* and mild statements as *"Yes/No"* are associated to large companies and small companies respectively.

INSERT FIGURE 3.4 HERE

3.4.2 Perception and Materiality

As the first pillar of the Solvency II framework shows (EIOPA, 2011), Insurance companies are exposed to several risk factors. Insurers rank technical and market risks as the most relevant while compliance risk and liquidity risk are considered as the least important. (Figure 3.5a). Subsamples, both size (Figure 3.5b) and country (Figure 3.5c) based, show specificities. By a size perspective large companies have a different risk perception than small and medium companies with the last to groups almost aligned. Large insurers tend to consider liquidity and market risks more relevant than technical risks than the smaller ones. By a country perspective Austrian insurers value more the exposure to market than technical risks.[8]

Overall I observe that the ranking is mainly driven by the capital surcharge associated to the specific risks. As a matter of fact the top ranked risks are the one included in the first pillar of Solvency II followed by the risk categories that may be included in the second pillar. The compliance risk, with its lack of clear definition and its total absence of specific capital surcharge is considered, independently by size and country, less relevant.

INSERT FIGURE 3.5 HERE

As a direct consequence only the 35% of the companies think that compliance risk is properly monitored (30% partially, 35% no answer) with a prevalence of positive results in Germany. Consistently with this answer the level of awareness across the organization tends to fade away when moving from the top level of the organization to the more operational levels where on average people are only partially aware of the compliance implications concerning the tasks they are in charge of or the areas they are supervising. This is also reflected in the structure of the information shared among risk management structures (Figure 3.6a and 3.6b). Only twelve companies provide full information and two companies partial information on the sanctions received to risk management structure in a backward looking perspective. Situation worsens if we focus on the forward looking perspective where figures change into four and ten respectively.

INSERT FIGURE 3.6 HERE

If the low number of sanctions received by companies in the last five years (only three companies were sanctioned) can justify the absence of specific reporting in a backward looking perspective, and more in general the lower priority assigned to the compliance risk, that should not preempt companies to monitor their future exposure. The exposure to compliance risk shall be by all means taken into account in the risk profile for several purposes e.g. *i)* products pricing, *ii)* re-engineering projects on processes or organizational structures and *iii)* right sizing initiatives.

[8] Rationales for these differences can be found in the business models, in the product portfolio and in the structure of the assets and liabilities. The evaluation of these aspects diverges form the scope of the paper, hence they are not treated.

Process reengineering activities and right sizing initiatives aim at adjusting the processes and the size of a company/department workforce in order to effectively and efficiently reach the assigned objectives. Usually, only business related activities and subsequent costs are taken into account in defining the proper sequence of the tasks and the resources needed. Potential costs deriving form compliance events are often neglected but in case of occurrence can heavily affect the economic results of a department and of a company as a whole. Therefore, a thorough knowledge on where the compliance risks are located across the organization and their potential economic impact must play a role in the definition of the control activities and in the proper allocation of resources.

According to the results of the survey, if on the one hand companies do not find relevant differences in the exposure to compliance risk among products, on the other hand they consider some processes/departments more exposed to compliance risk than others (Figure 3.7).[9] Overall, sales, investment, product management and accounting are considered the most exposed whereas operations and portfolio management least ones. Looking at the size sampling the behavior of large insurers detaches from the small and medium companies with the first group giving again more clear-cut evaluations. Specifically large insurers consider product management and sales by large the most risky activities while claims accounting and operations seem to be almost irrelevant from a compliance risk perspective.

INSERT FIGURE 3.7 HERE

3.4.3 Approaches

The lower priority assigned to the compliance risk is also reflected in the approach that insurers have in place to manage it. Only one-third of the companies explicitly include the compliance risk in their risk management framework. The virtuous ones (10 companies) approach the specific risks both in a backward looking perspective (loss data collection) and forward looking perspective (risk self-assessment) (Figure 3.8a and 3.8b).

INSERT FIGURE 3.8 HERE

An approach based on loss data collection and risk self-assessment joins the compliance risk to the better known operational risk management approaches and in particular to the advanced models based on the analysis of severity as well as frequency of realized events and on the analysis of scenarios. In line with the commonalities between compliance and operational risk, 40% of the companies encompass the compliance risk in their operational risk management framework and no one has a specific approach in place devoted to the compliance risk (Figure 3.9a and 3.9b).

[9]By a compliance risk perspective, companies tend on average to make no distinction between the different product categories under life and non-life businesses. To investigate it, I asked to rank a set of product categories (Motor, P&C, Health, Life traditional, Life with strong financial components) from the most to the least exposed to compliance events, namely to be exposed to sanction by the supervising authorities. The answer was on average on the mid-level risk for each of the categories. Some specificity emerges from the size based clustering. I consider these results biased by the focused activities on of some insurers included in the sample, hence I decided not to publish it.

INSERT FIGURE 3.9 HERE

Traditional operational risk frameworks should be considered a proper solution to approach the compliance risk only in case the losses and the risk self-assessment are conducted at a proper level of detail. Otherwise the results are meaningless both from an economic and managerial perspective. Compliance risk can be properly managed only if events are traced back to business unit or processes in order to understand where the most relevant issues come from and where potential losses are located. Unfortunately only ten companies register losses at business unit level and only four register them at process level (Figure 3.10).

INSERT FIGURE 3.10 HERE

Situation improves regarding the risk self-assessment where ten and six companies apply it at organizational unit and process level respectively (Figure 3.11). In line with my expectation, the principle of proportionality holds: the more detailed, hence complex, approaches are applied by the larger companies, while small companies limit their effort to simpler and approximated approaches.

INSERT FIGURE 3.11 HERE

A risk management system cannot exempt from a proper IT support. Not surprisingly and in line with the level of importance attributed to the compliance risk, only five insurers declare to have in place IT systems devoted to compliance risk and only six to the operational risk (Figure 3.12a). Intuitively dedicated systems are mainly used by large companies. (Figure 3.12b).

INSERT FIGURE 3.12 HERE

3.4.4 Needs

Despite the previous section depicts a situation with big room for improvements in the approach to compliance risk. Consistently with the low priority assigned to it, companies seem not keen on investing on improving their approach to compliance in the short run. Only few German companies (15%), independently from the size, plan to invest in the enhancement of the compliance risk management (Figure 3.13a and 3.13b).

INSERT FIGURE 3.13 HERE

Areas of improvements are strongly driven by the size of the insurers (Figure 3.14b). Data gathering initiatives devoted to collect losses and self-assessment processes are the top priority for large and mid-size companies, whether small insurers tend to invest more in software and IT tools. The picture is consistent with the stage of maturity of the risk management structure of the different companies: developed organizations usually have already an IT infrastructure supporting the risk management actions in place, hence their investments are devoted to enrich the database supporting modeling projects.[10] Small insurers are usually in the early stage of risk management hence they need to invest in the IT infrastructure before moving towards data gathering and modeling. Differences emerge from a country perspective. However the geographical specificities are strictly correlated with the size of the insurers included in the sample hence it does not contain additional information.

INSERT FIGURE 3.14 HERE

3.4.5 Reputational Risk

Reputational Risk can be defined as the possibility of potential losses due to a reputational deterioration or to a negative perception of the company's image among its customers, counterparties, shareholders and Supervisory Authority. It is the risk deriving from the deterioration of the reputation or from a negative perception of the undertakings image among the various stakeholders due, for example, to the low quality of the services offered, to the placement of inadequate policies or to the behavior of the sales force, which can entail monetary or non-monetary losses. Thus the reputational risk tends to represent a second level effect triggered by events, such as operational or compliance related events with a significant level of importance in terms of magnitude or frequency.

In general companies share the mentioned view. As a matter of fact, despite the provided answers are partially in contrast with the perimeters definition of the compliance risk provided in the section "perimeter and definition", almost half of the sample (47% against 5%) agrees in considering the reputational risk as a second level effect (Figure 3.15a). Consensus is spread across all the size-based cohorts with large companies oriented for stronger statements. Country based cohorts do not present significant differences.

INSERT FIGURE 3.15 HERE

Proceeding in the line of argumentation about the second level effect, operational events are considered as the most relevant triggers for reputational risk, followed by compliance events business strategy issues and investment strategy related issues (Figure 3.16a). The analysis of the subsamples shows a general consensus among small and mid-size companies. Large insurers tend to consider that the implications deriving from the definition of the strategy are more relevant than those resulting from compliance risk in causing reputational events (Figure 3.16b). Again, no differentiation at country level can be observed (Figure 3.16c).

INSERT FIGURE 3.16 HERE

Furthermore, I tried to understand whether insurers are more concerned from a reputational perspective about the severity or the frequency of an event. According to the results, it seems

[10] Here I implicitly assume that large companies are by an organizational perspective more structured than the smaller ones.

that the deterioration of the reputation stems more from the severity of the triggering (first level) event rather than form the frequency. 25% of the sample considers elected triggers for reputational implication events with high severity; 27% believe that an event should be characterized by both the elements to generate reputational issues. None of the participants deem the high-frequency as a sufficient element to generate reputational events (Figure 3.17a). More in detail, severity seems to be considered the unique trigger by small enterprises. For the large players reputation is more likely to be jeopardized by sever and recurrent events (50%) as reported in Figure 3.17b.

INSERT FIGURE 3.17 HERE

3.5 Main Remarks

3.5.1 Definition and Perimeter

Within the limitation of the restricted sample and the potential biases introduced by the size and geographical distribution of the participants, valuable indications can be inferred from the survey. Among insurers the perimeter and the definition of the compliance risk is somehow blurred. No clear-cut indication on the perimeter emerges from the market and the partial overlapping with the operational risks does not help in its definition. As a matter of fact, even if many companies declare to have the concept of compliance risk defined, the definitions are opaque, not sole and not always shared within the organization. Additionally the different hierarchical levels of the insurers are not always fully aware of the duty and the responsibility coming from the management of the compliance risk and the related information are not completely shared as well. Nevertheless two main elements, namely risk factors and time, emerged from the survey as driver to shape a clearer picture of the compliance risk.

Agreed on that I am taking into account only risks emerging from the regulations, the analysis of the risk factors allows dissecting between operational risks and compliance risks. According to the established definitions, operational risks are all the risks that can be traced back to personnel, processes and system shall be included in the operational risk perimeter.[11] During the preparatory meeting and in survey the following definitions were shared: *i)* external non-compliance risk as the risks rising from missing or partial adequacy to EU directives or local rules in the defined deadlines; *ii)* internal non-compliance risk as the risks arising from missing or partial adequacy to internal rules (ethical code, regulations, processes and procedures); *iii)* legal risk as the risk of losses deriving from mistakes in contracts or legal binding documents that cannot be traced back to illegal actions. Starting from these definitions, it is straightforward to understand how related events are triggered by misbehaving people, wrongly followed / poorly designed processes or system failures. Additionally each of these events can be prevented via specific management actions. I therefore include the two risk categories among the operational risks.

[11] Basel II and Solvency II definitions report *the risk of loss resulting from inadequate or failed internal processes, people and systems* Bank of international Settlement (2006) and European Commission (2015)).

If on the one hand the legal risk shall not be considered part of the compliance risk due to its pure operational nature, on the other hand the non-compliance risks are fully eligible to be listed under the category of the compliance risk. According to the provided answers the compliance risk shall include i) internal and external non-compliance risk and ii) regulatory risks defined as the risk of losses arising from changes in the regulatory framework or unfavorable changes in the jurisprudence track records. It is worth noting that the latter risk category due to the ex-post nature of the cause of the event, cannot be approached through personnel processes or systems, therefore it is not part of the operational risk category.

I utilize the *time* dimension to distinguish between the compliance risk and the reputational risk. Reputational Risk is defined as a consequential risk resulting from the insurgence of loss events such as operational or compliance risks. It arises when the primary events lead to severe effects both in terms of frequency or magnitude that can affect the company image and the relationship with the stakeholders in a negative way. From the definition it derives that reputational risks follow a first level events with fashionable lag. Thus the reputational risk has to be excluded from the perimeter of the compliance risk.

Figure 3.18 displays a graphical representation of the described segmentation of risk categories.

INSERT FIGURE 3.18 HERE

Against the presented scenario the following definition of compliance risk emerges:

Compliance risk encompasses all and only the risks arising from missing or partial adequacy to EU directives, local rules or internal rules in the defined deadlines and changes in the regulatory framework or unfavorable changes in the jurisprudence track records.

In line with the argumentation presented, the reputational risk is not mentioned in the compliance risk category.

3.5.2 Approaches

Compliance risk is not a top priority for the German and Austrian insurers included in the panel. The conclusion is driven by two main aspects: *i)* the survey has been done in the period that preceded the enforcement of Solvency II (European Commission, 2015), hence companies are still prioritizing the risk modules concurring to the determination of the Solvency Capital Requirement such as market risk, counterparty risk and underwriting risk; *ii)* the low amount of sanctions distributed by supervisors in the recent years.

Despite of its relative relevance, companies manage the compliance risk through the operational risk management framework, namely exploiting risk management processes and informative systems devoted to the assessment and measurement of the operational risks to manage the compliance risk. The approaches to the operational risk can be deemed as proportional to the size of the companies included in the sample, hence no use of advanced internal models is reported. Most of the participants rely on risk self-assessment and loss data collections run at company level and in some cases at organizational unit level. Only few companies trace back information to a process level. Companies are nevertheless aware of the need of investing in models and processes for operational risk and compliance assessment.

3.6 Conclusions and Way-forward

The absence of clear-cut indications from regulators and supervisors do not help in finding a shared and commonly accepted definition and a well-defined perimeter of the compliance risk.

With this work I try to fill the gap by deriving from a survey extended to insurers based in Germany and Austria a shared definition of compliance risk. Also, elaborating on the answers provided, I proposed a clear perimeter for the compliance risk based on two elements: the time and the originating risk factors.

Despite the limitation of the sample that could introduce biases in term of size and geographical coverage the indication that emerges from the work represents an enhancement of the current understanding of the compliance risk on the insurance market. The provided definition and perimeter of the compliance risk should be of interest for several players of the insurance arena. Regulators can benefit in the process of evolving regulation by having a look at the point of view of undertakings. Insurers and consultancy companies can find inspiration for the evolution of the proposed approach and model for risk management, model management and capital allocation.

A foreseen evolution of this work is the extension of the survey to other jurisdictions and major player of the European insurance industry in order to overcome potential country based and size based biases already highlighted. Additionally the proposed classification represent the base for the evolution of proactive process/organizational structure based model to assess the compliance risk in forward and backward looking perspective.

3.7 Appendix

3.7.1 Definitions

Effect The effect is the outcome of an event. It is characterized by frequency and severity and it can affect both balance sheet (regulatory capital) and income statement (profit).

Event An Event is an occurrence that can generate one or many losses to the company.

Frequency The frequency measures the number of occurrences associated to a specific event in a given timeframe.

Legal risk Risk of losses deriving from mistakes in contracts or legal binding documents that cannot be traced back to illegal actions.

Non-compliance risk external Risks rising from missing or partial adequacy to EU directives or local rules in the defined deadlines.

Non-compliance risk internal Risks rising from missing or partial adequacy to internal rules (ethical code, regulations, processes and procedures).

Regulatory risk Risk of losses arising from changes in the regulatory framework or unfavorable changes in the jurisprudence track records.

Reputational Risk Consequential risk resulting from the insurgence of loss events such as operational or compliance risks. It arise when the primary events lead to severe effects both in terms of frequency or magnitude that can affect in a negative way the company image and the relationship with the stakeholders.

Risk Factor Identifiable element that, if included in the risk profile of a company, expose them to a risk, namely to the possibility of being subject to a loss event or to an unexpected gain.

Severity The severity measure the magnitude of an event.

3.8 Figures

Figure 3.1: Sample Composition.
Size cohorts and business decomposition are defined according to 2014 underwritten premiums.

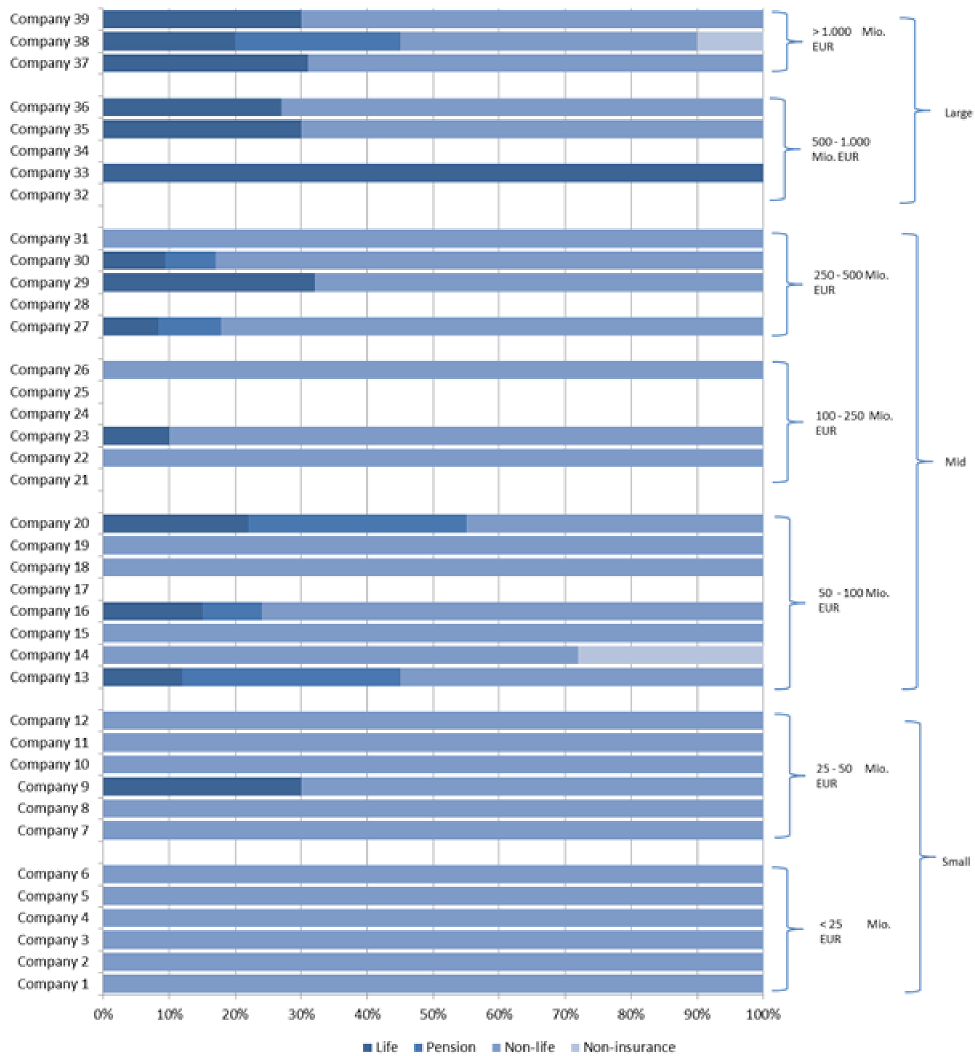
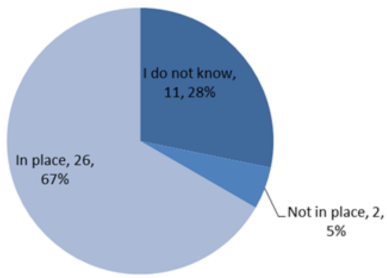


Figure 3.2: Does your company have in place a clear definition of compliance risk?

(a) Full Sample



(b) Subsamples

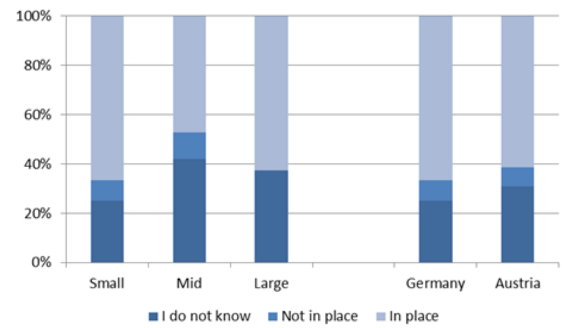
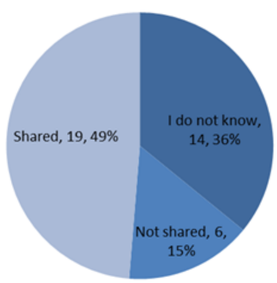


Figure 3.3: Is the definition of compliance risk shared and agreed across the whole organization?

(a) Full Sample



(b) Subsamples

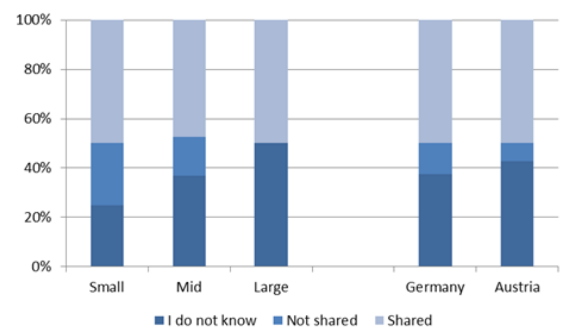
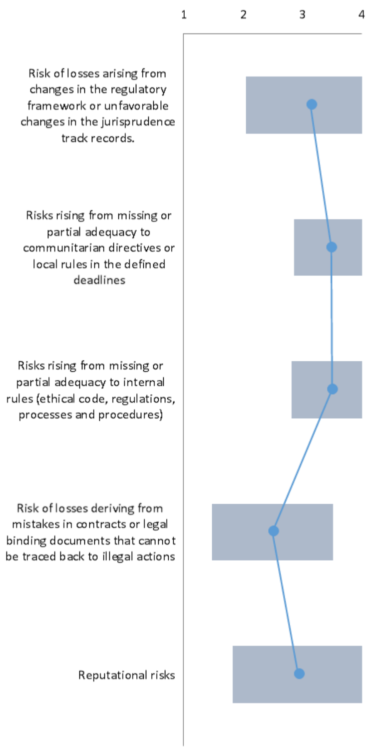


Figure 3.4: Are those risk categories included under the umbrella of the compliance risk? Dots display the average, boxes display the variance. 1:=Absolutely No; 2=No; 3=Yes; 4=Absolutely Yes.

(a) Full Sample
.



(b) Subsample(Size)
•=Large; ∗=Mid; ■=Small.

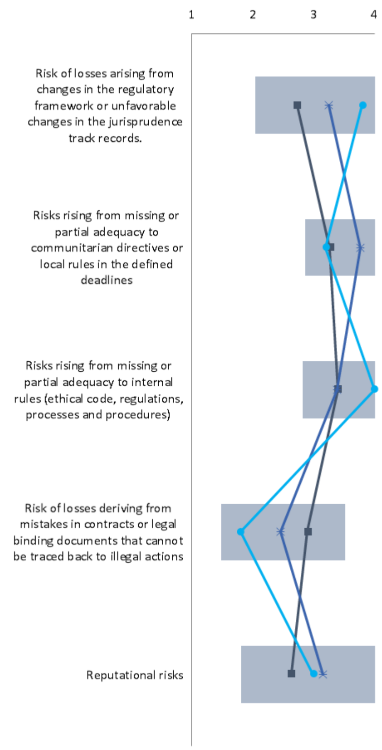


Figure 3.5: How do you rank the following risk category in term of importance in your company? Dots display the average, boxes display the variance. 1:=Most important;6:= Least important.

(a) Full Sample
.

(b) Subsamples(Size)
●=Large; ∗=Mid; ■=Small.

(c) Subsamples(Country)
●=Germany; ■=Austria.

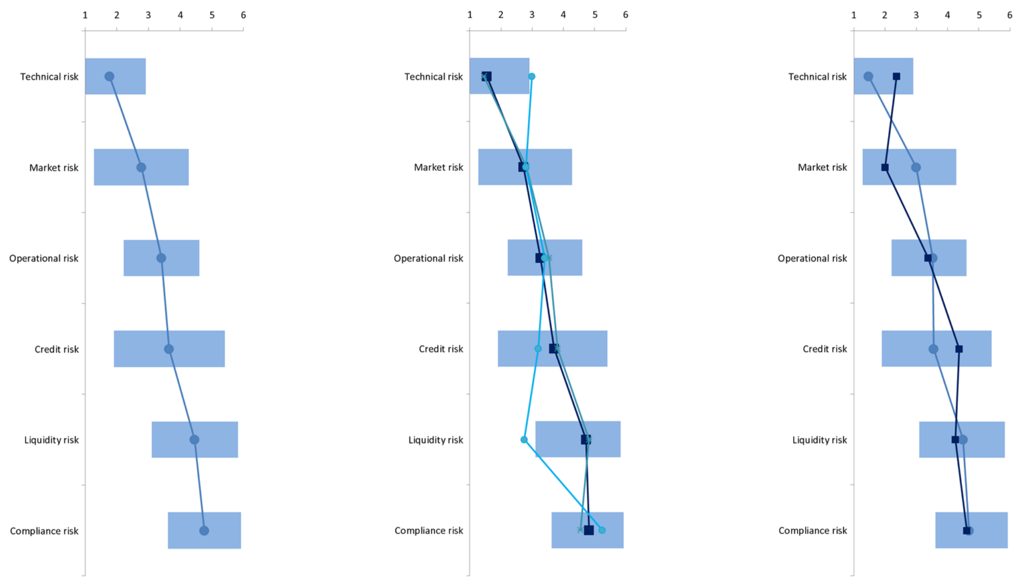


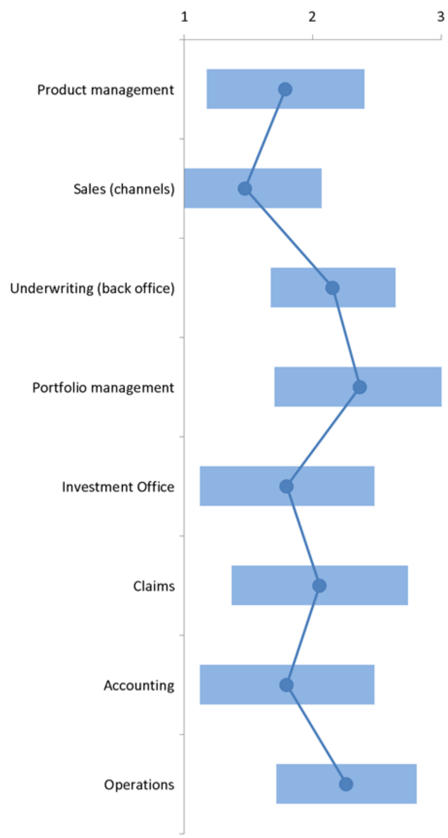
Figure 3.6: Level of information

(a) Do Risk Committee or other risk management structure have information about the sanctions received by the company in the previous periods?
.

(b) Do Risk Committee or other risk management structure have information about the potential sanctions your company is exposed in case of inspections?

Figure 3.7: Do you consider the exposure to compliance risk the following departments High(1) / Medium(2) / Low(3)?
Dots display the average, boxes display the variance

(a) Full Sample
.



(b) Subsamples(Size)
•=Large; ∗=Mid; ■=Small.

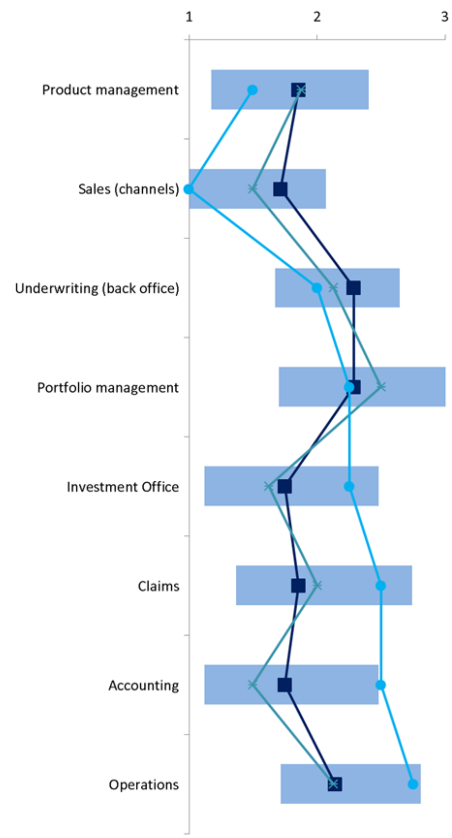
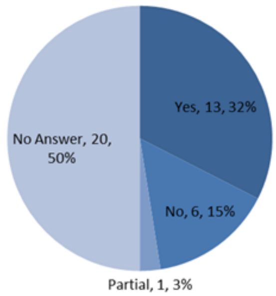


Figure 3.8: Your management risk approach includes the measurement of compliance risk in a:

(a) Forward looking perspective



(b) backward looking perspective

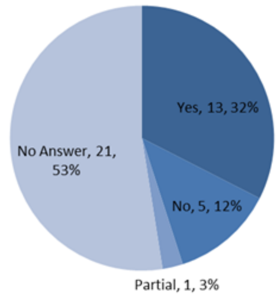
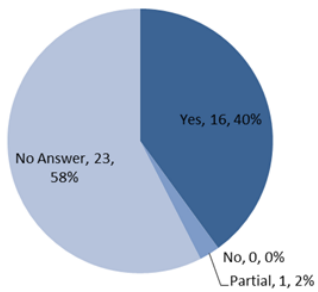


Figure 3.9: Is the compliance risk embedded in the operational risk management framework?

(a) Full sample



(b) Subsample

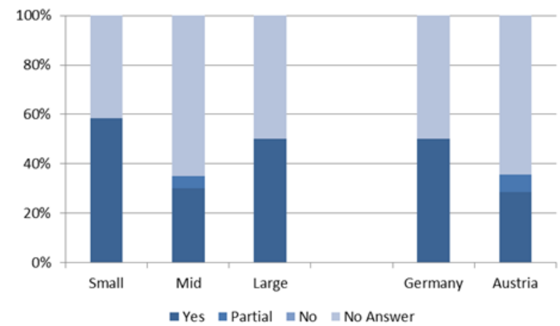
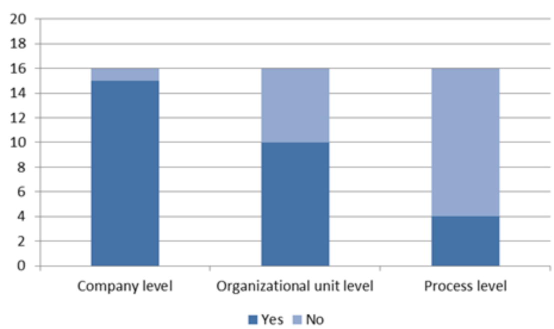


Figure 3.10: Do you register losses / potential losses at:

(a) Full sample



(b) Subsample

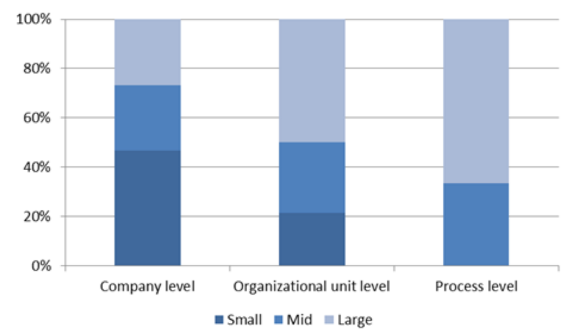
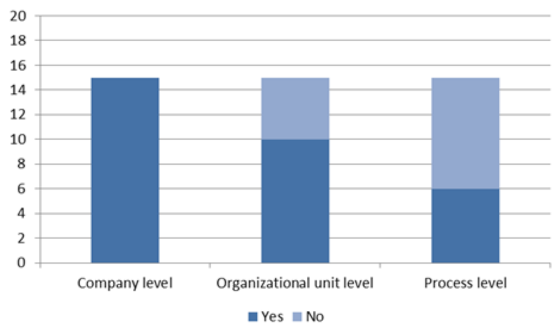


Figure 3.11: The risk self assessment is run at:

(a) Full sample



(b) Subsample

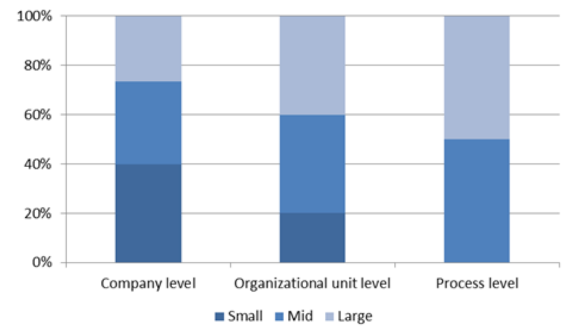
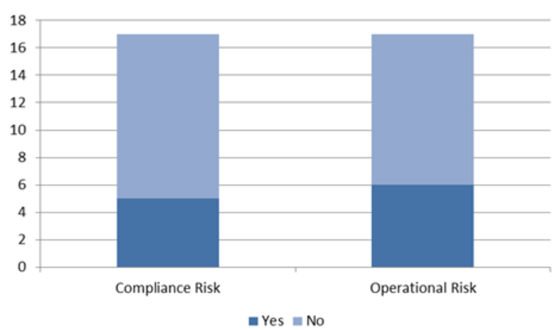


Figure 3.12: Do you have specific software to model:

(a) Full sample



(b) Subsample

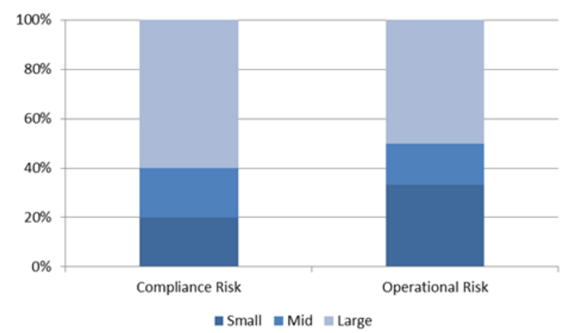
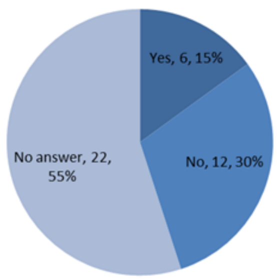


Figure 3.13: Does your company will invest on the improvement of the compliance risk approaches in the near future?

(a) Full sample



(b) Subsample

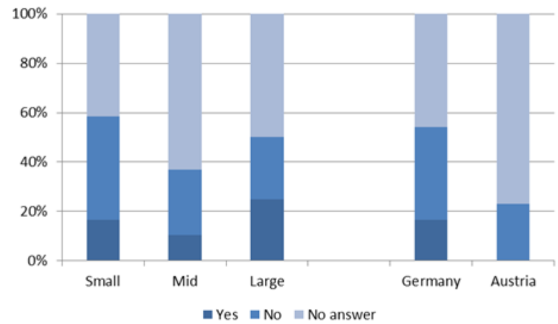
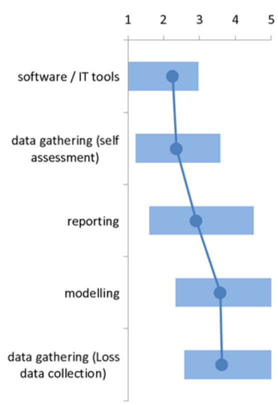
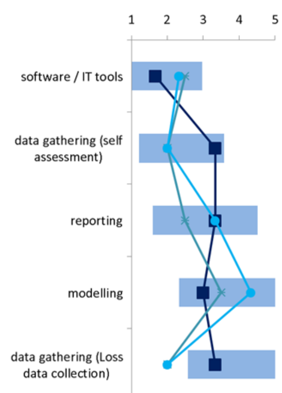


Figure 3.14: On which of the following areas does your company plan to invest (please rank for priority) Dots display the average, boxes display the variance. 1:=Most important;6:=Least important.

(a) Full Sample
.



(b) Subsamples(Size)
●=Large; ∗=Mid; ■=Small.



(c) Subsamples(Country)
●=Germany; ■=Austria.

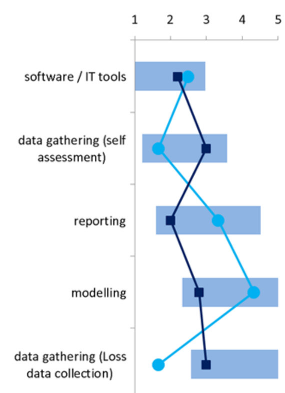


Figure 3.15: Do you agree with the following definition: “Reputational Risk is a consequential (secondary) risk resulting from the typical risks of the insurance business, such as operational or compliance risks. It arise when the primary events”

(a) Full sample (b) Subsample

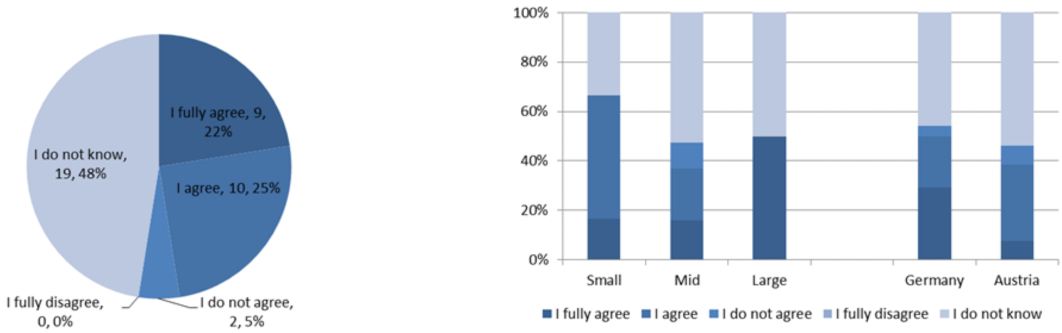


Figure 3.16: What do you think are the main sources for reputational risk? (please rank) Dots display the average, boxes display the variance. 1:=Most important;6:= Least important.

(a) Full Sample
.
.

(b) Subsamples(Size)
●=Large; ∗=Mid; ■=Small.

(c) Subsamples(Country)
●=Germany; ■=Austria.
.

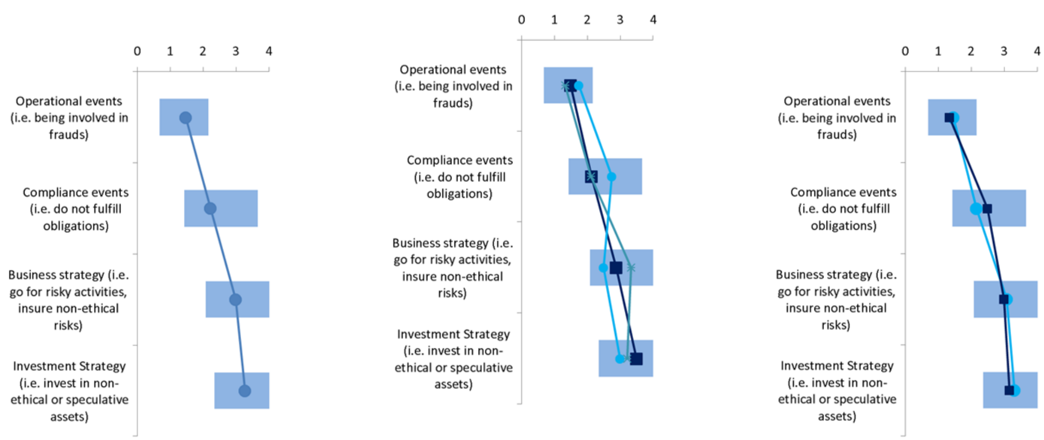
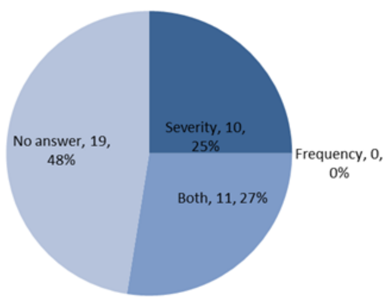


Figure 3.17: In your opinion, the main trigger for a reputational event is the frequency or the severity of a primary event?

(a) Full sample



(b) Subsample

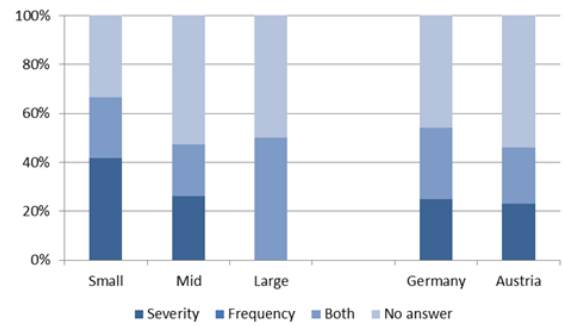
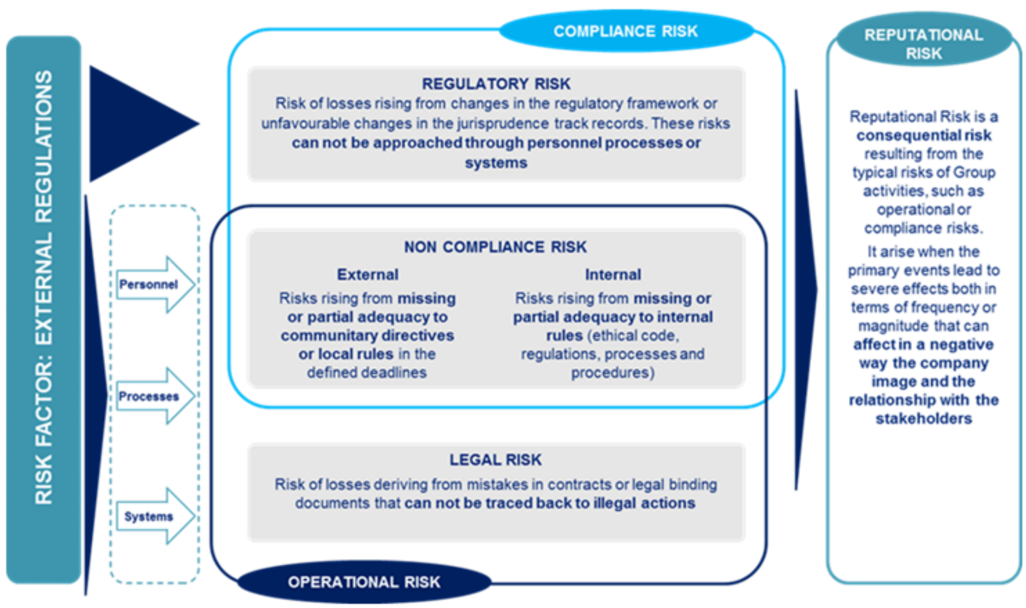


Figure 3.18: Perimeter of the complaince risk.



Bibliography

Acharya, V. V., Pedersen, L. H., Philippon, T., and Richardson, M. P. (2010). Measuring Systemic Risk. *FRB of Cleveland Working Paper*, (10-02).

Adrian, T. and Brunnermeier, M. K. (2011). CoVaR. *National Bureau of Economic Research Working Paper*, (17454).

Agle, K.P., R. R. and Wolff, K. (2013). Method and system for assessing compliance risk of regulated institutions. Technical report, US Patent App US Patent 8,543,444, 2013.

Albert O. Hirschman (1964). The paternity of an index. *The American Economic Review*, 54(5):761–762.

Albizzati, M. and Geman, H. (1994). Interest rate risk management and valuation of the surrender option in life insurance policies. *Journal of Risk and Insurance*, 61(2):616637.

Allen, W. A. and Wood, G. (2006). Defining and Achieving Financial Stability. *Journal of Financial Stability*, 2(2):152–172.

Ampudia, M. and Van-den Heuvel, S. (2017). Monetary policy and bank equity values in a time of low interest rates. *Working paper*.

Angrist, J. D. and Krueger, A. B. (1999). Empirical Strategies in Labor Economics. *Handbook of labor economics*, 3:1277–1366.

Arseneau, D. (2017). How would u.s. banks fare in a negative interest rate environment? *Finance and Economics Discussion Series, Board of Governors of the Federal Reserve System (U.S.)*, 2017-30.

BaFin (2013). Bafin annual report 2013: Measures to protect policyholders. `http://http://www.bafin.de/SharedDocs/Veroeffentlichungen/EN/Jahresbericht/2013/jb_2013_IV_3_5_me`.

Baluch, F., Mutenga, S., and Parsons, C. (2011). Insurance, Systemic Risk and the Financial Crisis. *The Geneva Papers on Risk and Insurance-Issues and Practice*, 36(1):126–163.

Banerjee, R., Latto, D., and McLaren, N. (2014). Using changes in auction maturity sectors to help identify the impact of qe on gilt yields. *Economic Journal*, 124:453–479.

Bank of England (2013). Prudential regulation authority, policy: Europe and uk - pillar 2 systems of governance.
http://www.bankofengland.co.uk/pra/Documents/solvency2/pillar2.pdf.

Bank of international Settlement (2006). International convergence of capital measurement and capital standards.
http://www.bis.org/publ/bcbs128.pdf.

Bell, M. and Keller, B. (2009). Insurance and Stability: the Reform of Insurance Regulation. *Zurich Financial Services Group Working Paper*.

Berdin, E. and Grndl, H. (2015). The effect of a low interest rate environment on life insurers. *The Geneva Papers on Risk and Insurance-Issues and Practice*, 40(3):385–415.

Berdin, Elia and Sottocornola, Matteo (2015). Assessing the Systemic Relevance of the European Insurance Industry. *Financial Stability Report - December 2015*.

Bernanke, B. S. and Kuttner, K. (2005). What explains the stock market's reaction to federal reserve policy? *The Geneva Papers on Risk and Insurance-Issues and Practice*, 60:1221–1257.

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

Billio, M., Getmansky, M., Lo, A. W., and Pelizzon, L. (2012). Econometric Measures of Connectedness and Systemic Risk in the Finance and Insurance Sectors. *Journal of Financial Economics*, 104(3):535–559.

Bisias, D., Flood, M., Lo, A. W., and Valavanis, S. (2012). A Survey of Systemic Risk Analytics. *Annu. Rev. Financ. Econ.*, 4(1):255–296.

Bogen, K. (1996). The effect of questionnaire length on response rates - a review of the literature. proceedings of the section on survey research methods. *National Bureau of Economic Research Working Paper*, pages 1020–1025.

Borio, C. (2003). Towards a Macroprudential Framework for Financial Supervision and Regulation? *CESifo Economic Studies*, 49(2):181–215.

Borio, C. and Disyatat, P. (2011). Global Imbalances and the Financial Crisis: Link or no Link? *Bank for International Settlements Working Paper*, (346).

Briciu, L. and Lisi, G. (2015). An event study analysis of ecb balance sheet policies since october 2008. *European Union Economic Brief*, 1.

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

Brunnermeier, M. K., Dong, G., and Palia, D. (2012). Banks Non-Interest Income and Systemic Risk. *AFA 2012 Chicago Meetings Paper*.

Chen, H., Cummins, J. D., Viswanathan, K. S., and Weiss, M. A. (2014). Systemic Risk and the Interconnectedness between Banks and Insurers: An Econometric Analysis. *Journal of Risk and Insurance*, 81(3):623–652.

Chen, H., Curdina, V., and Ferrero, A. (2012). The macroeconomic effect of large-scale asset purchase programmes. *Economic Journal*, 122:289–315.

Christophersen, C. and Zschiesche, J. (2015). Macroprudential Objectives and Instruments for Insurance - An Initial Discussion. *Financial Stability Report - May 2015*.

Chung, H., Laforte, J., Reifschneider, D., and Williams, J. (2010). Have we underestimated the likelihood and severity of zero lower bound events? *Journal of Money, Credit and Banking*, 44:47–82.

Cook, T. and Hahn, T. (1998). The effect of changes in the federal funds rate target on market interest rates in the 1970s. *Journal of Monetary Economics*, 24:331–351.

Crocket, A. (2000). Marrying the micro- and macro-prudential dimensions of financial stability. Remarks before the Eleventh International Conference of Banking Supervisors, held in Basel, 20-21 September 2000.

Cummins, J. D. and Weiss, M. A. (2014). Systemic Risk and the US Insurance Sector. *Journal of Risk and Insurance*, 81(3):489–582.

D'Amico, S., English, W., Lopez-Salido, D., and Nelson, E. (2012). The federal reserve's large-scale asset purchase programmes: Rationales and effects. *Economic Journal of Finance*, 122:415–446.

Das, S. R. and Uppal, R. (2004). Systemic Risk and International Portfolio Choice. *The Journal of Finance*, 59(6):2809–2834.

Deloitte Consulting (2014). Reputational risk survey report. `http://www2.deloitte.com/it/it/pages/governance-risk-and-compliance/articles/reputation-at-risk.html`.

Deutsche Bundesbank (2013). Financial stability review 2013. Technical report.

Draghi, M. (2012). Text of the video message given at the award ceremony for the second luca pacioli award. speech by mario draghi, president of the ecb.

ECB (2015). Ecb announces expanded asset purchase programme.

Ehrmann, M., Fratzscher, M., Guerkanyak, R., and Swanson, E. (2011). Convergence and anchoring of yield curves in the euro area. *Review of Economics and Statistics*, 93:350–364.

EIOPA (2011). EIOPA Report on the fifth Quantitative Impact Study (QIS5)for Solvency II. Technical report.

EIOPA (2013). Financial stability report, second half year report 2013.

EIOPA (2014a). Financial stability report, second half year report 2014.

EIOPA (2014b). The underlying assumptions in the standard formula for the solvency capital requirement calculation.
`https://eiopa.europa.eu/Publications/Standards/EIOPA-14-322_Underlying_Assumptions.pdf`.

EIOPA (2015). Financial stability report, second half year report 2015.

EIOPA (2015). Guidelines on the extension of the recovery period in exceptional adverse situations.

EIOPA (2016). Report on long term guarantees measures and measures on equity risk.

EIOPA (2017a). Final report on consultation paper no. 16/003 on the methodology to derive the ultimate forward rate and its implementation.

EIOPA (2017b). Risk dashboards may 2017.

EIOPA (2017c). Technical documentation of the methodology to derive EIOPAs risk-free interest rate term structures. https://eiopa.europa.eu/Publications/Standards/Technical

Eling, M. and Pankoke, D. (2012). Systemic Risk in the Insurance Sector–What Do We Know? *University of St. Gallen, School of Finance Working Papers*, (2012/22).

Eling, M. and Schmeiser H. (2010). Insurance and the credit crisis: Impact and ten consequences for risk management and supervision. *The Geneva Papers on Risk and Insurance-Issues and Practice*, 35(1):9–34.

European Commission (2005). Financial services policy 2005-2010. *European Commission White Papers*, 2005(15).

European Commission (2013). 2013/36/EU - Directives on access to the activity of credit institutions and the prudential supervision of credit institutions and investment firms.
`http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:176:0338:0436:En:PDF`.

European Commission (2015). 2015/35/EU - Directive supplementing Directive 2009/138/EC of the European Parliament and of the Council on the taking-up and pursuit of the business of Insurance and Reinsurance (Solvency II).
`http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L:2015:012:FULL&from=EN`.

European Parliament and of the Council of 25 (2009). Directive 2009/138/EC on the Taking-Up and Pursuit of the Business of Insurance and Reinsurance (Solvency II).

European Parliament and the Council of 25 (2014). REGULATION (EU) No 1286/2014 on key information documents for packaged retail and insurance-based investment products (PRIIPs).

Financial Stability Board (2009). Guidance to Assess the Systemic Importance of Financial Institutions, Markets and Instruments: Initial Considerations. *Report to G20 Finance Ministers and Governors*.

Gambacorta, L., H. B. and Peersman, G. (2014). The effectiveness of unconventional monetary policy at the zero lower bound: A cross-country analysis. *Journal of Money, Credit and Banking*, 46:615–642.

Garry, J. S. (2004). Defining Financial Stability. *IMF Working Paper*, (187).

Gatzert, N. (2008). Asset Management and Surplus Distribution Strategies in Life Insurance: An Examination with Respect to Risk Pricing and Risk Measurement. *Insurance: Mathematics and Economics*, 42(2):839–849.

Geneva Association (2010). Systemic Risk in Insurance: an Analysis of Insurance and Financial Stability. Technical report, Special Report of The Geneva Association Systemic Risk Working Group, Switzerland.

Getmansky, M., Girardi, G., Hanley, K., Nikolova, S., and Pelizzon, L. (2017). Portfolio similarity and asset liquidation in the insurance industry. *Available at SSRN: https://ssrn.com/abstract=2749691 or http://dx.doi.org/10.2139/ssrn.2749691*.

Gray, D. F. and Jobst, A. A. (2011). Modelling Systemic Financial Sector and Sovereign Risk. *Sveriges Riksbank Economic Review*, (2).

Grosen, A. and Lchte Jrgensen, P. (2000). Fair valuation of life insurance liabilities: the impact of interest rate guarantees, surrender options, and bonus policies. *Insurance: Mathematics and Economics*, 26(1):3757.

Group of Twenty (2009). Enhancing sound regulation and strenghtening transparency. G20 Working Group 1, 25 March.

Harrington, S. E. (2009). The Financial Crisis, Systemic Risk, and the Future of Insurance Regulation. *Journal of Risk and Insurance*, 76(4):785–819.

Holsboer, J. H. (2000). The impact of low interest rates on insurers. *Geneva Papers on Risk and Insurance: Issues and Practice*, 25(1):38–58.

Huang, X., Zhou, H., and Zhu, H. (2012). Systemic Risk Contributions. *Journal of Financial Services Research*, 42(1-2):55–83.

IAIS (2011). Insurance and financial stability.

IAIS (2016). Global systemically important insurers: Updated assessment methodology.

IAIS (2017). Activities-based approach to systemic risk - interim consultation paper. https://www.iaisweb.org/page/consultations/current-consultations/activities-based-approach-to-systemic-risk//file/70440/interim-aba-cp-final-for-launch.

IBM (2016). Governance, risk and compliance - integrated solutions for enterprise-wide grc. `http://www.ibm.com/analytics/us/en/business/governance-risk-compliance/`.

Ibragimov, R., Jaffee, D., and Walden, J. (2011). Diversification Disasters. *Journal of financial economics*, 99(2):333–348.

Insurance Europe (2016). European insurance in figures - 2015 data.

Ippolito, F., Ozdagli, A. K., and Perez, A. (2015). Is bank debt special for the transmission is bank debt special for the transmission. *Unpublished manuscript. Universitat Pompeu Fabra.*

IVASS (2008). Regolamento 20, 20 article 19, sub 2, letter h. `http://www.ivass.it/ivass_cms/docs/F23818/Regulation%2020%20-%2030%20Jun%202014.pdf`.

Joint Committee of the European Supervisory Authorities (2017). Report on risks and vulnerabilities of the eu financial system april 2017.

Joyce, M., Lasosa, A., Stevens, I., and Tong, M. (2011). The financial market impact of quantitative easing in the united kingdom. *International Journal of Central Banking*, 7:113–161.

Kapetanios, G., Haroon, I., and Theodoridis, K. (2012). Assessing the economy-wide effects of quantitative easing. *International Journal of Central Banking*, 122:316–347.

Kelley, K., Clark, B., Brown, V., Sitzia, J. (2003). Good practice in the conduct and reporting of survey research. *EInternational Journal of Quality in the Healthcare*, 15(3):261–266.

Kessler, D., Montchalin, A., and Thimann, C. (2004). *The Macroeconomic Role of Insurance.* Oxford University Press.

King, R. G., Plosser, C., Stock, J., and Watson, M. (1991). Stochastic trends and economic fluctuations. *American economic Review*, 81:819–840.

Kling, A., R. A. and Ru, J. (2007a). The impact of surplus distribution on the risk exposure of with profit life insurance policies including interest rate guarantees. *Journal of Risk and Insurance*, 74(3):571589.

Kling, A., R. A. and Ru, J. (2007b). The interaction of guarantees, surplus distribution, and asset allocation in with-profit life insurance policies. *Insurance: Mathematics and Economics*, 40(1):164178.

Krishnamurthy, A. and Vissing-Jorgensen, A. (2011). The effects of quantitative easing on long-term interest rates. *Brookings Papers on Economic Activity*, 2:215–265.

Li, C. and Wei, M. (2013). Term structure modelling with-supply factors and the federal reserve's large-scale asset purchase programs. *International Journal of Central Banking*, 9:3–39.

List Group (2014). Multicompliance evolution.
`http://www.list-group.com/uk/grc/compliance.asp`.

Mackinlay, A. (1997). Event studies in economics and finance. *Journal of Economic Literature*, 35:13–39.

Meyer, B. D. (1995). Natural and quasi-Experiments in Economics. *Journal of Business & Economic Statistics*, 13(2):151–161.

Oliver Wyman (2015). Streamlining compliance risk and internal audit.
`http://www.oliverwyman.com/content/dam/oliver-wyman/global/en/2015/mar/Streamlining_Risk_Compliance_Internal_Audit.pdf`.

Pelizzon, Loriana and Sottocornola, Matteo (2016). The impact of the monetary policy interventions on the insurance industry. *Financial Stability Report - December 2016*.

Pericoli, M. and Veronese, G. (2016). Monetary policy surprises and channels of transmission. *Working Paper - Banca d'Italia*.

Power, M., Ashby, S., and Palermo, T (2015). Risk culture in financial organisations. *London School of Economics Risk Report*.

Raffestin, L. (2014). Diversification and Systemic Risk. *Journal of Banking & Finance*, 46(3):85–106.

Rigobon, R. (2003). Identification through heteroskedasticity. *The review of Economics and stasistics*, 85(4):777–792.

Rogers, J. H., Scotti, C., and Wright, J. H. (2014). Evaluating asset-market effects of unconventional monetary policy: A cross-country comparison. *International Finance Discussion Papers*, 1101.

Sanchez, M. and Morchio, G. (1992). Probing "don't know" answers: Effects on survey estimates and variable relationships. *The Public Opinion Quarterly*, 56(4):454–474.

SAS (2012). Enterprise grc. fact sheet.
`http://www.sas.com/content/dam/SAS/en_us/doc/factsheet/sas-enterprise-grc-104493.pdf`.

Statistics Canada (2003). *Survey Methods and Practices.* Catalogue no. 12-587-X ISBN 0-660-19050-8.

Swiss Re (2003). Reinsurance – a Systemic Risk. *Sigma*, 5/2003.

The Group of Thirty (2006). Reinsurance and International Financial Markets. *Washington D.C., US.*

Wagner, W. (2010). Diversification at Financial Institutions and Systemic Crises. *Journal of Financial Intermediation*, 19(3):373–386.

Wedow, M. and Kablau, A. (2011). Gauging the Impact of a Low-Interest Rate Environment on German Life Insurers. *Deutsche Bundesbank Discussion Papers No. 02/2011.*

Weiß, G. N. and Mühlnickel, J. (2014). Why do Some Insurers Become Systemically Relevant? *Journal of Financial Stability*, 13:95–117.

Wooldridge, J. M. (2010). *Econometric Analysis of Cross Section and Panel Data.* MIT press.

Estratto per riassunto della tesi di dottorato

Studente: Matteo Sottocornola ________________________ matricola: 956325 ____________

Dottorato: ECONOMIA ____

Ciclo: 29 __________

Titolo della tesi : Essays on insurance regulation ____

Abstract:

English[1]:

The recently enforced Solvency II regime introduced relevant improvements in the insurance micro-prudential supervision including the move from a book based to a consistent market based valuation of the assets and the liabilities of insurance undertakings. Like other market based micro-prudential regulation Solvency II suffers of well known drawbacks such as the procyclicality of the valuation and the potential incentive for undertakings to commonly behave against specific circumstances. The latter element in particular, even if it is not of a concern by a micro-prudential perspective, could generate unintended detrimental effects at system level emphasizing the conflict between micro and macro-prudential regimes. Being (re)insurances provider of long-term funding to the economy, a potential misalignment in the macro- and micro- supervision might generate material externalities to the whole economy. Being Solvency II applied to long term investors, it encompasses since its first enforcement qualitative and quantitative elements with macro-prudential effects aimed at smoothing the divergences between the goals of micro- and macro-prudential regimes. This work contributes to understanding of the systemic implication of the (re)insurers with specific reference to the undertaken activities and their sensitivity to monetary policy actions implemented by the Central Banks. Furthermore, it analyses the level of enforcement of the current regulatory regimes. Eventually, this thesis aims at providing a conceptual contribution to the improvements of the micro- and macro-prudential supervision in insurance.

The first chapter investigates systemic risk in the insurance industry. The contribution is twofold: at first a cross sectional analysis based on 3 market based measures (linear Granger causality test, conditional value at risk and marginal expected shortfall) on the systemic contribution of the insurance industry vis-a'-vis banks and non-financial industry is provided. Secondly we investigate the determinants of the systemic risk contribution within the insurance industry by using balance sheet level data. Evidence suggests that *i)* the insurance industry shows a persistent systemic relevance over time and plays a subordinate role in causing systemic risk compared to banks, and that *ii)* within the industry, those insurers which engage more in non-insurance-related activities tend to pose more systemic risk. These results shed new light on the role of insurers in posing systemic risk and on the main determinants therein. This is a particularly relevant contribution on the debate on macroprudential supervision in insurance.

The second chapter investigates the effect of the conventional and unconventional (e.g. Quantitative Easing) monetary policy intervention on the insurance industry. The work at first measures whether and to what extent the last Quantitative Easing programme launched by the European Central Bank - ECB affected the stock performances of a large sample of (re)insurers by constructing an event study around the announcement date. Then, we enlarge the time frame by looking at the monetary policy surprise effects over a period of 12 years. In the second part of the paper we build a set of balance sheet based indices, aimed at identifying the characteristics of (re)insurers which determine their sensitivity to the monetary policy actions. Evidences suggest that a single intervention extrapolated from the comprehensive strategy cannot be utilized to estimate the effect of the central banks' actions on the markets. The extended analysis on the monetary policy surprises

[1] In case of uncertainty in the interpretation of the two versions of the abstract, the english version shall be taken as a reference.

shows how impact of the monetary interventions on the (re)insurers change over time. The expansionary monetary policy interventions, when generating an instantaneous reduction of interest rates, impinge a movement in the stock prices in the same direction till September 2010. This effect turns to positive during the European sovereign debt crisis and it fades away in 2014-2015. The analysis of the balance sheet indices suggests that the sensitivity of (re)insurers to the monetary policy actions is mainly driven by the asset allocation and in particular by the exposures to fixed income assets. This work provides further contribution to the literature on the analyses of the monetary policy enriching it with a specific focus on the insurance industry.

The third chapter elaborates over the concept of compliance risk in the European insurance industry. In the absence of a common definition and subsequent blurred perimeter at European and national level, the work propose a shared definition and a clear indication on which risks have to be included under the umbrella of the compliance risk. The topic is approached via a survey extended to insurance companies based in Germany and Austria by posing a set of questions on the perception, materiality, approaches, models and foreseen evolution on the compliance risk. Within the limitation of the approach and of the sample, the survey spots the lower priority assigned by the companies to the compliance risk in the year of enforcement of Solvency II and the subsequent initial stage of evolution of the models and the approaches in place to manage it. The survey allows inferring a clear and shared definition of the compliance risk among the insurers and provides valuable indication for setting its perimeter. The increased clearness would ease the convergence to a common standard the enforcement by insurance undertakings of Solvency II in its completeness including the qualitative and quantitative aspects aimed at reducing its unintended potential negative effects at macro-prudential level.

Italiano:

La normative Solvency II recentemente introdotta contempla il passaggio dalla valutazione di attivi e passivi da valore contabile a valore di mercato, pertanto rappresenta un consistente miglioramento nell’approccio alla supervisione microprudenziale delle assicurazioni. Basandosi su valori di mercato, Solvency II, presenta le stesse problematiche di altri approcci microprudenziali che si rifanno agli stessi principi, fra cui la prociclicalita’ e l’incentivo per le imprese di assicurazione a reagire comunemente a eventi esterni. In particolare le reazioni comuni da parte delle compagnie assicurative, ancorche’ di scarso interesse a livello microprudenziale, possono generare effetti consistenti a livello di sistema mettendo in evidenza i potenziali conflitti fra i regimi macro e microprudenziali con elevati impatti sull’economia se riferiti a soggetti come le assicurazioni che froniscono capitali a lungo termine. Essendo applicata a investitori a lungo termine, Solvency II ha previsto fin dal principio una serie di elementi quali e quantitativei atti a smorzare le potenziai divergenza fra i regimi micro e macroprudenziali nel maecato assicurativo Europeo. Il presente lavoro si pone come obiettivo quello di chiarire ulteriormente le implicazioni sistemiche delle assicurazioni e il livello di applicazine del relativo sistema regolamentare. In ultima istanza questa tesi ambisce a fornire un contributo al miglioramento della supervisione micro e macroprudenziale nelle assicurazioni.

Il primo capitolo indaga il rischio sistemico nell’industria assicurativa. Il contributo della ricerca e’ duplice: nella prima parte viene raffrontato il contributo sistemico delle imprese assicurative a quello delle banche e delle imprese industriali attraverso una analisi cross-settoriale applicando tre misure di rischio sistemico basate su dati di mercato (Granger causality test, conditional value at risk and marginal expected shortfall). Nell seconda parte indaghiamo cosa detrmina a livello di bilanciola maggiore o minore sistemicita delle imprese assicurative. Le evidenze empiriche suggeriscono che: i) le assicurazioni contribuiscono costantemente al rischio sistemico ma in maniera minore rispetto alle banche; ii) fra le assicurazioni la maggiore sistemicita’ e’ legata all’esposizione ad attivita’ non tradizionali. I risultati ottenuti aiutano a chiarire il ruolo sistemico delle assicurazinoni e sono di particolare interesse nel dibattito sulla supervisione macroprudenziale nelle assicurazioni.

Il secondo capitolo analizza gli effetti degli interventi di politica monetaria convenzinali e non (i cosidetti Quantitative Easing) sulle imprese assicurative. Nella sua prima parte, il lavoro analizza se e in che termini l’ultimo programma di Quantitative Easing lanciato dalla Banca Centrale Europea ha avuto effetti sui corsi azionari delle imprese assicurative attraverso un *event study* applicato al giorno dell’annuncio. Estendiamo quindi l’analsi degli effetti delle politiche monetarie sui valori azionari applicando il concetto di *monetary policy surprise* sulle compagnie assicurative e non in un periodo di 12 anni. Nella seconda parte dell’articolo ci concentrriamo sulla costruzione di indici di bilancio finaizzati ad individuare quali caratteristiche rendono le compagnie assicurative piu o meno sensibili alle azioni di politica monetaria. L’analisi suggerisce che un singolo intervento estrapolato dalla strategia generale applicata dalla Banca Centrale Europea non fornisce stime robuste suglie ffettidelle politiche monetarie sui mercati azionari. Invece, l'analisi delle *monetary policy surprises* evidenzia come gli impatti degli interventi di politica monetaria sulle assicurazioni cambiano nel tempo. Le politiche espansive, quando generano una immediata riduzione dei tassi di interesse, hanno effetti negativi sui corsi azionari fino al Settembre del 2010. L'effetto sui prezzi delle azioni diventa invece positivo durante la cridi dei debiti sovrani in Europa, tuttavia le evidenze statistiche svaniscono nel 2014 e nel 2015. L'analisi sugli indici di bilancio evidenzia come la sensitivita' delle assicurazioni alle politiche monetarie sia principalmente riconducibile all'allocazione degli attivi ed in particolare al livello degli investimenti in titoli a reddito fisso. Questo lavoro si inserisce nel genrale contesto delle analisi sulle politiche monetarie fornendo un dettaglio sul mercato assicurativo.

Il terzo capitolo sviluppa il concetto di rischio di compliance nell'industria assicurative Europea. In assenza di una comune definizione di rischio di compliance e conseguentemente del suo perimetro non ben delimitato, questo lavoro propone una definizione condivisa e una chiara indicazione di quali rischi debbono essere inclusi nel rischio di compliance. La tematica e' approcciata attraverso un sondaggio indirizzato a compagnie assicurative operanti in Germania e Austria e contenente domande sulla percezione, materialita', approcci e modelli utilizzati nella gestione del rischio di compliance. Nelle limitazioni nel campione, il sondaggio evidenzia la bassas priorita' assegnata dalle compagnie assicurative al rischio di compliace confermata dallo stadio iniziale di sviluppo dei modelli e dei processi deputati alla sua gestione. Il sondaggio consente tuttavia di dedurre una definizione del rischio di compliace chiara e condivisa. Fornisce altresi importanti elementi per la definitione del suo perimetro.

Firma dello studente

____

Università Ca'Foscari Venezia

DEPOSITO ELETTRONICO DELLA TESI DI DOTTORATO

DICHIARAZIONE SOSTITUTIVA DELL'ATTO DI NOTORIETA'

(Art. 47 D.P.R. 445 del 28/12/2000 e relative modifiche)

Io sottoscritto Matteo Sottocornola

nato a Reggio Emilia (prov. RE) il 13 Febbraio 1975

residente a Frankfurt am Main in Gerbermuehlstrasse n. 63

Matricola (se posseduta) 956325 Autore della tesi di dottorato dal titolo:

Essays on insurance regulation

Dottorato di ricerca in Economia

(in cotutela con Goethe Universitaet Frankfurt)

Ciclo 29

Anno di conseguimento del titolo 2018

DICHIARO

di essere a conoscenza:

1) del fatto che in caso di dichiarazioni mendaci, oltre alle sanzioni previste dal codice penale e dalle Leggi speciali per l'ipotesi di falsità in atti ed uso di atti falsi, decado fin dall'inizio e senza necessità di nessuna formalità dai benefici conseguenti al provvedimento emanato sulla base di tali dichiarazioni;

2) dell'obbligo per l'Università di provvedere, per via telematica, al deposito di legge delle tesi di dottorato presso le Biblioteche Nazionali Centrali di Roma e di Firenze al fine di assicurarne la conservazione e la consultabilità da parte di terzi;

3) che l'Università si riserva i diritti di riproduzione per scopi didattici, con citazione della fonte;

4) del fatto che il testo integrale della tesi di dottorato di cui alla presente dichiarazione viene archiviato e reso consultabile via internet attraverso l'Archivio Istituzionale ad Accesso Aperto dell'Università Ca' Foscari, oltre che attraverso i cataloghi delle Biblioteche Nazionali Centrali di Roma e Firenze;

5) del fatto che, ai sensi e per gli effetti di cui al D.Lgs. n. 196/2003, i dati personali raccolti saranno trattati, anche con strumenti informatici, esclusivamente nell'ambito del procedimento per il quale la presentazione viene resa;

6) del fatto che la copia della tesi in formato elettronico depositato nell'Archivio Istituzionale ad Accesso Aperto è del tutto corrispondente alla tesi in formato cartaceo, controfirmata dal tutor, consegnata presso la segreteria didattica del dipartimento di riferimento del corso di dottorato ai fini del deposito presso l'Archivio di Ateneo, e che di conseguenza va esclusa qualsiasi responsabilità dell'Ateneo stesso per quanto riguarda eventuali errori, imprecisioni o omissioni nei contenuti della tesi;

7) del fatto che la copia consegnata in formato cartaceo, controfirmata dal tutor, depositata nell'Archivio di Ateneo, è l'unica alla quale farà riferimento l'Università per rilasciare, a richiesta, la dichiarazione di conformità di eventuali copie.

Data ________________ **Firma** ________________________________

AUTORIZZO

- l'Università a riprodurre ai fini dell'immissione in rete e a comunicare al pubblico tramite servizio on line entro l'Archivio Istituzionale ad Accesso Aperto il testo integrale della tesi depositata;
- l'Università a consentire:
    - la riproduzione a fini personali e di ricerca, escludendo ogni utilizzo di carattere commerciale;
    - la citazione purché completa di tutti i dati bibliografici (nome e cognome dell'autore, titolo della tesi, relatore e correlatore, l'università, l'anno accademico e il numero delle pagine citate).

DICHIARO

1) che il contenuto e l'organizzazione della tesi è opera originale da me realizzata e non infrange in alcun modo il diritto d'autore né gli obblighi connessi alla salvaguardia di diritti morali od economici di altri autori o di altri aventi diritto, sia per testi, immagini, foto, tabelle, o altre parti di cui la tesi è composta, né compromette in alcun modo i diritti di terzi relativi alla sicurezza dei dati personali;
2) che la tesi di dottorato non è il risultato di attività rientranti nella normativa sulla proprietà industriale, non è stata prodotta nell'ambito di progetti finanziati da soggetti pubblici o privati con vincoli alla divulgazione dei risultati, non è oggetto di eventuali registrazione di tipo brevettuale o di tutela;
3) che pertanto l'Università è in ogni caso esente da responsabilità di qualsivoglia natura civile, amministrativa o penale e sarà tenuta indenne a qualsiasi richiesta o rivendicazione da parte di terzi.

A tal fine:
- dichiaro di aver autoarchiviato la copia integrale della tesi in formato elettronico nell'Archivio Istituzionale ad Accesso Aperto dell'Università Ca' Foscari;
- consegno la copia integrale della tesi in formato cartaceo presso la segreteria didattica del dipartimento di riferimento del corso di dottorato ai fini del deposito presso l'Archivio di Ateneo.

Data __________________ **Firma** __________________________________

La presente dichiarazione è sottoscritta dall'interessato in presenza del dipendente addetto, ovvero sottoscritta e inviata, unitamente a copia fotostatica non autenticata di un documento di identità del dichiarante, all'ufficio competente via fax, ovvero tramite un incaricato, oppure a mezzo posta

Firma del dipendente addetto ....

Ai sensi dell'art. 13 del D.Lgs. n. 196/03 si informa che il titolare del trattamento dei dati forniti è l'Università Ca' Foscari - Venezia.
I dati sono acquisiti e trattati esclusivamente per l'espletamento delle finalità istituzionali d'Ateneo; l'eventuale rifiuto di fornire i propri dati personali potrebbe comportare il mancato espletamento degli adempimenti necessari e delle procedure amministrative di gestione delle carriere studenti. Sono comunque riconosciuti i diritti di cui all'art. 7 D. Lgs. n. 196/03.