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Beiträge zu wirtschaftswissenschaftlichen
Problemen der Versicherung

Thomas Nowak

Non-Life Insurance-Linked Securities: Risk and Pricing Analysis

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Beiträge zu wirtschaftswissenschaftlichen Problemen der Versicherung 69
Herausgegeben von Prof. Dr. Andreas Richter und Prof. Dr. Thomas Hartung

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Geleitwort

Insurance-Linked Securities (ILS) erfahren nicht nur in der Versicherungspraxis sondern auch in der Versicherungswissenschaft seit über 20 Jahren Aufmerksamkeit. Impulse für die Verbriefung von Versicherungsrisiken entstanden zwar zunächst in der Praxis, führten dann nach und nach aber zu einer intensiven Auseinandersetzung mit ILS in der versicherungswissenschaftlichen Literatur. Ihre Kernidee besteht darin, Versicherungsrisiken aus den eng abgegrenzten Märkten der Erst- und Rückversicherungswirtschaft herauszulösen und mittels Verbriefungsstrukturen auf Kapitalmärkten handelbar zu machen.

Das Interesse von Investoren an handelbaren Versicherungsrisiken wird damit begründet, dass diese keine oder nur sehr geringe Korrelationen mit anderen gehandelten Assetklassen aufweisen würden und somit zur Portfoliooptimierung beitragen könnten. Aus der Praxis wird zudem häufig das - im Grunde zum gerade genannten widersprüchliche - Argument angeführt, dass verbriefte Versicherungsrisiken mit attraktiven Renditeerwartungen versehen sind. Bereits an dieser Stelle wird eine Art von "cultural clash" ersichtlich, der aus dem Aufeinandertreffen von in der Versicherungswirtschaft üblichen, aktuariell geprägten Risikobewertungsmethoden und dem auf der Idee der Arbitragefreiheit basierenden Bewertungsansatz der Kapitalmarkttheorie resultiert. Beide Bewertungsansätze lassen sich jeweils theoretisch begründen, führen jedoch in der praktischen Anwendung zu teils divergenten Ergebnissen. Investoren in ILS stehen aber vor dem Dilemma, Preise für solche Verbriefungen einschätzen und beurteilen zu müssen. Somit stellt sich die Frage, welche grundsätzliche Bewertungskonzeption für die Bewertung und Preisfindung (im Sinne eines fairen Marktpreises) von ILS "besser" geeignet ist - die aktuarielle oder die kapitalmarkttheoretische.

An dieser Stelle setzt die vorliegende Schrift an. Aufbauend auf einer grundlegenden Analyse der Zahlungsstrom- und Risikostruktur von ILS werden in ihr gängige aktuarielle und kapitalmarkttheoretische Bewertungskonzepte auf ihre Eignung zur Preisfindung bei ILS untersucht. Damit werden ein theoretischer Beitrag zum tieferen Verständnis der Verbriefung von Versicherungsrisiken geleistet und Hinweise auf mögliche Sekundärmarktbewertungen geliefert.

Ich wünsche der Schrift von Nowak die ihr gebührende Aufmerksamkeit und einen entsprechenden Leserkreis sowohl in der Versicherungswissenschaft als auch in der Versicherungspraxis.

München, im August 2014 Univ.-Prof. Dr. Thomas Hartung

Vorwort

Die vorliegende Arbeit fertigte ich während meiner Tätigkeit als Wissenschaftlicher Mitarbeiter an der Professur für Versicherungswirtschaft der Universität der Bundeswehr München an. Sie wurde im März 2014 von der Fakultät für Wirtschafts- und Organisationswissenschaften als Dissertation angenommen.

An dieser Stelle möchte ich mich bei Univ.-Prof. Dr. Thomas Hartung, dem Inhaber der Professur für Versicherungswirtschaft, für die Betreuung und die Übernahme des Erstgutachtens sowie bei Univ.-Prof. Dr. Andreas Brieden für das Anfertigen des Zweitgutachtens herzlich bedanken. Großer Dank gebührt auch Univ.-Prof. Dr. Friedrich Sell, dem Vorsitzenden der Prüfungskommission, für die Organisation meines Promotionsverfahrens und Univ.-Prof. Dr. Eva-Maria Kern sowie Univ.-Prof. Dr. Andreas Schüler für ihren Beitrag in der Prüfungskommission.

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Zu guter Letzt möchte ich an dieser Stelle meine Dankbarkeit gegenüber meiner Familie für die stetige und vielschichtige Unterstützung und die generell ermöglichte Bildungslaufbahn zum Ausdruck bringen.

München, im August 2014 Thomas Nowak

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List of Abbreviations

a.s.	almost surely
AFIR	Actuarial Approach for Financial Risks
AIR	Applied Insurance Research
ALM	Asset-Liability Management
APT	Arbitrage Pricing Theory
ART	Alternative Risk Transfer
ASTIN	Actuarial Studies In Non-life Insurance
BCBS	Basel Committee on Banking Supervision
càdlàg	continue à droite, limites à gauche
CAF	Centre for Analytical Finance
CAPM	Capital Asset Pricing Model
cat bond	catastrophe bond
cat model	catastrophe model
CatXL	Catastrophe Excess of Loss Reinsurance Contract
CEA	Comité Européen des Assurances
CEIOPS	Committee of European Insurance and Occupational Pensions Supervisors
DCF	Discounted Cash Flow
ECEE	European Conference on Earthquake Engineering
ed.	editor
eds.	editors
EMM	Equivalent Martingale Measure
et al.	et alii
FIFA	Fédération Internationale de Football Association

HdV	Handwörterbuch der Versicherung
i.i.d.	independent and identically distributed
IAA	International Actuarial Association
IAIS	International Association of Insurance Supervisors
IASB	International Accounting Standards Board
ICIAM	International Congress of Industrial and Applied Mathematics
IFRS	International Financial Reporting Standards
ILS	Insurance-Linked Securities
ISPV	Insurance SPV
LEV	Limited Expected Value
LIBOR	London Interbank Offered Rate
n.a.	no author given
n.p.	no page given
NBER	National Bureau of Economic Research
OPM	Option Pricing Model
P&C	Property and Casualty
PCS	Property Claim Services
PDE	Partial Differential Equation
QMC	Quasi-Monte Carlo
RMS	Risk Management Solutions
ROL	Rate On Line
S&P	Standard & Poor's
SCR	Solvency Capital Requirement
SOA	Society of Actuaries
SPE	Special Purpose Entity

SPR	Special / Single Purpose Reinsurer
SPV	Special Purpose Vehicle
WEF	World Economic Forum
WISU	Das Wirtschaftsstudium
XL	Excess of Loss Reinsurance Contract

List of Symbols

$\|\|X\|\|_p$	$E(\|X\|^p)^{1/p}$ for $p > 1$
$(\mathscr{F}_t)_{0\leq t\leq T}$	filtration
$(\Omega, \mathscr{F}, P)$	probability space
#	cardinality of a set
η	probability of a reinsurance payment in the collective model
$\exp(x) = e^x$	exponential function
$\forall$	for all
∞	infinity
$\langle (N(t))_{t\geq 0}, (X_i)_{i\in\mathbb{N}} \rangle$	risk process
$\langle N, (X_i)_{i\in\mathbb{N}} \rangle$	collective (risk) model
$\mathbb{1}_A(\omega)$	indicator variable for some set $A \subset \Omega$ and $\omega \in \Omega$
$\mathbb{N}$	set of positive integers
$\mathbb{N}_0$	set of non-negative integers
$\mathbb{R}$	real line
$\mathbb{R}_+$	set of positive real numbers $(0, \infty)$
$\mathbb{R}_+^0$	set of non-negative real numbers $[0, \infty)$
$\mathscr{B}(\mathbb{R})$	Borel σ-field of $\mathbb{R}$
$\mathscr{F}$	σ-field of Ω
$\mathscr{H}_t$	set of all reinsurance strategies $(\xi_s)_{t\leq s\leq T}$ starting at time t
$\mathscr{Q}$	set of EMM
$\mathscr{S}$	set of subexponential distributions
$\mathscr{X}$	set of all risks X

$\max\{X-d,0\}$	left censored and shifted variable X by d
$\min\{X,d\}$	limited loss variable of a random variable X by d
$\mu(\cdot)$	mean value function of the claim process $N(t)$
ν_j	claim number numeration under an XL contract
Ω	state space
$\overline{F}_X$	decumulative distribution or survival function of F_X
$\overset{d}{=}$	equality in distribution
Π	premium principle
π_t^Q	arbitrage-free price of a cat option at time t with respect to Q
Π_t	earned reinsurance premium at time t
$\Pi_{[\alpha,p]}$	gross risk premium of FISCHER'S (2003) premium principle
$\psi(u)$	ruin probability with initial capital u
$\psi(u,t)$	ruin probability up to a point in time t
$\psi_{r_c}(u)$	ruin probability with a constant interest rate r_c
ρ	relative safety loading
$\sigma(X)$	standard deviation of a random variable X
θ	mixing variable
ξ_s	reinsurance strategy
B_t^*	standard Brownian motion under an EMM
B_t	standard Brownian motion
$c(Q)$	arbitrage-free premium density with respect to EMM Q
$Cov(X,Y)$	covariance of random variables X and Y
$CV(X)$	coefficient of variation of a random variable X
e	Euler's number
$E(X)$	expectation value of a random variable X

$E[X;d]$	limited expected value function of a random variable X by d
$E^Q(X)$	expected value of a random variable X under the measure Q
$ES_\varepsilon(X)$	expected shortfall at confidence level $\varepsilon \in (0,1)$ of a random variable X
F_X	distribution function of a random variable X
f_X	density function of a random variable X
F_X^{*n}	n-fold convolution of F_X
F_{mix}	mixture distribution function
$F_{X,I}$	integrated tail distribution of a random variable X
$FG_T(\xi)$	final gain at time T by reinsurance strategy ξ
FV	face value of an ILS
g_1	distortion function of Wang transform 1
g_2	distortion function of Wang transform 2
G_t	net surplus process
$H_g(X)$	Choquet integral of X with distortion function g
I_t	index value at time t
$L^0(\Omega,\mathscr{F},P)$	set of all a.s. finite random variables on $(\Omega,\mathscr{F})$
$L^p(\Omega,\mathscr{F},P)$	set of all X on $(\Omega,\mathscr{F},P)$ with $E(\|X\|^p)^{1/p} < \infty$ for $p > 1$
L_t	geometric Lévy process
$M(h,t)$	moment generating function
M_n	partial maximum
N	claim number variable
$N'' = N'''$	reinsurer's claim number under an unlimited XL contract
$N'(t)$	reinsurer's claim number under an XL contract up to time t

$N(t)$	claim number up to time t
$o(1)$	for any real-valued function h, $h(x) = o(1)$ as $x \to x_0 \in [-\infty, \infty]$ means that $\lim_{x \to x_0} h(x) = 0$
P, Q	probability measures
$P \sim Q$	P is equivalent to Q
p_X	expected occurrence frequency of a risk X during an insurance period
Q_h	Esscher transformed measure with parameter h
Q_k	Student's t-distribution function with k degrees of freedom
Q_M	Merton's Measure
Q_{h^*}	risk-neutral Esscher measure with parameter h^*
R	one-year ruin probability
r	constant risk-free interest rate
$r(t)$	time dependent risk-free interest rate
R_{ALT}	stochastic yield rate of an alternative risky investment
r_{c}	a constant rate of interest
R_{ILS}	ILS investors' stochastic rate of return
r_{inf}	uniform inflation rate
S	aggregate claim amount
S'	primary insurer's aggregate claim amount under an unlimited XL contract
S''	reinsurer's aggregate claim amount under an unlimited XL contract
S'''	reinsurer's aggregate claim amount under a limited XL contract
$S'''(t)$	reinsurer's aggregate claim amount under a limited XL contract up to time t

$S''(t)$	reinsurer's aggregate claim amount under an unlimited XL contract up to time t
$S(t)$	aggregate claim amount up to time t
S_{ILS}	aggregate loss variable of an ILS
$SL(X)$	safety loading for bearing a risk X
T_i	claim arrival times
T_{Ruin}	ruin time
$T_{I,K}$	first passage time of I_t through the trigger level K
u	utility function
$U(t)$	risk reserve at time t
$Var(X)$	variance of a random variable X
$V@R_{\varepsilon}(X)$	value at risk at confidence level $\varepsilon \in (0,1)$ of a random variable X
W_i	claim inter-arrival times
X'	claims with reinsurance participation under an XL contract
X''	reinsurer's claim amount under an unlimited XL contract
X'''	reinsurer's claim amount under a limited XL contract
$X, X_1, \ldots$	random variables denoting claim amounts
$X_{\overline{d}}$	excess loss variable of a random variable X given $X > d$
$\text{B}(m, \vartheta)$	binomially distributed with parameters m and ϑ
$\text{Exp}(\lambda)$	exponentially distributed with parameter $\lambda \in \mathbb{R}_+$
$\text{NB}(\beta, \vartheta)$	negative binomially distributed with parameters β and ϑ
$\text{N}(.)$	standard normal distribution function
$\text{N}(m, \delta^2)$	normally distributed with parameters m and δ^2
$\text{Pois}(\lambda)$	Poisson distributed with intensity parameter $\lambda \in \mathbb{R}_+$

1 Introduction

1.1 Background

Securitization is the financial process of pooling financial claims and the corresponding cash flows from illiquid assets, such as automobile and mortgage loans or leases, and transforming them into tradable securities which are sold to investors in the capital markets. The technique of securitization was introduced by the Bank of America in 1977. It became popular through the issuance of so-called *mortgage-backed securities* which securitize cash flows from mortgage loans.[1]

The advantages of securitizations are twofold for banks. First, securitizations provide a form of regulatory arbitrage since the selling of risky loans reduces the required regulatory capital. Therefore, securitizations release capital and enable further lending. Second, loans can be sold at competitive prices. The sale proceeds can be invested in assets which improve the interest rate risk management and the asset diversification.[2]

In the early 1990's, the insurance-reinsurance industry began to use the technique of securitization to securitize cash flows based on insurance risk[3].[4] Today, this form of securitization is known as *risk securitization*.[5] By ap-

1 See HAN / LAI (1995), p. 286, and COWLEY / CUMMINS (2005), pp. 193-194.

2 See COWLEY / CUMMINS (2005), p. 194, and HAN / LAI (1995), pp. 286-287, referring to PAVEL (1986), GREENBAUM / THAKOR (1987), PAVEL / PHILLIS (1987), KOPFF / LENT (1988), and HARVEY (1991).

3 In this work, the term insurance risk serves as an umbrella term for any kind of risk which is insured by insurers.

4 The idea of trading insurance risk outside the insurance-reinsurance sector is first proposed by GOSHAY / SANDOR (1973) even before banks started to securitize loans. The authors suggest reinsurance futures markets, like commodity futures markets, for the trading of reinsurance futures contracts. However, the functionality of those futures contracts is different from the securitization instruments analyzed in this text.

5 See WAGNER (1997), p. 517, and CULP (2006), p. 487. Risk securitization is also known as *insurance* and as *reinsurance securitization*. The risk protection seeker, in risk securitization processes called *cedent*, *originator*, or *sponsor*, needs not to be a primary insurance or reinsurance company necessarily. Theoretically, any economic entity could use the technique of risk securitization for transferring risks. For example, the owner and operator of Tokyo Disneyland, Oriental Land Co., used it to cover against

plying this technique, an insurance risk transfer is achieved by the issuance of bond-like securities to investors in the capital markets. The securities are connected to insurance related events by having a risk-linked (i.e. an insurance event-linked) payoff structure.[6]

Usually, (re)insurance companies are characterized as *risk warehouses*. They diversify risk internally and raise equity capital in the security markets to cover the residual risk which is not eliminated through pooling.[7] Alternatively, the residual risk is transferred to another risk warehouse (i.e. a reinsurance company) but remains traditionally within the insurance-reinsurance industry.[8] Therefore, the concept of risk securitization is inconsistent with the traditional model of (re)insurance. It describes a non-traditional way of reinsurance or retrocession by transferring risks out of the insurance-reinsurance industry to the participants in the capital markets.[9]

In contrast to the securitization of loans, the aim of risk securitization is not to sell assets or fund raising. The main objective is to create a financing structure for insurance risk which is based on a risk transfer from the insurance-reinsurance sector to the financial markets and their investors. Primarily, it shall insulate a risk seller's balance sheet from the securitized risk.[10]

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earthquake damages of the theme park (see CULP (2006), p. 503, and MÜLLER (2000), pp. 215-216) and the Fédération Internationale de Football Association (FIFA) applied it to preserve financial support in the case of the cancellation of the FIFA World Cup 2006 in Germany (see GÜNTHER (2006), p. 1207, and WOO (2004), pp. 4-5). However, this text concentrates on (re)insurance companies as cedents. Therefore, investors of risk securitizations provide some special form of reinsurance.

6 See SWISS RE (2006), p. 3, and BANKS (2006), pp. 116-117. According to JAFFEE / RUSSELL (1997) and DOHERTY (2000a), those types of securities are in fact nothing new. They represent the modern version of a special, event dependent loan called *contract of bottomry*. Merchants had already used such loans to fund naval trading ventures in the ancient world. In the case of the loss of ship or cargo, merchants had not to repay them (see JAFFE / RUSSELL (1997), p. 207 and p. 218, and DOHERTY (2000a), p. 523).

7 See CUMMINS / TRAINAR (2009), p. 476.

8 See CUMMINS / TRAINAR (2009), p. 464.

9 See WAGNER (1997), p. 517.

10 See CULP (2005), p. 385, and CUMMINS / TRAINAR (2009), p. 476.

The development of risk securitization is connected directly with the occurrences of major natural catastrophes[11] in the early to mid 1990's in the U.S., which hit the property and casualty (P&C) insurance industry, and with the constantly rising frequency and loss potential of natural disasters which threaten the insurance-reinsurance industry.[12] In this context, Hurricane Andrew in Florida in 1992 and the Northridge Earthquake in California in 1994 have to be mentioned as a starting point for risk securitization activities. They caused the reinsurance market to reach a capacity limit and rapidly rising reinsurance premiums.[13] Finally, they triggered a hard market in the insurance-reinsurance underwriting cycle.[14] In this environment, the insurance industry was not able to satisfy the rising demand of insurance cover against natural catastrophes.[15] Moreover, estimates suggested at that time that the capacity of the natural catastrophes prone U.S. insurance industry itself is generally not sufficient to provide enough cover against natural catastrophe loss events.[16]

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[11] Catastrophes can be divided in *natural* and *man-made catastrophes*. From the viewpoint of the insurance industry, natural catastrophes are caused by "extreme or exceptional events" arising from the perils windstorm, including storm surge if covered, flood, earthquake, hail, and subsidence. Man-made catastrophes are caused by "extreme or exceptional events" arising from motor, fire, marine, aviation, liability, credit, suretyship, and terrorism (see CEIOPS (2010), p. 7).

[12] See ALBRECHT / SCHRADIN (1998), p. 575, CEIOPS (2009), p. 1, and KIELHOLZ / DURRER (1997), p. 3. For reasons for the increasing losses, see KUNREUTHER / MICHEL-KERJAN (2009a), pp. 123-124.

[13] In 1997 U.S. dollars, Hurricane Andrew and the Northridge Earthquake caused damages of $45 billion including $30 billion insured losses. The cumulative insured losses from natural catastrophes during the twelve year period from 1980-92 were only about $25 billion (see FROOT (1999a), p. 1). Therefore, at those times, these two catastrophic events alone caused insured losses which exceeded the cumulative insured losses of natural catastrophes from the previous dozen years. This trend has continued. Between 1970 and 2008, the 25 most costly insured catastrophes happened after 1987, 17 of them after 2000 (see KUNREUTHER / MICHEL-KERJAN (2009a), pp. 120-122, and SWISS RE (2013), pp. 1-2).

[14] See CEIOPS (2009), p. 2, and CUMMINS (2007), p. 191.

[15] See ALBRECHT / SCHRADIN (1998), p. 576, BOUZOUITA / YOUNG (1998), p. 314, and LALONDE (2005), p. 143.

[16] See ALBRECHT / SCHRADIN (1998), p. 576, CUMMINS et al. (2002), KIELHOLZ / DURRER (1997), p. 3, and NIEHAUS (2002), pp. 587-589. For more information about the beginnings of risk securitization, see, e.g., NELL / RICHTER (2005), pp. 322-331, HOMMEL / RITTER (2005), pp. 341-345, and LAM (2003), pp. 96-99.

In order to enhance the insufficient capacity, additional sources of risk-bearing capital had to be detected and tapped from outside the insurance-reinsurance industry. In this situation, raising risk-bearing capital from the capital markets and their investors seemed attractive for several reasons. First, capital markets are highly capitalized. Their capacity amounts to a multiple of the capacity of the insurance-reinsurance industry. Even the values of their daily fluctuations are larger than the losses caused by natural catastrophes.[17] Second, capital markets and their investors have always dealt with many forms of risks and asset classes. Third, the enormous number of market participants provides a possibility to atomize even large risks efficiently.[18]

The tradable insurance risk-linked capital market issues generated by risk securitization transactions are called *insurance-linked securities* (ILS).[19] They serve as an innovative financial vehicle which transfer insurance risks from

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17 See CUMMINS (2007), p. 183, CUMMINS / TRAINAR (2009), p. 475, CUMMINS / WEISS (2009), p. 494 and p. 521, FROOT et al. (1995), p. 21, KIELHOLZ / DURRER (1997), pp. 3-4, and LALONDE (2005), p. 143. Even the amounts of losses of catastrophes like Hurricane Katrina in 2005, which are large compared to the total equity capital of global reinsurers, represent less than 0.5% of the value of U.S. stock and bond markets (see CUMMINS / WEISS (2009), p. 494 and p. 521, and CUMMINS (2012), p. 49). Generally, the equity capital of insurers and reinsurers, the capacity of the global reinsurance industry, and the loss amount of a catastrophe with a probability of occurrence in the 1%-2% range, which is large in comparison with the capacity of the global reinsurance industry, are minuscule compared with the total volume of securities traded in capital markets (see CUMMINS / TRAINAR (2009), p. 475).

18 See ALBRECHT / SCHRADIN (1998), p. 576, CEIOPS (2009), p. 2, and LOUBERGÉ et al. (1999), pp. 127-128.

19 See BANKS (2006), p. 117. ILS and other non-traditional forms of reinsurance are subsumed under the term *alternative risk transfer* (ART). For more information about ART, see, e.g., BANKS (2006), CULP (2005), and LIEBWEIN (2009). Like ART, ILS are a relatively new field and the basic understanding and vocabulary differ between user groups (see BANKS (2006), p. 49). For example, some subsume ILS, insurance derivatives, and contingent capital structures under the term ILS (see, e.g., BERGE (2005), p. 38, and LIEBWEIN (2009), p. 458). This text does not follow this notion and describes ILS as bond-like securities connected to insurance risk. Many equivalent terms exist for this notion of ILS, like act of god bonds, mostly used in connection with natural events, event-linked bonds or securities, insurance-linked bonds or notes, insurance-backed securities or bonds or notes, reinsurance-linked securities, catastrophe-linked notes, catastrophe bonds (cat bonds), etc. Often, the terms ILS and cat bonds are used analogously. In this text, the term cat bond is used in connection with catastrophe risk securitizations.

(re)insurance companies to investors in the capital markets.[20] In doing this, the cash flow structure of ILS is similar to those of bonds whereas, depending on the contract design characteristics, the amounts and dates of their coupons and principal payments are inversely connected with the occurrence of insurance loss events.[21]

Generally, ILS can be classified by the origin and the severity of the securitized insurance risk. The risk can be P&C insurance risk (i.e. non-life insurance risk) or life insurance risk. The severity of the securitized risk can reach from non-catastrophic risk (*high frequency-low severity risk*) to catastrophic risk (*low frequency-high severity risk*).[22]

1.2 Objectives

The trend that catastrophes cause ever growing insurance and overall losses is intact.[23] Hence, the need of conducting risk securitizations may likely remain in order to atomize and transfer extreme risks to investors outside the insurance-reinsurance industry. Accordingly, the number and volume of non-life insurance risk related securitization transactions have almost increased continuously since the 1990's until 2007. In 2008 and 2009, the financial crisis left its mark on the ILS market. However, it shows signs of a current revitalization with a substantial number of first time issuers.[24]

At the beginning of 2014, the issued ILS capacity amounts about 17 billion U.S. dollars. More than 150 investors actively monitor and own ILS. Nevertheless, just about 15 to 20 core investors dominate a concentrated and relatively illiquid ILS market. A few specialized market makers exist who provide services for investors and support secondary market liquidity in an environment where buying and selling is mostly conducted on a matched

20 See SWISS RE (2006), p. 4.

21 See ALBRECHT / SCHRADIN (1998), p. 578.

22 See SWISS RE (2006), p. 4. According to this classification, cat bonds securitize low frequency-high severity risk.

23 See KUNREUTHER / MICHEL-KERJAN (2009a), pp. 120-122, and SWISS RE (2013), pp. 1-2.

24 See CUMMINS (2008), pp. 31-33, CUMMINS (2012), pp. 49-51, GALEOTTI et al. (2013), pp. 401-402, and DUBINSKY (2014), p. 17.