

Institute of Insurance Economics



University of St.Gallen

# **WHAT DRIVES INSURERS' DEMAND FOR CAT BOND INVESTMENTS? EVIDENCE FROM A PAN-EUROPEAN SURVEY**

ALEXANDER BRAUN

KATJA MÜLLER

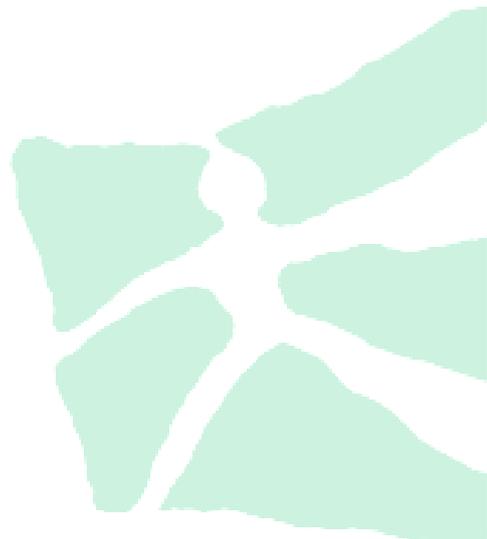
HATO SCHMEISER

**WORKING PAPERS ON RISK MANAGEMENT AND INSURANCE NO. 113**

**EDITED BY HATO SCHMEISER**

**CHAIR FOR RISK MANAGEMENT AND INSURANCE**

**OCTOBER 2012**



# What Drives Insurers' Demand for Cat Bond Investments? Evidence from a Pan-European Survey

Alexander Braun, Katja Müller, Hato Schmeiser\*

## Abstract

Although catastrophe bonds are continuing to gain importance in today's risk transfer and capital markets, little is known about the decision-making processes that drive the demand for this aspiring asset class. In the paper at hand, we focus on one segment of the investing community. Our main research goal is to identify major determinants of the cat bond investment decision of insurance and reinsurance companies. For this purpose, we have conducted a comprehensive survey among senior executives in the European insurance industry. Evaluating the resulting data set by means of exploratory factor analysis and logistic regression methodology, we are able to show that the expertise and experience with regard to cat bonds, the perceived fit of the instrument with the prevailing asset and liability management strategy, as well as the applicable regulatory regime are significant drivers of an insurer's propensity to invest. These statistical findings are supported by further qualitative survey results and additional information from structured interviews with the investment managers of four large dedicated cat bond funds.

**Keywords:** cat bonds, investment decision, determinants, insurance companies, exploratory factor analysis, logistic regression, expert interviews

**JEL classification:** G11; G15; G22; G28

## 1 Introduction

For almost two decades, insurance and reinsurance companies have been employing insurance-linked securities (ILS) and derivatives to hedge against peak losses in the capital markets. The undoubtedly most successful of these alternative risk transfer measures is the catastrophe (cat) bond, an instrument that allows natural disaster risk to be traded over the counter. As is typical for securitizations, cat bonds are issued out of a special purpose vehicle (SPV), which then holds the principal paid by investors in the form of highly rated collateral.<sup>1</sup> The sponsoring company enters into a reinsurance contract (or cat swap) with the SPV and, in case a catastrophe occurs and causes losses in excess of the preset threshold, it is reimbursed with the proceeds of the collateral while investors lose all or part of their principal. To

---

\*Alexander Braun, Katja Müller, and Hato Schmeiser are from the Institute of Insurance Economics, University of St. Gallen, Kirchlistrasse 2, CH-9010 St. Gallen. We are grateful to Andreas Lindemuth and Stephan Schreckenber of Swiss Re for supporting the idea for this paper and providing helpful comments and suggestions.

<sup>1</sup> Note that until early 2009, cat bonds used to be protected against collateral losses by means of a total return swap (TRS). However, in the aftermath of the financial crisis four transactions ended up in distress, since the default of their swap counterparty Lehman Brothers coincided with a severe impairment of the collateral assets. Consequently, the TRS feature has been removed in more recent transactions. Instead, credit risk is meant to be largely eliminated through stricter collateral arrangements (see, e.g., Towers Watson, 2010).

determine whether a payment under the embedded reinsurance contract is due, cat bond structures can feature a variety of different trigger mechanisms.<sup>2</sup> Up until the trigger event or maturity, investors are compensated for bearing the natural disaster risk through regular coupons that consist of a floating interest rate such as LIBOR, plus the cat bond spread (see, e.g., Braun, 2012). Due to their comparatively high yields and presumably rather low return correlations with traditional asset classes, cat bonds have repeatedly been described as an appealing investment opportunity (see, e.g., Litzenberger and Beaglehole, 1996, Schoechlin, 2002, Cummins and Weiss, 2009). Yet, the current investor base for this kind of asset is largely dominated by money managers and a few specialized investment funds. This raises questions about the determinants of the institutional demand for cat bonds.

Several authors have discussed potential catalysts and impediments for the evolution of the catastrophe risk markets, considering both traditional reinsurance and securitization. Froot (1999), for example, suggests that securitization can help to improve the efficiency of the distribution of natural hazard losses, and postulates five key success factors for cat bond issues. Furthermore, Niehaus (2002) explores market imperfections that hamper the optimal sharing of natural disaster risk via reinsurance contracts and cat bonds. In his opinion, the unresolved question of pricing these instruments in a portfolio context has an impact on the demand, since it determines how confident investors are in the zero-beta characteristics of the asset class. Similarly, Froot (2001) develops a number of supply-and-demand-related explanations for the fact that the empirically observed amount of reinsurance and cat bond transactions is considerably lower than suggested by risk management theory. He finds the market power of reinsurance companies and impediments to the inflow of financing from the capital markets to be the most likely reasons for this phenomenon. Another relevant study has been authored by Gibson et al. (2007), who examine why capital-market-based risk transfer solutions have not replaced traditional reinsurance as the primary means for sharing catastrophe risk. They conclude that reinsurance should be preferred in situations where information from the capital markets is costly to acquire and largely redundant. In addition, Cummins and Trainar (2009) consider the advantages and disadvantages of reinsurance and securitization from a risk management perspective. In this context, they note that cat bonds primarily attract investors due to their still relatively high yields, their low correlation with traditional asset classes, the fact that they are collateralized, and the lower complexity as well as better alignment of interest between investors and ceding companies compared to other types of asset-backed securities (ABS). Apart from that, Ibragimov et al. (2009) derive a model that serves to explain the limited supply of protection against catastrophe risk offered by insurers and reinsurers. In their view, the typical heavy-tailed loss distributions associated with natural disasters imply a substantial reduction in diversification benefits that may lead to a situation where individual firms do not have an incentive to offer coverage. Finally, Lakdawalla and Zanjani (2011) illustrate that the full collateralization of cat bonds hinders deeper market penetration, whereas diversification benefits in the context of traditional reinsurance portfolios allow for a more efficient deployment of capital. In their view, this impediment can only be surpassed if securitizations offer substantially lower friction costs than reinsurance contracts.

---

<sup>2</sup> A description of the different trigger types for cat bonds can, e.g., be found in Swiss Re (2006).

A related strand of literature is directly concerned with factors that determine the supply of cat bonds by sponsors and the demand for these instruments by investors. Bantwal and Kunreuther (2000) employ behavioral economic aspects such as ambiguity aversion, myopic loss aversion, and the fixed costs of education in order to explain institutional asset managers' reluctance to invest in cat bonds. They suggest that, to increase demand and promote further market growth, issuers should aim for a larger degree of security standardization, reduce pricing uncertainty, and strive to enhance investor expertise with regard to the asset class. Moreover, within his comprehensive overview of alternative risk transfer instruments, Cummins (2005) describes cat bonds as a valuable means for portfolio diversification, and emphasizes that more standardized and transparent transactions as well as the development of a public secondary market would help to realize the full potential of the asset class. Cummins (2008) additionally mentions the difficulty involved in obtaining transactional information as an obstacle for further growth. A wide range of issues that hinder the expansion of the ILS markets is also discussed in a study by the World Economic Forum (2008). Amongst others, the considered problems for sponsors comprise basis risk, the instruments' accounting and regulatory treatment, inconsistent rating methodologies, insufficient data quality and disclosure, the costs of structuring a securitization deal, and the relatively low level of experience with securitization in the insurance industry. Investors, on the contrary, are said to be concerned about the lack of standardization, the limited liquidity and secondary market trading activity, the nontransparent nature of certain trigger mechanisms, and the complexity involved in ILS valuation. Similar problems are identified by Cummins and Weiss (2009) as well as Bouriaux and MacMinn (2009), who also discuss major demand drivers, such as the risk-return profile and diversification benefits of the asset class and the latest advances in risk modeling methodology. Barrieu and Loubergé (2009), in contrast, claim that the common arguments for the supposedly disappointing development of the cat bond market to date, such as the lack of investor familiarity with the instrument, parameter uncertainty, and the trade-off between moral hazard and basis risk, are not convincing. Instead, they suspect downside risk aversion in combination with the ambiguity surrounding the correlation between natural disaster losses and capital market crash scenarios to be responsible for the limited demand. Finally, Hagedorff et al. (2011) draw on the model framework proposed by Merton (1974), in order to demonstrate that the risk reduction benefits of cat bonds are confined to sponsors with a high default probability or a large exposure to natural disaster risk. They point to this lack of universal applicability as an explanation for the underwhelming development of the market to date.

Despite the relatively large body of literature on supply, demand, and growth drivers in the markets for catastrophe risk, to the best of our knowledge, relatively little is known about the motivation of insurance companies to act as cat bond investors. In particular, no analysis of the determinants of their respective investment decision has been conducted to date. Therefore, with this paper we aim to address an important research gap by identifying and analyzing the main drivers and obstacles with regard to the demand for cat bond investments in the insurance industry. For this purpose, we developed a comprehensive questionnaire that was distributed to senior executives of almost 500 European insurance companies. Moreover, to complement the information received by the survey participants and provide additional evidence for the robustness of our results, we have also conducted structured inter-

views with the investment managers of the four largest dedicated cat bond funds that together absorb almost 80 percent of the outstanding volume. Our findings should provide a thorough insight into the decision-making process that underlies cat bond investments of insurance companies and can thus help to address pressing issues, reduce investment barriers, and support further growth of the cat bond market.

The remainder of this paper is structured as follows. In Section 2, we review the current size and investor base of the cat bond market and develop eight hypotheses concerning the determinants of an insurance company's decision to invest in this asset class. Furthermore, Section 3 contains a description of our survey as well as a brief introduction to the statistical techniques of exploratory factor analysis and logistic regression that are used to evaluate the resulting data set. Section 4 represents the main part of the paper, including descriptive statistics, the derivation of our key empirical findings, and the discussion of the qualitative results from the open survey questions and expert interviews. Finally, in Section 5 we draw our conclusion and propose ways to tackle the major barriers that currently seem to prevent insurance companies from engaging in cat bond investments on a larger scale.

## **2 The Demand for Cat Bonds**

### **2.1 Current Market Size and Investor Base**

Although, in its early days, the cat bond market suffered from low capacities and a lack of investor interest, it has undergone a major development since the 1990s. In the 10 years between 1997 and 2007, issuance volume has increased more than sevenfold from less than USD 1 billion to over USD 7 billion (see Cummins and Weiss, 2009). Furthermore, Guy Carpenter (2011) estimates that the outstanding risk capital for nonlife cat bonds summed up to more than USD 10 billion in 2011. Apart from the market size, a significant evolution could also be observed with regard to the investor base of this asset class. According to Swiss Re (2009), primary insurers and reinsurers together purchased a total of 55 percent of the cat bond volume issued in 1999. The remaining demand came from money managers (30 percent) as well as hedge funds, banks, and dedicated cat bond funds (5 percent each). By 2009, however, the market structure had changed dramatically, with dedicated cat bond funds (46 percent), money managers (23 percent), and hedge funds (14 percent) now providing the vast majority of risk capital. At the same time, the combined share of insurance and reinsurance companies had fallen to a mere 8 percent. To explain this low level of demand compared to other types of institutional investors, the driving factors behind the investment decision of asset managers in the insurance sector need to be revealed.

### **2.2 Development of Hypotheses**

In the following, we develop a total of eight hypotheses that served us as guidance for the design of the questionnaire as well as the schedule for the expert interviews. Although some of the postulated determinants have already been mentioned in earlier articles, they have not yet been empirically tested with an explicit focus on insurance companies as investors.

Larger insurers generally have more financial and professional resources at their disposal than small or medium-sized companies. Consequently, they may, for example, afford to put the necessary cat-modeling and data analysis technology in place, hire additional asset management specialists, or establish a dedicated investment team that focuses on ILS. This implies that the sheer size of an insurance company could have an influence on its ability to gain access to the cat bond market and leads us to expect the following:

*H<sub>1</sub>: Larger insurance companies are more likely to invest in cat bonds.*

In addition, due to the ever-growing importance of modern risk management techniques and processes, insurers make their investment decisions in accordance with preset a asset and liability management (ALM) strategy. Thus, they will tend to avoid investments that are perceived to be at odds with their ALM goals, while focusing on those that they find to be overall attractive and to fit well into their portfolio. This could, for example, imply that certain firms do not consider investing in risks that they are exposed to through their insurance policies. We therefore state the hypothesis:

*H<sub>2</sub>: The better the perceived fit of cat bonds with the ALM strategy of an insurer, the more likely the company is to invest.*

Asset managers in the insurance industry continuously search for and analyze potential investment opportunities. Due to the complexity of today's capital markets, specialized in-house expertise and experience is a crucial success factor for the structuring and maintenance of portfolios of a wide range of asset types. In particular, with respect to niche instruments such as cat bonds, a better understanding may lead to a notable increase in investor demand (see, e.g., Bantwal and Kunreuther, 2000). Based on this consideration, we postulate:

*H<sub>3</sub>: More expertise and experience with regard to the cat bond asset class increase an insurer's propensity to invest.*

It has been repeatedly emphasized that cat bonds exhibit an appealing risk-return profile (see, e.g., Cummins and Weiss, 2009). However, insurers need to acknowledge this benefit in order to become interested in the asset class. Hence, we hypothesize:

*H<sub>4</sub>: Insurance companies that perceive the risk-return potential of cat bonds to be advantageous are more likely to invest.*

Another characteristic of cat bonds is their typically low correlation with traditional asset classes (see, e.g., Bouriaux and MacMinn, 2009). This circumstance provides them with a considerable diversification potential which could influence the investment decision in case insurance companies recognize it. Consequently, we add the following hypothesis:

*H<sub>5</sub>: The propensity of insurers to invest in cat bonds rises with the degree to which they perceive the asset class to offer them diversification benefits.*

Furthermore, it can be expected that investors are more likely to purchase cat bonds if they view them to be relatively liquid and standardized assets, which are associated with low administration costs and adhere to transparent pricing rules (see, e.g., World Economic Forum, 2008). We summarize these and similar aspects in a factor called perceived administrative complexity and suppose:

*H<sub>6</sub>: The less administrative complexity insurance companies associate with cat bonds, the more likely they are to invest in this asset class.*

In general, institutional investors like to decide based on the evaluation of facts and figures. Hence, the decision-making process of insurance companies could be facilitated if, for example, transaction data, pricing information, and historical performance figures for the cat bond asset class were readily available. Against this background, it is evident that the currently restricted access to cat bond prospectuses is considered to hamper the development of the market (see, e.g., Cummins, 2008). Taken together, one could suspect that:

*H<sub>7</sub>: The more insurance companies perceive relevant data and information on cat bonds to be readily available, the more likely they are to invest.*

For the protection of the policyholders' interests, the assets of an insurance company are classified as either tied (restricted) or free. The free assets reflect the firm's equity capital and thus typically account for a comparatively small percentage of the total portfolio. A much larger fraction, in contrast, is represented by the tied assets, which are meant to cover the firm's technical provisions at all times. Consequently, they need to adhere to strict requirements with regard to investment types, diversification, and risk management.

As will be discussed in Section 4, all companies in our sample are either subject to EU or Swiss regulation. Explicit lists of asset categories that can be employed to cover the technical provisions of insurers within the European Union are included in Article 21 of the third nonlife insurance Directive of the European Council (Directive 92/49/EEC) and Article 23 of the Directive of the European Parliament and the Council concerning life assurance (Directive 2002/83/EC). These legal acts comprise a general category termed "debt securities, bonds, and other money and capital market instruments", which, taking into account their fixed income format, also seems applicable to cat bonds. However, in accordance with this EU legislation, individual member states may also establish more detailed guidelines with regard to the characteristics of acceptable investments. In Germany and Austria, for example, the act on the supervision of insurance undertakings (in German: "Versicherungsaufsichtsgesetz", VAG) empowers the government and the national regulatory authority, respectively, to enact provisions that contain binding conditions for the tied assets.<sup>3</sup> These legal acts, called "Anlageverordnung" (AnlV) in Germany and "Kapitalanlageverordnung" (KAVO) in Austria, do not explicitly rule out cat bond investments and contain an opening clause for those asset classes that are not included in their predefined lists.<sup>4</sup> Since the requirements with regard to the tied assets in other European countries are also based

<sup>3</sup> See paragraph 54(2) VAG Germany and paragraph 78(3) VAG Austria.

<sup>4</sup> These opening clauses can be found in paragraph 2(2) AnlV and paragraph 2(1) No. 9 KAVO.

on the above-mentioned EU directives, they can be assumed to be quite similar. Hence, we do not expect explicit severe regulatory constraints with regard to the cat bond asset class for insurance companies in EU member states.

In Switzerland the act on the supervision of insurance undertakings states that the Swiss Federal Council may enact provisions that govern tied assets and leave it up to the Swiss Financial Market Supervisory Authority (FINMA) to determine additional details.<sup>5</sup> The respective guidelines have been incorporated into Article 79(1) of the “Aufsichtsverordnung” (AVO) and are further substantiated in FINMA’s circular letter on the investment of tied assets (see FINMA, 2008). Clause II.D.a of this document, which includes the general principles with regard to eligible investments, states that the tied assets must not include insurance risk, and clause III.C.b.bb explicitly forbids the purchase of ILS. Hence, Swiss insurers may only consider cat bond investments within their free assets. This implies that their asset management departments have less options to employ the instrument than those of their European counterparts. The consideration of this legal background results in our last hypothesis:

*H<sub>3</sub>: Due to binding regulatory constraints, Swiss insurers are less likely to invest in cat bonds.*

In this context it should be noted that regulatory constraints in the broader sense could also arise due to the capital requirements associated with cat bond investments under the Swiss Solvency Test (SST) or Solvency II. More specifically, if an insurer perceives the resulting capital charges to be ambiguous or inappropriate, it could tend to avoid the asset class. However, under both regulatory frameworks cat bond investments are virtually treated in the same way as the catastrophe risk exposure incurred through traditional (re)insurance contracts. Hence, we do not expect a significant impact on the investment decision of insurance companies and refrain from formulating an explicit hypothesis. Similarly, we deem it unlikely that the accounting treatment of the instrument turns out to be relevant in this regard. Nevertheless, our survey included a set of questions to measure the firm’s perception of the capital requirements and accounting treatment of cat bond investments. Based on the corresponding information, the correctness of these expectations will be confirmed.

## 3 Data and Methodology

### 3.1 Questionnaire Design

Before the development of our questionnaire, we engaged in an intensive dialogue with ILS experts from a large Swiss reinsurance company. The aim was to identify and better understand the potential drivers of the demand for cat bond investments. Apart from the company size and constraints due to the regulatory regime, the determinants hypothesized in Section 2.2 are latent variables, i.e., multifaceted constructs that cannot be directly observed. Thus, in order to capture each relevant factor as comprehensively as possible, we devised specific measurement variables (also called observed variables or items).<sup>6</sup> After the

---

<sup>5</sup> See Article 20 VAG Switzerland.

<sup>6</sup> To the best of our knowledge, there are no existing item sets in the literature that would fit the context of our study.

preparation of a first questionnaire draft, we again consulted industry professionals and academics to obtain feedback concerning wording and completeness, based on which we implemented final changes by rephrasing, adding, or deleting certain items. A high-level overview of the chosen questionnaire structure can be found in Figure 1. In part A, we inquired key figures related to the answering insurance company, such as the country of incorporation, the business model (insurer, reinsurer), the number of employees, the balance sheet size, and the premium volume. Furthermore, part B constituted of questions with regard to the firm’s cat bond investment activities. Parts C to H contained sets of measurement variables for the determinants experience and expertise, perceived risk-return and correlation characteristics, perceived administrative complexity, perceived availability of data and information, as well as accounting or regulatory aspects. In the final part, the participants were given the opportunity to provide further comments. Altogether, the questionnaire comprised 41 items which are measured on six-point Likert scales.<sup>7</sup> Potential biases due to respondents who are too unfamiliar with the subject to provide a reliable opinion are minimized, since we also allowed to select a “do not know” button for each item.



Figure 1: Overview of the Questionnaire Structure.

### 3.2 Participant Recruitment

To recruit relevant participants for our web-based survey, we made use of the key informant technique. The aim was to contact senior executives, preferably CEOs and CFOs, since they should be well informed about the companies’ strategic investment decisions as well as the corresponding reasons behind them. Hence, we collected the addresses of a total of 490 insurance and reinsurance companies from Austria,

<sup>7</sup> Likert scales are a common way to capture an individual’s level of agreement or disagreement with a specific statement (see Likert, 1932). An even number of points means that a neutral answer is not possible. Instead, the respondent is forced to choose a positive or negative stance.

France, Germany, Italy, the Netherlands, Sweden, Switzerland, the UK, Finland, Portugal, Belgium, and Greece. Based on the gathered information, we invited the targeted participants per mail to take part in our survey. The questionnaire was made available online in early February 2012. Two reminders were sent out via e-mail, one after three and another one after six weeks. In total, the companies had nine weeks' time to complete the questionnaire. While survey participation in general was anonymous, respondents were offered to receive the results of our study if they chose to provide their contact information.

### 3.3 Sample Characteristics and Imputation

Overall, 64 companies reacted to the invitation, which corresponds to a response rate of 13.1 percent. On average, it took the participants 11 minutes to complete the survey. However, a number of firms terminated the questionnaire too early to be included in our analysis. We therefore had to adequately impute missing values as far as possible or remove all cases for which essential items were missing and imputation was impossible. Our final data set is based on the responses of 44 participants, who completed the essential parts of the questionnaire, such as the company background and the question whether or not they have invested in cat bonds in the past and/or plan to do so in the future.<sup>8</sup> Of these 44 participants, 36 provided their views on all of the included item sets. This subsample is used for the inference statistical analysis.

### 3.4 Exploratory Factor Analysis

The factor scores for each potential determinant are derived by means of exploratory factor analysis (EFA), a statistical methodology that explains the covariance (correlation) structure of observed random variables in terms of a smaller number of latent variables. The following is an analytical representation of the general EFA model:<sup>9</sup>

$$X = \Lambda\xi + \delta, \quad (1)$$

where  $X$  is the vector of observed variables,  $\Lambda$  represents the factor loadings matrix,  $\xi$  is the vector of latent variables (factors), and  $\delta$  stands for the vector of unique factors (residuals). Applying matrix algebra, one can derive the covariance matrix  $\Sigma$  implied by the model:

$$\Sigma = \Lambda\Phi\Lambda' + \Psi_\delta, \quad (2)$$

with  $\Phi$  being the covariance matrix of the factors and  $\Psi_\delta$  being the covariance matrix of the residuals.<sup>10</sup> The parameters (factor loadings and residual variances) for the EFA model are determined by means of maximum likelihood estimation (MLE), so that the model-implied covariance (correlation) matrix fits

<sup>8</sup> 14 of the participants provided us with information about their positions in the company. According to their statements, five Chief Investments Officers and two other members of the executive boards answered our questionnaire. Furthermore, two survey participants are directors whereas another five claimed they are Head of Asset Management or Senior Risk Manager. Thus, we believe that we did manage to approach the key informants we wanted to.

<sup>9</sup> The notations in this subsection have been adopted from Jöreskog (1967).

<sup>10</sup> When EFA is conducted with standardized variables,  $\Phi$  reduces to the identity matrix.

its empirically observed counterpart as closely as possible.<sup>11</sup> Based on the derived factor loadings, it is possible to compute factor score estimates  $\hat{\xi}$  that can be used to represent the determinants of the cat bond investment decision in further analyses. For this purpose, we select the regression method, which employs the sample covariance matrix  $\hat{\Sigma}$  and the estimated factor loadings matrix  $\hat{\Lambda}$  as follows:

$$\hat{\xi} = \hat{\Lambda}'\hat{\Sigma}^{-1}X. \quad (3)$$

### 3.5 Logistic Regression Model

To address our main research question, we require a statistical methodology that determines the influence of a set of  $k$  metric explanatory (predictor) variables  $x$  on a binary (dichotomous) dependent variable  $y$ , i.e., one that takes on only two values: one and zero (investor and non-investor). In the following, the sampling units (insurance companies) will be indexed by  $i$  ( $i = 1..n$ ). To begin with, consider the following linear regression model:

$$y_i = \beta_0 + \beta_1x_{i1} + \beta_2x_{i2} + \dots + \beta_kx_{ik} + \epsilon_i = \mathbf{x}'_i\boldsymbol{\beta} + \epsilon_i, \quad (4)$$

where  $y_i$  represents the value of the dependent variable for insurance company  $i$ ,  $x_{ik}$  is the value of the independent variable  $k$  for insurance company  $i$ , the  $\beta_k$  are the regression coefficients (including an intercept  $\beta_0$ ), and  $\epsilon_i$  denotes the zero-mean disturbance term. In matrix notation, the information about the predictor variables is contained in the column vector  $\mathbf{x}_i$  and  $\boldsymbol{\beta}$  represents the vector of regression coefficients. Instead of the dichotomous variable itself, a binary response model predicts the probability  $\pi_i$  that  $y_i$  assumes a value of one, given  $\mathbf{x}_i$ . Since  $y_i$  is dichotomous, we know that  $\pi_i = \Pr[y_i = 1] = E(y_i)$ . Inserting into Equation (4), we get:

$$\pi_i = \mathbf{x}'_i\boldsymbol{\beta}. \quad (5)$$

Equation (5) is known as the linear probability model (LPM) and can be estimated by means of ordinary least squares (OLS) methodology. Unfortunately, this simple choice approach suffers from a number of drawbacks: it may produce outcomes of less than zero and greater than one (out-of-bounds predictions), it violates the basic OLS assumption of homoskedastic residuals, and the corresponding error distribution is non-normal (see, e.g., Wooldridge, 2008). These issues can be avoided by drawing on the well-established logit model, which links the predictors to the probabilities by means of the sigmoid shaped logistic function  $P(z) = 1/(1 + \exp(-z))$ :<sup>12</sup>

$$\pi_i = P(\mathbf{x}'_i\boldsymbol{\beta}) = \frac{1}{1 + \exp(-\mathbf{x}'_i\boldsymbol{\beta})}. \quad (6)$$

The linear combination  $\mathbf{x}'_i\boldsymbol{\beta}$  describes a latent variable  $z$ , called the logit. Accordingly, in logistic regression terminology, the elements of  $\boldsymbol{\beta}$  are known as logit coefficients. They are determined by means of MLE, i.e., the (log-)likelihood function is maximized by means of a numerical algorithm in order to

<sup>11</sup> Note that classical EFA requires the observed variables to be normally distributed.

<sup>12</sup> The logistic function  $P(\cdot)$  is also the cumulative distribution function (cdf) of a standard logistically distributed random variable. It translates any real number into a value between zero and one.

identify the logit coefficients that are most likely associated with the observed values for  $y$  and  $\mathbf{x}$ . The logit is the natural logarithm of a magnitude  $\Omega$ , termed the odds, which equals the probability of the dependent variable taking on the value one divided by the probability of it taking on the value zero, conditional on the set of predictors:

$$\Omega = \frac{\Pr(y = 1|\mathbf{x})}{\Pr(y = 0|\mathbf{x})} = \frac{1/(1 + \exp(-z))}{1 - 1/(1 + \exp(-z))} = \exp(\mathbf{x}'\boldsymbol{\beta}). \quad (7)$$

Being confined to the interval  $[0, +\infty)$ , the odds are another measure of effect strength in the logistic regression model. If they equal one, both outcomes of the dependent variable are equally likely. The further they deviate from one, the stronger the (positive or negative) link between the dependent variable and the regressors.<sup>13</sup>

## 4 Empirical Results

### 4.1 Descriptive Statistics

In this section, we present descriptive statistics to characterize the composition of our sample. The first column of Table 1 shows the number (and percentages) of insurance companies categorized by country, business model (insurer, reinsurer), business line (life, nonlife, multiline), and geographic investment scope (global, regional). In addition, we indicate whether or not the firms act as cat bond sponsors, invest in securitizations in general, and belong to a larger insurance group. Accounting for 31.82 percent of the survey respondents, Swiss insurers are slightly overweighted in the data set. Apart from that, however, the participants are relatively evenly spread across European countries. Furthermore, almost 80 percent of the covered firms are primary insurers. This is a positive indication for the representativeness of the sample, since reinsurers are also much rarer in the reference population (i.e., European insurance companies). Similarly, a majority of about 70 percent run a multiline insurance business, comprising both life and nonlife divisions.<sup>14</sup> With respect to their geographic investment scope, around 60 percent replied that they exclusively focus on regional (national or European) assets and markets, while only 40 percent consider themselves to be global investors. Hence, we seem to have a well-balanced mix of small, medium-sized, and large companies. Moreover, more than 80 percent of the respondents stated that they do not act as cat bond sponsors. Again, this implies that the data should be representative, since only a few large primary insurers and reinsurers in Europe with the resources and capabilities to sponsor and structure cat bond transactions have actually employed this risk transfer instrument to date. Finally, half of the firms in the sample invest in at least one other type of securitization, such as ABS, collateralized debt obligations (CDOs), or covered bonds, and the vast majority of the responding entities are part of a group.

<sup>13</sup> Note that  $\pi$ ,  $z$ , and  $\Omega$  essentially provide the same information. A probability  $\pi_i$  of 0.5 corresponds to a logit  $z$  of 0 and odds  $\Omega$  of 1. Each of these values implies that both outcomes of  $y$  exhibit the same likelihood.

<sup>14</sup> Four of the firms in this category responded that they additionally run a health insurance line.

	Full Sample		Investors		Non-investors	
	No.	Percent	No.	Percent	No.	Percent
Austria	4	9.09	2	15.38	2	6.45
France	1	2.27	0	0.00	1	3.23
Germany	6	13.64	3	23.08	3	9.68
Italy	5	11.36	3	23.08	2	6.45
Netherlands	2	4.55	0	0.00	2	6.45
Sweden	3	6.82	1	7.69	2	6.45
Switzerland	14	31.82	2	15.38	12	38.71
UK	2	4.55	1	7.69	1	3.23
Finland	3	6.82	1	7.69	2	6.45
Portugal	2	4.55	0	0.00	2	6.45
Belgium	1	2.27	0	0.00	1	3.23
Greece	1	2.27	0	0.00	1	3.23
<b>Total</b>	<b>44</b>	<b>100.00</b>	<b>13</b>	<b>100.00</b>	<b>31</b>	<b>100.00</b>
Primary Insurers	35	79.55	7	53.85	28	90.32
Reinsurers	9	20.45	6	46.15	3	9.68
<b>Total</b>	<b>44</b>	<b>100.00</b>	<b>13</b>	<b>100.00</b>	<b>31</b>	<b>100.00</b>
Life Business	4	9.09	1	7.69	3	9.68
Nonlife Business	9	20.45	4	30.77	5	16.13
Multiline Business	31	70.45	8	61.54	23	74.19
<b>Total</b>	<b>44</b>	<b>100.00</b>	<b>13</b>	<b>100.00</b>	<b>31</b>	<b>100.00</b>
Global Investor	18	40.91	7	53.85	11	35.48
Regional Investor	26	59.09	6	46.15	20	64.52
<b>Total</b>	<b>44</b>	<b>100.00</b>	<b>13</b>	<b>100.00</b>	<b>31</b>	<b>100.00</b>
Cat Bond Sponsor	7	15.91	6	46.15	1	3.23
No Cat Bond Sponsor	37	84.09	7	53.85	30	96.77
<b>Total</b>	<b>44</b>	<b>100.00</b>	<b>13</b>	<b>100.00</b>	<b>31</b>	<b>100.00</b>
Securitization Investor	20	45.45	11	84.62	9	29.03
No Securitization Investor	24	54.55	2	15.38	22	70.97
<b>Total</b>	<b>44</b>	<b>100.00</b>	<b>13</b>	<b>100.00</b>	<b>31</b>	<b>100.00</b>
Group	35	79.55	9	69.23	26	83.87
Single Entity	9	20.45	4	30.77	5	16.13
<b>Total</b>	<b>44</b>	<b>100.00</b>	<b>13</b>	<b>100.00</b>	<b>31</b>	<b>100.00</b>

Table 1: Sample Composition

This table shows the composition of the sample of 44 firms that has been generated from the respondents of a survey among 490 European insurers and reinsurers. The data is categorized by country, business model (insurer, reinsurer), business line (life, nonlife, multiline), geographic investment scope (global, regional), sponsoring activity (cat sponsor, no sponsor), other securitization investments such as ABS, CDOs, and covered bonds (investor, non-investor), as well as organizational structure (single entity, insurance group). In addition, each category is further differentiated into cat bond investors and non-investors. Cat bond investors are defined as those insurance companies, which stated that they will continue or begin to hold cat bonds in their asset portfolios in the future.

In the second and third column of Table 1, we have split the sample into those firms that do and those that do not invest in cat bonds.<sup>15</sup> As could be expected, only about 30 percent (13/44) of the respondent firms actually invest in cat bonds. Taking into account the low percentage of insurers among the current investor base of the cat bond asset class as discussed in Section 2.1, the large fraction of 70.45 percent (31/44) non-investors is another cue for the representativeness of our sample. Interestingly, the majority of investors (61.54 percent) come from Austria, Germany, or Italy. At least half of the survey participants from these countries have disclosed themselves as cat bond investors. Furthermore, most non-investors in the sample are based in Switzerland (38.71 percent), and over 90 percent of the non-investors are primary insurers. In contrast, more than 40 percent of the investors are reinsurers or, to put it differently, two-thirds (6/9) of the reinsurers in the sample do invest in cat bonds. This might be some initial evidence for hypotheses 1, 2, and 3, since the firm's size, the expertise and experience with cat bonds, as well as the fit of the asset class with the firm's ALM strategy are characteristics that can be expected to vary considerably between the average primary insurer and reinsurer. Similarly, the fact that almost all non-investors (96.77 percent) do not act as cat bond sponsors and a majority of them have a regional investment focus (64.52 percent) supports these hypotheses. The reason for this is that only a few large and experienced reinsurance companies dominate the cat bond sponsoring business, and insurers with a geographically limited asset management scope are likely to be smaller and less experienced with rather exotic asset classes such as cat bonds. In addition, judging by the higher share of pure nonlife insurers among the investors, it seems that the propensity to purchase cat bonds might somehow be related to the risk expertise that an insurance company accumulates through its business lines. Lastly, we observe that almost 85 percent of the cat bond investors in our sample also hold other securitizations, while more than 70 percent of the non-investors do not. Thus, the experience with and the general affinity to invest in securitized assets could also exert an influence on insurance companies' demand for cat bonds.

Table 2 contains mean, median, standard deviation, minimum, and maximum for the number of employees, the balance sheet size, and the premium volume of the firms in our sample. These variables have been included in the survey as proxies for the company size. Again, we additionally distinguish between investors and non-investors. When examining the respective figures, we notice that for all three variables the medians are smaller than the means, i.e., the distributions seem to exhibit some degree of positive skewness (long right tail). Moreover, the minimum and maximum values indicate that the sample covers a range of very differently sized companies. The smallest insurer, for example, employs only 14 staff members, while the largest workforce amounts to 60,000 people.<sup>16</sup> Similar observations can be made for the balance sheet sizes and premium volumes. A simple comparison of the sample means of these three size proxies between investors and non-investors reveals that, on average, the former are larger. However, since this discrepancy could be simply caused by the random draw through our survey, one needs to rely on statistical inference in order to make a statement about the underlying population of European insurance companies. The most common procedure in this regard is the two-sample t-test for the equality

<sup>15</sup> We define cat bond investors as those insurance companies, which stated that they will continue or begin to hold cat bonds in their asset portfolios in the future.

<sup>16</sup> Note that all entities with less than 4,000 employees are part of insurance groups.

<b>Full Sample</b>	<b>Mean</b>	<b>Median</b>	<b>S. D.</b>	<b>Min</b>	<b>Max</b>	<b>K-S Stat.</b>	<b>p-value</b>	
No. of Employees	6,667.80	1,225.00	13,365.14	14.00	60,000.00	0.3224	0.0002	***
Balance Sheet (mn EUR)	38,975.24	10,492.93	78,202.53	0.18	400,000.00	0.3249	0.0002	***
Premium Volume (mn EUR)	8,529.05	1,775.00	18,971.43	0.11	107,900.00	0.3265	0.0002	***
<b>Investors</b>								
No. of Employees	9,102.85	1,250.00	17,035.41	87.00	47,000.00	0.3644	0.0633	*
Balance Sheet (mn EUR)	50,347.32	22,500.00	84,651.67	360.00	240,000.00	0.3732	0.0392	**
Premium Volume (mn EUR)	8,580.91	3,735.00	11,197.83	460.00	32,600.00	0.2774	0.2697	
<b>Non-investors</b>								
No. of Employees	5,646.65	1,200.00	11,674.88	14.00	60,000.00	0.3147	0.0043	***
Balance Sheet (mn EUR)	34,206.30	9,296.00	76,287.88	0.18	400,000.00	0.3334	0.0020	***
Premium Volume (mn EUR)	8,507.31	1,308.00	21,580.55	0.11	107,900.00	0.3766	0.0002	***

Table 2: Descriptive Statistics for the Company Sizes

This table contains the mean, median, standard deviation, minimum, and maximum for the number of employees, the balance sheet size, and the premium volume of the insurance companies in the sample. These three variables serve as proxies for the firm size. In addition, location and dispersion statistics have been provided separately for the subsamples of cat bond investors and non-investors. The last three columns show the results of a Kolmogorov-Smirnov (K-S) test of the null hypothesis that the variables are normally distributed.

<b>No. of Employees</b>		<b>Balance Sheet Size (mn EUR)</b>		<b>Premium Volume (mn EUR)</b>	
N	44	N	44	N	44
Mann-Whitney U	218.0000	Mann-Whitney U	237.5000	Mann-Whitney U	249.0000
Standard Error	39.6440	Standard Error	39.6820	Standard Error	39.6850
p-value	0.8400	p-value	0.4880	p-value	0.3260

Table 3: Mann-Whitney U Test

Results of a Mann-Whitney U test to assess whether the differences in the average number of employees, balance sheet size, and premium volume between investors and non-investors are statistically significant. The test is based on the null hypothesis that the two samples under consideration have been drawn from the same distribution.

of means. The typical prerequisites for this test are normally distributed data, equal sample sizes, and equal sample variances (see, e.g., Sawilowsky and Blair, 1992). The former condition can be checked by means of the Kolmogorov-Smirnov (K-S) goodness-of-fit test, the results of which are displayed in the last two columns of Table 2. Since we reject the null hypothesis of normality in all cases but one (see p-values), the aforementioned two-sample t-test will not be applied. Instead, we decide to conduct the more robust Mann-Whitney U test to assess whether the differences in the means between investors and non-investors are statistically significant. This nonparametric test is based on the null hypothesis that the two samples under consideration have been drawn from the same distribution. The results are shown in Table 3. For all three size proxies (number of employees, balance sheet size, premium volume) the p-values exceed 0.1. To put it differently, this is a first indication that company size might not matter with regard to the cat bond investment decision of insurance companies.

Finally, to get an initial impression of the importance of some potential determinants discussed in Section 2.2, we have asked the insurance companies that participated in the survey to state whether or

Determinant	Full Sample			Investors			Non-investors		
	relevant	irrelevant	sum	relevant	irrelevant	sum	relevant	irrelevant	sum
Expertise/Experience <i>in percent</i>	15 41.67	21 58.33	36 100.00	8 66.67	4 33.33	12 100.00	7 29.17	17 70.83	24 100.00
Risk/Return/Correlation <i>in percent</i>	16 44.44	20 55.56	36 100.00	10 83.33	2 16.67	12 100.00	6 25.00	18 75.00	24 100.00
Administrative Complexity <i>in percent</i>	16 44.44	20 55.56	36 100.00	9 75.00	3 25.00	12 100.00	7 29.17	17 70.83	24 100.00
Data Availability <i>in percent</i>	12 33.33	24 66.67	36 100.00	8 66.67	4 33.33	12 100.00	4 16.67	20 83.33	24 100.00
Regulatory Constraints <i>in percent</i>	10 27.78	26 72.22	36 100.00	3 25.00	9 75.00	12 100.00	7 29.17	17 70.83	24 100.00
Accounting Issues <i>in percent</i>	7 19.44	29 80.56	36 100.00	4 19.05	17 80.95	21 100.00	3 12.50	21 87.50	24 100.00

Table 4: Potential Determinants of the Investment Decision

Numbers and percentages of the insurance companies that stated whether or not a certain factor has influenced their decision to invest in cat bonds. Due to the exclusion of cases with missing data, the overall sample size drops to  $N = 36$ .

not certain factors had an influence on their cat bond investment decision.<sup>17</sup> Table 4 shows the respective results.<sup>18</sup> Interestingly, the aspects expertise and experience, risk-return (and correlation) profile, administrative complexity, and data availability are considered relevant by the majority of investors, while they do not seem to be of importance to most non-investors. Constraints due to capital charges and accounting issues, in contrast, have been declared to be irrelevant by both groups. This finding supports our expectation expressed in Section 2.2 that these two aspects do not affect an insurance company's propensity to invest in cat bonds.

## 4.2 Determinants of the Cat Bond Investment Decision

As explained in Section 3.4, before estimating the logistic regression model, we run an EFA to extract a set of latent constructs from the observed variables in our sample. For the resulting factor structure to be meaningful and properly interpretable, the correlations between items that are associated with the same factor should be high, while those between items that represent different factors should be low. This idea underlies the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy, which indicates whether a data set is suitable for an EFA. Being defined between zero and one, KMO values below 0.5 imply that EFA should not be applied, whereas KMO values in excess of 0.8 mean that the sample is particularly well suited for the analysis (see Kaiser, 1974). Following an iterative process guided by the KMO measure,

<sup>17</sup> As explained in Section 3.4, most of the determinants are latent factors, which have been measured by means of observed variables or so-called items. Within the questionnaire, each determinant was represented by a whole battery of such items. The relevant/irrelevant questions to which we refer in this paragraph preceded those item batteries. The only exception is the factor "perceived fit with the company's ALM strategy" (hypothesis 2), for which a relevance/irrelevance question has not been posed. The reason is that the respective item battery was included in a more general section of the questionnaire that captured further details with regard to the firm's past, present, and future cat bond investments.

<sup>18</sup> Note that the number of respondents  $N$  has dropped from 44 to 36, since eight firms have not provided information with regard to the item batteries for the latent variables at all. Hence, imputation was not possible and the respective cases have been excluded from the following analyses due to missing data.

we identified 15 of the 41 items as problematic and removed them from our sample. The remaining 26 items lead to a solid KMO value of 0.7041. Furthermore, in order to check the EFA precondition of normality, the K-S goodness-of-fit test has been employed. Apart from very few exceptions, we do not find significant deviations from the normal distribution, implying that the items can be used in a factor analysis.<sup>19</sup> Subsequently, we conduct Bartlett's test of sphericity and find the correlations of the items to be statistically significant on the 1 percent level with a  $\chi^2$  test statistic of 1,106.16 and 325 degrees of freedom. Since the EFA procedure relies on the correlation (covariance) matrix of the observed variables to derive the latent constructs, this test result is another indication for the suitability of our data.

For the initial factor extraction we choose the principal components analysis. This procedure produces an orthogonal factor structure (i.e., the pairwise factor correlations are zero) by repeatedly searching for linear combinations of the items that account for the largest fraction of the still unexplained variance, until the number of extracted factors equals the number of items.<sup>20</sup> The usual result is that, on the one hand, the majority of items strongly load on the first few factors and, on the other hand, substantial cross-loadings of items with more than one factor arise. Consequently, it is common to rotate the extracted factor structure in order to generate a more coherent pattern of loadings that considerably improves interpretability.<sup>21</sup> For this purpose, we resort to the orthogonal varimax rotation approach, which repositions the axes of the factor space such as to maximize the variance of the squared loadings per factor. Moreover, since EFA does not provide a theoretical foundation for the number of factors to be retained, our hypotheses from Section 2.2 serve as the main guidance for the dimensionality of the model. In addition, we employ the Kaiser criterion, which states that only factors with eigenvalues in excess of one should be retained.<sup>22</sup>

Table 5 summarizes the results of the EFA.<sup>23</sup> As can be inferred from the rotated factor loadings matrix, we decided in favor of a five-factor model that is compatible with our hypotheses. This solution is also supported by the Kaiser criterion (see eigenvalues).<sup>24</sup> In sum, the five factors account for more than 80 percent of the variation in the data. Furthermore, apart from two exceptions, all factor loadings that belong to one item battery exceed 0.60, underlining a strong influence of the common factors on the observed variables through which they have been measured.<sup>25</sup> This is also reflected by the low number of cross-loadings above 0.4 as well as the high values for Cronbach's alpha, which measures the internal

<sup>19</sup> Due to the standard nature of the K-S statistic and the multitude of variables, we decided not to report these results.

<sup>20</sup> Taken together, the principal components explain the total variance of all items.

<sup>21</sup> In rotated factor structures, most items tend to load relatively high on one factor, while exhibiting rather weak cross-loadings with others.

<sup>22</sup> Being defined as the sum of squared factor loadings across all items, eigenvalues represent the amount of the total variance explained by a factor. As EFA is commonly performed with standardized variables, each item exhibits an eigenvalue of one. Thus, intuitively the Kaiser criterion requires factors to explain at least as much variance as individual items.

<sup>23</sup> In order to enhance the readability and interpretability of this table, factor loadings below 0.4000 have been suppressed.

<sup>24</sup> Note that there is actually a sixth factor, which exhibits an eigenvalue just slightly above one. However, it contributes a mere 3.85 percent of explained variance and is neither supported by our theory, nor clearly associated with a specific item battery. In addition, no item exhibits a loading in excess of 0.6 with regard to this factor. Hence, we chose not to include it in the final factor model.

<sup>25</sup> The factor loadings can be interpreted as correlation coefficients between indicator variables and factors.

Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Cat bonds ...					
... fit well in our portfolio					0.8440
... are compatible with our ALM strategy					0.9165
... are an attractive asset class	0.4792		0.4125		0.6470
Our firm ...					
... is very experienced in the asset class	0.8706				
... has a strong cat bond expertise	0.8930				
... fully understands the typical risks	0.8171				
... can handle the modeling/valuation/risk mgmt	0.9292				
... possesses cat bond portfolio mgmt skills	0.8915				
... understands the accounting treatment	0.8479				
... understands the regulatory treatment	0.7481				
... commands the necessary overall resources	0.9126				
The following information is readily available:					
– Transaction data		0.9066			
– Pricing information		0.8346			
– Historical performance figures		0.5494			
– Loss experience		0.7486			
– Deal documents		0.8976			
– Overall cat bond data availability		0.9489			
The cat bond asset class exhibits ...					
... a strong historical performance	0.5020		0.8025		
... an attractive return potential			0.7539		
... a high relative value			0.8458		
... an appealing overall risk-return profile	0.4828		0.7713		
Cat bonds ...					
... are standardized		0.6568		0.5616	
... are liquid				0.8083	
... are associated with low administration costs		0.4289		0.6631	
... expose investors exclusively to insurance risk				0.8532	
... are not associated with credit risk				0.7821	
Eigenvalues	8.9929	6.7188	2.1114	1.9237	1.7278
Explained Variance (percent)	34.5879	25.8416	8.1209	7.3990	6.6455
Cumulative Explained Variance	34.5879	60.4295	68.5504	75.9494	82.5949
Cronbach's $\alpha$	0.9653	0.9318	0.9152	0.8761	0.8819

Table 5: Rotated Factor Loadings Matrix with Additional Statistics

Factor loadings resulting from an EFA for 26 items that have been measured on Likert scales. KMO measure of sampling adequacy: 0.7041. Bartlett's test of sphericity:  $\chi^2$ -value = 1,106.16, 325 degrees of freedom, p-value = 0.0000. Extraction method: principal component analysis. Rotation method: varimax with Kaiser normalization. Dimensionality: all factors that are compatible with a hypothesis from Section 2.2 and exhibit eigenvalues greater than unity have been retained (Kaiser criterion). This leads to a five-factor solution. In order to enhance the readability and interpretability of this table, factor loadings below 0.4000 have been suppressed. The eigenvalue of each factor (i.e., the sum of squared factor loadings across all items) is a measure for the amount of variance it explains. In sum, the five factors explain 82.5949 percent of the total variance. Cronbach's alpha has been computed to measure the internal consistency of each item battery.

$N = 36$	$\beta_i$	$\exp(\beta_i)$	s.e.	Wald	p-value	sig.
Constant	0.3867	1.4721	0.9034	0.1832	0.6686	
Company Size	-0.0002	0.9998	0.0001	1.6369	0.2008	
Expertise and Experience	3.5537	34.9413	1.6473	4.6537	0.0310	**
Perceived Fit with Strategic ALM	3.0297	20.6905	1.4511	4.3591	0.0368	**
Perceived Data Availability	0.4424	1.5565	0.6264	0.4989	0.4800	
Perceived Administrative Complexity	-0.8880	0.4115	0.8645	1.0550	0.3044	
Perceived Risk-Return Profile	0.1325	1.1416	0.6774	0.0382	0.8449	
Perceived Diversification Benefits	0.5492	1.7319	0.6929	0.6283	0.4280	
Regulatory Constraints	-4.9872	0.0068	2.5702	3.7652	0.0523	*
<b>Goodness of Fit</b>	$\chi^2$	df	p-value			
$-2LL_0$ (null model)	45.8290	34	0.0847			
$-2LL_m$ (considered model)	20.3100	26	0.7766			
$LR$ (likelihood ratio test)	25.5190	8	0.0013			
$HL$ (Hosmer-Lemeshow test)	10.2841	7	0.1730			
<b>Pseudo <math>R^2</math>-measures</b>						
Cox and Snell	0.5078					
Nagelkerke	0.7053					
McFadden	0.5568					

Table 6: Logistic Regression with all Potential Determinants

Results for a logistic regression of the dichotomous dependent variable (investor/non-investor) on eight explanatory variables (plus constant). The coefficients  $\beta_i$  indicate the magnitude of the effect of each independent variable on the logit,  $\exp(\beta_i)$  represents the corresponding impact on the  $OR$ , and s.e. is the standard error of the respective parameter. The Wald statistic is employed to test the significance of the logit coefficients. Goodness of fit (based on the  $\chi^2$  distribution):  $-2LL_0$  = minus two times the log-likelihood value for the null model (includes only a constant);  $-2LL_m$  = minus two times the log-likelihood value for the considered model ( $H_0$ : perfect model fit);  $LR$  (likelihood ratio) equals the difference between  $-2LL_0$  and  $-2LL_m$  ( $H_0$ : all logit coefficients of the considered model are zero);  $HL$  = Hosmer-Lemeshow statistic ( $H_0$ : the observed and predicted event rates do not differ in each category of the dependent variable). Pseudo  $R^2$ -measures are defined between zero and one with values in excess of 0.4 indicating a good model fit. Significance levels: \*\*\* = 1 percent, \*\* = 5 percent, \* = 10 percent.

Observed	Predicted		% Correct
	Investor	Non-investor	
Investor	10	2	83.33
Non-investor	1	23	95.83
Overall			91.67

Table 7: Classification Table for Model with all Potential Determinants

This classification table can be employed to evaluate the predictive accuracy of the logistic regression model in Table 6. It shows how many of the observed values for the dichotomous dependent variable (investor/non-investor) are correctly predicted. The figures are based on a cutoff value of 0.5, i.e., all firms for which the probability of investing as implied by the model exceeds 0.5 are classified as investors. The model correctly predicts 83.33 percent of the investors, 95.83 percent of the non-investors, and 91.67 percent of all cases.

consistency of each factor. Thus, the 26 items that have been included in the EFA lead to a meaningful factor structure. In line with our arguments in Section 2.2, we interpret the five factors as follows:

- Factor 1: expertise and experience with regard to the cat bond asset class (hypothesis 3)
- Factor 2: perceived availability of data and information on the cat bond asset class (hypothesis 7)
- Factor 3: perceived attractiveness of the risk-return profile (hypothesis 4)
- Factor 4: perceived administrative complexity (hypothesis 6)
- Factor 5: perceived fit with the insurance company’s ALM strategy (hypothesis 2)

This EFA output enables us to test five of our eight hypotheses within a logistic regression analysis. In order to control for the remaining three determinants postulated in Section 2.2, we need to draw on further independent variables. More specifically, 2 of the 15 items that were not suited for the EFA have been averaged to form an additional factor, reflecting hypothesis 4 (diversification benefits of cat bonds). In addition, we include the number of employees as a proxy for the firm size (hypothesis 1).<sup>26</sup> Finally, to account for hypothesis 8, we coded a dummy variable for the regulatory constraints, which equals one if the company is subject to Swiss investment rules and zero otherwise.

The results for a logistic regression model, comprising these eight independent variables, are shown in Table 6. Unreported collinearity diagnostics such as the tolerance and the variance inflation factor (VIF) indicate that multicollinearity is not an issue. The coefficients  $\beta_i$  reflect the magnitude of the effect of each independent variable on the logit,  $\exp(\beta_i)$  represents the corresponding impact on the *OR*, and s.e. is the standard error of the respective parameter. The Wald statistic is employed to test the significance of the individual logit coefficients. Examining the corresponding p-values and significance levels, we notice that the coefficients of the regressors “expertise and experience”, “perceived fit with the firm’s ALM strategy”, and “regulatory constraints” turn out to be statistically significant.<sup>27</sup> Consistent with the corresponding hypotheses, the first two variables exhibit a positive impact, while the last factor reduces the logit and the investment probability. All other factors, on the contrary, appear to be irrelevant with regard to the insurers’ decision to add cat bonds to their portfolios.

Table 6 also contains the typical goodness-of-fit measures for logistic regression models.  $-2LL_0$  and  $-2LL_m$  equal minus two times the log-likelihood value for a null model that includes only a constant and minus two times the log-likelihood value for the considered model, respectively. The higher the value of  $-2LL_m$ , the worse the actual model fit. Since  $-2LL_m$  (also known as deviance) is  $\chi^2$ -distributed

<sup>26</sup> We have also estimated alternative model specifications based on the balance sheet size and the premium volume to ensure that the reported significance level for the size factor is robust with regard to the employed proxy.

<sup>27</sup> Note that we also conducted analyses with the 13 spare items, which are neither used in the EFA nor reflect a specific hypothesis. Five of these items cover more detailed aspects with regard to accounting treatment and solvency capital requirements, another five represent specific transactional characteristics such as TRS features and collateral arrangements, and one asks for the respondents’ overall risk perception. Unreported logistic regression results indicate that none of these variables adds any explanatory power to the model. Furthermore, additional qualitative characteristics such as the company type (primary insurer vs reinsurer) or business line (life vs nonlife) have been tested via dummy variables. In this regard, we find that being a reinsurance company exhibits a significant positive impact on the investment decision. However, this can be simply explained by the fact that the characteristic “reinsurer” is highly predictable through a combination of the factors expertise/experience as well as perceived fit with the ALM strategy, and is thus already covered by our model.

with  $N - k - 1$  degrees of freedom ( $k$  equals the number of explanatory variables), we can use it to test the null hypothesis of a perfect model fit that, due to the p-value of 0.7766, cannot be rejected.<sup>28</sup> A closely related statistic is the likelihood ratio,  $LR$ , which equals the difference between  $-2LL_0$  and  $-2LL_m$ , thus providing a means for the assessment of the fit of the considered model relative to the null model. It is also  $\chi^2$ -distributed with degrees of freedom equal to the difference in the degrees of freedom of  $-2LL_0$  and  $-2LL_m$  and forms the basis for the likelihood ratio test. In our case, the respective null hypothesis that all logit coefficients are jointly zero can be rejected on the 1 percent significance level (p-value: 0.0013). Therefore, adding the tested regressors leads to a significant improvement in the model fit compared to the null model. Furthermore, we conduct the Hosmer-Lemeshow test. Based on the corresponding variable  $HL$ , which is  $\chi^2$ -distributed with seven degrees of freedom, it is not possible to reject the null hypothesis that the observed and predicted event rates are equal for each category of the dependent variable. The overall good model fit indicated by these statistics is further underlined by the fact that the values of the pseudo  $R^2$ -measures by Cox and Snell, Nagelkerke, and McFadden are all above 0.4.<sup>29</sup> Finally, turning to the classification table (Table 7), we find that the model correctly predicts 83.33 percent of the investors, 95.83 percent of the non-investors, and 91.67 percent of all firms.<sup>30</sup>

Since all but three of the tested independent variables turned out to be insignificant, we should be able to remove them without losing much explanatory power. The results for such a reduced model, merely comprising the regressors “expertise and experience”, “perceived fit with the firm’s ALM goals”, and “regulatory constraints”, can be found in Table 8. Again, the coefficients for these variables are statistically significant.<sup>31</sup> Moreover, as expected, the goodness-of-fit statistics and pseudo  $R^2$ -measures have hardly changed. Similarly, the figures reported in the classification table for this new model (Table 9) suggest a strong predictive accuracy. More specifically, although it includes five independent variables less than the previous model, it still correctly predicts 83.33 percent of the investors, 83.33 percent of the non-investors, and 83.33 percent of all firms in the sample.

To sum up, through our quantitative results, we are able to provide evidence for hypotheses 2, 3, and 8. The remaining hypotheses, however, cannot be confirmed. Consequently, the expertise and experience of insurance companies concerning cat bonds, the extent to which they perceive a fit of the asset class with their ALM strategy, and the prevailing regulatory regime seem to be the key determinants of the investment decision. To assess the importance of these factors relative to each other, one needs to consider the respective effect strengths. According to the logit coefficient of 2.4740, the strongest impulse for an

<sup>28</sup> We are aware that the  $-2LL_m$  statistic is sensitive to the distribution of the cases among the categories of the dependent variable. If the sample is very unbalanced in this regard, it may provide a too optimistic assessment of the model fit.

<sup>29</sup> Although they cannot be interpreted exactly in the same way, pseudo  $R^2$ -measures have been developed to mimic the well-known  $R^2$  of the linear regression analysis (see, e.g., Wooldridge, 2008). They equal zero if the independent variables exhibit no explanatory power at all. Values above 0.4 indicate a good model fit.

<sup>30</sup> These figures are based on a cutoff value of 0.5, i.e., all firms for which the probability of investing as implied by the model exceeds 0.5 are classified as investors.

<sup>31</sup> Peduzzi et al. (1996) propose that, as a rule of thumb, logistic regression models require a minimum of 10 events per explanatory variable to avoid biased regression coefficients and misestimation of the standard errors. Since the 36 participants in our sample comprise only 12 investors, we have additionally tested each of the three determinants in a separate model, thus increasing this ratio above the critical level. In doing so, we ensure the robustness of our results.

$N = 36$	$\beta_i$	$\exp(\beta_i)$	s.e.	Wald	p-value	sig.
Expertise and Experience	2.4740	11.8694	0.9830	6.3336	0.0118	**
Perceived Fit with ALM Strategy	2.2814	9.7899	0.9887	5.3239	0.0210	**
Regulatory Constraints	-3.3251	0.0360	1.4184	5.4955	0.0191	**
<b>Goodness of Fit</b>	$\chi^2$	df	p-value			
$-2LL_0$ (null model)	49.9070	35	0.0490			
$-2LL_m$ (considered model)	24.9120	32	0.8096			
$LR$ (likelihood ratio test)	24.9950	2	0.0000			
$HL$ (Hosmer-Lemeshow test)	4.2433	7	0.7514			
<b>Pseudo <math>R^2</math>-Measures</b>						
Cox and Snell	0.5006					
Nagelkerke	0.6674					
McFadden	0.5008					

Table 8: Logistic Regression with Significant Determinants

Results for a logistic regression of the dichotomous dependent variable (investor/non-investor) on three explanatory variables (without a constant). The coefficients  $\beta_i$  indicate the magnitude of the effect of each independent variable on the logit,  $\exp(\beta_i)$  represents the corresponding impact on the  $OR$ , and s.e. is the standard error of the respective parameter. The Wald statistic is employed to test the significance of the logit coefficients. Goodness of fit (based on the  $\chi^2$  distribution):  $-2LL_0$  = minus two times the log-likelihood value for the null model (includes only a constant);  $-2LL_m$  = minus two times the log-likelihood value for the considered model ( $H_0$ : perfect model fit);  $LR$  (likelihood ratio) equals the difference between  $-2LL_0$  and  $-2LL_m$  ( $H_0$ : all logit coefficients of the considered model are zero);  $HL$  = Hosmer-Lemeshow statistic ( $H_0$ : the observed and predicted event rates do not differ in each category of the dependent variable). Pseudo  $R^2$ -measures are defined between zero and one with values in excess of 0.4 indicating a good model fit. Significance levels: \*\*\* = 1 percent, \*\* = 5 percent, \* = 10 percent.

Observed	Predicted		% Correct
	Investor	Non-investor	
Investor	20	4	83.33
Non-investor	2	10	83.33
	Overall		83.33

Table 9: Classification Table for Model with Significant Determinants

This classification table can be employed to evaluate the predictive accuracy of the logistic regression model in Table 8. It shows how many of the observed values for the dichotomous dependent variable (investor/non-investor) are correctly predicted. The figures are based on a cutoff value of 0.5, i.e., all firms for which the probability of investing as implied by the model exceeds 0.5 are classified as investors. The model correctly predicts 83.33 percent of the investors, 83.33 percent of the non-investors, and 83.33 percent of all cases.

	<b>Full Sample</b>	
	No.	Percent
<b>Aspects encouraging cat bond investments</b>		
"Cat bonds offer attractive returns/have a low fundamental correlation with other asset classes."	6	15.79
"It can be better to write cat bond business than to use the conventional market."	6	15.79
"We are obtaining knowledge of the cat bond market to use these instruments in the future."	2	5.26
<b>Aspects opposing cat bond investments</b>		
"They do not fit with our asset and liability management."	9	23.68
"We have not undertaken a particular effort due to regulatory constraints."	6	15.79
"Missing know-how."	4	10.53
Other reasons	2	5.26
<b>Further comments</b>	3	7.89

Table 10: Open Questions

This table gives an overview of the responses to the open questions in the survey. 24 participants have commented on different aspects regarding their decision to invest or not to invest in cat bonds. The answers are categorized by aspects encouraging and aspects opposing cat bond investments. The percentage figures are based on a total of 38 responses to open questions.

investment in cat bonds emanates from the expertise/experience of a company. With a corresponding value of 2.2814, however, the perception that the asset class is in line with the ALM strategy has a similarly large positive impact on the likelihood to invest. In contrast to that, the binding regulatory constraints with regard to the tied assets faced by Swiss companies strongly oppose these factors (logit coefficient:  $-3.3251$ ), causing a significant reduction of the investment probability. Thus, Swiss insurers seem to be a lot less likely to invest in cat bonds than EU-based firms, even if they exhibit the same values with regard to the two aforementioned factors.

### 4.3 Further Qualitative Results

#### Open Survey Questions

To complement our inference statistics, we additionally included five open questions in the questionnaire. Thereby, the participants were given the opportunity to express opinions and ideas with regard to different aspects of their cat bond investment decision. Overall, we obtained 38 responses to open questions from 24 different key informants. A comprehensive list of quotations has been included in the Appendix.

For reasons of efficient reporting, we have grouped the answers in this section based on their key messages. The respective results are shown in Table 10. A total of 14 statements contain aspects that encourage the firms to invest in cat bonds. Six of these, i.e., 15.79 percent of all comments, are centered around the attractive risk-return profile of cat bonds as well as the low correlation with other asset classes. Since these factors were not found to be statistically significant in the logistic regression analysis of Section 4.2, we need to assume that they are merely a decisive factor for certain insurers but not for the majority of firms. In another six responses (15.79 percent), the respective participants point out that their companies view cat bond investments as a means for market expansion and to comple-

ment their traditional insurance business. This is quite an interesting consideration, which has not been hypothesized *ex ante* and was thus missing in our questionnaire design. Hence, for the time being, we need to take into account that this might be an additional determinant while leaving the confirmation of its statistical significance for future research. Finally, two answers (5.26 percent) name the intension to acquire know-how about the cat bond market as the main reason for the investment decision. This provides further support for the factor expertise and experience, which has been identified as one of the main drivers in the previous section.

Moreover, 21 answers brought forward reasons not to purchase cat bonds. Since the majority of survey participants are non-investors (see Table 1), it could be expected that the negative statements outnumber the arguments in favor of an investment in this asset class. Consistent with our statistical results, a lacking fit of cat bonds with regard to the ALM considerations of the company is stressed in nine comments (23.68 percent). Furthermore, in six (15.79 percent) responses the key informants note that their firm refrains from cat bond investments due to regulatory constraints. Particularly the FINMA guidelines regarding “tied assets” are referred to several times, thus confirming our logistic regression results for  $H_8$ .<sup>32</sup> Apart from these aspects, four answers (10.53 percent) revolve around the missing expertise and experience that would be needed to make adequate investment decisions with regard to cat bonds. Again, this supports our previous findings with regard to  $H_3$ . Finally, the responses to the open survey questions also comprise a totally new aspect counted under “other reasons”.<sup>33</sup> One company does not seem to show any interest in cat bond investments because they want to avoid losses due to perils that their stakeholders do not expect to be part of their exposure. The fact that earthquakes in Japan would not be associated with a purely European insurance company is mentioned as an example in this context.

Most answers to the open survey questions help to underline and further illustrate the results of our empirical analysis. Indeed, it appears that a large number of the participants made comments that can be associated with one of the three significant determinants identified in Section 4.2. In addition to that, however, we were able to gather new information with regard to the investment decision that could not be captured by the preset items in the questionnaire. The aspects revealed in this regard should be taken into account in future empirical research on this topic.

### **Interviews with Managers of Dedicated Cat Bond Funds**

In addition to the survey, we conducted structured interviews with the investment managers of four large and influential dedicated cat bond funds. Together, their assets under management amount to approximately USD 7.73 billion, which represented 76.19 percent of the outstanding cat bond volume in 2011 (see Guy Carpenter, 2011). Thus, our interview partners possess information about a large part of the market and profound knowledge of their clients’ investment decisions as well as the reasons behind them.

<sup>32</sup> A penalization in terms of the Solvency II capital charges for cat risk, in contrast, is only criticized in a single response.

<sup>33</sup> The second statement in the category “other reasons” refers to the low degree of liquidity of cat bonds. This consideration is covered by factor 4 of the empirical analysis (perceived administrative complexity).

This characterizes them as key informants for our study. The interviews were carried out in March and April 2012. All participants received the same set of questions and were asked to answer either in form of a telephone interview or in writing. The generally low level of cat bond investments in the insurance industry (see Section 2.1) is also reflected by the investor base of the considered funds. While two of them do not have insurers among their current investors at all, the other two pointed out that less than 1 percent of their total client money comes from the insurance industry. Several reasons for this phenomenon have been provided by our interview partners.

One of them emphasizes that the regulatory constraints in Switzerland are the main factor behind the limited interest in cat bond investments shown by the local insurance industry. According to his clients, FINMA insists on a strict separation of business lines. Companies that are exclusively regulated as life or health insurers are not permitted to invest in cat bonds at all, since this would be economically equivalent to the underwriting of insurance contracts in the property and liability sector. Nonlife insurers, in contrast, for which natural disaster risk is part of their core business, do not face such an explicit restriction with regard to the asset class. However, their potential for cat bond investments is still considerably constrained due to the tied asset investment rules set by FINMA. This statement provides further support for  $H_8$ .

Other explanations revolve around the determinant expertise and experience. Our interviewees find this aspect to be especially relevant in times of market turbulence. Under such circumstances as during the financial crisis in 2008, those insurance firms without an in-depth knowledge about the cat bond market are the first to abandon their engagement as investors. It has also been stated that there are a number of reinsurers as well as large primary insurers with considerable cat bond expertise and experience. When willing to invest, those firms only consider direct investments. Smaller insurers, on the other hand, often lack know-how with regard to the structures, the market, or certain catastrophe risks in general and thus, if at all, access the asset class through dedicated cat bond funds. We view these arguments as an additional confirmation of  $H_3$ .

Furthermore, the question whether the risk-return and correlation profiles of cat bonds have a certain impact on the investment decision was affirmed during three of the interviews. This is in line with the statements of some of the survey participants. Hence, those insurers that actually invest in cat bonds might view the beneficial characteristics of the asset class to be great enough to overcome some of the other factors that exhibit a negative impact on their investment decision. Nevertheless, the corresponding determinants did not turn out to be statistically significant in our empirical analysis, implying that one should be cautious about a generalization of these opinions. Therefore, in the absence of further evidence,  $H_4$  and  $H_5$  can still not be ultimately confirmed.

Similarly, three interview partners state that an improvement in the availability of data and information on the cat bond asset class would be likely to have a positive influence on the demand. In this context, they point to a potentially severe conflict of interest. Since the asset management of those

insurance companies that act as cat bond investors needs to assess prospective transactions, it desires as much publicly available information as possible. The sponsor, in contrast, is interested in a high level of discretion, particularly for indemnity deals, in order to avoid that its competitors gain too much insight into its underwriting activities. Consequently, insurers seem to believe that they can get better data on the actual exposure when they insure the risk rather than relying on offering documents of cat bond transactions. Moreover, it has been mentioned that substantial changes in the risk models of the major analytics firms (RMS, EQECAT, AIR) negatively affect the interest in the asset class, since investors generally tend to avoid cat bonds that are perceived to hide a considerable amount of model risk. Although these are interesting new insights, the insignificance of the respective factor within the empirical analysis prevents the confirmation of  $H_7$ .

Finally, the interviews revealed two perspectives concerning the cat bond investment decision of insurance companies that had not been anticipated in Section 2.2. Interestingly, these are consistent with the new aspects that we identified based on the answers to the open survey questions. The first point, which has been mentioned by two of the interviewees, can be described as political reasons for the decision not to buy cat bonds. More specifically, although stakeholders might benefit from this asset class through enhanced diversification, the management of insurance companies can be reluctant to accept exposures outside of their core market due to the associated career risks. In doing so, they aim to avoid the responsibility for losses due to natural hazards in locations where their company is not even represented with its insurance operations. Apart from that, our interview partners indicated that some firms have embraced cat bonds as a complement to their conventional business. While some insurers exclusively approach the topic from an asset management perspective, others consider cat bond investments as a relative value trade with regard to insurance products. If the pricing of a cat bond issue is more attractive than that of a corresponding traditional contract, these companies will switch to the former in order to benefit from its superior risk-return trade-off.

## 5 Summary and Conclusion

Our main research goal in this paper is to identify major determinants of the cat bond investment decision of insurers. For this purpose, we conducted a comprehensive survey among senior executives in the European insurance industry. Evaluating the corresponding data set by means of EFA and logistic regression methodology, we are able to show that the expertise and experience with regard to cat bond investments, their perceived fit with the prevailing ALM strategy, and the regulatory regime exert a significant influence on an insurer's propensity to invest. In contrast to that, the perception of the asset class's risk-return profile, diversification benefits, administrative complexity, as well as the availability of data and information on cat bond transactions seem to be of lesser relevance. Similarly, we do not find evidence for an impact of firm size, accounting treatment, or solvency capital requirements. These statistical results are complemented by further qualitative survey answers and additional information from structured interviews with the investment managers of four large dedicated cat bond funds.

Our findings should be highly relevant to cat bond issuers and policymakers alike. Since, in general, insurance companies represent a central source of institutional investor demand in the capital markets, the reduction of existing investment barriers with regard to cat bonds could generate a substantial growth impulse for this asset class. It appears that, theoretically, issues relating to the first two determinants (lack of expertise/experience, perceived fit with the ALM strategy) could be simply overcome by properly educating prospective market participants and disseminating more information about the merits of adding cat bond exposure to the balance sheet of a typical insurance company. Particularly life insurers should be able to exploit the virtues of the instrument, since it may serve as a diversification tool for both their asset and liability risks. Impediments arising due to regulatory constraints such as the rigid legal investment guidelines set by FINMA, however, seem a lot more difficult to address. In this respect, it might be helpful to initiate an intensive dialogue with the regulators, highlighting that, from a risk sharing and performance perspective, it may be economically reasonable to permit that insurance companies allocate a limited fraction of their asset portfolios to cat bonds.

Future work could be aimed at overcoming some of the limitations of our study. The most important aspect in this regard relates to sample size. Indeed, it would be helpful to verify our results based on a much broader survey, for example, including U.S. insurance companies or even adopting a global scope. In addition, the qualitative information that was gathered through open survey questions and structured interviews raised completely new aspects for which measurement variables had not been incorporated in our original questionnaire design. Hence, an examination of the statistical significance of these potential determinants is still outstanding. Finally, follow up research could also aim to overcome certain limitations of the chosen maximum likelihood estimators by resorting to Bayesian inference.

## 6 Appendix: Answers to the Open Survey Questions

### 6.1 Aspects Encouraging Cat Bond Investments

#### Risk-Return Profile and Diversification Benefits

- *Attractive returns.*  
(Germany; Reinsurer; Director)
- *Decent expected return proposition.*  
(Finland; Primary Insurer; Portfolio Manager)
- *Attractive returns.*  
(Switzerland; Reinsurer; Head of Nonlife Risk Transformation)
- *Potentially attractive spreads.*  
(Switzerland; Primary Insurer)
- *Cat bond returns typically have a low fundamental correlation with other asset classes.*  
(Finland; Primary Insurer; Portfolio Manager)
- *Diversification.*  
(Switzerland; Primary Insurer)

#### Market Expansion/Complement the Traditional Insurance Business

- *For visibility in this market place – it can be better to “write” cat bond business than to use the conventional market.*  
(UK; Reinsurer; Managing Director)
- *Market expansion.*  
(Italy; Primary Insurer; Managing Director)
- *Certain risks are not available in form of traditional reinsurance.*  
(Germany; Reinsurer; Director)
- *Due to the evolution of the business it could be interesting to invest in this asset class.*  
(Italy; Primary Insurer; Director)
- *Market making.*  
(Switzerland; Reinsurer; Head of Nonlife Risk Transformation)
- *Cat Bonds are the most liquid asset class inside the non-life risk category.*  
(Finland; Primary Insurer; Portfolio Manager)

#### Expertise and Experience with Regard to the Asset Class

- *To test the market.*  
(Sweden; Reinsurer; Group CFO)
- *Obtaining knowledge of the cat bond market to use these instruments in the future.*  
(Netherlands; Primary Insurer; Senior Risk Manager)

## 6.2 Aspects Opposing Cat Bond Investments

### Fit with Strategic Asset and Liability Management Goals

- *At the moment, they do not exactly fit in our asset and liability management.*  
(Italy; Primary Insurer)
- *The decision not to invest in cat bonds is based on a total balance sheet view and the regional risk profile of our company.*  
(Switzerland; Primary Insurer; Director)
- *We are very conservative in our investment approach.*  
(Greece; Primary Insurer)
- *Do not fit our ALM considerations.*  
(Austria; Primary Insurer; Market Risk Manager)
- *Main focus in matching liabilities.*  
(Finland; Primary Insurer; Chairman of the Board)
- *Strategic decision. Ultimately, we do not want to buy risks that we already insure.*  
(Switzerland; Primary Insurer; CIO)
- *We do not treat them as investments, since they are correlated with our key cat risks.*  
(UK; Reinsurer; Managing Director)
- *We acquire our cat risk through reinsurance and feel no need to buy it through assets.*  
(Portugal; Primary Insurer; CFO)
- *As a reinsurer we are already exposed to natural disasters risk. Investing in cat bonds would create a dependency between our insurance results and investment results.*  
(Belgium; Reinsurer; Member of the Executive Board)

### Regulatory Constraints

- *We have not undertaken a particular effort due to regulatory constraints.*  
(Switzerland; Primary Insurer; Head of Investments)
- *Not allowed to invest according to FINMA rules guiding “Gebundene Vermögen” (tied assets), therefore no particular efforts undertaken.*  
(Switzerland; Primary Insurer; Head of Asset Management)
- *All our investments need to qualify for tied assets. Considering the local asset management knowledge/team, these investments will not qualify as “tied assets” and hence we cannot invest.*  
(Switzerland; Primary Insurer; Risk Manager)
- *See FINMA regulation covering “Gebundene Vermögen” (tied assets).*  
(Switzerland; Primary Insurer; Head of Investments)

- *We maintain a very low risk profile, which ensures that we meet the Swiss regulatory tied assets requirement.*  
(Switzerland; Primary Insurer; Controller)
- *Under Solvency II, cat risk is heavily penalized in terms of capital requirements.*  
(Portugal; Primary Insurer; CFO)

### **Expertise and Experience with Regard to the Asset Class**

- *Missing know-how.*  
(Italy; Primary Insurer; Director)
- *We are more confident in traditional investment asset classes.*  
(Italy; Primary Insurer; Director)
- *Opacity: we have difficulties to properly value cat bonds.*  
(Switzerland; Primary Insurer)
- *The risk exposures and the risk accumulation are difficult to assess and monitor.*  
(Switzerland; Primary Insurer; CIO)

### **Other Reasons**

- *Although the risk-return profile is very interesting, it can be difficult to explain to our stakeholders that we could have made a loss due to a peril that our stakeholders don't expect to be our risk. For example, a Japanese earthquake is not a peril that our stakeholders expect to cause a loss for an insurer only active in Europe.*  
(Netherlands; Primary Insurer; Senior Risk Manager)
- *Not very liquid*  
(Italy; Primary Insurer; Managing Director)

### **6.3 Further Comments**

- *We have only invested in a cat bond fund that has no specific restrictions.*  
(Italy; Primary Insurer)
- *Our ILS investments are not covered by our ordinary asset management activities but are managed by our dedicated ILS department, which is part of the reinsurance division.*  
(Germany; Reinsurer; Director)
- *The entity in our group that holds cat bonds is a Bermudian affiliate.*  
(UK; Reinsurer; Managing Director)

## References

- AnIV (2011). Verordnung über die Anlage des gebundenen Vermögens von Versicherungsunternehmen (Anlageverordnung). *www.bafin.de*.
- AVO (2009). Verordnung über die Beaufsichtigung von privaten Versicherungsunternehmen (Aufsichtsverordnung). *www.admin.ch*.
- Bantwal, V. J. and Kunreuther, H. C. (2000). A Cat Bond Premium Puzzle? *Journal of Behavioral Finance*, 1(1):76–91.
- Barrieu, P. and Loubergé, H. (2009). Hybrid CAT Bonds. *Journal of Risk and Insurance*, 76(3):547–578.
- Bouriaux, S. and MacMinn, R. (2009). Securitization of Catastrophe Risk: New Developments in Insurance-Linked Securities and Derivatives. *Journal of Insurance Issues*, 32(1):1–34.
- Braun, A. (2012). Pricing in the Primary Market for Cat Bonds: New Empirical Evidence. *Working Papers on Risk Management and Insurance*, No. 116.
- Cummins, J. D. (2005). Convergence in Wholesale Financial Services: Reinsurance and Investment Banking. *Geneva Papers on Risk and Insurance – Issues and Practice*, 30(2):187–222.
- Cummins, J. D. (2008). CAT Bonds and Other Risk-Linked Securities: State of the Market and Recent Developments. *Risk Management and Insurance Review*, 11(1):23–47.
- Cummins, J. D. and Trainar, P. (2009). Securitization, Insurance, and Reinsurance. *Journal of Risk and Insurance*, 76(3):463–492.
- Cummins, J. D. and Weiss, M. A. (2009). Convergence of Insurance and Financial Markets: Hybrid and Securitized Risk-Transfer Solutions. *Journal of Risk and Insurance*, 76(3):493–545.
- Directive 2002/83/EC (2002). Directive 2002/83/EC of the European Parliament and of the Council of 5 November 2002 concerning life assurance. <http://eur-lex.europa.eu>.
- Directive 92/49/EEC (1992). Council Directive 92/49/EEC of 18 June 1992 on the coordination of laws, regulations and administrative provisions relating to direct insurance other than life assurance and amending Directives 73/239/EEC and 88/357/EEC (third non-life insurance Directive). <http://eur-lex.europa.eu>.
- Froot, K. A. (1999). The Evolving Market for Catastrophic Event Risk. *Risk Management and Insurance Review*, 2(3):1–28.
- Froot, K. A. (2001). The Market for Catastrophe Risk: A Clinical Examination. *Journal of Financial Economics*, 60(2-3):529–571.
- Gibson, R., Habib, M. A., and Ziegler, A. (2007). Why Have Exchange-Traded Catastrophe Instruments Failed to Displace Reinsurance? *Working Paper*.

- Guy Carpenter (2011). World Catastrophe Reinsurance Market Report.
- Hagendorff, B., Hagendorff, J., and Keasey, K. (2011). The Risk Implications of Insurance Securitization: Do Catastrophe Bonds Lower the Default Risk of Issuers? *Working Paper, Leeds University*.
- Ibragimov, R., Jaffee, D., and Walden, J. (2009). Nondiversification Traps in Catastrophe Insurance Markets. *Review of Financial Studies*, 22(3):959–993.
- Jöreskog, K. G. (1967). Some Contributions to Maximum Likelihood Factor Analysis. *Psychometrika*, 32(4):443–482.
- Kaiser, H. (1974). An Index of Factorial Simplicity. *Psychometrika*, 39(1):31–36.
- KAVO (2012). Verordnung der Finanzmarktaufsichtsbehörde (FMA) über Kapitalanlagen zur Bedeckung der versicherungstechnischen Rückstellungen durch Unternehmen der Vertragsversicherung (Kapitalanlageverordnung). *www.fma.gv.at*.
- Lakdawalla, D. and Zanjani, G. (2011). Catastrophe Bonds, Reinsurance, and the Optimal Collateralization of Risk Transfer. *Journal of Risk and Insurance*, forthcoming.
- Likert, R. (1932). A Technique for the Measurement of Attitudes. *Archives of Psychology*, 22(140):1–55.
- Litzenberger, R. and Beaglehole, D. (1996). Assessing Catastrophe Reinsurance-Linked Securities as a New Asset Class. *Journal of Portfolio Management (Special Issue)*, pages 76–86.
- Merton, R. C. (1974). On the Pricing of Corporate Debt: The Risk Structure of Interest Rates. *Journal of Finance*, 29(2):449–470.
- Niehaus, G. (2002). The Allocation of Catastrophe Risk. *Journal of Banking and Finance*, 26(2-3):585–596.
- Peduzzi, P., Concato, J., Kemper, E., Holford, T. R., and Feinstein, A. R. (1996). A Simulation Study of the Number of Events per Variable in Logistic Regression Analysis. *Journal of Clinical Epidemiology*, 49(12):1373–1379.
- Sawilowsky, S. S. and Blair, R. C. (1992). A More Realistic Look at the Robustness and Type II Error Properties of the t Test to Departures from Population Normality. *Psychological Bulletin*, 111(2):352–360.
- Schoechlin, A. (2002). Where’s the Cat Going? Some Observations on Catastrophe Bonds. *Journal of Applied Corporate Finance*, 14(4):100–108.
- Swiss Financial Market Supervisory Authority (FINMA) (2008). Anlagen im gebundenen Vermögen sowie Einsatz von derivativen Finanzprodukten bei Versicherern. *Rundschreiben 2008/18*.
- Swiss Re (2006). Securitization: New Opportunities for Insurers and Investors. *Sigma 7/2006*, (Zurich, Switzerland).

- Swiss Re (2009). The Role of Indices in Transferring Insurance Risk to the Capital Markets. *Sigma* 4/2009, (Zurich, Switzerland).
- Towers Watson (2010). Catastrophe Bonds Evolve to Address Credit Risk Issues. *Report*, (May).
- VAG Austria (2012). Bundesgesetz vom 18. Oktober 1978 über den Betrieb und die Beaufsichtigung der Vertragsversicherung (Versicherungsaufsichtsgesetz). *www.fma.gv.at*.
- VAG Germany (2012). Gesetz über die Beaufsichtigung der Versicherungsunternehmen (Versicherungsaufsichtsgesetz). *www.bafin.de*.
- VAG Switzerland (2011). Bundesgesetz betreffend die Aufsicht über Versicherungsunternehmen (Versicherungsaufsichtsgesetz). *www.admin.ch*.
- Wooldridge, J. M. (2008). *Introductory Econometrics. A Modern Approach*. South-Western, Mason, 4th edition.
- World Economic Forum (2008). Convergence of Insurance and Capital Markets. *Report*, (October).