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The Drivers and Value of Enterprise Risk Management: Evidence from ERM Ratings

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Abstract

In the course of recent regulatory developments, holistic enterprise-wide risk management (ERM) frameworks have become increasingly relevant for insurance companies. The aim of this paper is to contribute to the literature by analyzing determinants (firm characteristics) as well as the impact of ERM on the shareholder value of European insurers using the Standard & Poor's ERM rating to identify ERM activities. This has not been done so far, even though it is of high relevance against the background of the introduction of Solvency II, which requires a holistic approach to risk management. Results show a significant positive impact of ERM on firm value for the case of European insurers. In particular, we find that insurers with a high quality risk management (RM) system exhibit a Tobin's *Q* that on average is about 6.5% higher than for insurers with less high quality RM after controlling for covariates and endogeneity bias.

Keywords: ERM; S&P ERM rating; firm characteristics; shareholder value; Solvency II
JEL classification: G22; G24; G32; O52

1. Introduction

In the course of the recent regulatory development in the aftermath of the financial crisis, e.g. the introduction of Solvency II in 2016, holistic enterprise-wide risk management (ERM) frameworks have become increasingly relevant for insurance companies. Solvency II requires an integrated, enterprise-wide perspective on a firm's entire risk portfolio in contrast to traditional silo-based risk management approaches, and the risk management system has to be consistent with the company's overall business strategy (see, e.g., Gatzert and Wesker, 2012). Moreover, rating agencies such as Standard & Poor's or A.M. Best emphasize the importance of a holistic risk management and have started to consider specific ERM rating categories to evaluate the financial strength as well as the creditworthiness of insurance companies (see,

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e.g., S&P, 2013a). While ERM activities are highly relevant for insurers to comply with Solvency II requirements (especially Pillar 2), the implementation of an ERM system should also contribute to enhancing shareholder value according to the theoretical and empirical literature, e.g. by supporting the board and senior management with necessary risk management information, by increasing capital efficiency, and by better exploiting natural hedges within the company (see, e.g., Meulbroek, 2002; Aebi et al., 2012).

In the literature, several empirical papers analyze the determinants and value of ERM. Besides describing the stage of the ERM implementation (see, e.g., Beasley et al., 2009; Altuntas, Berry-Stoelzle, and Hoyt, 2011a, 2011b), further empirical studies focus on determinants of ERM implementation (see, e.g., Liebenberg and Hoyt, 2003; Beasley et al., 2005; Hoyt and Liebenberg, 2011; Pagach and Warr, 2011; Farrell and Gallagher, 2015; Lechner and Gatzert, 2018). Another strand of the literature addresses the impact of an ERM implementation on a firm's shareholder value (see, e.g., Hoyt and Liebenberg, 2011; McShane et al., 2011; Baxter et al., 2013; Farrell and Gallagher, 2015; Ai et al., 2016; Lechner and Gatzert, 2018). Most of these empirical studies show that ERM can indeed contribute to increasing shareholder value.

However, most of the empirical studies use announcements of Chief Risk Officer (CRO) appointments or a keyword search in annual reports regarding the existence of a CRO or a risk management committee as a proxy to determine whether an ERM system is implemented or not (see, e.g., Liebenberg and Hoyt, 2003; Pagach and Warr, 2011; Eckles et al., 2014). Farrell and Gallagher (2015) further use a survey approach referred to as the Risk Maturity Model by the Risk and Insurance Management Society. This approach is based on self-reported assessments of executives in risk management, which are generally subject to personal judgements. An objective way to proxy ERM activities is given by the Standard & Poor's ERM rating introduced in 2005 (see S&P, 2005). The rating approach of an independent third party is already used in previous studies, but in most cases using US data and focusing on the time period of the financial crisis (see McShane et al., 2011; Baxter et al., 2013; Nair et al., 2014). Ai et al. (2016) extend this view by using a larger sample period from 2006 to 2013, but also using US data. We contribute to the literature by investigating the impact of ERM quality on firm value for an extended time horizon (covering predominantly the period after the financial crisis) and in particular for the special case of Europe, which has not been done so far. Additionally, the findings in the previous studies using US data might not be fully applicable to the European insurance market due to different characteristics when juxtaposing both regulatory regimes, such as the development towards a principles-based approach under Solvency II in Europe compared to a rather static rules-based regulation in the US (see, e.g., Gatzert and Schmeiser, 2008; Eling et al., 2009), or different approaches for group solvency assessments. Unlike the US regulatory system, intra-group risk dependencies and thus risk diversification effects are explicitly taken into account for group solvency requirements in Europe (see Gatzert and Wesker, 2012). Hence, a special focus on European data extends previous results and provides valuable insights on the impact of ERM on firm value.

The aim of this paper is thus to contribute to the literature by analyzing the impact of ERM on the shareholder value of European insurance companies using the S&P's ERM rating to identify the insurers' ERM activities. This has not been done so far and is also of high relevance against the background of the introduction of Solvency II in Europe, which necessitates a holistic approach to risk management. While Solvency II became effective in 2016, the introduction of a new regulatory framework is a dynamic process instead of an abrupt change from one year to a following year, and firms have already started to prepare for Solvency II several years ago. Our analysis is thus intended to provide insight regarding the value of ERM with specific focus on European insurance companies, where we also study the determinants for implementing an ERM system (firm characteristics). By making use of the independent assessment represented by the S&P's ERM rating, we are also able to overcome potential limitations regarding the determination of ERM.

Our data set consists of a sample of insurance industry conglomerates that are operating in different countries in Europe for the time period from 2007 to 2015 and captures the development towards the Solvency II introduction. We focus on publicly-traded insurers in order to be able to calculate Tobin's *Q* as a market-based measure of firm value, which is consistent with the literature. We first use logistic regression analyses to study the determinants of an ERM implementation. To measure the impact of ERM on firm value, we follow Hoyt and Liebenberg (2011) and apply a full maximum-likelihood treatment-effects model in a two-equation system to control for the endogeneity bias of ERM activities. The problem of endogeneity may thereby arise due to the fact that there are factors that have an impact on the decision to implement ERM and on the firm value at the same time. In a first equation (*ERM* Equation), the indicator variable ERM is regressed on various factors, while in a second equation (*Q* Equation), firm value is modeled as a function of ERM and covariates. The treatment-effects approach thus allows us to model these two equations simultaneously in order to avoid the problem of endogeneity.

The remainder of the paper is structured as follows. Section 2 provides a literature overview leading to the hypotheses development. In Section 3, we describe our data set and present the approach of our analysis comprising a logistic regression and a treatment-effects model. Section 4 provides the study results, robustness tests as well as a comparison with previous findings, and Section 5 summarizes and gives concluding remarks.

2. Literature and Hypotheses Development

2.1. Definitions and Motives of Enterprise Risk Management

The importance of enterprise-wide risk management has increased considerably in recent years. While previously, firms focused on financial and hazard risk mitigation in their risk management activities (see, e.g., Farrell and Gallagher, 2015), firms with a holistic risk management approach now pursue risk management in a more strategic, systematic and offensive way by taking into account opportunities with upside potential as well as threats with a downside protection, i.e. a protection against the “costly lower-tail outcomes” (see, e.g., Meulbroek, 2002; Nocco and Stulz, 2006). In contrast to traditional risk management, ERM also models, measures, analyzes, prioritizes, and responds to additional risks types such as operational and reputational risk within a corporate-wide and centralized coordinated framework (see, e.g., Gordon et al., 2009; Whitman, 2015). An integral part of holistic risk management approaches is also the integration of the enterprise-wide risk-reward perspective into the corporates’ strategic managerial decisions (see, e.g., Hoyt and Liebenberg, 2011; Che and Liebenberg, 2017).

To consider all material risks faced by an enterprise in a holistic way, there are several guidelines for a possible implementation of an ERM system. One prominent ERM framework that is often referred to is published by the Committee of Sponsoring and Treadway Commissions in 2004, which defines ERM as (see COSO, 2004, p. 2)[1,2]:

“*a process, effected by an entity’s board of directors, management and other personnel, applied in strategy setting and across the enterprise, designed to identify potential events that may affect the entity, and manage risk to be within its risk appetite, to provide reasonable assurance regarding the achievement of the entity’s objectives.*”

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[1] Further frameworks include the joint Australia/New Zealand 4360:2004 Standard (2004); ISO 31000:2009 Risk Management (2009); FERMA – Risk Management Standard (2002); KPMG Enterprise Risk Management Framework (2001) Casualty Acturial Society (CAS) – Enterprise Risk Management Framework (2003); Casualty Acturarial Society (CAS) Enterprise Risk Management Framework; Risk and Insurance Management Society (RIMS) Risk Maturity Model for ERM (see Rochette, 2009; Gatzert and Martin, 2015).

[2] A new version of the COSO ERM Framework document was released for review and public comment on June 15, 2016. The public exposure period ends on September 30, 2016 and final documents are expected to be released in 2017. The June 2016 revision titled, *Enterprise Risk Management—Aligning Risk with Strategy and Performance*, defines enterprise risk management as: “The culture, capabilities, and practices, integrated with strategy-setting and its execution, that organizations rely on to manage risk in creating, preserving, and realizing value.” This revised definition further highlights the expectation that ERM can affect value.

Hence, in contrast to a traditional silo-based risk management, ERM enables firms to approach risks in an enterprise-wide, consolidated, structured, dynamic, and continuous way with a long-term perspective while taking into account a firm's strategy, all employees, its knowledge base, processes and technologies (see, e.g., Dickinson, 2001; Hoyt and Liebenberg, 2011). Due to the incorporation of risk management within corporate strategy, ERM must be a top-down directed process (instead of a mid-level technical function) with responsibility at the board level (see, e.g., Aebi et al., 2012; Nair et al., 2014).

By considering interdependencies between risk positions and by aggregating risks into one risk portfolio for the enterprise, firms are able to improve the understanding of their overall risk exposure. This enables the use of natural hedges among the different risk sources and the avoidance of redundant risk management expenditures (see, e.g., Meulbroek, 2002; Nocco and Stulz, 2006; Eckles et al., 2014). Companies thus have to manage the residual risk only, which remains as a result of diversification effects amongst the different business units as well as amongst various risk categories (see Hoyt and Liebenberg, 2015; Che and Liebenberg, 2017). As a consequence of the reduced overall risk of failure, firms should be able to increase their performance and, in turn, to increase their shareholder value (see, e.g., Pagach and Warr, 2011; Hoyt and Liebenberg, 2011).

Besides a company's objective to maximize its shareholder value, the implementation of an enterprise-wide risk management system has become increasingly relevant due to an increasing complexity of risks through, e.g., more sophisticated business models and emerging risk sources, increasing dependencies between risk sources, proper methods of risk identification and quantification as well as the consideration of ERM systems in rating processes (see, e.g., Hoyt and Liebenberg, 2011; Pagach and Warr, 2011).

When specifically considering the insurance industry, the fundamental improvements of enterprise-wide risk management approaches are, to some extent, also induced by regulatory pressure in the wake of the implementation of Solvency II. The introduction of the reformed European insurance legislation at the beginning of 2016 has been a major milestone in the development of ERM. Insurance companies are encouraged to strengthen their risk management approaches by developing and defining an adequate risk appetite, well-conceived risk governance systems, and comprehensive standards regarding risk reporting, among others requirements. The second pillar of Solvency II also aims to align risk management more closely with the fundamental strategic decisions of the insurer. This emphasizes that a holistic risk management system is a key component to satisfy requirements of Solvency II, and an ERM system is a possibility to fulfill these requirements (see, e.g., S&P, 2016).

ERM in insurance companies is also recognized by rating agencies such as Standard & Poor's or A.M. Best in their overall rating procedures (see Hoyt and Liebenberg, 2011; Eckles et al., 2014), e.g., Standard & Poor's started in 2005 to consider specific ERM rating categories to evaluate the financial strength as well as the creditworthiness of insurance companies (see, e.g., S&P, 2005; S&P, 2013a; Berry-Stoelzle and Xu, 2016). It is assumed that insurance companies with improved ratings are able to achieve higher premiums due to enhanced safety levels or reduced inefficiencies in the course of the individual risk assessment, thus helping firms to achieve higher overall returns (see McShane et al., 2010).

2.2. Hypothesis development: The value relevance of ERM

The major aim of the paper is to contribute to the literature by analyzing the impact of ERM on the shareholder value of European insurance companies. While we hypothesize that ERM has a positive impact on a firm's shareholder value, implementing a holistic ERM system is associated with considerable costs for the appointment of a Chief Risk Officer (CRO), the establishment of a risk committee at the board-level, the development of a risk culture across the entire company, or the extended efforts regarding public relations (see, e.g., Hoyt and Liebenberg, 2011; Bohnert et al., 2017). Nevertheless, we assume that ERM adopting firms are able to increase their shareholder value because the benefits should exceed the ERM implementation expenditures (see, e.g., Pagach and Warr, 2011). This hypothesis is based on the theoretical discussion and underlying assumptions laid out in Table 1, where we also present previous research that provides statistically significant results for the value adding impact of ERM. In addition, we provide a broad summary of previous empirical literature analyzing this relationship in Table A.5 in the Appendix, thereby differentiating between the underlying sample (country, observation, time), the proxy regarding value and ERM measuring, and the main result of each study.[3]

[3] Table A.6 in the Appendix further presents studies with a focus on the impact of ERM on firm performance using various other (performance) measures.

Table 1: Hypothesis development regarding the value relevance of ERM

Determinant / impact on *Q*	Theoretical discussion and underlying assumptions
	Empirical findings of the impact of ERM on firm value
ERM +	- By reducing a firm's total risk and decreasing or eliminating the likelihood of "costly lower-tail" outcomes (essentially large losses), ERM firms are able to limit the probability of financial distress or even bankruptcy (direct costs) and to avoid indirect costs, such as reputational effects with stakeholders (e.g.; *S96; NS06; M02; GLT09; PW10; PW11; BX16*) - The portfolio-based risk management approach helps to reduce inefficiencies caused by a lack of coordination between different risk management departments and various risk categories as well as exploiting natural hedges that may arise across the enterprise (*HL11; FG15*) - ERM allows an adequate monitoring and management of the company's entire risk portfolio and thus enables firms to bear more business risk, which allows achieving a long-term competitive advantage by optimizing the risk-return tradeoff (*M02; NS06; HL11; S15*) - Through an efficient capital allocation due to a proper internal decision making, ERM firms tend to invest in more valuable net present value projects and, in turn, to improve firm performance (*MR01; LH03; HL11*) - ERM is beneficial through improved risk management disclosures to outsiders such as regulators, investors or rating agencies regarding the firm's risk profile and financial situation. This reduction of information asymmetries leads to improved conditions at the capital market and to a decrease of expected costs of regulatory scrutiny (*M02; LH03; HL11; MNR11; BX16*) - ERM reduces earnings volatility by increasing the probability of firms to invest in profitable projects which can be funded internally (*LH03; ABH11a*)
	HL08; HL11;MNR11; BBHY13, FG15; ABW16; LG18

Notes: While the theoretical assumptions for the value adding impact of ERM are listed above the crossline, the previous research that provided statistically significant results is shown below the crossline; S96: Stulz (1996); MR01: Myers and Read (2001); M02: Meulbroek (2002); LH03: Liebenberg and Hoyt (2003); NS06: Nocco and Stulz (2006); HL08: Hoyt and Liebenberg (2008); GLT09: Gordon et al. (2009); PW10: Pagach and Warr (2010); ABH11a: Altuntas et al. (2011a); HL11: Hoyt and Liebenberg (2011); MNR11: McShane et al. (2011); PW11: Pagach and Warr (2011); BBHY13: Baxter et al. (2013); FG15: Farrell and Gallagher (2015); S15: Sekerci (2015); ABW16: Ai et al. (2016); BX16: Berry-Stoelzle and Xu (2016); LG18: Lechner and Gatzert (2018).

To isolate the relationship between ERM and firm value, we control for other variables and assume that the firm characteristics firm size, return on assets, financial leverage, dividends, and sales growth have an impact on firm value. Previous literature finds an ambiguous effect of firm size on shareholder value through, e.g., economics of scale and scope versus agency problems or greater bureaucratic and regulatory requirements (see, e.g., Zou, 2010; McShane et al., 2011; Li et al., 2014; Sekerci, 2015; Che and Liebenberg, 2017). Next, return on assets should be associated with increasing firm value, e.g. through positive signals to the capital market (see, e.g., Allayannis and Weston, 2001; Hoyt and Liebenberg, 2011; Tahir and Razali, 2011). The association between a firm's value and their capital structure is two-fold, since greater leverage may create investment opportunities through additional positive net present value projects (see Li et al., 2014) or may realize tax savings through enhanced interest payments (see Zou, 2010), while firms with greater leverage may face problems due to a higher probability of suffering financial distress (see, Pagach and Warr 2010). The dividend payouts can be interpreted as a positive signal of a firm's financial situation and the payout reduces free cash flows that otherwise could be used in the own interest of managers (see

Hoyt and Liebenberg, 2011) or suboptimal projects (see Jensen, 1986). However, the payout also limits financial resources for investments in future projects, and thus, the disbursement of cash may restrict a firm's growth opportunities (see Sekerci, 2015). Lastly, firm's shareholder value is determined by generating (still unrealized) positive cash flows by investing in future projects. Thus, firms with improved strategic decisions regarding net present value projects may achieve a greater sales growth, and this may lead to an enhanced firm value (see Pagach and Warr, 2010). In contrast, firms with greater growth opportunities require more financial resources for funding these future projects. The uncertainty of future earnings is associated with greater asymmetric information in the capital market, which may lead to increasing external debt costs, and thus to a decrease in firm value (see Beasley et al., 2008).[4]

2.3. Hypothesis development: Determinants of ERM implementation

The second aim of the paper is to identify firm characteristics that determine the implementation of an ERM system. Some of the previously identified firm characteristics that are hypothesized to have an impact on a company's shareholder value may also impact a firm's decision to engage in ERM activities. To deal with this potential endogeneity bias, we follow Hoyt and Liebenberg (2011) and apply a two-equation system, which on the one hand jointly estimates firm characteristics that favors the likelihood of ERM implementations, and on the other hand evaluates the impact of ERM and further (control) variables on shareholder value. Based on the literature,[4] we hypothesize that the following firm characteristics have an impact on the implementation of an ERM system:

Firm size: Larger firms have the institutional size to support the administrative costs of a high quality ERM program, i.e. to deploy financial, technological and human resources (see Beasley et al. 2005), and have the ability to distribute fixed costs of running an ERM system over multiple business units (see Berry-Stoelzle and Xu, 2016). Furthermore, rising firm size is associated with an increasing scope and complexity of uncertainties (see, e.g., Altuntas et al., 2011a) and a greater risk of financial distress as well as more volatile operational cash flows (see Pagach and Warr, 2011). As a result, larger firms should be more likely to adopt an ERM system.

Financial leverage: The impact of financial leverage is ambiguous. On the one hand, firms may decide to increase leverage due to their improved risk awareness (see Hoyt and Liebenberg, 2011). Secondly, greater leverage increases the likelihood and the expected costs

[4] For detailed discussions, we refer to Bohnert et al. (2017), who give an extensive overview about the relationship between firm value and firm characteristics as well as a comprehensive summary regarding theoretical arguments and empirical findings of ERM determinants.

of lower-tail outcomes and financial distress. Thus, firms with greater leverage implement ERM programs aiming at a reduction of this likelihood (see Pagach and Warr, 2011). In addition, with the aid of high quality ERM, firms can present an appropriate company strategy to the capital market, a trustful risk handling, and an adequate risk policy, thus receiving improved debt conditions (see Meulbroek, 2002). On the other hand, greater leverage is associated with enhanced financial risk, which may lead to fewer resources to implement an adequate ERM program (see Baxter et al., 2013).

Capital opacity: Firms with more intangible assets implement ERM due to problems with liquidating these assets at a fair market value, especially in times of financial distress (see, e.g., Hoyt and Liebenberg, 2011). Additionally, more opaque companies might be undervalued, and ERM thus helps to reduce these information asymmetries (see Pagach and Warr, 2011).

Financial slack: While ERM using firms may increase financial slack (ratio of cash and short-term investments to total assets) to reduce the probability of financial distress (see Hoyt and Liebenberg, 2011), it is also reasonable that firms may decide to reduce the level of financial slack due to improved risk awareness (see Pagach and Warr, 2010).

Stock price and cash flow volatility: The previous literature is ambiguous regarding the relationship between volatility and the likelihood of ERM implementations. One the one side, greater volatility can lead to an enhanced need of external financing, which requires improved corporate risk management (see Baxter et al., 2013). Especially more volatile firms benefit from ERM by reducing the likelihood of lower tail outcomes (see Beasley et al., 2008). On the other side, ERM programs can reduce the volatility of stock returns as well as earnings, e.g., due to the ability to account for interdependencies between traditional risk classes and to reduce the likelihood of financial distress (see Liebenberg and Hoyt, 2003; Hoyt and Liebenberg, 2011). Thus, adequate ERM programs are not yet implemented.

3. Data and Methodology

3.1. Data

Following the literature, we measure company value by Tobin's *Q*, which restricts the sample to publicly-traded insurance companies having a market value of equity that is transparently accessible through the stock market. Tobin's *Q* describes the ratio of the market value of a firm's assets and their replacement costs (see, e.g., Hoyt and Liebenberg, 2011). While *Q*-results greater than 1 indicate an efficient use of a firm's assets (value creation), *Q*-values less than 1 are an indicator for rather inefficiently operating companies (see Lindenberg and Ross, 1981). In comparison to other ratios (e.g. stock returns or return on assets), Q is advantageous due to the fact that risk adjustment or standardization is not preconditioned (see, e.g., Lang and Stulz, 1994; Hoyt and Liebenberg, 2011). In addition, Q is almost free from management discretion and represents a future-oriented view of market expectations, which is in line with the lagged realization of benefits as a result of the implementation of an enterprise-wide risk management system (see Lindenberg and Ross, 1981; Lin et al., 2012).

Our sample consists of 41 European insurance companies, for which we obtained detailed financial data through the Thomson Reuters Datastream database. By focusing on insurance industry conglomerates that are all providing insurance services in different business lines across different countries in Europe, we avoid potential biases associated with industry-specific, country-specific, and inter-industry heterogeneity.[5]

Due to the lack of ERM disclosure requirements (see Gatzert and Martin, 2015), one major challenge of empirical studies on ERM is to determine an adequate and meaningful ERM proxy. In most cases the enterprise-wide risk management activities are evaluated by announcements of Chief Risk Officer (CRO) appointments or a keyword search in annual reports regarding, e.g., the existence of a CRO or a risk management committee (see, e.g., Liebenberg and Hoyt, 2003; Pagach and Warr, 2011; Lechner and Gatzert, 2018), a specifically created ERM index (see Gordon et al., 2009; Farrell and Gallagher, 2015), or ERM surveys (see Beasley et al., 2005; Sekerci, 2015). These procedures can be disadvantageous due to the lack of an appropriate and reliable measurement for the extent of the ERM engagement (see McShane et al., 2011). To address these limitations, consistent with e.g. McShane et al. (2011), we use the Standard & Poor's ERM rating for European insurance companies for distinguishing between insurers with a high quality and a less high quality risk management system. The S&P ERM rating for European insurance companies is first provided for 2007 and available for the years 2007, 2008, 2010, 2011, 2013, and 2015 (and also 2014 for 15 companies, which were manually researched). Based on the availability of the ERM S&P rating of the 41 European insurance companies in the period from 2007 until 2015, our final sample is composed of 207 firm-year observations,[6] which covers about 60% of the European insurance

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[5] It is also important to note that our sample is equally affected by the preparatory measures of Solvency II in the different EU member states.

[6] The selection of the companies in our final sample is based on three steps: (1) based on the availability of the Standard & Poor's ERM rating of European insurance companies; (2) the restriction towards publicly-traded insurance companies due to the requirement of a market value of equity in order to determine the Tobin's Q; and (3) the availability of values for the selected (control) variables.

market[7] measured by gross premiums for the year 2015 and thus our sample represents an economically substantial portion of the market (see Insurance Europe, 2016).[8]

3.2. Standard & Poor's ERM rating

The financial strength and creditworthiness of an insurance company is evaluated by Standard & Poor's based on eight components. Since 2005, Standard & Poor's incorporates the assessment of an insurer's enterprise-wide risk management approach as an integral component of the overall firm rating using a separate major category (see S&P, 2005; S&P, 2013a). In order to assess the insurer's extent of the ERM engagement, S&P analyzes whether a company implemented a systematic, consistent and strategic sophisticated risk management approach that effectively limits large losses in the future through the optimization of the tradeoff between risk and reward. The sophisticated and comprehensive ERM assessment by Standard & Poor's focuses on five main firm attributes, namely risk management culture, risk controls, emerging risk management, risk models, and strategic risk management (see S&P, 2013a). A summary of the description of each sub-category is given in Table 2.

Each of these five attributes is evaluated with a score "positive", "neutral", or "negative" depending on the degree of fulfillment.[9] As a result of this assessment, an insurer will be classified into one of five ERM rating categories (see S&P, 2013a). While the titles of the rating categories have changed to some extent (see Table A.1 in the Appendix), the fundamental definitions generally remained the same (see S&P, 2005; S&P, 2009; S&P, 2013a).

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7 In total, approximately 3,700 insurance companies with about 975,000 employees are operating in Europe in 2015 (see Insurance Europe, 2016).

8 The total number of 207 firm-year observations is composed of 19 firm-year-observations of 2007, 31 of 2008, 36 of 2010, 36 of 2011, 39 of 2013, 15 of 2014, and 31 of 2015. For further information regarding the distribution of insurance companies and ratings across countries, see Table A.2 in the Appendix.

9 A detailed overview about scoring the five ERM attributes is given in S&P (2013a, p. 6).

Table 2: Description of the main attributes of the S&P ERM rating (see S&P, 2013a)

Category	Description
Risk management culture	- Embeddedness of risk management in all processes of the insurer's business operation and corporate (strategic and long-term) decision-making - Focus on the insurer's philosophy towards risks in general, e.g. risk appetite, risk governance and organizational structure, risk communication and risk reporting
Risk controls	- Assessment of the insurer's processes for identifying and managing their risk exposures within the enterprise - Focus on the risk types credit and counterparty risks, interest rate risks, market risks, insurance risks, and operational risks
Emerging risk management	- Focus on the ability of an insurer to identify risks that can pose an essential threat in the future, e.g. existence of early-warning systems - Assessment of the level of preparedness of an insurer concerning managing emerging risks
Risk models	- Analyses of the efficiency of risk models regarding the evaluation of risk exposures, risk correlations and diversification, risk mitigation strategies and capital requirements, among other aspects - Focus on the evaluation of the robustness, consistency, and completeness of the insurer's risk models
Strategic risk management	- Assessment of the firm's ability to optimize risk-adjusted returns by focusing on required risk capital and the capital allocation among different product and business lines in general - Analysis of strategic risk management decisions regarding consistency with the insurer's given risk appetite

Notes: A detailed overview of the development of the notation of the main attributes of the S&P ERM rating since its incorporation in October 2005 is given in the Appendix in Table A.1. While the titles of the main attributes have partly changed, the fundamental definitions generally remained the same (see S&P, 2005; S&P, 2009; S&P, 2013a).

Insurers with ratings "very strong" and "strong", where the first category corresponds to the former best category "excellent", provide a comprehensive view of all risks that comprises the entire company. In addition, these insurance companies consider risk management within the strategic decision-making process and incorporate risk and risk management when optimizing risk-adjusted returns. Hence, these companies use an enterprise-wide risk management approach and thus belong to the group of users with high quality risk management (RM).[10] In contrast to this, insurance companies with rating categories below "strong", in particular "adequate with positive trend" (category between 2009 to 2013), "adequate with strong risk controls" (category since 2009), "adequate" (since 2005) and "weak" (since 2005), do not provide a comprehensive view regarding all material risks that includes all business lines of the entire enterprise. Therefore, firms with these rating categories lack a clear vision of their overall risk profile and generally exhibit a traditional risk management approach with a silo-based focus (see S&P, 2005; S&P, 2009; S&P, 2013a), thus belonging to the group of firms with less high quality RM. Table 3 provides an overview of the most important characteristics of the five S&P ERM rating categories.

[10] This assumption is consistent with McShane et al. (2011).

Table 3: Description of the scores of the S&P ERM rating (see S&P, 2009; S&P, 2013a)

Score ERM	Description
Very strong	- The insurer exhibits an excellent implementation across all elements of the ERM framework and shows at least a good assessment for their internal economic capital model - Strong ability to identify, measure, manage, and control corporate risks in a consistent, continuous and enterprise-wide manner within the chosen risk tolerances - Risk and risk management are strongly incorporated in the insurer's corporate strategic decision-making
Strong	- One or both of risk models or emerging risk management is scored "neutral", while the other ERM elements are evaluated as "positive" - The insurer deals with risks using a coordinated, enterprise-wide approach and takes into account the risk management view in its corporate strategic decisions. However, the implementation is still not as developed as that of an insurer with "very strong ERM".
Adequate with strong risk controls	- While the risk controls of an insurer are assessed "positive", the ERM assessment regarding the further main attributes of the insurer indicates only adequate characteristics, e.g. because of a neutral appraisal concerning the incorporation of strategic risk management - A comprehensive perspective with all risks that comprises the entire company is still missing
Adequate	- "Neutral" assessment of the insurers' implementation regarding risk management culture and risk controls. - Even though an insurer has the qualification for risk identification and management, the process has not yet incorporated all material risks of the insurer. In addition, an enterprise-wide, comprehensive coordination of risks across the enterprise is absent
Weak	- "Negative" assessment of the insurer's implementation regarding risk management culture and risk controls - Limited capabilities of identifying and managing risk exposures within the company or missing predetermined risk tolerance guidelines

Notes: A detailed overview of the development of the notation of the main attributes of the S&P ERM rating since its incorporation in October 2005 is given in the Appendix in Table A.1. While the titles of the rating categories have partly changed, the fundamental definitions generally remained the same (see S&P, 2005; S&P, 2009; S&P, 2013a).

3.3. Methodology

We first identify firm characteristics (determinants) that influence an insurance company's decision to engage in ERM activities, where we use a binary variable to identify an ERM system (with $ERM = 1$ in case an insurer has a high quality risk management system, and $ERM = 0$ otherwise). This is done via a logistic regression, where we analyze the following relationship for an ERM implementation as a function of firm characteristics:

$$ERM = f\left(Size,\ Leverage,\ Opacity,\ Slack,\ LnLagSdReturns,\ CV(EBIT)\right) \tag{1}$$

Next, we aim to assess the impact of ERM activities on firm value. In order to model this relationship, one could apply a regression model with firm value as the dependent variable and firm characteristics as independent variables including a dummy variable for ERM. This ERM variable's coefficient would then provide insights about this relationship. In doing so, one assumes the dummy variable for ERM to be given exogenously. However, this is not the case here, since the decision to introduce an ERM system is driven by the anticipated benefits of an ERM engagement and affected by firm characteristics that also have an impact on firm value directly, i.e. the *ERM* variable is endogenous and we have to deal with a self-selectivity problem (see, e.g., Lee, 1978; Heckman, 1978, 1979; Maddala, 1983; Guo and Fraser, 2010; Hoyt and Liebenberg, 2011; Greene, 2012). Table 4 provides an overview and the definitions of the relevant variables that are used in the analysis.

Table 4: Definition of variables

Variable	Measurement
ERM	1 = High quality RM (S&P ERM scores: very strong / excellent / strong) 0 = Less high quality RM (S&P ERM scores: adequate with positive trend / adequate with strong risk controls / adequate / weak)
Q	(Market value of equity + book value of liabilities) / book value of assets
Size	Natural logarithm of book value of assets
ROA	Net income / book value of assets
Leverage	Book value of liabilities / market value of equity
Opacity	Intangible assets / book value of assets
Slack	Cash and short-term investments / book value of assets
Dividends	1 = Insurer paid dividends (i.e. dividend payments > 0) in the respective year 0 = Otherwise
SalesGrowth	(Sales(t) – sales(t–1)) / sales(t–1)
LnLagSdReturns	Natural logarithm of the standard deviation of monthly stock returns for the prior year (cum dividend)
CV(EBIT)	Coefficient of variation (standard deviation / mean) of EBIT (earnings before interest and taxes) of the two prior years and the respective year

Notes: ERM scores are based on Standard & Poor's (2007, 2008, 2010, 2011, 2013b, 2014a-o, 2016); financial data on insurers is retrieved from Thomson Reuters Datastream at the end of the fiscal year of the corresponding firm with the following variable definitions and symbols: Market value of equity = market capitalization (WC08001), book value of liabilities = total assets (WC02999) – total shareholders' equity (WC03995), book value of assets = total assets (WC02999), intangible assets = total intangible other assets net (WC02649), cash and short-term investments = cash & equivalents generic (WC02005), net income = net income available to common (WC01751), sales = net sales or revenue (WC01001), dividend payments = cash dividends paid total (WC04551), EBIT = earnings before interest and taxes (WC18191); all calculations are done in thousands of Euros, i.e. for different currencies, conversion to Euros using the corresponding exchange rate of December 12 of the respective year also retrieved from Thomson Reuters Datastream (USEURSP, UKEURSP, SWEURSP, NWEURSP).

We thus follow Hoyt and Liebenberg (2011) and apply a treatment-effects model to model the dummy variable for ERM as endogenous.[11] The treatment-effects model is set up via a two equation approach (see, e.g., Guo and Fraser, 2010; Greene, 2012), namely the regression equation (denoted as *Q* Equation hereafter),

$$Q_{it} = x'_{it}\beta + ERM_{it}\delta + \varepsilon_{it} \tag{2}$$

[11] There are several mathematical approaches to address endogeneity concerns, such as a treatment-effects model or an instrumental variable (IV) approach. In line with previous empirical literature such as Hoyt and Liebenberg (2011), and given the lack of appropriate instrumental variables in our case which are necessary to model an IV approach, we apply a treatment-effects model by setting up this two-equation approach.

and the selection equation (denoted *ERM* Equation subsequently)

$$ERM_{it}^{*} = z_{it}'\gamma + u_{it}, \tag{3}$$

where $ERM_{it} = 1$, if $ERM_{it}^{*} > 0$, and $ERM_{it} = 0$ otherwise. The error terms ε_{it} and u_{it} are assumed to be normally distributed with a mean vector of zero, variances of σ_{ε} and 1, and a covariance of ρ.

When combining both Equations (2) and (3), this leads to two states, i.e. a treatment state (company with high quality RM activities, i.e. *ERM* = 1) and a non-treatment state (less high quality RM activities, i.e. *ERM* = 0), which is given as follows (see, e.g., Quandt, 1958, 1972; Greene, 2012)

$$E\left[Q_{it} \mid ERM_{it}, x_{it}, z_{it}\right] = \begin{cases} x_{it}'\beta + \delta + \rho\sigma_{\varepsilon}\lambda\left(-z_{it}'\gamma\right), & \text{if } ERM_{it} = 1,\ ERM_{it}^{*} > 0 \\ x_{it}'\beta + \rho\sigma_{\varepsilon}\left[\frac{-\varphi(z_{it}'\gamma)}{1-\Phi(z_{it}'\gamma)}\right], & \text{if } ERM_{it} = 0,\ ERM_{it}^{*} \leq 0, \end{cases}$$

where $\lambda\left(-z_{it}'\gamma\right)$ is the inverse Mills ratio (see Greene, 2012, p. 873), and φ is the density function and Φ is the cumulative distribution function of the standard normal distribution.

The coefficients can be estimated via a maximum-likelihood approach (see, e.g., Maddala, 1983 for details on the estimation procedure). Since our sample partly contains multiple observations per insurance company and thus observations that are correlated, we allow for intragroup correlations for each company, but assume that observations are independent for different companies, i.e. no intergroup correlation. Thus, firm-level clustering is accounted for when estimating standard errors to account for panel data structures (see, e.g., Guo and Fraser, 2010; Hoyt and Liebenberg, 2011; Greene, 2012; Ai et al., 2016).

We thus simultaneously analyze the effect of firm characteristics on ERM implementation and their impact along with the impact of ERM on firm value. The *Q* Equation (2) and *ERM* Equation (3) can thus be stated as follows by using the relevant firm characteristics:

$$Q = f\left(ERM \mid Size,\ ROA,\ Leverage,\ Dividends,\ SalesGrowth\right), \tag{4}$$

and

$$ERM = f\left(Size,\ Leverage,\ LnLagSdReturns\right), \tag{5}$$

where in the *ERM* Equation (5) we restrict the set of firm characteristics to only those variables that have been identified as significant in the logistic regression.[12]

4. RESULTS

4.1. Descriptive statistics

Table 5 shows first descriptive statistics for the relevant variables, which are based on the total number of 207 firm-year observations, whereof 82 firm-year observations have a high quality RM system in place and 125 do not.[13]

Table 5: Summary statistics

Variable	Mean	Std. Dev.	1st Quart.	Median	3rd Quart.
Q	1.0123	0.0641	0.9852	1.0023	1.0249
ERM	0.3961	0.4903	0.0000	0.0000	1.0000
Size	17.8562	1.7134	17.0005	17.8992	19.3459
ROA	0.0087	0.0260	0.0025	0.0057	0.0134
Leverage	16.2347	13.1455	6.5405	12.0089	22.1960
Opacity	0.0217	0.0249	0.0050	0.0167	0.0266
Slack	0.0333	0.0396	0.0117	0.0233	0.0435
Dividends	0.9662	0.1812	1.0000	1.0000	1.0000
SalesGrowth	0.0088	0.3436	-0.0563	0.0124	0.0741
LnLagSdReturns	1.9397	0.4810	1.5905	1.8759	2.2447
*CV(EBIT)**	0.6179	3.1011	0.1290	0.2507	0.6171

*Notes: Total number of observations is 207 (*variable CV(EBIT) is based on 191 observations); the unlogged variants of Size (in million Euros) is 160,022 (mean) and 59,363 (median); the market capitalization of our sample (in million Euros) is 10,110 (mean) and 4,636 (median); the standard deviation of monthly stock returns for the prior year (with dividend) is 7.86% (mean) and 6.53% (median).*

For an initial assessment of the impact of ERM on firm value and the covariates, we next provide univariate statistics in Table 6, where we contrast the group of insurance companies hav-

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[12] Including additional control variables that are not significant in case of our data set (assessed by the results of the logistic regression approach) or that are found to be generally insignificant in previous empirical studies, do not improve results and goodness-of-fit of the treatment-effects model. Hence, the selection process (*ERM* Equation (5)) within the full maximum-likelihood treatment-effects estimation is significantly affected by the variables *Size*, *Leverage*, and *LnLagSdReturns*.

[13] The 82 firm-year observations with a high quality RM system comprise data for 23 (out of a total of 41) different insurance companies, whereas the 125 firm-year observations with less high quality RM are made up of 31 different insurers. Note that we have several firm-year observations of a single company within our time period implying that a single company can be represented in both groups due to changes over time.

ing a high quality RM system in place (*ERM*=1), which includes the rating categories "very strong" (also formerly "excellent") and "strong", and those that do not (*ERM*=0). The latter group consists of observations with the company ratings "adequate with positive trend", "adequate with strong risk controls", "adequate", and "weak". We thereby calculate means and medians for the different variables and test for differences between the two groups. In case of the mean, we first apply Levene's robust test statistic for the equality of variances and subsequently use a two-sample t test with equal variances or unequal variances according to the outcome of the Levene's test. In case of the median, we apply the Wilcoxon rank-sum (Mann-Whitney) test, which tests whether the two samples have the same distribution.[14]

Table 6: Differences in mean and median for firms with and without ERM

	Mean			Median		
Variable	*ERM* = 1	*ERM* = 0	Diff.	*ERM* = 1	*ERM* = 0	Diff.
Q	1.018	1.009	0.009	1.007	1.001	0.006**
Size	18.599	17.369	1.230***	18.982	17.512	1.471***
ROA	0.011	0.007	0.004	0.008	0.004	0.004**
Leverage	13.682	17.909	-4.227**	10.099	13.743	-3.644**
Opacity	0.021	0.022	-0.002	0.019	0.015	0.004
Slack	0.032	0.034	-0.002	0.024	0.022	0.002*
Dividends	1.000	0.944	0.056***	1.000	1.000	0.000**
SalesGrowth	-0.027	0.032	-0.059	0.007	0.015	-0.009
LnLagSdReturns	1.750	2.064	-0.314***	1.670	2.092	-0.422***
CV(EBIT)	0.571	0.652	-0.081	0.251	0.253	-0.003

Notes: Total number of observations is 207, besides for the variable CV(EBIT), which is based on 191 observations; Standard errors are given in parentheses and statistical significance is denoted by '', '**', and '***' for the 10%, 5%, and 1% level, respectively; differences in the means are tested based on a two-sample t test; differences in the median are tested based on the Wilcoxon rank-sum test and a median test is also calculated with significant results on the 10% level: Q, Leverage, Opacity, and on the 1% level: Size, ROA, LnLagSdReturns; the unlogged variants of Size (ERM = 1) (in million Euros) is 253,804 (mean) and 175,349 (median), (ERM = 0) is 98,501 (mean) and 40,286 (median); the market capitalization (ERM = 1) (in million Euros) is 18,369 (mean) and 12,261 (median), (ERM = 0) is 4,694 (mean) and 2,595 (median); the standard deviation of monthly stock returns for the prior year (with dividend) (ERM = 1) is 6.44% (mean) and 5.31% (median), (ERM = 0) is 8.79% (mean) and 8.10% (median).*

The results show that the mean and median of Tobin's *Q* are slightly higher for companies with a high quality RM program compared to those without. While the difference in the mean is not significant at a 10% level, the Wilcoxon rank-sum tests rejects the hypothesis at a 5% level, implying that we can conclude that the two samples are drawn from populations with

[14] Furthermore, we also apply the nonparametric equality-of-medians test, which explicitly tests the differences in medians (in contrast to the Wilcoxon rank-sum that tests the difference in the distribution).

different distributions, i.e. these results support the assumption that ERM can contribute to a higher Tobin's *Q*.[15]

Concerning the further firm characteristics, we further find that firms with a highly developed RM tend to be larger *(Size)* and exhibit a lower financial leverage *(Leverage)* compared to companies with a less developed risk management system. In addition, insurers of the high quality RM group are more likely to pay *Dividends*, whereas the volatility of stock returns for the previous year (*LnLagSdReturns*) is smaller on average for companies with a high quality RM system. The comparison further shows a significant difference in the median of the variable *Slack* for the two groups, suggesting that insurers with high quality RM programs tend to have more cash and short-term investments compared to their book value of assets than insurers from the less high quality RM group. Lastly, the result concerning the variable *ROA* implies that insurance companies with a highly developed RM program are more profitable on average. Due to the fact that the determinant *Return on Assets* is presumed to be an accounting measure for value, this univariate result supports the assumption of the value adding impact of ERM. The findings of the remaining variables (*Opacity* and *SalesGrowth*) do not show statistically significant differences between the subsamples.

Table 7 further reports summary statistics regarding the distribution of the Standard & Poor's ERM ratings as well as contains information regarding the average of *Q*, *Size* and *ROA* for the different rating categories. The results support the notion that an increasing improvement of the rating is associated with an enhancement of firm value and performance measured with the variables *Q* and *ROA*. Additionally, according to Table 7, firms with better S&P ERM ratings tend to be larger, thus supporting the assumption of a positive relationship between ERM and firm size.

We next assess the characteristics of those companies that considerably improved their ERM ratings over the sample period. Toward this end, we split our sample into three subsamples and calculate means as well as medians for the different variables, and test for differences between the respective groups. First, we consider companies that remain in the rating categories of less high quality risk management across the entire sample period (18 firms or about 44% of the total sample). Second, we have a group of companies that are rated in the S&P ERM categories "strong" and "very strong" across the entire sample period (10 firms or about 24%). Third and most importantly, we summarize companies that improve their ERM ratings

[15] In addition to this, the median test indicates differences in the medians of Tobin's *Q* with and without high quality RM on the 10% level of significance.

considerably over the sample period (from less high quality to high quality risk management) (10 firms or about 24%).[16]

The findings reveal that companies which considerably improve their S&P ERM rating over time exhibit a higher Tobin's *Q* and are more profitable in terms of a higher *ROA* compared to the subsample of companies that consistently have a less high quality RM (significant differences in means). Furthermore, company size tends to be an essential driver for high quality RM implementations, since the means and medians of firm size are lowest for firms with less high quality RM, followed by firms that considerably improve their ratings over time, and highest in case of firms that are highly rated across the sample period. In addition, RM improving firms exhibit the highest amount of liquid capital (in relation to a firms' book value of total assets), i.e. highest *Slack*, compared to the groups of firms that have less high quality or high quality RM systems across the entire sample period. This result might be explained through the necessary financial resources that are required when restructuring firm processes to implement high quality RM programs. A further finding supports this argument, since firms that considerably improve their rating over time have a higher degree of debt capital (in relation to a firm's book value of total assets) compared to firms that already implemented high quality RM systems (significant differences in means).

Table 7: Distribution of the S&P ERM ratings and selected statistics for each rating category

ERM Rating	In %	Avg. *Q*	Avg. *Size* (Billion Euros)	Avg. *ROA* (in %)
Very strong / excellent	7.73	1.027822	263.29	1.33%
Strong	31.88	1.015578	251.50	1.07%
Adequate with strong risk controls[17]	25.12	1.011763	138.74	0.95%
Adequate	34.30	1.006099	71.35	0.56%
Weak	0.97	1.015548	16.05	0.19%

[16] Note that three companies are excluded from this analysis, since these companies were switching between less high quality and high quality.

[17] Insurers with ratings of the category "adequate with positive trend" are allocated to the category "adequate with strong risk controls" due to the almost similar characteristics of both categories. During 2009 to 2013, S&P added this category to better differentiate between the large number of companies in this category. While the defined characteristics in both rating categories were almost the same, insurers have been rated as "adequate with positive trend", if S&P had the opinion that the companies' ERM rating will be improved to the point of the rating category "strong" in the next six to 24 months. However, these companies do not provide a fully functional enterprise-wide perspective of risk management at the time of the rating realization (rather a silo-based approach), which is a necessary requirement to be rated in category "strong" (see S&P, 2005; S&P, 2009; S&P, 2013a).

In addition, Table 8 provides insights concerning the absolute frequency of the S&P ERM ratings over time for the period of 2007 to 2015 (except for ratings for the year 2009 and 2012) as well as for the relative frequency for the two groups "high quality risk management" and "less high quality risk management". Most remarkably, the proportion of firms with high quality RM programs is continuously increasing from 36.8% in 2007 to 51.6% in 2015. This fact reinforces the enormous increment of perceived importance of firms to implement a holistic enterprise-wide risk management system.[18]

Table 8: Rating developments for the period 2007 to 2015

ERM Rating / year	2007	2008	2010	2011	2013	2014	2015	*Total*
Very strong / excellent	1	1	0	0	5	3	6	16
Strong	6	10	12	14	10	4	10	66
Adequate with strong risk controls*	0	8	12	11	11	5	5	52
Adequate	11	11	12	11	13	3	10	71
Weak	1	1	0	0	0	0	0	2
Total	19	31	36	36	39	15	31	207
High quality RM	36.8%	35.5%	33.3%	38.9%	38.5%	46.7%	51.6%	39.6%
Less high quality RM	63.2%	64.5%	66.7%	61.1%	61.5%	53.3%	48.4%	60.4%

*Notes: *Category "Adequate with strong risk controls" includes the ratings "Adequate with positive trend" from the years 2009 to 2013, see Footnote 17, p. 19.*

4.2. Drivers for implementing enterprise risk management

We next identify firm characteristics that have an impact on ERM engagement, i.e. we apply a logistic regression given in Equation (1). *ERM* is the binary dependent variable and as independent variables firm characteristics are used that have been identified in the literature to have an influence on ERM implementation. The results of the logistic regression are reported in Table 9.[19]

Consistent with Hoyt and Liebenberg (2011) and Lechner and Gatzert (2018), the findings confirm that company size (*Size*) has a significant positive impact on an ERM implementation at the 1% level. Hence, an increasing scope and complexity of risks as well as, e.g., the greater risk of financial distress of larger companies lead to more high quality RM implementa-

[18] For further information regarding the distribution of insurance companies and ratings across countries, see Table A.2 in the Appendix.

[19] To check the goodness-of-fit of the logistic regression model, we calculated the Pseudo R-squared (R^2: 0.2890); which is approximately in line with comparable studies (see Beasley et al., 2005; Razali, Yazid, and Tahir, 2011; Lechner and Gatzert, 2018).

tions. Furthermore, a significant negative impact can be observed for financial leverage (*Leverage*), supporting the argument that firms with high quality RM programs may reduce leverage in order to decrease the risk of debt payout defaults. Next, we find evidence for a negative significant association between the volatility of stock returns (*LnLagSdReturns*) and the likelihood of an ERM implementation, which is in contrast to the findings in Hoyt and Liebenberg (2011). This result can be explained by the fact that insurers with a highly developed RM system already benefit from their holistic perspective. Larger volatility usually leads to a stronger need of external financing and, thus, an increased likelihood of financial distress, which both require improvements concerning the corporates' risk management. High quality RM further enables firms to manage and smooth cash flows, which should also be associated with a reduced variation of monthly stock returns.

None of our other explanatory variables, namely the ratio between intangible assets and the book value of assets (*Opacity*), the ratio of cash and short-term investments to the book value of assets (*Slack*) as well as the variation of EBIT (*CV(EBIT)*), are statistically significant determining factors for an ERM implementation.

Table 9: Logistic regression estimates

Variable	*ERM*
Size	0.926401 (0.159444)***
Leverage	-0.089498 (0.021245)***
Opacity	-13.540500 (10.58002)
Slack	2.970313 (5.403621)
LnLagSdReturns	-1.608776 (0.427378)***
CV(EBIT)	0.083017 (0.056134)
Constant	-12.396550 (2.740545)***
Number of observations	191
Pseudo R-squared	0.2890

*Notes: Standard errors are given in parentheses and statistical significance is denoted by '***' for the 1% level. Even though the logistic regression approach does not incorporate firm-level-clustering, the results are still robust as can be seen in the full maximum-likelihood treatment-effects model.*

4.3. The value of enterprise risk management

We finally apply the treatment-effects model, where we use the variables *Size*, *Leverage,* and *LnLagSdReturns* in the *ERM* Equation (5)[20] and the variables *ERM**, *Size*, *ROA, Leverage*, *Dividends*, and *SalesGrowth* in the *Q* Equation (4). The results of the model are shown in Table 10. Most importantly, the coefficient of *ERM** is positive and statistically significant (at the 1% level). Hence, high quality RM programs increase an insurance company's Tobin's *Q* by about 6.5% when using the stated covariates and when controlling for an endogeneity bias.[21]

Table 10: The value of ERM: Full maximum-likelihood treatment-effects estimates

Variable	*ERM* Equation (5)	*Q* Equation (4)
*ERM**		0.065036 (0.022599)***
Size	0.457870 (0.097457)***	-0.009411 (0.007041)
ROA		0.824742 (0.632122)
Leverage	-0.034288 (0.012893)***	0.000056 (0.000547)
Dividends		0.095154 (0.037861)**
SalesGrowth		-0.002568 (0.008304)
LnLagSdReturns	-0.763255 (0.214964)***	
Constant	-6.471962 (1.641862)***	1.054563 (0.111742)***
Number of observations	207	
Number of clusters (firms)	41	
Likelihood-ratio test	9.02***	
Wald test	23.88***	

*Notes: Standard errors are adjusted for firm-level clustering and given in parentheses, where statistical significance is denoted by '**' and '***' for the 5% and 1% level, respectively. In addition, we also run the full maximum-likelihood treatment-effects model with clustering of the years (number of clusters: 7 (2007, 2008, 2010, 2011, 2013, 2014, and 2015)), showing robust results.*

In addition, we find evidence for a positive relationship between *Dividends* and Tobin's *Q*. This supports the hypothesis that a payout of dividends might limit free cash flows in a firm, which otherwise could be used for a manager's other projects and not necessarily in favor of a company's efficiency. This result further confirms the argument that dividend payments can be regarded as a positive signal for a firm's financial situation for the capital market and par-

20 According to our logistic regression analysis, the variables *Size*, *Leverage*, and *LnLagSdReturns* have a statistically significant influence on the decision of firms regarding the implementation of high quality RM programs. Therefore, these variables are decisive for the selection process (*ERM* Equation (5)) within the full maximum-likelihood treatment-effects estimation and adding further covariates that are insignificant (*Opacity*, *Slack*, and *CV(EBIT)*) do not have an impact on the test results as robustness tests show.

21 Multicollinearity can be excluded, see relevant correlations in Table A.3 in the Appendix.

ticularly for investors. Thus, this might lead to an increased shareholder value. With respect to the further explanatory variables *Size*, *ROA, Leverage*, and *SalesGrowth*, we do not find significant relationships with Tobin's *Q*.

To test the appropriateness of the joint estimation of the *ERM* Equation (5) and the *Q* Equation (4), we run the Wald test and the likelihood-ratio test, which evaluate the independence of both equations and the goodness-of-fit, respectively. The tests' results allow us to reject the null hypothesis that the residuals from Equations (4) and (5) are uncorrelated at a 1% level, which supports the joint estimation and the application of the full maximum-likelihood treatment-effects model. We further adjust the standard errors in the treatment-effects model for both firm-level clustering (reported in Table 10) as well as for a clustering in years (results remain virtually identical and are thus omitted here).

4.4. Robustness

In what follows, we conduct robustness tests that reinforce our previous findings. In a first step, we run analyses without data of the years 2007 and 2008, which could both lead to biased rating evaluations for the years 2007 and 2008. In particular, we run the analysis without data for 2007 in order to exclude sensitivity problems for the first year of the S&P ERM rating introduction. We additionally drop firm-year observations for 2008 to avoid distortionary effects from the financial crisis. Both regressions reveal stable results that are consistent with the previous findings. The analysis without observations for the year 2007 supports our main findings, in particular that firms with high quality RM programs are valued about 6.9% higher (at a 1% level of significance) compared to insurers with less high quality RM. The results of our sample without firm-year observations for both years 2007 and 2008 still show a statistically significant (at the 5% level) enhanced value of 4.3% for firms with a high quality RM program.

As described in Section 3.1., while we have access to Standard & Poor's ERM rating lists for the years 2007, 2008, 2010, 2011, 2013, and 2015, we manually searched for the corresponding ERM ratings for the relevant companies for the year 2014 with the result of 15 additional ratings. In a next step, we thus adjusted our sample and dropped the observations for the year 2014 to control for any biases that may arise through this approach. The findings of the full maximum-likelihood treatment-effects estimation with the adjusted sample without the observations for the year 2014 show no major differences, i.e. companies with a high quality RM program are valued about 6.7% higher (compared to 6.5% with the data set including the 2014 observations) than companies with less high quality RM (statistical significance at the 1% level).

We next conduct analyses without observations that belong to the S&P ERM rating category "adequate with strong risk controls",[22] since this category might be viewed as a transition zone between high quality RM and less high quality RM. While some characteristics of an insurer in this category, e.g. a positive assessment of risk controls, might be indicative for a holistic risk management system, the insurer has still adequate components within its risk management system, e.g. missing comprehensive perspective regarding the overall risk profile or not appropriate incorporation of risk management in the strategic long-term planning of the company (see S&P, 2009; S&P, 2013a). The findings remain virtually the same for the adjusted data set when removing these 52 firm-year observations. Companies with a high quality RM program are still valued about 5.6% higher in comparison to companies with less high quality RM (at 5% level of significance).

Apart from the arguments (see Section 2.2) leading to our assumption that the S&P ERM rating categories "very strong" and "strong" solely correspond to a high quality RM system and following the previous view of the categories "adequate with strong risk controls" and "adequate with positive trend" as a transition zone, we further run an analysis by adding companies with ratings of both latter mentioned categories to the group of insurers with high quality RM. In this case, companies with a highly developed RM program (adjusted RM group) are still valued about 2.9% higher as compared to companies with less highly developed RM programs (S&P ERM rating categories "adequate" and "weak"), but the finding is not statistically significant. Furthermore, the adequacy of the assumption for the joint estimation when using the treatment-effects model is not fulfilled in this case.[23] These results reinforce our previously applied classification approach with respect to the S&P ERM ratings.

In addition to the previous adjustments regarding the data set (removal of specific years or rating categories), Table 11 reports results for various specifications of the *Q* equation using the full maximum-likelihood treatment-effects estimation by holding the *ERM* equation constant. Toward this end, we gradually add covariates to the model. The first specification (*Q1*) contains the adjusted variable ERM^* only, which is determined through the Equation (3). While in *Q2*, the control variable *Size* is included, we additionally integrate *ROA* as an accounting-based measure for firm value and performance in the next specification *Q3*. We further add *Leverage* (*Q4*) and *Dividends* (*Q5*) to incorporate the ratio of the capital structure as well as an indicator whether the insurer pays out a dividend in the respective fiscal year. Lastly, *Q6* represents our holistic model described in Section 4.3. The results of the Likelihood-

[22] Category "adequate with strong risk controls" includes the ratings "adequate with positive trend" of the years 2009 to 2013, see Footnote 12.

[23] We run the Likelihood-ratio test to verify the assumption of the joint estimation of the *ERM* and the *Q* Equation, i.e. we calculate the correlation between both error terms.

ratio test (appropriateness of the joint estimation of the *Q* and the *ERM* equation) and of the Wald test (goodness-of-fit) from *Q1* to *Q6* indicate the adequacy of the treatment-effects approach. It is further noteworthy that the results are highly consistent across all specifications. Most importantly, we find clear evidence that high quality RM programs lead to higher values of Tobin's *Q*.

Table 11: Sensitivity analyses with specifications of the *Q* equation

Variable	*Q1*	*Q2*	*Q3*	*Q4*	*Q5*	*Q6*
ERM	0.0559 (0.0273)**	0.0756 (0.0207)***	0.0663 (0.0198)***	0.0639 (0.0262)**	0.0653 (0.0228)***	0.0650 (0.0226)***
Size		-0.0118 (0.0073)	-0.0072 (0.0065)	-0.0066 (0.0075)	-0.0094 (0.0070)	-0.0094 (0.0070)
ROA			0.8542 (0.6310)	0.8347 (0.6753)	0.8185 (0.6312)	0.8247 (0.6321)
Leverage				-0.0001 (0.0006)	0.0001 (0.0006)	0.0001 (0.0005)
Dividends					0.0957 (0.0378)**	0.0952 (0.0379)**
SalesGrowth						-0.0026 (0.0083)
Constant	0.9902 (0.0114)***	1.1936 (0.1304)***	1.1080 (0.1182)***	1.0996 (0.1270)***	1.0540 (0.1111)***	1.0546 (1.1117)***
Variable			*ERM*			
Size	0.4048 (0.1578)***	0.4754 (0.0997)***	0.4607 (0.1032)***	0.4587 (0.1049)***	0.4578 (0.0974)***	0.4579 (0.0975)***
Leverage	-0.0412 (0.0148)***	-0.0383 (0.0125)***	-0.0351 (0.0135)***	-0.0342 (0.0134)**	-0.0343 (0.0129)***	-0.0343 (0.0129)***
LnLagSdReturns	-0.7951 (0.2508)***	-0.7073 (0.2133)***	-0.7275 (0.2178)***	-0.7402 (0.2419)***	-0.7641 (0.2147)***	-0.7633 (0.2150)***
Constant	-5.3440 (2.5062)**	-6.8156 (1.7210)***	-6.5707 (1.7550)***	-6.5265 (1.7754)***	-6.4695 (1.6419)***	-6.4720 (1.6419)***
Number of observations			207			
Number of clusters (firms)			41			
Likelihood-ratio test	6.40**	17.23***	15.35***	5.16***	9.16***	9.02***
Wald test	4.19**	13.60***	11.72***	18.17**	23.84***	23.88***

*Notes: Standard errors are adjusted for firm-level clustering and given in parentheses, where statistical significance is denoted by '**' and '***' for the 5% and 1% level, respectively. In addition, Full ML treatment-effects model is also run with firm-year clustering (Number of clusters: 7 (2007, 2008, 2010, 2011, 2013, 2014, and 2015)), showing robust results.*

We next run additional analyses with the treatment-effects model using the variable *Return on Assets* as the dependent variable (instead of Tobin's *Q*) to further investigate and understand the benefits of ERM. The findings are reported in the Appendix in Table A.4. It is remarkable that our findings show a negative relationship between *ROA* and the quality of the RM implementation (statistically significant at 1% level), thus implying that less profitable insurers tend to have a higher quality level of enterprise-wide risk management programs. In contrast to Tobin's *Q*, which represents a future-oriented view of market expectations, the *ROA* as an accounting-based performance measure incorporates large start-up and administrative costs of ERM activities. However, the benefits of the implementation of an enterprise-wide risk management system are not directly reflected in the balance sheet. The implementation of ERM generally requires enormous financial and human efforts, while the countable advantages will only be realized in the accounting-based performance measure *ROA* over time.

5. SUMMARY

In this paper, we extend previous work by studying the impact of ERM on a firm's shareholder value, using data for 41 European insurance companies and Standard & Poor's ERM rating after 2007 to identify insurers' ERM activities. To the best of our knowledge, this has not been done so far, even though it is of high relevance against the background of regulatory requirements such as Solvency II, which implicitly requires the implementation of a holistic ERM system.

Our results show that ERM activities are associated with a significant positive impact on insurers' Tobin's *Q* (after controlling for covariates and endogeneity bias), which on average is about 6.5% higher for firms with a high quality RM (and thus ERM) system. This finding is mostly consistent with the previous literature (see Tables A.5 and A.6 in the Appendix), since we find, in line with Hoyt and Liebenberg (2008, 2011), McShane et al. (2011) (to some extent), Baxter et al. (2013), Farrell and Gallagher (2015), Ai et al. (2016) (combined effect of high quality ERM and product line diversification), and Lechner and Gatzert (2018), a significant positive relationship between high quality RM programs and the shareholder value of firms.

In addition, with respect to firm characteristics as determinants for an ERM implementation, we find that company size has a significant positive impact, while financial leverage and the variation of the monthly stock returns are significantly negatively related to ERM implementations.

In general, there are various circumstances that favor adequate enterprise-wide risk management approaches to add value: Companies are faced with an increasing number of new risk sources such as cyber, reputational or operational risks, have to manage enhanced complexities and interconnectedness of firm risks. Furthermore, more advanced methods of risk identification and quantification as well as the considerable progress regarding information technologies in the wake of the digitalization supported the development of ERM and its value-adding property by providing new technological capabilities. In addition, holistic risk management approaches are also driven by new risk-based regulations such as Solvency II for the European insurance industry.

Overall, our results show that ERM not only helps in fulfilling Solvency II risk management requirements, but that it can also contribute to generating significant value for insurance companies.

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APPENDIX

Table A.1: Development of the notation of the S&P ERM rating categories as well as of the main attributes of the S&P ERM rating process (see S&P, 2005; S&P, 2009; S&P, 2013a)

	2005	*2009*	*2013*
S&P ERM rating - categories	- Excellent	- Excellent	- Very Strong
	- Strong	- Strong	- Strong
		- Adequate with positive trend	
		- Adequate with strong risk controls	- Adequate with strong risk controls
	- Adequate	- Adequate	- Adequate
	- Weak	- Weak	- Weak
S&P ERM rating - main attributes	- Risk management culture	- Risk management culture	- Risk management culture
	- Risk controls	- Risk controls	- Risk controls
	- Extreme-event management	- Emerging risk management	- Emerging risk management
	- Risk and capital models	- Risk and economic capital models	- Risk models
	- Strategic risk management	- Strategic risk management	- Strategic risk management

Notes: While the notation of the S&P ERM rating categories as well as of the main attributes has changed to some extent, the fundamental definitions did rather remain constant. A comprehensive overview about the detailed definitions of the rating categories and the main attributes is given in S&P (2005), S&P (2009) and S&P (2013a).

Table A.2: Number of insurance companies and ratings across countries

Countries	Insurance companies	Firm-year observations	High quality RM ratings	Less high quality RM ratings
Austria	2	13	0	13
Belgium	1	5	0	5
France	5	26	12	14
Germany	6	35	24	11
Italy	3	18	1	17
Netherlands	2	7	3	4
Norway	2	4	0	4
Slovenia	2	9	0	9
Spain	1	6	0	6
Switzerland	7	32	20	12
United Kingdom	10	52	22	30
Total	41	207	82	125

Notes: The 82 firm-year observations with a high quality RM system consist of 23 (out of 41) insurance companies, whereas the 125 firm-year observations with less high quality RM are made up of 31 European insurers.

Table A.3: Correlation coefficients

Variable	*Q*	*ERM*	*Size*	*Leverage*	*ROA*	*SalesGrow.*
Q	1					
ERM	0.0716	1				
Size	-0.1128	0.3518***	1			
Leverage	-0.3196***	-0.1577**	0.4727***	1		
ROA	0.3568***	0.0778	-0.2812***	-0.3854***	1	
SalesGrowth	0.0195	-0.0844	-0.1339*	-0.0931	0.2003***	1
Dividends	0.2473***	0.1515**	0.1876***	-0.0232	0.0286	-0.1261*

Notes: Statistical significance is denoted by '', '**', and '***' for the 10%, 5%, and 1% level, respectively.*

Table A.4: Effects of ERM on ROA: Full maximum-likelihood treatment-effects estimates

Variable	*ERM* Equation (5)	*ROA* Equation
ERM		-0.029041 (0.009051)***
Size	0.400248 (0.099031)***	0.002581 (0.002165)
Leverage	-0.035992 (0.010253)***	-0.001072 (0.000408)***
Dividends		0.007687 (0.004746)
SalesGrowth		0.006884 (0.005383)
LnLagSdReturns	-0.466484 (0.188781)**	
Constant	-5.964604 (1.544574)***	-0.015922 (0.030952)
Number of observations	207	
Number of clusters (firms)	41	
Likelihood-ratio test	73.54***	
Wald test	16.23***	

*Notes: Standard errors are adjusted for firm-level clustering and given in parentheses, where statistical significance is denoted by '**' and '***' for the 5% and 1% level, respectively. In addition, Full ML treatment-effects model is also run with firm-year clustering (Number of clusters: 7 (2007, 2008, 2010, 2011, 2013, 2014, and 2015)), showing robust results.*

Table A.5: Empirical findings in previous studies: The value relevance of ERM

Study	Sample			Proxy		Main result
	Country	Observations	Time	Firm value	ERM	
HL08	USA	125 insurer	2000-2005	Tobin's *Q*	ERM/CRO key words	- ERM increases Tobin's Q by 16.7% (statistically significant at the 1% level)
HL11	USA	117 insurer	1998-2005	Tobin's *Q*	ERM/CRO key words	- ERM increases Tobin's *Q* by 19.884% (statistically significant at the 1% level)
MNR11	USA	82 insurer	2008	Tobin's *Q*	S&P ERM Rating	- Risk management activities up to S&P ERM Rating category 3 increase the firm value - Change from TRM (1-3) to ERM (4-5) does not lead to enhanced firm value
TR11	Malaysia	528 firms	2007	Tobin's *Q*	ERM definition by use of OSIRIS database	- Non-significant results concerning the valuation effect of ERM
LWY12	USA	85 insurer	2000-2007	Tobin's *Q*, *ROA*	ERM/CRO key words	- ERM decreases Tobin's *Q* by 5% (statistically significant at the 1% level) - ERM decreases *ROA* by 3.8% (statistically significant at the 5% level)
BBHY13	USA	165 firm-years	2006-2008	Tobin's *Q*, *ROA*	S&P ERM Rating	- ERM increases Tobin's *Q* by 3.4% (statistically significant at 5% level) - ERM increases *ROA* by 1.14% (statistically significant at the 5% level)
LWOMC 14	China	119 insurer	2010	Return on Equity	ERM definition by use of CIRC's records	- Positive, but not-significant relation between ERM and firm value
FG15	Interna-tional	225 firms	2006-2011	Tobin's *Q*	ERM survey - RIMS Risk Maturity Model for ERM	- ERM increases Tobin's *Q* by 25.3% (statistically significant at the 1% level) - Dividend payments are positive correlated to Tobin's *Q* (significant at the 5% level)
S15	Scandi-navia	150 firms	2011	Tobin's *Q*	ERM survey	- Positive, but not-significant relation between ERM and firm value
ABW16	North America	76 insurer	2006-2013	Tobin's *Q*, *ROA*	S&P ERM Rating	- The combined effect of product line diversification and the quality of a firm's ERM assessment is positive and significant associated with the per-formance of an insurer
LG18	Germany	160 firms	2013	Tobin's *Q*	ERM/CRO key words	- Firms using ERM exhibit an increased Tobin's *Q* of 41.6% on average in comparison to non-ERM firms (statistically significant at the 1% level)

Notes: HL08: Hoyt and Liebenberg (2008); HL11: Hoyt and Liebenberg (2011); MNR11: McShane et al. (2011); TR11: Tahir and Razali (2011); LWY12: Lin, Wen, and Yu (2012); BBHY13: Baxter et al. (2013); LWOMC14: Li et al. (2014); FG15: Farrell and Gallagher (2015); S15: Sekerci (2015); ABW16: Ai et al. (2016); LG18: Lechner and Gatzert (2018).

Table A.6: Comparison of previous studies regarding the performance impact of ERM

Study	Sample			Proxy		Main result
	Country	Observations	Time	Firm value	ERM	
BPW08	USA	120 firms	1992-2003	Cumulative abnormal returns	CRO key words	- No aggregate significant market reaction to the hiring of CROs - Results are dependent on various firm-specific characteristics (firm size, cash ratio, earnings volatility, and financial leverage)
GLT09	USA	112 firms	2005	Excess stock market return	ERM index (objectives of COSO)	- Relation between ERM and firm performance depends on the match between ERM and specific firm characteristics (environmental uncertainty, industry competition, size, complexity, monitoring by board of directors) - Firms with "proper match" between ERM and these variables could improve their performance
PW10	USA	106 firms	1992-2004	Various financial (performance) variables	CRO key words	- Overall limited findings with respect to a performance increase due to ERM adoption
GLPS15	USA	523 insurer	2004, 2006	Cost and revenue efficiency (DEA approach)	Tillinghast Towers Perrin ERM survey	- Depending on the existence of several risk management factors (e.g. using economic capital models, dedication of risk managers or risk committee, risk management reporting to the board or CEO), firms are able to improve their cost and revenue efficiency
NRMF14	USA	60 insurer	2007-2011	Stock price returns and profitability	S&P ERM Rating	- Superior ERM capability is associated with smaller decline in stock price during the downturn (within the financial crisis) and superior profitability during the upturn (after the financial crisis)

Notes: BPW08: Beasley et al. (2008); GLT09: Gordon et al. (2009); PW10: Pagach and Warr (2010); GLPS15: Grace, Leverty, Phillips, and Shimpi (2015); NRMF14: Nair et al. (2014).