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Determinants and Value of Enterprise Risk Management: Empirical Evidence from Germany

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DETERMINANTS AND VALUE OF ENTERPRISE RISK MANAGEMENT: EMPIRICAL EVIDENCE FROM GERMANY

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ABSTRACT

Enterprise risk management (ERM) has become increasingly relevant in recent years, especially due to an increasing complexity of risks and the further development of regulatory frameworks. The aim of this paper is to empirically analyze firm characteristics that determine the implementation of an ERM system and to study the impact of ERM on firm value. We focus on companies listed at the German stock exchange, which to the best of our knowledge is the first empirical study with a cross-sectional analysis for Germany and one of the first for a European country. Our findings show that size, international diversification, and the industry sector (banking, insurance, energy) positively impact the implementation of an ERM system, and financial leverage is negatively related to ERM engagement. In addition, our results confirm a significant positive impact of ERM on shareholder value.

Keywords: Enterprise risk management; firm characteristics; shareholder value

JEL Classification: G20; G22; G32

1. INTRODUCTION

In recent years, enterprise risk management (ERM) has become increasingly relevant, especially against the background of an increasing complexity of risks, increasing dependencies between risk sources, more advanced methods of risk identification and quantification and information technologies, the consideration of ERM systems in rating processes, as well as stricter regulations in the aftermath of the financial crisis, among other drivers (see, e.g., Hoyt and Liebenberg, 2011; Pagach and Warr, 2011). The implementation of an enterprise-wide perspective on a firm's entire risk portfolio thereby aims to enhance a firm's shareholder value by supporting the board and senior management of a firm to ensure an adequate monitoring and management of the company's entire risk portfolio (see Meulbroek, 2002, Beasley et al., 2005).The aim of this paper is twofold. First, we empirically identify firm characteristics that determine the implementation of an ERM system and thereby also identify cross-industry differences; second, the impact of ERM on firm value is studied. This is done based on a sample of firms operating in various industries and listed at the German stock exchange mar-

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ket. To the best of our knowledge, our study represents the first empirical analysis regarding determinants and value of ERM for Germany. Furthermore, by using a dataset with firms operating in different industries, we provide one of the first cross-sectional studies of ERM value relevance for a European country.

The empirical literature on ERM can generally be classified along three main lines of research. The first line is concerned with the stage of the ERM implementation using surveys, questionnaires or interviews, for instance (see, e.g., Thiessen et al., 2001; Kleffner et al., 2003; Beasley et al., 2009, 2010; Daud et al., 2010, Altuntas et al., 2011a, 2011b; Daud et al., 2011; Yazid et al. 2011). A second strand of the literature focuses on the determinants of ERM (see, e.g., Liebenberg and Hoyt, 2003; Beasley et al., 2005; Hoyt and Liebenberg, 2008, 2011; Pagach and Warr, 2011; Razali et al., 2011; Golshan and Rasid, 2012; Farrell and Gallagher, 2015). Third, the relevance of ERM activities on a firm's shareholder value is studied based on various empirical data (see, e.g., Hoyt and Liebenberg, 2008, 2011; Beasley et al., 2008; McShane et al., 2011; Baxter et al., 2013; Farrell and Gallagher, 2015; Tahir and Razali, 2011; Li et al., 2014b; Sekerci, 2015). A more detailed review of empirical evidence regarding determinants and value of ERM in the literature can be found in Gatzert and Martin (2015).

Most empirical studies conclude that ERM generally has a (significant) positive impact on firm value and performance, but evidence is also mixed. In addition, prior empirical research on ERM typically concentrates on specific industries (see, e.g., Hoyt and Liebenberg, 2008, 2011; Altuntas et al., 2011b, with focus on the insurance industry) or specific geographic areas, e.g. using U.S. data (see, e.g., Beasley et al., 2005; Hoyt and Liebenberg, 2008, 2011; Pagach and Warr, 2011), Malaysian data (see, e.g., Razali et al., 2011; Golshan and Rasid, 2012), or Chinese data (see, e.g., Li et al., 2014b). However, the generalization of empirical results from previous work is limited due to geographic and industrial restrictions regarding the underlying datasets. In particular, due to differences in regulation such as Solvency II, results that are valid for U.S. or Asian data may not necessarily be transferrable to European countries. Exceptions are the studies by Altuntas et al. (2011a, 2011b), who conduct a survey among 95 German property-liability insurers to examine how and under which circumstances insurance companies implement an ERM approach and which ERM components are necessary. However, their aim is not to derive statistical evidence on determinants or value of ERM. Another exception is Sekerci (2015), who provides insights regarding the value relevance of ERM of Scandinavian firms by using a self-constructed ERM survey, but without finding significant results regarding the value relevance of ERM and without focusing on ERM determinants. Hence, to the best of our knowledge, despite the relevance of determinants and value of ERM against the background of regulatory requirements in Europe, these questions have not been empirically studied to date with focus on the European market using

a cross-sectional sample of firms that operate in several segments or business units except for Scandinavia (but with focus on value only and without significant results), which allows identifying cross-industry differences regarding ERM implementations.

Thus, the aim of this paper is to fill this gap and to contribute to the literature by empirically studying firm characteristics and the value of ERM based on a sample of firms listed at the German stock exchange as a representative for a European market. We use both, logistic and Cox regression analyses, to study the determinants of ERM, thereby focusing on firm size, financial leverage, profitability, industry sector, the level of industrial and international diversification, capital opacity, a Big Four auditor, and the presence of a Big Three rating agency,[1] whereby the latter represents another extension of the previous literature. Second, we use a linear regression to study the value of ERM by using Tobin's Q to approximate shareholder value. The results provide insight regarding the determinants of ERM and the question whether ERM can actually create value with focus on the German market and depending on the respective industry, as regulation is currently strongly influencing firms to implement ERM systems. This is not only relevant for insurers due to the introduction of the European regulatory framework Solvency II, but also for international regulations, where substantial advances are made (e.g. ORSA in the U.S.).

One main finding is that larger, less leveraged and geographically more diversified companies, firms from the banking, insurance, or energy sector as well as less profitable firms are more likely to implement ERM systems. Furthermore, consistent with previous research, we find a statistically significant positive impact of ERM on firm value, thus confirming the value relevance of ERM.

The reminder of this paper is structured as follows. Section 2 reviews the related literature, while Section 3 describes the underlying data, methodology and research design. The fourth section presents the empirical findings and we summarize in Section 5.

2. LITERATURE REVIEW

There are various guidelines for the implementation of a holistic and enterprise-wide risk management.[2] One of the most common frameworks was introduced by the Committee of Sponsoring Organizations of the Treadway Commission (COSO) in 2004, which defines

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1 The Big Three rating agencies include Standard & Poor's, Moody's, and Fitch Ratings.

2 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 (see Rochette, 2009; Gatzert and Martin, 2015).

ERM as (see COSO, 2004, p. 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 entity objectives."* Thus, ERM considers all enterprise-wide risks within one integrated, consolidated framework to achieve a comprehensive corporate forward-looking risk-reward perspective, thereby explicitly taking into account interdependencies and opportunities, which is in contrast to the silo and downside risk perspective of traditional risk management (see, e.g., Nocco and Stulz, 2006; Rochette, 2009; Eckles et al., 2014). ERM frameworks further typically include the appointment of a senior executive such as a CRO or a committee of risk management experts (see Liebenberg and Hoyt, 2003), and should be directed top-down by the senior management due to its high relevance for achieving a firm's corporate strategic goals (see COSO, 2009). In addition, the establishment of a strong risk culture across all enterprise levels is essential to ensure an appropriate coordination and functionality of the ERM system (see Gatzert and Martin, 2015).

The holistic perspective on a firm's risk portfolio is intended to create value for companies by optimizing their risk-return tradeoff and thus generating long-term competitive advantages as compared to firms which identify, manage and monitor risks individually (see Nocco and Stulz, 2006). In particular, firms with an ERM system are assumed to better be able to make proper economic decisions, thus tending to invest in more valuable net present value projects (see Myers and Read, 2001). They can also avoid a duplication of risk management expenditures by exploiting natural hedges (see Hoyt and Liebenberg, 2011),[3] whereas the silo risk management causes inefficiencies due to the lack of coordination between the various risk management departments (see Hoyt and Liebenberg, 2011). Furthermore, a firm's total risk can be reduced, financial distress is less likely (see Meulbroek, 2002; Gordon et al., 2009), and risk management may reduce or eliminate "costly lower-tail outcomes" (see Stulz, 1996, 2003), which may also result in lower expected costs of regulatory scrutiny and external capital (see Meulbroek, 2002). In general, information asymmetries within the enterprise (for decision making) as well as regarding investors and stakeholders (for an evaluation regarding the firm's financial strength and risk profile) can be reduced (see Liebenberg and Hoyt, 2003) by an efficient risk communication, which can contribute to an increasing confidence in the firm by rating agencies, regulators, and, ultimately, customers.

The benefits of ERM are also supported by various empirical studies to a different extent. For instance, Hoyt and Liebenberg (2008, 2011) find a highly significant relation between ERM and firm value, with ERM increasing the shareholder value for U.S. insurance companies by

[3] Smithson and Simkins (2005) provide a comprehensive review regarding empirical papers that investigate the effect of hedging activities on shareholder value.

approximately 17% to 20%, respectively. McShane et al. (2011) use the five categories of the Standard & Poor's (S&P) ERM insurance rating[4] to assess the impact of risk management activities on firm value for a dataset of 82 worldwide insurance companies. Their results show a positive relationship between an increasing level of risk management and firm value,[5] while a change from traditional risk management to ERM does not lead to an increase in shareholder value. Based on a sample of 120 U.S. companies, Beasley et al. (2008) further find that the market reaction to a CRO announcement is firm-specific, being significant in case of non-financial firms while a general reaction is not observed. The cross-sectional study by Farrell and Gallagher (2015)[6] shows statistically significant relations, suggesting that an increasingly mature level of ERM is associated with enhanced firm value. Furthermore, analyzing data from Malaysian companies and Chinese insurers, Tahir and Razali (2011) and Li et al. (2014b) observe a positive but not significant impact of ERM on shareholder value. Similarly, a positive but not significant effect of ERM on Q is also found by Sekerci (2015), who focuses on Scandinavian listed firms. By analyzing 165 financial service enterprises, Baxter et al. (2013) additionally find evidence that ERM quality is positively associated with operating performance and earning response coefficients. Further articles show a significant positive (at least to some extent) impact of ERM on firm performance or market reactions (see, e.g., Gordon et al., 2009; Pagach and Warr, 2010; Grace et al., 2014; Baxter et al., 2013), thereby mainly focusing on the U.S. market and using various financial performance measures.[7] Overall, despite some mixed evidence, the empirical results thus generally confirm the theoretical arguments that a holistic ERM system can add value for a firm.

Given that ERM can create value, the question regarding the *determinants* arises, which make an implementation more likely for firms. In this regard, most articles observe a (significant) positive relation between ERM and *firm size* (see, e.g., Beasley et al., 2005; Hoyt and Liebenberg, 2008, 2011; Pagach and Warr, 2011; Farrell and Gallagher, 2015) except for Liebenberg and Hoyt (2003). Furthermore, a significant negative relation of ERM and *financial leverage* is observed in Hoyt and Liebenberg (2008, 2011), which is opposite to the find-

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[4] The S&P ERM rating categories for an insurer's score are (1) "very strong", (2) "strong", (3) "adequate with strong risk controls", (4) "adequate", or (5) "weak", from most to least credit-supportive (see Standard & Poor's, 2013).

[5] According McShane et al. (2011), the lower three categories of S&P´s ERM rating (weak, adequate and adequate with strong risk controls) reflect an increasing level of traditional risk management. The category "strong" as well as "very strong" represent firms that have progressed beyond silo risk management and therefore are considered as ERM.

[6] Farrell and Gallagher (2015) use the RIMS RMM model as a proxy for ERM implementation for the period from 2006 to 2011. The sample is composed of 225 international firms from various industries.

[7] Gordon et al. (2009) use the excess market return as a proxy for firm performance, Grace et al. (2014) apply the cost and revenue efficiency as dependent variable, Pagach and Warr (2010) analyze the ERM effect concerning several various financial variables, such as earnings or stock price volatility and Baxter et al. (2013) use the return on assets, Tobin´s Q and cumulative abnormal return for the three-day period centered around unexpected earnings announcements.

ings in Golshan and Rasid (2012) and Liebenberg and Hoyt (2003). Hoyt and Liebenberg (2008, 2011) further observe a significant positive relation of ERM adoption with *institutional ownership*, which is similar to Pagach and Warr (2011), who additionally identify *cash flow volatility* as a significant determinant. Beasley et al. (2005) find significant effects of the presence of a *Big Four auditor*[8] as well as *independence of the board of directors* on ERM adoption (see also Golshan and Rasid (2012) for the latter finding). Moreover, focusing on Malaysian data, Razali et al. (2011) and Golshan and Rasid (2012) show that *international diversification*, a firm's *capital structure*, and the *sales volume* are significant drivers for ERM systems.

3. Hypotheses Development, Empirical Method, and Data Sample

3.1 Hypotheses development and empirical method

As we have two research objectives by focusing on 1) selected determinants of ERM engagement and 2) the value impact of ERM systems, we use different empirical methods along with different time periods (a one-year and a multi-period sample), thereby following the literature. The application of the different regression models is intended to offer more comprehensive insight into the determinants and value of ERM. In what follows, we present the hypotheses development and the employed empirical method, first focusing on estimating the determinants of ERM engagement, and then the value relevance of ERM.

3.1.1 Determinants of ERM engagement

Consistent with the previously described empirical literature regarding the determinants of ERM engagement, we hypothesize that the following firm characteristics have an impact on the likelihood of an ERM implementation.

Firm size: Companies are faced with an increasing scope and complexity of risks (see Nocco and Stulz, 2006). According to the principle of proportionality, an increasing firm size is related to an increasing number of risks, which tends to result in a higher likelihood of ERM implementation (see Hoyt and Liebenberg, 2011). Additionally, larger firms are able to invest more financial, technological and human resources for implementing adequate ERM programs (see Beasley et al., 2005; Golshan and Rasid, 2012). In line with this and as described in Section 2, several articles find empirical evidence that larger firms are more likely to implement ERM systems (see, e.g., Hoyt and Liebenberg, 2011; Pagach and Warr, 2011; Farrell and Gallagher, 2015). We measure firm size using the natural logarithm of the firm's book

[8] The Big Four auditors include Deloitte, KPMG, EY and PricewaterhouseCoopers.

value of total assets (see, e.g., Hoyt and Liebenberg, 2011; Golshan and Rasid, 2012) and assume

H_1: Companies are more likely to implement an ERM system with increasing firm size.

Financial leverage: Besides firm size, the financial structure and in particular the ratio of debt (or liability) to asset capital, i.e. financial leverage, has empirically been shown to be a driver for ERM implementation, but with ambiguous results, including significant negative (see Hoyt and Liebenberg, 2008, 2011) as well as positive relations (see Liebenberg and Hoyt, 2003; Golshan and Rasid, 2012). On the one hand, firms with a holistic risk management may reduce financial leverage to "decrease the risk of debt-payout defaults" (Golshan and Rasid, 2012). On the other hand, it is reasonable that firms with an ERM system may decide to increase leverage as a result of their improved risk appreciation (see Hoyt and Liebenberg, 2011, p. 805). Furthermore, ERM activities enable firms to reduce debt costs by presenting the capital market an appropriate company strategy, a trustful risk handling as well as an adequate risk policy (see Meulbroek, 2002). This may contribute to more favorable conditions for debt capital, whereby raising additional debt is possible. Hence, we hypothesize

H_2: Companies are more likely to implement an ERM system with increasing financial leverage.

Return on assets: Another relevant determinant for ERM examined in the literature is the profitability of firms as measured by the return on assets (RoA) (see Razali et al., 2011, where the variable is not significant, however), which represents an indicator regarding the efficiency of the management by using its available assets to generate earnings, calculated by dividing a firm's annual net income by its book value of total assets (see Razali et al., 2011). We assume that companies with an increasing RoA are more likely to fund the required financial resources to implement ERM and thus assume

H_3: Companies are more likely to implement an ERM system with increasing return on assets.

Industry: Previous studies suggest that firms from specific industries are more likely to adopt an ERM system than others, e.g., because of different regulatory requirements or because of a higher (different) degree of risk awareness within the respective industry as compared to other sectors (see Beasley et al., 2005; Golshan and Rasid, 2012). The banking and the insurance industry, for instance, face considerable regulatory pressure with respect to a holistic risk management due to the risk-based solvency regulations Basel III and Solvency II, respectively (see, e.g., Beasley et al., 2005; Gatzert and Wesker, 2012). Banks and insurers are also in the focus of rating agencies such as Standard & Poor's, Moody's, Fitch Ratings or A.M. Best, where ERM practices are part of the credit rating process (see Beasley et al., 2008). Furthermore, firms from the financial sector generally aim to present an adequate and transparent risk management system to increase confidence at the capital markets and to acquire customers (see Hoyt and Liebenberg, 2008). Another industrial sector with stronger ERM requirements

due to regulatory restrictions, e.g. as a consequence of the downfall of Enron, is the energy industry (see Beasley et al., 2005; Pagach and Warr, 2011). According to the prior argumentation, we assume

H_4: Companies are more likely to implement an ERM system if they are operating in the banking, insurance or energy industry.

Div_Ind: Firms which are engaged in several segments or business units are generally more broadly diversified (see Pagach and Warr, 2011; Golshan and Rasid, 2012). Thus, on the one hand, a higher industrial diversification generally comes with a decrease of operational and financial risks due to diversification within the company (see Pagach and Warr, 2011). On the other hand, firms with a higher number of operating segments are faced with a higher risk complexity and therefore an increasing willingness to implement ERM (see Golshan and Rasid, 2012). Hoyt and Liebenberg (2011) and Gordon et al. (2009) find a statistically significant positive relation between diversification and the existence of ERM programs as well as the effectiveness of ERM. To indicate the industrial diversification status, we use a dummy variable, which takes the value 1 for firms operating in at least two different segments or business lines and 0 otherwise (see Hoyt and Liebenberg, 2011), and assume the following hypothesis

H_5: Companies are more likely to implement an ERM system if they are an operating in at least two segments or business lines.

Div_Int: Besides the industrial complexity of firms, the international diversification of organizations is regarded as another driver of ERM (see Hoyt and Liebenberg, 2011). Based on a similar line of reasoning as before, we expect a positive relation between international diversification and ERM engagement caused by the fact that internationally operating firms generally face a higher number and complexity of risks and need to comply with different national regulatory requirements (see Hoyt and Liebenberg, 2011). Following Razali et al. (2011), the international diversification dummy takes a value of 1 for firms with geographic segments or subsidiaries in countries besides Germany, and 0 otherwise. We thus assume

H_6: Companies are more likely to implement an ERM system if they are operating in geographic segments besides Germany.

Capital opacity: In times of financial distress, companies with more opaque assets may have problems to liquidate these assets at their fair market value (see Pagach and Warr, 2011; Golshan and Rasid, 2012). Furthermore, firms with increasing capital opacity are often undervalued due to higher information asymmetry (see Pagach and Warr, 2011). ERM programs can contribute to reducing this information asymmetry by communicating the risk profile as well as the financial strength to investors and other stakeholders (see Pagach and Warr, 2011). Following Hoyt and Liebenberg (2011), we define capital opacity as the ratio of intangible assets to the book value of total assets and assume the relationship

H_7: Companies are more likely to implement an ERM system with increasing capital opacity.

Big Four auditor: Several previous studies find a significant positive relationship between an ERM adoption and the selection of the firm's annual auditor (see Beasley et al., 2005; Golshan and Rasid, 2012), i.e. if the firm's annual auditor belongs to the Big Four KPMG, EY, Deloitte or PricewaterhouseCoopers, the firm is more likely to implement an ERM system (see Golshan and Rasid, 2012). One reason stated in the literature is that the Big Four are more careful regarding the firms' annual reports in order to uphold their reputation level (see Tolleson and Pai, 2011). Therefore, we assume

H_8: Companies are more likely to implement an ERM system if they are audited by one of the Big Four.

Big Three rating: Similarly and as a further and new potential determinant, we include the assignment of an external company rating, using a similar reasoning as for the previous determinant. A well-managed and transparent organization benefits from the publishing of a good rating (see Fraser and Simkins, 2010), as the confidence of capital market participants may be strengthened as a result of a firm's rating, if the rating is provided by one of the Big Three rating agencies Standard & Poor's, Moody's or Fitch Ratings, which belong to the largest and most accepted organizations worldwide (see Gibilaro and Mattarocci, 2011). Since 2005, Standard & Poor's, for instance, includes a separate ERM category to derive credit and financial strength ratings for insurance companies (see Hoyt and Liebenberg, 2011). Hence, we assume the hypothesis

H_9: Companies are more likely to implement an ERM system if they are rated by one of the Big Three rating agencies.

To estimate the effect of these determinants (firm characteristics) on the implementation of ERM systems in firm *i*, we first follow Liebenberg and Hoyt (2003) and use a logistic regression based on a one-year sample. This model is typically used for binary decisions, in this case the examination of factors that are hypothesized to be drivers of an ERM engagement. The binary dependent variable *ERM* assumes a value of 1 if a firm adopted an enterprise-wide risk management and 0 otherwise, and is explained by

$$\ln\left(\frac{p\left(ERM=1\right)}{1-p\left(ERM=1\right)}\right)=b_0+b_1x_1+b_2x_x+\ldots+b_nx_n+\varepsilon_i \qquad (1)$$

where the logarithmized quotient of the likelihood of a firm that is using ERM, given by $p(ERM=1)$ and its converse probability represents the odds ratio, $b_0, \ldots, b_n$ denote the estimated regression parameters of the selected determinants, and the coefficients $x_1,\ldots, x_n$ represent the firm characteristics, which we hypothesize to have a significant influence on a firm's decisions regarding whether to implement an ERM system or not. In particular, as discussed above, we assume the following variables to impact ERM engagements of firm *i*:

$$ERM_i = f\left(Size, Leverage, RoA, Industry, Div\_Ind, Div\_Int, Opacity, BigFour, BigThree\right)_i. \quad (2)$$

A major disadvantage of this approach is that a logistic regression together with a one-year sample generally ignores information contained in prior time periods (see Pagach and Warr, 2011). We thus additionally use a multi-period sample to run a Cox proportional hazard regression following Pagach and Warr (2011), which on the one hand is intended to support the results of the logistic model and on the other hand includes information regarding the development of a firm towards an ERM implementation decision over time. The time-extended data set when using the Cox proportional hazard regression is an event history data set, which reduces the number of observations over time. In case a firm implements an ERM program in year *t*, it exits from the data set in the following year *t*+1 (see Pagach and Warr, 2011), implying that the number of observations in the data set decreases from year to year. The Cox proportional hazard model is thus able to incorporate the development of a time series regarding ERM decisions. In accordance with the logit model, we estimate the hazard model by using a Cox proportional hazard function (see Cox, 1972), i.e. a function of the common effects of several determinants of ERM (see also Equation (2)) dependent on the corporate year *t* (see Pagach and Warr, 2011),

$$ERM_{it} = f\left(Size, Leverage, RoA, Industry, Div\_Ind, Div\_Int, Opacity, BigFour, BigThree\right)_i. \quad (3)$$

3.1.2 The value of ERM

The second main objective of our paper concerns the effect of ERM on a firm's shareholder value. Consistent with the previous empirical literature (see Section 2), we hypothesize that the implementation of an ERM system has a significant positive impact on firm value even though initiating and maintaining an ERM system may be highly cost-intensive (see, e.g., Hoyt and Liebenberg, 2011; Li, Wen, and Yu, 2012). We use a linear regression based on a one-year sample (see, e.g., Gordon et al. (2009) and Tahir and Razali (2011))[9;10] with several control variables and estimate the equation

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[9] To control for a potential endogeneity bias of the ERM choice, we additionally ran a full maximum-likelihood treatment effects model, which simultaneously estimates the ERM and the Q equation in a two-equation system approach. Using the one-year sample 2013 as well as an extended data set with 787 firm-year-observations between 2009 and 2013 (considering firm-level as well as firm-year-clustering), our results, i.e., the likelihood-ratio test for testing the level of correlation between the two error terms (see Guo and Fraser, 2009), do not support the joint estimation of both equations. For this reason, we perform separate analyses regarding the ERM choice and the impact on firm value.

[10] We use the one-year sample 2013 in order to avoid biases as a result of interdependences between two or more observations of the same company. Therefore, it is not necessary to adjust standard errors for firm-level or firm-year clustering (see Hoyt and Liebenberg, 2011).

$$Q = \beta_0 + \beta_1 ERM + \beta_2 Size + \beta_3 Leverage + \beta_4 RoA + \beta_5 Industry + \beta_6 Div\_Ind + \beta_7 Div\_Int + \beta_8 Opacity + \beta_9 Dividends + \varepsilon, \quad (4)$$

where we use Tobin's Q as a proxy for firm value, which represents the market value of the firm's assets in proportion to their replacement costs (see, e.g., Hoyt and Liebenberg, 2011; McShane et al., 2011) and is calculated by (see, e.g., Cummins et al., 2006; Hoyt and Liebenberg, 2011)

$$Tobin's\ Q = \frac{Market\ value\ of\ equity + Book\ value\ of\ liabilities}{Book\ value\ of\ total\ assets}. \quad (5)$$

The market value of equity is approximated by the product of a firm's share price and the number of outstanding common stock shares. If a firm offers preference stocks, we add the product of preference share price and number of preference stock shares as well (see Chung and Pruitt, 1994). While Q-values greater than 1 imply an efficient use of the firm assets, Q less than 1 indicates rather inefficient operating firms (see Lindenberg and Ross, 1981). Q does not require standardization or risk adjustments (see Hoyt and Liebenberg, 2011) and is hardly subject to managerial manipulation (see Lindenberg and Ross, 1981), which is also why Lang and Stulz (1994) state that Q is advantageous as compared to other performance measures such as stock returns or other accounting measures. The future-oriented view, which contrasts with historical accounting performance measures like the return on assets, is another important advantage because benefits of enterprise-wide risk management are not expected to be realized immediately but rather over time (see Hoyt and Liebenberg, 2008). To isolate the relationship between enterprise-wide risk management and Tobin's Q, we control for other firm variables as exhibited in Equation (4), which are described below.

Firm size: As described before, several previous studies observe positive dependencies between firm size and the likelihood of an ERM implementation. However, the impact of firm size on firm value is ambiguous. While the firm value of larger firm's possibly increases through economies of scale, greater market power and lower costs due to reduced insolvency risks (see McShane and Cox, 2009; McShane et al., 2011), several prior empirical studies also find a negative relationship attributed to greater agency problems (see, e.g., Lang and Stulz, 1994; Allayannis and Weston, 2001). As in case of the determinants, we define firm size as the natural logarithm of (book value of) total assets following Hoyt and Liebenberg (2011) in order to control for size-related variations in Q.

Financial leverage: Previous research also finds ambiguous effects of the capital structure on firm value. On the one hand, increasing debt capital can increase firm value by reducing free cash flow that otherwise might have been invested in inefficient projects (see Hoyt and

Liebenberg, 2011). In addition, an increasing debt capital may allow tax savings, which may enhance firm value (see Tahir and Razali, 2011). On the other hand, high debt ratios may increase the likelihood of financial distress (see Hoyt and Liebenberg, 2011). Following Hoyt and Liebenberg (2011) and Farrell and Gallagher (2015), we define financial leverage as the ratio of the book value of liabilities to the market value of equity.

Return on assets: The positive relationship between profitability and shareholder value is generally accepted in the literature (see Allayannis and Weston, 2001). Hence, the return on assets (RoA), defined as annual net income divided by (book value of) total assets, is included to control for firm profitability (see, e.g., Hoyt and Liebenberg, 2011; McShane et al., 2011).

Industry: To control for potential differences in Q due to the firm's industry sector, we include a dummy variable, which takes the value 1 for firms operating in the banking, insurance or energy sector, and 0 otherwise as is done regarding the determinants of ERM (see Hoyt and Liebenberg, 2011).

Div_Ind: The theory about the relation of industrial diversification and firm value is ambiguous. On the one hand, a higher degree of diversification will likely result in performance enhancement due to advantages of economies of scope as well as risk reduction based on interdependencies between several business lines (see Hoyt and Liebenberg, 2011). On the other hand, increasing industrial diversification may also result in a loss of information within conglomerates. Furthermore, not only difficulties when implementing ERM systems, but also possible agency problems may reduce the firm value of industrially diversified organizations (see, e.g., Lang and Stulz, 1994, Gordon et al., 2009). To take into account the impact of the complexity of firms, we thus use the dummy variable *Div_Ind*.

Div_Int: Similarly, international diversification may also cause more pronounced agency problems (see Hoyt and Liebenberg, 2011).

Capital opacity: To control for the impact of opaque assets on shareholder value, we include the variable *Capital opacity*, defined as the quotient of intangible assets and the book value of total assets (see, e.g., Pagach and Warr, 2010; Hoyt and Liebenberg, 2011).

Dividends: Following Hoyt and Liebenberg (2011) as well as Farrell and Gallagher (2015), we include a binary dummy variable *Dividends*, which takes the value 1 if the firm paid a dividend for the preceding fiscal year, and 0 otherwise. The effect of a dividend payout on the firm value is ambiguous in the literature. On the one hand, firms who pay out dividends to their shareholders limit their potential for investments in future projects and thus possibly restrict growth opportunities (see Hoyt and Liebenberg, 2011), which may also lead to a stag-

nation or decrease in firm value (see, e.g., Lang and Stulz, 1994; Allayannis and Weston, 2001). However, dividends also reduce free cash flows for managers, which could be used for their own interests (see Hoyt and Liebenberg, 2011), and dividend payments also provide a positive signal the capital market regarding the firm's financial situation (see Li et al., 2014a), implying that dividends may also increase firm value.

3.1.3 Summary of the variable definitions

A summary of the variables used in the logistic, Cox proportional hazard, and linear regression models is given in Table 1, including their measurement, the predicted sign as well as references to previous studies.

Table 1: Definition, measurement, and predicted sign of variables in regression analyses

Variable	Measurement	Predicted sign	References
Tobin's Q	(Market value of equity + Book value of liabilities) / book value of assets	*N/A*	HL(2008), HL(2011), MNR(2011), TR(2011), FG(2015)
ERM	1 = ERM, 0 = otherwise	+ (Tobin's Q)	HL(2011), PW(2011), GR(2012)
Firm size	Natural logarithm of book value of total assets	+ (ERM) +/- (Tobin's Q)	BCH(2005), HL(2008), RYT(2011), GR(2012)
Financial leverage	Book value of liabilities / market value of equity	+ (ERM) +/- (Tobin's Q)	BPW (2008), LH(2008), HL(2011), FG(2015)
Return on assets (RoA)	Annual net income / book value of total assets	+ (ERM) + (Tobin's Q)	HL(2008), HL(2011), RYT (2011), MNR(2011), TR (2011)
Industry	1 = firm operates in banking, insurance or energy industry, 0 = otherwise	+ (ERM)	LH(2003), BCH(2005), GR(2012)
Div_Ind	1 = firms operating in at least two segments or business lines, 0 = otherwise	+ (ERM) +/- (Tobin's Q)	HL(2008), HL(2011), GLT(2009), FG(2015)
Div_Int	1 = firms additionally operating outside of Germany, 0 = otherwise	+ (ERM) +/- (Tobin's Q)	HL(2008), HL(2011), RYT(2011), TR(2011), FG(2015)
Capital opacity	Intangible assets / book value of total assets	+ (ERM)	HL(2011), BPW(2008), PW(2010), PW (2011), GR(2012)
Big Four auditor	1 = Big Four auditor (PwC, EY, KPMG, Deloitte), 0 = otherwise	+ (ERM)	BCH(2005), GR(2012)
Big Three rating	1 = Big Three rating (S&P, Fitch Ratings, Moody's), 0 = otherwise	+ (ERM)	*N/A*
Dividends	1 = firm paid dividends in that year, 0 = otherwise	+/- (Tobin's Q)	HL(2008), HL(2011), FG(2015)

Notes: LH(2003): Liebenberg and Hoyt (2003); BCH(2005): Beasley, Clune, and Hermanson (2005); HL(2008): Hoyt and Liebenberg (2008); GLT(2009): Gordon, Loeb, and Tseng (2009); HL (2011): Hoyt and Liebenberg (2011); BPW(2008): Beasley, Pagach, and Warr (2008); PW(2010): Pagach and Warr (2010); MNR(2011): McShane, Nair, and Rustambekov (2011); PW(2011): Pagach and Warr (2011); RYT(2011): Razali, Yazid, and Tahir (2011); TR(2011): Tahir and Razali (2011); GR(2012): Golshan and Rasid (2012); FG(2015): Farrell and Gallagher (2015).

3.2 Sample description and ERM identification

We consider a sample of companies listed in the most important traded German stock indices DAX, MDAX, SDAX and TecDAX for the period from 2009 to 2013.[11] Firms operate in different industries and vary significantly regarding firm size, which allows us to examine industrial as well as size-related effects on shareholder value and on determinants of ERM implementation. In addition, by focusing on firms with corporate headquarters in the same geographic market, we control for potential biases due to differences in country-specific regulatory requirements. The data starts with the fiscal year 2009 in order to avoid distortionary effects from the financial crisis that peaked in 2008, and we compile two different samples to conduct the three regression types described before, including a static logistic model as well as a linear regression, which are applied to one year only (here: 2013), and the Cox proportional hazard regression for a multi-period sample from 2009 to 2013.

The first sample is composed of 160 companies with data from annual reports for 2013,[12] where 115 firms exhibit an ERM system and 45 did not. Due to the disclosure requirements of the publicly traded firms in Germany, we do not have to eliminate any company as a consequence of missing or erroneous data. As firms typically do not disclose their exact level of risk management or ERM activities (Gatzert and Martin, 2015), we follow Hoyt and Liebenberg (2011) and Pagach and Warr (2011), for instance, and perform a detailed keyword search,[13] using the following phrases, their synonyms and acronyms: "*enterprise risk management*", "*Chief Risk Officer*", "*COSO II – Integrated Framework*", "*risk committee*", "*holistic risk management*" and "*centralized risk manager*". Each successful hit was dated and coded with a binary variable (i.e., $ERM = 1$, otherwise 0). Overall, 115 companies in the sample were identified with an ERM program.

The second multi-period sample includes firm data from 2009 to 2013 and thus up to five observation years per company. In this case, we had to exclude 11 firms due to missing data, resulting in 149 remaining companies. For each corporate year, ERM activities were identified as laid out above, which serves as the triggering event in order to create the sample for the Cox proportional hazard regression. While firms i using ERM in year t are coded with the value $ERM_{it} = 1$, companies without ERM take the value 0. As a consequence of a firm's

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[11] The DAX is composed of 30 companies, the MDAX and the SDAX have a total of 50 members, and the TecDAX consists of 30 firms. Please see Appendix A.3 for a detailed list of companies in the sample.

[12] Distribution of the 115 ERM adopting firms in the respective index: 29 DAX, 36 MDAX, 31 SDAX and 19 TecDAX firms.

[13] Alternative approaches for identifying ERM systems include surveys (see Beasley et al., 2005), CRO appointments (see Liebenberg and Hoyt, 2003), Standard & Poor's ERM rating (see McShane et al., 2011), external database like the OSIRIS database (see Razali et al., 2011) or the construction of ERM indices (see Gordon et al., 2009).

ERM implementation in year *t*, the firm exits from the data set in the following year *t*+1. Hence, a firm can have a maximum of one observation with $ERM_{it} = 1$ (see Pagach and Warr, 2011), i.e. if the first ERM evidence of firm *i* occurs in its annual report 2009 (or before), the following observations from 2010 to 2013 are removed from the data set. Since 42 companies did not show any evidence of ERM, they remain in the data set with full five observation-years, hence providing 210 company-year observations. Overall, we thus obtain a multi-period sample from 2009 to 2013 with 407 company year observations as shown in Table 2. For example, while in 2009, 70 companies had an ERM system, 13 further companies established an ERM program in 2010, thus exiting the data set in 2011 and providing 26 (13 x 2 years) company-year observations for the time series. Overall, 37 companies out of 149 firms induced a triggering event, i.e. the implementation of ERM, between 2010 to 2013, as 70 companies already used an ERM program in 2009 and 42 companies still did not exhibit an ERM in 2013.

Table 2: Sample description: Identification of ERM by year

	Time-extended sample		Distribution regarding index affiliation			
Year	Number of companies with an ERM system established in year *t*	Number of company-year observations	DAX	MDAX	SDAX	TecDAX
2009 or before	70	70	21	18	19	12
2010	13	26	4	5	2	2
2011	6	18	2	2	1	1
2012	7	28	2	1	3	1
2013	11	55	0	3	4	4
ERM - total	= 107	= 197	29	29	29	20
Non-ERM	42	210	1	11	20	10
Total	= 149	= 407	= 30	= 40	= 49	= 30

4. EMPIRICAL RESULTS

4.1 Descriptive statistics

4.1.1 Summary statistics and univariate differences

We first focus on the one-year sample (year 2013) and compare the univariate statistics of two subsamples, namely the ERM adopting group composed of 115 firms and the control group without ERM, which includes 45 firms. The univariate statistics of the subsamples along with the differences in means and medians of firm characteristics for both groups are reported in Table 3.

Table 3: Univariate statistics and univariate differences between ERM-group versus non-ERM-group (year 2013)

		ERM group (N=115)					Non-ERM group (N=45)					Difference	
Variable	N	mean	median	SD	min	max	mean	median	SD	min	max	mean	median
Tobin's Q	160	1.736	1.347	1.019	0.873	5.821	1.694	1.410	0.993	0.636	4.943	0.042 (0.813)	-0.063 (0.647)
Firm size	160	22.254	21.735	2.037	18.243	28.108	20.806	20.563	1.424	17.936	24.484	1.448*** (0.000)	1.172*** (0.000)
Financial leverage	160	2.423	0.864	6.041	0.066	44.029	1.491	0.630	3.530	0.057	23.524	0.932 (0.333)	0.234 (0.119)
Return on assets	160	0.038	0.040	0.057	-0.167	0.222	0.056	0.039	0.113	-0.195	0.442	-0.018 (0.317)	0.001 (0.959)
Industry	160	0.130	0.000	0.338	0.000	1.000	0.020	0.000	0.149	0.000	1.000	0.110*** (0.006)	0.000** (0.041)
Div_Ind	160	0.110	0.000	0.318	0.000	1.000	0.040	0.000	0.208	0.000	1.000	0.070 (0.113)	0.000 (0.182)
Div_Int	160	0.920	1.000	0.270	0.000	1.000	0.760	1.000	0.435	0.000	1.000	0.160** (0.020)	0.000*** (0.004)
Capital opacity	160	0.197	0.137	0.177	0.0001	0.614	0.178	0.098	0.188	0.000	0.674	0.019 (0.544)	0.039 (0.282)
Big Four auditor	160	0.930	1.000	0.256	0.000	1.000	0.820	1.000	0.387	0.000	1.000	0.110* (0.088)	0.000** (0.041)
Big Three rating	160	0.380	0.000	0.488	0.000	1.000	0.110	0.000	0.318	0.000	1.000	0.270*** (0.000)	0.000*** (0.001)
Dividends	160	0.826	1.000	0.381	0.000	1.000	0.756	1.000	0.435	0.000	1.000	0.070 (0.343)	0.000 (0.312)

N: = Number of firms; SD: = Standard Deviation; ***, **,* : = statistical significance at the 99, 95, 90%-confidence level; statistical significance of difference in means is based on a t-test. Statistical significance of difference in medians is based on a nonparametric Wilcoxon rank sum test.

It can be seen that the mean of Tobin's Q for firms with ERM is 1.736 and thus slightly higher as compared to 1.694 for firms without ERM, while the median of Tobin's Q for ERM firms is lower with 1.347 as compared to 1.410 for firms without an ERM system, thus exhibiting an ambiguous effect of ERM regarding the value relevance, which, however, is not statistically significant.[14]

Concerning firm characteristics, we find that both the mean and the median of firm size is significantly higher for firms with ERM programs. In addition, firms with an ERM system rather operate in the banking, insurance or energy sector and tend to be more internationally diversified. Furthermore, the results of the univariate statistics show that ERM-adopting firms are more frequently audited by one of the Big Four auditing firms and are rated by one of the Big Three rating agencies for a financial strength and credit rating as compared to firms that do not have an ERM system. Regarding the remaining variables (financial leverage, return on assets,[15] industrial diversification, capital opacity,[16] dividends), we do not observe any univariate statistically significant differences between the two subsamples.

4.1.2 Pearson and spearman´s rank correlation coefficients

The correlation analysis between Tobin's Q, ERM and the determinants is reported in Table A.1 in the Appendix.[17] To test for multicollinearity, we additionally compute the variance inflation factors (VIFs). The general lack of high bivariate correlation coefficients[18] between the examined variables and the examined VIFs[19] suggest that multicollinearity does not pose a problem in the regression analyses.

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[14] The rather large values of Q as compared to other studies (see, e.g., Hoyt and Liebenberg, 2011) can be explained by the economic trend, as the considered indices reached peak levels after a steady increase in the aftermath of the financial crisis at the time of data elicitation (end of year 2013). Therefore, in tendency the firms' increased share prices implied higher Q-values.

[15] Sensitivity analyses have shown that the marginal areas of the variable return on assets do not have a (noticeable) effect on the regression results. Hence, we did not have to eliminate these firm observations.

[16] The data of the univariate statistics of capital opacity, i.e. the mean and median of the ERM and Non-ERM group, approximately correspond to the results of comparable cross-industry studies, e.g. Farrell and Gallagher (2015). Differences to the results in Hoyt and Liebenberg (2011), for instance, can be explained by the sample (cross-industry sample versus focus on the insurance industry).

[17] We consider both since the Pearson correlation coefficient is especially suitable for intervals or ratio scales that are normally distributed, while the Spearman rank-order correlation is typically used to analyze interdependencies of ordinal data.

[18] An absolute value of the bivariate correlation coefficients greater than 0.8 indicates strong linear associations and, therefore, multicollinearity may be a problem (see Mason and Perreault, 1991). Our correlation analysis shows the highest bivariate correlation between the variables Tobin's Q and financial leverage with a Spearman rank-order correlation of -0.789 (see Table A.1 in the Appendix).

[19] All examined VIFs are below the critical value of 10 (see, e.g., Mason and Perreault, 1991; Kutner et al., 2005).

4.2 Empirical results regarding the determinants of an ERM implementation

4.2.1 Results of the logistic regression

As described in Section 3, we first conduct a multivariate analysis by using a logistic regression to estimate the impact of firm characteristics on firms' decisions whether they will implement ERM programs or not. The results based on the sample with firm data for the year 2013 (N = 160) are shown in Table 4. The considered determinants are listed in the first column, the second column reports the predicted sign, and the third column contains the estimated parameter of the considered determinant by the regression model. The remaining columns display the standard error (S.E.), the Wald chi-square value, the p-value as well as the multiplicative change in the odds ratio exp(B).

Table 4: Logistic regression results

Dependent variable = ERM

Variable	Predicted sign	Parameter estimate (B)	S.E.	Wald	p-value	exp(B)
Intercept		-11.021	3.780	8.499	0.004***	0.000
Firm size	+	0.495	0.179	7.605	0.006***	1.640
Financial leverage	+	-0.118	0.062	3.587	0.058*	0.889
Return on assets	+	-0.010	0.024	0.175	0.676	0.990
Industry	+	1.908	1.508	1.600	0.206	6.738
Div_Ind	+	0.030	0.859	0.001	0.972	1.030
Div_Int	+	1.206	0.553	4.750	0.029**	3.340
Capital opacity	+	0.005	0.012	0.196	0.658	1.005
Big Four auditor	+	0.386	0.600	0.414	0.520	1.472
Big Three rating	+	0.216	0.673	0.103	0.749	1.241
Model fit:						
$R^2_{Nagelkerke}$	0.253					

Notes: See Table 1 for variable description; ***, **,*:= statistical significance at the 99, 95, 90%-confidence level; sample with data from 2013; number of observations=160.

First, in line with Hoyt and Liebenberg (2011), Farrell and Gallagher (2015) as well as Pagach and Warr (2011), we find evidence that larger firms are more likely to implement an ERM system. Second, our logistic regression results provide evidence that less leveraged firms are significantly related to ERM implementations, which is also in line with Hoyt and Liebenberg (2011). In addition, a statistically significant positive relationship between ERM and international diversification can be observed, i.e., firms operating in geographic segments in addition to Germany are more likely to implement an ERM system. None of the further examined firm characteristics of the model show significant relations with a firm's decision regarding an ERM engagement.

In addition, to study the influence of potential outliers, we run an analysis without eight outlying observations identified based on standardized residuals, which also confirmed the relationships between firm size and ERM as well as international diversification and ERM. While the estimated parameter of financial leverage is still indicative for the fact that less leveraged firms are more likely to implement ERM, this relationship is no longer significant after the sample adjustment.

To estimate the goodness-of-fit of the logit model (predictive power), the pseudo $R^2_{Nagelkerke}$ is calculated and with 0.253 is approximately in line with comparable studies (see Beasley et al., 2005; Razali et al., 2011). While the logistic regression model of Beasley et al. (2005) has a higher pseudo R^2 of 0.280, Razali et al. (2011) obtain a goodness-of-fit of 0.185. In addition, the results of the Hosmer-Lemeshow goodness of fit test (Hosmer-Lemeshow chi^2 (8) = 6.83; p = 0.555) indicate the overall adequacy of the logit model.

4.2.2 Results of the Cox proportional hazard model

We next use a Cox proportional hazard regression based on the time-extended sample from 2009 to 2013, which is intended to obtain more reliable test statistics (see also Pagach and Warr, 2011).[20] Results are displayed in Table 5. The values of the column "exp(B)" report the multiplicative change in the hazard ratio for a unit shift in the respective determinant. Thus, exp(B) indicates the likelihood of a change in the dependent variable ERM as the triggering event, i.e. the relative probability that a firm adopts an ERM system resulting from a unit change of a firm characteristics in comparison to the baseline case.[21] While a hazard ratio less than one indicates a negative influence of firm characteristics on ERM decisions, a ratio greater than one implies a positive relationship of the examined determinant regarding the adoption of ERM (see Pagach and Warr, 2011).[22]

The findings of the Cox regression confirm the statistically significant influence of firm size and international diversification of firms regarding the decision to implement an ERM system. In addition, in contrast to our expectations, we observe a significant negative relationship

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[20] We also conducted tests regarding the assumption of proportional hazards, which showed the appropriateness of each covariate as well as of the entire Cox model due to the fulfillment of the assumption of proportionality.

[21] The baseline case $h_{(0)}$ constitutes the hazard for the triggering event when all covariates take the value zero (see Cox, 1972).

[22] A hazard ratio „exp(B)" approaching one generally implies a lower influence of the considered variable on ERM, and vice versa (see Pagach and Warr, 2011). For instance, the results of the hazard ratios of firm size (exp(B)=1.262) or financial leverage (exp(B)=0.981) imply that for each additional unit of firm size / financial leverage, the likelihood of a firm to reach the triggering event (*ERM*=1) within one year is increased / decreased by a factor of 26.2 % (=1.262-1) and 1.9 % (=1-0.981), respectively, if all other variables are held constant.

between profitability, measured by the return on assets, and ERM, indicating that especially less profitable firms are more likely to implement an ERM system. This relation may be explained by the considerable financial and human resources required implementing an ERM system, such as the appointment of a CRO, the development of a risk culture across all business units or the establishment of a risk committee at the board level (see, e.g., Hoyt and Liebenberg, 2011; Lin et al., 2012). While costs immediately impact the income statement, the benefits of ERM are expected to be realized over time (see also discussion in Section 3.1.2). Nevertheless, it should be taken into account that the negative influence of profitability on an ERM implementation, while significant, is relatively small with a multiplicative change in the hazard ratio of merely 0.975. We also find evidence for the fact that the industry matters, i.e., firms operating in highly regulated banking, insurance or energy sector are more likely to implement ERM programs.

Table 5: Cox proportional hazard regression results

Dependent variable = ERM

Variable	Predicted sign	Parameter estimate (B)	S.E.	Wald	p-value	exp(B)
Firm size	+	0.233	0.076	9.354	0.002***	1.262
Financial leverage	+	-0.019	0.014	1.744	0.187	0.981
Return on assets	+	-0.025	0.013	3.902	0.048**	0.975
Industry	+	0.711	0.353	4.055	0.044**	2.036
Div_Ind	+	0.185	0.311	0.355	0.551	1.203
Div_Int	+	1.016	0.434	5.469	0.019**	2.762
Capital opacity	+	0.001	0.006	0.027	0.870	1.001
Big Four auditor	+	0.216	0.383	0.320	0.572	1.242
Big Three rating	+	-0.053	0.305	0.031	0.861	0.948

Notes: See Table 1 for variable description; ***, **,*:= statistical significance at the 99, 95, 90%-confidence level; sample with data from 2009-2013; number of observations=407.

Concerning the capital structure and in particular the debt-to-equity ratio (in case of the Cox regression), the level of industrial diversification as well as the rate of intangible assets, we do not find significant effects. This also holds for the firm's decision to assign one of the Big Three rating agencies or to be audited by one of the Big Four auditing firms.

4.3 Empirical results regarding the impact of ERM on shareholder value

The second main objective of our paper is to estimate the effect of ERM on shareholder value using Tobin's Q as a proxy for firm value by running a linear regression for the year 2013. The regression results are exhibited in Table 6.

The empirical findings in Table 6 confirm our hypothesis regarding the value relevance of ERM, showing a statistically significant positive result at the 95%-confidence level, i.e., firms

with an ERM system exhibit a significantly enhanced Tobin's Q of 0.416 on average compared to Non-ERM firms, taking into account the respective control factors. The goodness-of-fit is generally comparable with previous studies, and multicollinearity does not pose a problem in our analysis as can be seen from the correlation statistics as well as the VIFs and tolerance values, respectively, which are far below/above the critical values of 10 and 0.1, respectively (see, e.g., Mason and Perreault, 1991; Kutner et al., 2005).

Table 6: Linear regression results

Dependent variable = Tobin's Q

Variable	Predicted sign	Parameter estimate (B)	S.E.	p-value	VIF	Tolerance
Intercept		5.215	0.962	0.000***		
ERM	+	0.416	0.163	0.012**	1.195	0.837
Control variables:						
Firm size	+ / -	-0.170	0.047	0.000***	1.966	0.509
Financial leverage	+ / -	0.008	0.017	0.647	1.856	0.539
Return on assets	+	0.051	0.010	0.000***	1.373	0.728
Industry		-0.027	0.278	0.923	1.537	0.650
Div_Ind	+ / -	0.058	0.244	0.813	1.123	0.890
Div_Int	+ / -	-0.219	0.212	0.303	1.084	0.922
Capital opacity		0.011	0.004	0.007***	1.108	0.903
Dividends	+ / -	-0.419	0.202	0.040**	1.411	0.709
Model fit:						
R^2 / adjusted R^2	0.330 /0.290					

Notes: See Table 1 for variable description; ***, **,*:= statistical significance at the 99, 95, 90%-confidence level; sample with data from 2013; number of observations=160.

In contrast to the assumption of a positive relation between firm size and shareholder value through benefits of economics of scale and scope or lower costs of insolvency risks, an increasing firm size has a negative effect on Tobin's Q, thus reinforcing potential agency problems. Furthermore, we find evidence that dividend payments reduce the shareholder value of firms, possibly due to the fact that payouts may prevent net present value projects (see Allayannis and Weston, 2001).[23] The influence of financial leverage, industry, the level of industrial as well as international diversification is insignificant, while capital opacity as well as the return on assets are rather small but significant, thus confirming the assumption that profitability enhances the firms' shareholder value.

We further conduct sensitivity analyses with five different regressions to test the above mentioned results. Control variables were thereby added step-by-step to the explanatory variable

[23] In line with previous ERM literature (see, e.g., Hoyt and Liebenberg, 2011; Farrell and Gallagher, 2015), we use a binary coded variable *dividend*. A sensitivity analysis with dividend yields shows almost the same results and confirms the robustness of the linear regression model concerning dividend payouts.

ERM to ensure the robustness of the relation of Tobin's Q and ERM.[24] The estimated coefficients are reported in Table A.2 in the Appendix and confirm the robustness of the effect of ERM on shareholder value for the considered sample. Only the direct regression between Q and ERM (Q1) without integrating any control variables shows an insignificant but positive impact of ERM on firm value, while all other regressions (Q2–Q5) confirm the significant effect.

In addition, due to the right-skewed distribution of Q, we conducted another regression by using the natural logarithm of Q as the dependent variable instead of Q. The corresponding results are virtually the same as in Table 6 with the exception that dividend payments no longer have a significant influence on firm value (ln (Q)). However, the results still support the observation that ERM-using companies are valued significantly higher. Furthermore, to study the influence of potential outliers, we further ran the linear regression without twelve outlying observations identified based on standardized as well as the studentized residuals, which also supported our main result regarding the value relevance of ERM.

4.4 Comparison with findings from previous studies

Most of our findings are consistent with the previous literature as can be seen in Table 7. In line with Hoyt and Liebenberg (2008, 2011), Pagach and Warr (2011) as well as Farrell and Gallagher (2015), we find statistically significant evidence for the positive relationship between firm size (H_1) and the implementation of an ERM system. In addition, the results of the logistic regression are in line with Hoyt and Liebenberg (2008, 2011) by showing a statistically significant negative association between financial leverage (H_2) and ERM engagement. Unexpectedly, we find a negative, statistically significant relation of return on assets (H_3) and ERM. While significant, our estimated coefficients of return on assets are still relatively small, with a multiplicative change in the odds ratio of 0.990 (logistic regression) and a multiplicative change in the hazard ratio of 0.975 (Cox proportional hazard regression). Hence, the probability of the multiplicative change of the variable *ERM* and the likelihood to reach the triggering event (*ERM*=1) within one year decreases with each additional unit of RoA with 1%, or 2.5%, respectively.

Consistent with the result in Beasley et al. (2005), firms belonging to the banking, insurance or energy sector (H_4) are more likely to implement an ERM system. In addition, our logit

[24] While the first specification in Table A.2 (Q1) computes the direct relation of Q and ERM, (Q2) additionally considers firm size to control for size-related effects. With reference to Hoyt and Liebenberg (2011), the third specification (Q3) includes additional accounting ratios (financial leverage and return on assets). We then add further variables typically used in Tobin's Q models, where Q4 adds the variables industrial as well as international diversification to control for firm complexity and Q5 includes the variables industry, capital opacity, dividends as well as Big Four auditor and Big Three rating.

model as well as the Cox regression confirm the significant positive relationship between international diversification (H_6) and an ERM implementation. While this finding is in line with Razali et al. (2011), Hoyt and Liebenberg (2011) and Farrell and Gallagher (2015) find a significant negative relationship. Our results for the German market thus suggest that firms operating in at least two countries have to face a higher number and more complex risks, and also have to comply with various national regulations, where ERM can be helpful. In addition, contrary to our expectations, our results do not show a statistically significant relation between industrial diversification (H_5) or capital opacity (H_7) and ERM, which is similar to previous work.

Table 7: Comparison of ERM determinants for the German market with previous studies for other countries

Hypothesis	H_1	H_2	H_3	H_4	H_5	H_6	H_7	H_8	H_9
Study (country)	**Firm size**	**Financial leverage**	**RoA**	**Industry**	**Div_ Ind**	**Div_ Int**	**Capital opacity**	**Big 4 auditor**	**Big 3 rating**
Expected sign	+	+	+	+	+	+	+	+	+
Log. regression	+***	-*	ns	ns	ns	+**	ns	ns	ns
Cox regression	+***	ns	-**	+**	ns	+**	ns	ns	ns
LH (2003) (USA)	-*	+**		ns		ns			
BCH (2005) (Int.)				+***				+***	
HL (2008) (USA)	+***	-**			ns	ns			
HL (2011) (USA)	+***	-**			ns	-*	ns		
PW (2011) (USA)	+***	ns			ns		ns		
RYT (2011) (Malaysia)	ns	ns	ns			+*			
GR (2012) (Malaysia)	ns	+*		ns	ns		ns	+*	
FG (2015) (Int.)	+***	ns			ns	-**	ns		

Note: LH(2003): Liebenberg and Hoyt (2003); BCH(2005): Beasley, Clune, and Hermanson (2005); HL(2008): Hoyt and Liebenberg (2008); HL (2011): Hoyt and Liebenberg (2011); PW(2011): Pagach and Warr (2011); RYT(2011): Razali, Yazid, and Tahir (2011); GR(2012): Golshan and Rasid (2012); FG(2015): Farrell and Gallagher (2015); Literature review see also Gatzert and Martin (2015, p. 35); see Table 1 for variable description; ***, **,*:= statistical significance at the 99, 95, 90%-confidence level; ns:= analyzed relationship with non-significant regression result.

When looking at the impact of having one of the Big Four auditors (H_8), the findings of the logistic as well as the Cox regression analyses show the predicted (positive) sign as in Beasley et al. (2005) as well as Golshan and Rasid (2012), but the relation is not significant in our data set. This is the same for the newly included variable Big Three rating (H_9), which is further ambiguous regarding the sign depending on the applied regression (see Table 7).

With respect to the second objective, our result based on the linear regression show a positive and statistically significant impact of ERM on firm value (Tobin's Q). This supports our assumption that firms with an integrated holistic ERM program can gain a (long-term) competitive advantage as compared to firms using silo-based risk management approaches, and is

consistent with Beasley et al. (2008), Hoyt and Liebenberg (2008, 2011), McShane et al. (2011) and Farrell and Gallagher (2015).

5. SUMMARY

This paper empirically studies the impact of firm characteristics on a firm's decision to implement ERM programs as well as the impact of ERM on firm value for the German stock exchange market, which represents one of the first studies using a cross-sectional dataset for a European country and the first for the case of Germany. We use a logistic regression and a Cox proportional hazard regression with different time series to examine the drivers of ERM, and a linear regression to investigate the impact of ERM on firm value using Tobin's Q.

Our results regarding the determinants of ERM show that larger companies as well as internationally operating firms are more likely to adopt an ERM system. Therefore, the increasing number and complexity of risks as well as the different national regulatory requirements may motivate larger and internationally operating firms to invest the necessary financial and human resources to implement a holistic ERM system. Furthermore, we show that less leveraged firms are more likely to implement ERM, implying that firms with a holistic risk management system may reduce the amount of debt capital (relative to equity capital) in order to avoid suffering financial distress. Our study is also in line with findings from previous work by showing that firms from the banking, insurance or energy sector are more likely to establish an ERM program, which can be explained by a stricter regulation, historical crisis events (for instance financial crisis or Enron scandal) as well as potentially stronger risk awareness in general. Contrary to our expectations, the Cox regression shows a significant negative relationship between the return on assets (i.e. a firm's profitability) and ERM implementations, which may be explained by the considerable financial and human resources required to implement and to maintain an ERM system. While costs immediately impact the income statement, the benefits of ERM are expected to be realized over time. Regarding the Cox regression, one generally also has to take into account that approximately 45% of the companies had already implemented an ERM system in 2009 or before and that the firm characteristics, leading to these implementations are not direct observable with our model, while for the remaining sample, determinants can be observed.

Regarding the value relevance of ERM, our results for the German market are consistent with previous findings by showing a significant positive impact of ERM on shareholder value after controlling for other determinants of firm value. In this context, future work should scrutinize the causality of ERM and Q. While we argue and provide evidence that ERM enhances the shareholder value, it could be also possible that more valuable firms will rather implement ERM, e.g. to uphold their advantaged value position.

One major challenge of the present study is the absence of an explicit firm disclosure regarding an ERM implementation, as companies usually do not provide detailed information regarding their risk management system. We thus use a keyword search as is done in previous work, which to some extent relies on subjective appraisals whether firms operate their risks in an integrated and holistic manner. To overcome this difficulty, future research using European data could use surveys (see Beasley et al., 2005), questionnaires, ERM ratings (see McShane et al., 2011), or ERM indices (see Gordon et al., 2009), for instance.

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Table A.1: Pearson \ spearman rank correlation coefficients (N=160)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	0.036 (0.649)	-0.415*** (0.000)	-0.789*** (0.000)	0.528*** (0.000)	-0.272*** (0.001)	0.023 (0.777)	0.077 (0.336)	0.441*** (0.000)	-0.079 (0.321)	-0.289*** (0.000)	0.059 (0.461)
0.019 (0.813)	1	0,337*** (0.000)	0.124 (0.120)	-0.004 (0.959)	0.162** (0.040)	0.106 (0.183)	0.226*** (0.004)	0.085 (0.283)	0.162** (0.040)	0.265*** (0.001)	0.080 (0.313)
-0.388*** (0.000)	0.328*** (0.000)	1	0.576*** (0.000)	-0.298*** (0.000)	0.343*** (0.000)	0.240*** (0.002)	0.080 (0.316)	-0.082 (0.302)	0.239*** (0.002)	0.681*** (0.000)	0.219*** (0.005)
-0.241*** (0.002)	0.077 (0.333)	0.512*** (0.000)	1	-0.647*** (0.000)	0.373*** (0.000)	0.022 (0.782)	-0.061 (0.441)	-0.333*** (0.000)	0.078 (0.327)	0.430*** (0.000)	-0.045 (0.569)
0.381*** (0.000)	-0.104 (0.189)	-0.209*** (0.008)	-0.200** (0.011)	1	-0.258*** (0.001)	0.096 (0.226)	0.070 (0.382)	0.230*** (0.003)	-0.167** (0.035)	-0.171** (0.030)	0.500*** (0.000)
-0.203** (0.010)	0.162** (0.040)	0.439*** (0.000)	0.551*** (0.000)	-0.143* (0.071)	1	0.036 (0.654)	0.063 (0.429)	-0.221*** (0.005)	0.111 (0.162)	0.321*** (0.000)	0.005 (0.947)
-0.026 (0.741)	0.106 (0.183)	0.217*** (0.006)	-0.052 (0.513)	0.016 (0.841)	0.036 (0.654)	1	0.122 (0.126)	0.109 (0.169)	0.107 (0.177)	0.205*** (0.009)	-0.005 (0.949)
-0.048 (0.550)	0.226*** (0.004)	0.115 (0.146)	0.059 (0.456)	-0.013 (0.871)	0.063 (0.429)	0.122 (0.126)	1	0.184** (0.020)	0.126 (0.112)	0.210*** (0.008)	0.006 (0.940)
0.226*** (0.004)	0.048 (0.544)	-0.063 (0.428)	-0.249*** (0.002)	0.064 (0.421)	-0.207*** (0.009)	0.073 (0.359)	0.120 (0.131)	1	-0.115 (0.148)	-0.026 (0.744)	0.020 (0.805)
-0.007 (0.927)	0.162** (0.040)	0.230*** (0.003)	0.080 (0.315)	-0.170** (0.031)	0.111 (0.162)	0.107 (0.177)	0.126 (0.112)	-0.144* (0.069)	1	0.176** (0.026)	-0.111 (0.163)
-0.282*** (0.000)	0.265*** (0.001)	0.712*** (0.000)	0.310*** (0.000)	-0.144* (0.070)	0.321*** (0.000)	0.205*** (0.009)	0.210*** (0.008)	-0.052 (0.513)	0.176** (0.026)	1	0.154 (0.052)
-0.053 (0.507)	0.080 (0.313)	0.203** (0.010)	-0.059 (0.455)	0.414*** (0.000)	0.005 (0.947)	-0.005 (0.949)	0.006 (0.940)	0.028 (0.727)	-0.111 (0.163)	0.154* (0.052)	1

P-values appear in brackets; Pearson correlation coefficients can be found below the diagonal while spearman correlations are presented above; ***, **,*:= statistical significance at the 99, 95, 90%-confidence level.

Variable
(1) Tobin's Q
(2) ERM
(3) Firm size
(4) Financial leverage
(5) Return on assets
(6) Industry
(7) Div_Ind
(8) Div_Int
(9) Capital opacity
(10) Big Four auditor
(11) Big Three rating
(12) Dividends

Table A.2: Robustness tests regarding the impact of ERM on firm value depending on the integration of various control variables

		Linear regression // Dependent variable = Tobin's Q									
		(Q1)		(Q2)		(Q3)		(Q4)		(Q5)	
Variable	**predicted Sign**	**Parameter estimate (B)**	**p-value**	**Paramter estimate (B)**	**p-value**	**Parameter estimate (B)**	**p-value**	**Parameter estimate (B)**	**p-value**	**Parameter estimate (B)**	**p-value**
Intercept		1.694 (0.151)	0.000***	6.352 (0.821)	0.000***	5.481 (0.903)	0.000***	5.702 (0.951)	0.000***	5.185 (1.205)	0.000***
ERM	+	0.042 (0.178)	0.813	0.366 (0.172)	0.034**	0.396 (0.163)	0.016**	0.417 (0.168)	0.014**	0.394 (0.163)	0.017**
Control variables:											
Firm size				-0.224 (0.039)	0.000***	-0.193 (0.043)	0.000***	-0.199 (0.045)	0.000***	-0.188 (0.060)	0.002***
Financial leverage						0.001 (0.015)	0.955	0.003 (0.015)	0.860	0.011 (0.017)	0.516
Return on assets						0.042 (0.009)	0.000***	0.042 (0.009)	0.000***	0.052 (0.010)	0.000***
Industry										-0.030 (0.276)	0.913
Div_Ind								0.140 (0.249)	0.575	0.040 (0.243)	0.871
Div_Int								-0.140 (0.216)	0.519	-0.263 (0.215)	0.223
Capital opacity										0.012 (0.004)	0.003***
Dividends										-0.368 (0.202)	0.071*
Big Four auditor										0.464 (0.239)	0.054
Big Three rating										0.006 (0.212)	0.976
Model Fit:											
R^2 / adjusted R^2		0.000 / -0.006		0.175 / 0.164		0.273 / 0.254		0.276 / 0.248		0.347 / 0.298	

Standard errors appear in brackets. ***, **,*: = statistical significance at the 99, 95, 90%-confidence level.

Table A.3: Companies in the sample for the year 2013

German stock exchange market indices (12/31/2013)

DAX (30)	MDAX (50)	SDAX (50)	TecDAX (30)
Adidas AG	Aareal Bank AG	Alstria Office-Reit AG	Adva Optical Networking SE
Allianz AG	Airbus Group EV	Air Berlin PLC	Aixtron SE
BASF AG	Aurubis AG	Amadeus Fire AG	BB Biotech AG
Bayer AG	Axel Springer AG	Balda AG	Bechtle AG
Beiersdorf AG	Bilfinger SE	Bauer AG	Cancom SE
BMW AG	Brenntag AG	BayWa AG	Carl Zeiss Meditec AG
Commerzbank AG	Celesio AG	Betrandt AG	Compugroup Medical AG
Continental AG	Deutsche Euroshop AG	Biotest AG	Dialog Semiconducter PLC
Daimler AG	Deutsche Wohnen AG	C.A.T. Oil AG	Draegerwerk AG
Deutsche Bank AG	DMG Mori Seiki AG	Centrotec Sustainable AG	Drillisch AG
Deutsche Börse AG	Deutsche Annington SE	CeWe Color Holding AG	Evotec AG
Deutsche Lufthansa AG	Duerr AG	Comdirect Bank AG	Freenet AG
Deutsche Post AG	ElringKlinger AG	CTS Eventim AG	Jenoptik AG
Deutsche Telekom AG	Evonik Industries AG	Delticom AG	Kontron AG
E.ON SE	Fielmann AG	Deutsche Beteiligungs AG	LPKF Laser&Electronics AG
Fresenius Medical Care KGaA	Fraport AG	Deutsche Office AG	Morphosys AG
Fresenius SE & Co. KGaA	Fuchs Petrolub SE	Deutz AG	Nemetschek AG
Heidelberg Cement AG	GAGFAH S.A.	DIC Asset AG	Nordex AG
Henkel AG & Co. KGaA	GEA Group AG	Gesco AG	Pfeiffer Vacuum Technology AG
Infineon Technologies AG	Gerresheimer AG	GfK SE	PSI AG
K+S AG	Gerry Weber International AG	Grammer AG	Qiagen N.V.
Lanxess AG	Hannover Rück SE	Grenkeleasing AG	QSC AG
Linde AG	Hochtief AG	Hamborner REIT AG	Sartorius AG
Merck KGaA	Hugo Boss AG	Hawesko Holding AG	SMA Solar Technologies AG
Munich Re AG	Kabel Deutschland Holding AG	HHLA AG	Software AG
RWE AG	Kion Group AG	Heidelberger Druck. AG	Stratec Biomedical AG
SAP AG	Klöckner & Co. SE	Hornbach Holding AG	Telefonica Dtl. Holding AG
Siemens AG	Krones AG	H&R AG	United Internet AG
Thyssenkrupp AG	Kuka AG	Indus Holding AG	Wirecard AG
Volkswagen AG	LEG Immobilien AG	Jungheinrich AG	XING AG
	Leoni AG	König & Bauer AG	
	MAN SE	KWS Saat AG	
	Metro AG	MLP AG	
	MTU Aero Engines AG	Patrizia Immobilien AG	
	Norma Group SE	Puma SE	
	Osram Licht AG	Rational AG	
	ProSieben Sat.1 Media AG	SAG Holland S.A.	
	Rheinmetall AG	Schaltbau Holding AG	
	Rhoen-Klinikum AG	SGL Carbon SE	
	RTL Group S.A.	SHW AG	
	Salzgitter AG	Sixt AG	
	Sky Deutschland AG	Stroer Media AG	
	Stada Arzneimittel AG	Takkt AG	
	Suedzucker AG	Tipp24 AG	
	Symrise AG	Tom Tailor Holding AG	
	TAG Immobilien AG	Villerory & Boch AG	
	Talanx AG	Vossloh AG	
	Tui AG	VTG Aktiengesellschaft	
	Wacker Chemie AG	Wacker Neuson SE	
	Wincor Nixdorf AG	Zooplus AG	