Secondary Publication

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The effect of risk management disclosure on idiosyncratic risk : evidence from annual reports

Date of secondary publication: 06.07.2026

Version of Record (Published Version), Article

Persistent identifier: urn:nbn:de:bvb:473-irb-115975x

Primary publication

Oehler, Andreas; Neuss, Charlotte (2026): The effect of risk management disclosure on idiosyncratic risk : evidence from annual reports, in: Review of managerial science : RMS, Berlin ; Heidelberg [u.a.]: Springer, Vol. 20, No. 8, pp. 2617–2656, doi: 10.1007/s11846-025-00944-4.

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Review of Managerial Science (2026) 20:2617–2656
https://doi.org/10.1007/s11846-025-00944-4

ORIGINAL PAPER

The effect of risk management disclosure on idiosyncratic risk: evidence from annual reports

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Received: 13 September 2024 / Accepted: 26 September 2025 / Published online: 23 October 2025
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Abstract

In this study, we analyze annual reports to explore the relationship between firms' risk management disclosures and idiosyncratic risk, measured as idiosyncratic volatility (*IVOL*). Our analysis focuses on companies listed on the German CDAX index over the period from 2002 to 2020. The findings reveal that companies which disclose comprehensive details about their engagement in the cybernetic cycle of risk management experience a notable decrease in *IVOL* in the following year. This study also includes an analysis with a subset of firms that have reported the adoption of an enterprise risk management (ERM) system. The study does not support a negative relationship between the disclosure of ERM and *IVOL*. Our results suggest that the stock market places greater value on disclosures related to specific risk adjustment strategies and risk control rather than on the adoption of an organizational risk management framework as the modern ERM framework. This highlights the value of risk management disclosure and especially the importance of the risk management process, which is relevant for managers, stakeholders, regulators as well as for investors.

Keywords Risk management disclosure · Idiosyncratic risk · Idiosyncratic volatility · Company risk management

JEL Classification G30 · G32 · D83

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1 Introduction

Risk management is a fundamental element of every business strategy, and regulatory reforms have expanded public policies related to risk management and risk management disclosure.[1] Risk management disclosures, which include forward-looking information, are difficult to quantify but occupy a unique position in annual reports. Their primary objective is to mitigate information asymmetry between well-informed managers and shareholders (Kravet and Muslu 2013). These disclosures help firms to transparently communicate their known risks and risk management activities that stock market participants can include in their investment decisions. At the same time, the disclosure of (serious) risks can lead to negative stock market reactions (Elshandidy and Shrives 2016) and can result in high costs of disclosure (Leuz and Wysocki 2016), e.g., due to spill-over effects to competitors. To avoid such negative feedback, firms often resort to making their risk management disclosures ambiguous (Dobler et al. 2011; Kravet and Muslu 2013). This ambiguity, however, may introduce uncertainty regarding future cash flows, potentially increasing stock price volatility and diminishing the disclosures' utility for investors.

We analyze how firms' risk management disclosure, and especially disclosed risk management activities, are perceived by investors. Previous studies focus on the information quality of risk management disclosure and find low transparency (Dobler et al. 2011) and even cheap talk (Kravet and Muslu 2013). On the other hand, more recent studies show risk management information to be useful for market participants (Campbell et al. 2014; Elshandidy and Shrives 2016). Moreover, empirical results show a negative relationship between risk disclosure and firm risk (e.g., Benlemlih et al. 2018; Düsterhöft et al. 2023; Kim and Yasuda 2018).

The focus of these studies is mostly on specific risks (e.g., Bao and Datta 2014; Jin et al. 2024; Yang et al. 2018), tone (Tan and Yeo 2023), or the amount of risk management disclosure (e.g., Düsterhöft et al. 2023; Elshandidy and Shrives 2016; Kim and Yasuda 2018; Kravet and Muslu 2013), i.e., risk-related words in a document. An empirical analysis focusing on the whole risk management process is – to the best of our knowledge – has not been performed before. As shown by Campbell (2014) and Jin et al. (2024), different risk disclosures topics contain different levels of detail and can be differently perceived by investors. Since the risk management process plays a crucial role in dealing with risks, investors are likely to be sensible to this information, however, previous literature did not investigate the whole risk management process. We combine research ideas from previous studies to proxy risk management information and analyse the whole risk management process. This allows to examine how different steps of the risk management cycle are perceived by investors, which is a crucial topic for regulators, risk managers and investors. Therefore, we use firms' risk management disclosure, which allows us to identify several specific risk management activities. Transparent corporate disclosure on risk management should include comprehensive details about the risk management cycle, including identification, measurement, adjustment, and control of risks. This is relevant as the transpar-

[1] For example, the Sarbanes–Oxley Act of 2002 in the US and the Corporate Sector Supervision and Transparency Act (KonTraG) of 1998 in Germany.

ency is likely to differ between steps. According to the signaling theory, managers have incentives to disclose risk information in areas where they effectively identify and manage their risks to distinguish themselves from other companies which are less effective (Elshandidy and Shrives 2016).

We use annual reports of German firms from 2002 to 2020 and perform automated content analysis with a focus on risk management disclosure. We denote each step of a standard risk management process with a variable. Specifically, we focus on risk identification, risk adjustment, and risk control. Keywords are selected ex-ante and an automated content analysis counts the presence or the frequency of keywords that are disclosed in the annual reports. According to previous literature, we focus on firm's disclosure practices within one particular country (e.g., Deumes 2008; Elshandidy and Shrives 2016; Filzen 2015; Kim and Yasuda 2018; Miihkinen 2012; Oliveira et al. 2011). While some studies focus on specific branches (e.g., Dobler et al. 2011; Düsterhöft et al. 2023), the present study covers firms from multiple industries but excludes financial firms due to their stricter risk management regulation. Including firms from multiple industries enhances the generalizability of the findings and allows for a more comprehensive assessment of how risk disclosure affects firm-specific risk across diverse operational contexts.

We find that the risk management disclosures from publicly traded companies significantly reduce the idiosyncratic volatility (*IVOL*) in the following year. This indicates that risk management disclosures contribute to a more transparent information landscape for the market, thus reducing the idiosyncratic risk. We compare our findings on risk management disclosures with the disclosure of the Enterprise Risk Management (ERM) framework. While ERM disclosures are not associated with a reduction in *IVOL*, and in some models, even show a positive relationship, we find that specific disclosures on risk adjustment activities and risk control measures are significantly associated with lower *IVOL*. Risk control is significant in models with firm-fixed effects and when combined with the other steps of risk management disclosure. This suggests that the disclosure of risk control practices within firms over time may help reduce firm-specific risk, whereas ERM references appear less informative to market participants.

This study contributes to the literature on the usefulness of risk disclosures and their implications in financial markets (Campbell et al. 2014; Elshandidy et al. 2018; Hope et al. 2016; Jin et al. 2024; Kohlbeck and Luo 2024; Kravet and Muslu 2013). We focus on risk management disclosure and its specific steps based on standard risk management literature (e.g., Oehler et al. 2015; Oehler and Unser 2002) and find evidence that risk management disclosure conveys relevant information that is considered by stock market participants. Thereby, we offer insights into the usefulness of risk disclosures. This is important for firms as this research underscores the importance of high-quality risk disclosures as a tool to reduce firm-specific uncertainty. Especially in industries with fewer formal risk disclosure requirements or poor information environment, firms could reduce volatility by providing comprehensive risk management disclosures (see Chaudhry and Gupta (2023) for the use of derivatives). Also, for investors, our results provide insights into how firms' risk communication affects stock volatility, aiding in portfolio risk assessment. Furthermore, the findings underscore the importance of existing risk disclosure regulations by dem-

onstrating their role in reducing firm-specific volatility and enhancing market stability. Moreover, the results support ongoing regulatory efforts to improve corporate transparency and suggest that future reporting regulations should encourage more specific and standardized risk disclosures. By ensuring that firms provide clear and comprehensive risk information, regulators can help investors make more informed decisions and contribute to a more stable and efficient market environment. As risk management research faces the difficulty of data accessibility, we provide an alternative risk management measure using firm disclosure. Our technique can be applied to a large number of documents even in different languages. We also contribute to the literature by adding insights into the field of firm risk and ERM literature since the ERM literature mostly focuses on effects related to firm performance and firm value, However, only a few studies have examined how the stock market responds specifically to ERM disclosures, as most focus on firm value or accounting-based performance measures, which may not directly reflect investor perception. (see McShane et al. 2011; Pagach and Warr 2011).

The remainder of this article is structured as follows: In the next section, we provide a review of the related literature and develop our hypothesis. In Sect. 3, we describe our data and methodological approach. In Sect. 4, we present and discuss our results. In Sect. 5, we provide robustness checks, and Sect. 6 concludes.

2 Literature review and hypothesis development

2.1 Firm risk management

Modigliani and Miller (1958) established a world with perfect capital markets in which risk management does not create value. In such a setting, risk management practices have a negative net present value and, therefore, theoretically, should not be implemented. Additionally, idiosyncratic risk can be diversified through portfolio construction (Markowitz 1952; Mossin 1966; Sharpe 1964). From this strict neoclassical perspective, risk management targeting idiosyncratic risk is not necessary. However, in imperfect capital markets, risk management becomes a value-creating activity. Specifically, it can help mitigate frictions such as tax distortions (Graham and Smith 1999; Modigliani and Miller 1963), bankruptcy and financial distress costs (Kraus and Litzenberger 1973), external financing constraints (Froot et al. 1993), and agency costs (Jensen and Meckling 1976). Moreover, many investors are not fully diversified, making idiosyncratic risk economically relevant and worth managing at the firm level (e.g., Blume and Friend 1975; Goyal and Santa-Clara, 2003; Iachan et al. 2022). Firms that have comprehensive risk management systems can reduce the likelihood and impact of adverse events. This can lower earnings volatility, reduce uncertainty in strategic decision-making, and enhance the firm's risk-return profile (Baxter et al. 2013). The uncertainty regarding a firm's risk is not covered by standard systematic risk measures (Anderson et al. 2009; Bali and Zhou 2016; Brenner and Izhakian 2018) and therefore contributes to idiosyncratic risk. From a capital markets perspective, this reduction in uncertainty can lead to a lower perception of idiosyncratic risk by investors and analysts. From an agency theory perspective, risk

management also serves as a governance mechanism as it helps align managerial behavior with shareholder interests and reduces information asymmetry between the firm and external stakeholders (Stulz 1996).

The literature defines standard risk management as a cybernetic cycle in which the firm can evaluate the performance of risk management itself over time and reflects the dynamic changes in internal and external conditions (Oehler et al. 2015; Oehler and Unser 2002; Williams and Heins 1964). The cybernetic cycle comprises the identification and measurement of risk as well as controlling for risks. Risk identification results in a comprehensive list of relevant risks that managers can then use to measure risks quantitatively (e.g., by using downside measures) and qualitatively (e.g., by conducting expert interviews). This step comprises the consideration of interdependencies between different risks and the detection of portfolio effects in order to determine the overall risk position (Crockford 1980; Oehler and Unser 2002).

Firms face different types of risk. The risks relevant to our study are those related to, or arising from, idiosyncratic components, i.e., a firm's business model. These risks include business risk but also financial risks that originate in the operating area but affect financial outcomes. Business risk is connected to the firm's operations and must be mitigated to survive in the long run. However, it can be exploited to generate competitive advantages in technology, distribution, or information. Financial risk arises from changes in interest rates, commodity prices, equity prices, and foreign currency values and mainly comprise market, credit, liquidity, legal, and operational risks (Bitz 1993; Fabozzi and Peterson Drake 2009; Fatemi and Luft 2002; Oehler and Unser 2002).

The identification and the measurement of risks form the basis for the evaluation of the potential economic consequences for stakeholders. The following step is to specify the overall risk strategy. Risk adjustment strategies typically include hedging, insuring, and diversifying (Crockford 1980; Oehler and Unser 2002). The last step is risk control and covers the analysis of the performance of the risk management itself. This step facilitates the identification of inadequate assumptions, changes in the internal or external environment, or an inappropriate application of risk adjustment strategies by comparing the actual and the target risk levels and structures (Oehler et al. 2015; for the whole section see Oehler and Unser 2002).

Corporate hedging with derivatives and the purchase of insurance reduces the expected bankruptcy costs by lowering the probability of financial distress (Mayers and Smith 1982; Smith and Stulz 1985), and by reducing volatility (Bartram et al. 2011; Froot et al. 1993). However, besides using derivatives to hedge financial risks that may affect revenues, firms can use derivatives to speculate and thereby take on risk (Cheng and Cheung 2021). Based on the agency theory, self-interested managers of leveraged firms might increase firm's riskiness by using derivatives (Bartram 2019; Hentschel and Kothari 2001; Jensen and Meckling 1976; Myers 1977). In addition, the ability of a derivative to hedge an identified risk exposure may be imperfect or difficult to measure (Campbell et al. 2019). The empirical evidence on the value-enhancing effects of derivatives is mixed. Carter et al. (2006) and Bartram et al. (2009) find a positive relationship between firm value and hedging. Cornaggia (2013) argues that the relationship between firm value and risk management is driven by improved productivity stemming from effectively managing risks. Further studies

find a negative relationship between the use of derivatives and firm risk (e.g., Bartram 2019; Bartram et al. 2011; Chaudhry and Gupta 2023; Cheng and Cheung, 2021). Bae et al. (2018), however, focus on currency derivatives and find no evidence that their use leads to lower firm risk as measured by the volatility in profitability. Few studies find a negative relationship between the use of derivatives and firm value, which is especially found in the oil and gas industry (e.g., Bae et al. 2016; Jin and Jorion 2006). Based on the meta-studies from Bessler et al. (2019) and Bachiller et al. (2021) hedging with derivatives generally adds to firm value. Therefore, we assume that firms primarily use derivatives to reduce risks and thereby increase firm value. This indicates the disclosure of using derivatives should reduce the *IVOL*.

The purchase of insurance is comparable to hedging; however, insurances manage pure risk. Instead of building a hedging position, the firm pays predetermined ex-ante costs (i.e., the insurance premium) and thereby avoids high costs following an accidental loss and interruptions in normal business operations (e.g., MacMinn and Garven 2000). This reduces the uncertainty of future cash flows, which can be translated into lower *IVOL*. Yang et al. (2025) find that property insurance reduces uncertainty from negative cash flows and thereby promotes corporate innovation.

The central aim of risk management is to find the optimum between risk-taking and related benefits. Firms performing risk management with the aim of risk reduction by insuring, diversifying or hedging can be assumed to show lower firm-specific risk. Stock prices vary beside general financial news and industry-based events, due to individual firm behavior by changing investors' confidence about a firms' future cash flows (see e.g., Rubin and Rubin 2013). Volatility is defined as the standard deviation of an asset's return and can be characterized as uncertainty related to the stock prices that changes with new information. If firm's risk management disclosure incorporates information that reduces uncertainty, idiosyncratic risk should decrease. However, the main challenge is to get risk-related information. We use risk management disclosure from annual reports as a proxy for firms' risk management, for example the purchase of insurances.

2.2 Risk management disclosure

To examine the relationship between risk management disclosure and idiosyncratic risk, we perform an automated textual analysis, which is a common approach to handle the challenge of finding suitable risk management measures. Other studies use firm disclosures in which words, sentences or other units are counted (e.g., Bao and Datta 2014; Campbell et al. 2014; Dobler and Luckner 2018; Elshandidy and Shrives 2016; Filzen 2015; Jin et al. 2024; Miihkinen 2012; Oliveira et al. 2011; Yang et al. 2018). We develop risk management disclosure variables that incorporate the steps of the cybernetic risk management cycle and examine their relationship with *IVOL*. We use *IVOL* to measure idiosyncratic risk.

According to the disclosure theory (Verrecchia 1983), firms balance the trade-off between benefits of transparency (e.g., reduced information asymmetry) against the potential costs of revealing sensitive information. This trade-off applies to risk management disclosure as well. As stated by Kravet and Muslu (2013), three possible relationships between risk management disclosure and *IVOL* exist. The null argument

is that risk disclosures have no effect on *IVOL* because the disclosure is not specific or boilerplate. The convergence argument is that risk disclosures can reveal unknown or underestimated risk factors and thereby increase the investors' risk perception (see also Kothari et al. 2009). The divergence argument is that risk disclosures can resolve known risk factors and thereby reduce the risk perception.

Campbell et al. (2014) show that risk factor disclosures reduce information asymmetry and play a crucial role in investors' evaluation of firm risk. In a voluntary setting, Moumen et al. (2015) show that risk disclosure enhances the market's ability to forecast future earnings, indicating that such disclosures contain value-relevant and forward-looking information. This supports the notion that risk-related information in annual reports helps reduce information asymmetry and investor uncertainty, which in turn may translate into lower firm-specific risk. Hope et al. (2016) show that more specific risk disclosure is related to positive capital market reactions measured as abnormal returns. Yang et al. (2018) find the disclosure of self-identified risks including risk-related keywords in 10-K filings to be positively related to audit fees. This suggests a positive association between client risks and audit fees, and this indicates the usefulness of risk disclosures. A negative relationship between risk management disclosure and *IVOL* can be explained by the signaling theory.[2] Firms highlight their activities to reduce the impact of risks. Investors value these actions, which reduce uncertainty about future cash flows and, in turn, lower *IVOL*. Kim and Yasuda (2018) examine the introduction of mandatory business risk disclosure and find a negative relationship with total risk. This is in line with the findings from Huang et al. (2022) showing that the introduction of mandatory risk disclosure reduced managers' perceived litigation risk leading to a higher information environment, i.e., higher quality and transparency of disclosure for investors. Kohlbeck and Luo (2024) have documented that the length of market risk disclosure is related to reduced liquidity uncertainty. Düsterhöft et al. (2023) focus on the utility industry and find that more risk reporting (measured as pages with risk-related content) is related to lower *IVOL*. Therefore, our first hypothesis is:

H1: *Risk management disclosure is related to lower idiosyncratic volatility (signaling hypothesis)*

However, managers are likely to show incentives to prevent negative reactions leading to boilerplate statements. This in turn can result in an insignificant relationship or increase the *IVOL*. Especially the disclosure of the identified risks can be seen as bad news and lead to changes in the investors' risk perception. As shown by Kothari et al. (2009), market participants can become more uncertain about a firm's future when receiving negative information. As explained by Jin et al (2024), firms that actively engage in identifying and communicating potential firm-specific risks can be expected to have a positive association between their risk disclosures and the likelihood of default in the subsequent fiscal period, which increases *IVOL*. Moreover, firms with high proprietary costs provide less specific risk-factor disclosures

[2] Although there are further theories in context of (risk) disclosure practices, a uniform theory that explains different risk disclosure practices does not exist (Ntim et al. 2013).

(Hope et al. 2016), resulting in little or no reduction in uncertainty. This uncertainty is again linked to *IVOL,* as it arises from firm-specific information. Therefore, we formulate our second hypothesis:

H2: *Risk management disclosure is related to higher idiosyncratic volatility (bad news hypothesis)*

2.3 Enterprise risk management (ERM)

In the last two decades, the risk management concept ERM has gained significant attention, and simultaneously, discussions regarding its usefulness and uniqueness have emerged. ERM shifts the focus from traditional methods to a more strategic risk management function, and is characterized by an integrated approach (Liebenberg and Hoyt 2003). The benefits of ERM include, for example, improved risk awareness and compliance, and enhanced operational and strategic decision-making (e.g., Beasley et al. 2005; Hoyt and Liebenberg 2011). According to Nocco and Stulz (2022), ERM allows firms to reduce risks that are not related to their business core and effectively enables firms to take more strategic business risks leading to advantages in their core business. In 2004, the Committee of Sponsoring Organizations of the Treadway Commission (COSO) provided a framework for the ERM, which firms have extensively adopted (Beasley et al. 2010).

ERM is an improved risk management system by considering a firm-wide risk portfolio with interrelationships between risks, while traditional risk management is characterized by a department-by-department perspective that is inefficient due to a lack of coordination between departments (e.g., Grace et al. 2015; Hoyt and Liebenberg 2011). However, the importance of an integral risk policy, and that risks should not be considered separately, was already noted earlier (Imboden 1983, p. 125 f.). Comparing the ERM with standard risk management as a cybernetic cycle (Oehler and Unser 2002) demonstrates that building a risk portfolio that considers the correlations is not an ERM-specific characteristic of risk management and the coordination of risk management policies among departments was a requirement that existed before the ERM (Hoffmann 1985).

The comparison of ERM to traditional risk management is hampered by plenty of different definitions of ERM (Bromiley et al. 2015). Although there is no clear consensus about what ERM really covers, there is a literature strand focusing on the determinants of firms implementing the ERM and its effects. Several keywords (e.g., the presence of a chief risk officer (CRO)), see Liebenberg and Hoyt (2003) and Beasley et al. (2005)) have been found to be related to the implementation of an ERM system (Berry-Stölzle and Xu 2018; Lechner and Gatzert 2018).

Consultants often promote ERM as a novel and superior risk management concept compared to traditional risk management. Although the implementation of ERM incorporates organizational and structural movement in a firm,[3] the core of the

[3] The coordination of an ERM system by a CRO or by a committee of experts is not different from other risk management concepts. A firm's board of directors always executes decisions made under the consideration of a risk-return trade-off. In Germany, listed firms are subject to the implementation of an early

risk management including risk adjustment is very consistent with the standard risk management, such as the reduction of external capital costs or earnings volatility.[4] Moreover, engagement in risk management is always connected to business strategy, setting objectives, and decision-making (Arena et al. 2010; Hoffmann 1985; Oehler and Unser 2002).

The strong focus on keywords to identify the ERM aligns with our research design. So far, we are interested in the relationship between risk management disclosure and *IVOL*, thereby focusing on the whole risk management process. Therefore, we can include a comparison of our results with the disclosure of an ERM system. This is interesting as it allows us to compare the results with the disclosure of a standard risk management process. Moreover, most existing studies examine the relationship between ERM and firm performance, focusing on outcomes such as Tobin's Q, return on assets, or investment efficiency. In contrast, research on how ERM affects stock market reactions and investor-perceived risk remains limited (see McShane et al. 2011; Pagach and Warr 2011). This study addresses that gap by shifting the focus toward purely market-based outcomes, such as *IVOL*.

One might argue that ERM reflects a framework and therefore cannot be compared to the disclosure of risk management activities. However, and according to the ERM literature, it covers a sophisticated risk management including an expansion of internal control systems following strategic, operations, reporting and compliance goals (Mishra et al. 2019). The consideration of interrelationships among risks thereby leads to improved decision-making in accordance with the business strategy. According to Eckles et al. (2014), firms with ERM can identify the full potential of risks and find ways to naturally hedge risks within the portfolio, i.e., risks reduce or eliminate themselves. The international ERM literature has shown a positive relation between ERM and firm performance (e.g., Farrell and Gallagher 2015; Florio and Leoni 2017; Horvey and Ankamah 2020; Lechner and Gatzert 2018; Malik et al. 2020; Silva et al. 2019). Berry-Stölzle and Xu (2018) find that the adoption of ERM is related to lower cost of equity for financial-firms. However, the arguments supporting this reduction can also be applied to non-financial firms, e.g., improvement in available information about a firm's risk profile. Prior research suggests that ERM enhances internal decision-making, particularly by mitigating underinvestment in settings where firms face capital constraints (Berry-Stölzle et al. 2024; Nocco and Stulz 2022). Kamiya et al. (2021) show that cyberattacks are more likely to occur in firms without the ERM, i.e. firms without a risk committee.

Therefore, ERM adoption should contribute to a more stable and predictable risk environment, which in turn may reduce firm-specific uncertainty as perceived by investors. Since the ERM is related to higher firm performance, for example, measured as Tobins' Q (e.g., Hoyt and Liebenberg 2011; Lechner and Gatzert 2018), this indicates that the investors expect a stronger performance which can also lead to lower *IVOL* as the uncertainty of future cash flows lowers. ERM also reflects a firm's

warning system according to the Article § 91 stock corporation code (AktG). Adding further risk executives to decision-making does not lead to a new risk management framework.

[4] From a theoretical perspective, risk management – ERM or not – creates value by protecting cash flows (Froot et al. 1993), i.e., stable returns and reduced volatility.

commitment to strong corporate governance as it is often accompanied by formal oversight structures, such as risk committees, and dedicated roles like chief risk officers. These structures can reduce agency problems and thereby reduce firm-specific uncertainty.

Taken together, according to the ERM literature, if firms have implemented the ERM, it is reasonable to assume sophisticated risk management activities. The disclosure of the ERM can therefore be interpreted as a signaling effect, leading to the following hypothesis.

H3: *The disclosure of ERM is related to lower idiosyncratic volatility (signaling hypothesis)*

However, given the costs that are related to the implementation of an ERM system (Beasley et al. 2023; Lin et al. 2012), the market evaluation could also be negative, i.e., a positive relationship between the disclosure of ERM (as a risk management framework) and *IVOL*. Gordon et al. (2009) display that the relationship between ERM and firm performance depends on how well the implementation was matched with firm-specific factors. Firms might disclose the ERM as 'window dressing' without creating value for the firm (Bailey et al. 2018). McShane et al. (2011) use risk management ratings and explain that firm value increases with increasing (standard) risk management capability but there is no additional increase in value for firms achieving a rating for the ERM capability. This indicates that market participants evaluate enhanced risk management only up to a certain threshold. This leads us to the second ERM-hypothesis.

H4: *The disclosure of ERM is related to higher idiosyncratic volatility (bad news hypothesis)*

3 Data and methodology

3.1 Stock data

We focus on stocks listed on the CDAX. This is a broad German stock index that comprises all prime and general standard equities. We focus on German data due to its cultural, legal, financial, and regulatory context. German firms tend to disclose high levels of risk information mandatorily and/or voluntarily (Elshandidy et al. 2015; Elshandidy and Shrives 2016). To have a dataset that is free of a survivorship bias, we obtain the data on monthly index compositions from Thomson Reuters Datastream from 2002 to 2020. The analysis does not include stock data before 2002 because of the low availability of annual reports and information on risk management. In total, we have 1,039 different International Security Identification Numbers (ISINs) for the period. We include firms from various industries and size categories to capture industrial and size effects, however, we remove firms with fewer than three available annual reports during the time period. We exclude these firms since two or three reports will not provide sufficient data to extract insight and will more likely

introduce noise into the sample. Moreover, firms might show reporting irregularities since they only show a few reports. We also remove financial firms from our dataset as they are subject to stricter regulatory requirements for risk management and because their business model is heavily tied to financial risks. We only keep firms with available control variables which leads to our final sample of 5,151 firm-year observations (i.e., annual reports) for 524 firms between 2002 and 2020.

Datastream's total return index is used for the calculation of daily and monthly returns. The daily market, size, book-to-market, and momentum factors (Carhart 1997) for Europe come from the Kenneth French Data Library (KFDL).[5] To minimize the influence of outliers and data errors, we compute monthly total and idiosyncratic volatility based on daily returns for each stock. *IVOL* is computed as the standard deviation in the residuals obtained by fitting a 4-factor model to the respective time-series of daily stock returns (Bouslah et al. 2018; Horn 2023; Oehler and Horn 2025; Oehler and Schneider 2022). The 4-factor model is defined as:

$$R_{it} - R_{Ft} = \beta_{1i} * RMRF_t + \beta_{2i} * SMB_t + \beta_{3i} * HML_t + \beta_{4i} * WML_t + \alpha_i + \varepsilon_{i,t} \quad (1)$$

where R_{it} is the daily stock return of firm *i* and R_{Ft} is the risk-free return in time *t*. $RMRF_t$ represents the return of the market portfolio net of the risk-free return in time period *t*. SMB_t and HML_t reflect the size and book-to-market factors by Fama and French (1993). WML_t is a factor capturing momentum as identified by Jagadeesh and Titman (1993). $\varepsilon_{i,t}$ is the residual per time period *t*. The idiosyncratic risk of firm *i* is measured as the daily *IVOL* per month *m* and is defined as $\sqrt{var(\varepsilon_{i,d})}$ for all days *d* of month *m*. To examine the relationship between risk management disclosure and future idiosyncratic risk, we construct a yearly measure of *IVOL* using daily stock return data. The resulting monthly *IVOL* values are first annualized, then averaged over the calendar year to obtain a firm-year level *IVOL* measure. To ensure a forward-looking interpretation, we then shift the *IVOL* variable by one year, so that the *IVOL* in year t+1 is used as the dependent variable for disclosure and control variables from year t. This approach allows us to test whether risk management disclosure is associated with changes in future firm-specific risk, while maintaining consistency with the fiscal year structure of the accounting-based control variables, which are aligned with year t financial statements. For robustness, we additionally compute total volatility as the standard deviation in the daily returns and we also used the 5-factor model by Fama and French (2015).

3.2 Textual data

The keyword search is performed on reports written in German. Our automated content analysis[6] concentrates on a selection of keywords from diverse reporting categories, carefully selected to ensure they are unaffected by a company's specific

[5] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html; accessed June 13, 2022.

[6] We use Rapid Miner Studio for textual analysis. This software allows textual analysis for reports in different languages and can process multilingual in- and output.

terminology. Following the cybernetic cycle of risk management, we denote each step with a variable.

In practice, risk identification involves the documentation of risks and opportunities of a firm. Risks that are not documented will not be considered in the subsequent steps of the cycle. According to Mishra et al. (2019) risk can be classified into four classes of strategic, operational, financial, and hazard risks. To avoid multicollinearity, we do not consider different variables for each risk class. Instead, we count the number of different risks mentioned in an annual report (after controlling for different German linguistic constellations) and thereby include risks from all risk classes.

The next step is the measurement of risks. First, we assume that all firms measure their risks and second, that they do not describe in detail their measurement approaches. Specifications like the usage of a risk matrix or the application of Monte-Carlo simulations exist, but extracting more details that could be used to divide firms into groups cannot be extracted from publicly available data like annual reports. This kind of information clearly reflects sensible content and will therefore be related to high disclosure costs or in other words: Firms are likely to withhold information relating to the measurement and the direct (monetary) impact to the firm (Dye 1985; Kravet and Muslu 2013). We therefore continue with the next step – the risk adjustment. According to the risk management literature (e.g., Crockford 1980; Oehler and Unser 2002), the most common risk adjustment strategies are the purchase of insurance, diversification, and hedging with derivatives (see also e.g., Lin et al. 2012).

Derivatives can be identified using keyword search (e.g., Bartram et al. 2009; Gupta et al. 2024). Using the keywords from Bartram et al. (2009), we identify users of financial derivatives (i.e., no original financial instruments). We use the more general keywords: '∗derivat∗', '∗derivat∗' in combination with 'financial instrument∗', 'hedging transaction', and the following keywords for specific financial instruments: '∗swap∗', '∗cap∗', '∗floor∗', and '∗forward transaction∗'. The '∗' signifies any additional character(s). The dummy takes a value of one if the use of a specific financial instrument is disclosed. Otherwise, we use the more general keywords. Due to mandatory reporting regulation, firms also report if they are not using financial derivatives (including the running text as well as tables). In this case, the number of identified keywords in a given annual report is lower compared to the disclosure of firms using financial derivatives. Besides extensive manual verification of the results from textual analysis, we apply a threshold of 10 general mentions to set the derivative-dummy to one.

To analyze insurance purchases, researchers can evaluate data from insurance firms or surveys (e.g., Adams et al. 2011; Shackelford 2012; Thistlethwaite et al. 2020). An alternative approach – which we follow – is to identify insurance information using annual reports (Zou 2010). To construct the insurance measure, we initially query a list of all words that contain the word 'insurance'. Thereby, we identify several categories of insurance types and other insurance descriptions.[7] We only keep words that reflect specific insurances (e.g., building insurance). We eliminate insurances that are mandatory (e.g., car insurance) or mentioned by a firm, but the

[7] Expressions that consist of two separate words in English but were only one word in the German language. The term 'insurance premium' that is one word in German, is excluded.

insurance does not provide coverage for the firm itself, for example, insurances for employees or descriptions of (compulsory) insurances, e.g., such as those related to social security obligations. We deliberately exclude the general word 'insurance'. This is important because we argue that investors can only react to risk management disclosure if firms transparently and specifically report their activities, i.e., formulations about insurances in general reflect non-transparent and unspecific information (Hope et al. 2016). Our final measure counts the number of reported specific insurances. We do not include repetitions of the single insurances.

We perform a keyword search for the diversification variable. Although a possible definition of diversification would be if a firm operates in different industries, for example, classified by Standard Industrial Code (SIC), this approach might be biased by other incentives besides risk reduction (Aggarwal and Samwick 2003). Our diversification dummy consists of the single keywords 'diversification' and 'diversified' as well as keywords containing 'diversification' (e.g., 'diversification strategy', which is one word in German). Although further keywords like synonyms seem to be suitable, we limit the number to those that did not depend on the textual context. More general words like 'separated' occurs often together with descriptions of organizational structure and responsibilities that do not clearly relate to risk management itself.

We do not specifically address the adjustment of operational risks due to several factors. The adjustment of operational risks relies on their measurement. However, assessing operational risks is difficult for firms as they suffer from lack of data as losses are both relatively infrequent and unique to each firm (McShane 2018). Consequently, finding a comprehensive measure for the adjustment of operational risks, particularly through the analysis of annual reports, presents a significant challenge. Although annual reports do contain keywords linked to operational risks – such as references to employee training and awareness programs or audit processes – these terms may overlap with other reporting domains, thereby complicating their extraction and analysis through automated textual methods. Finally, operational risks are often managed through internal control systems, which incorporates similar steps to those in a risk management system. This includes the interconnected steps outlined in the COSO model: control environment, risk assessment, control activities, information and communication, and monitoring (Committee of Sponsoring Organizations of the Treadway Commission 2013).

To finish one cycle of the risk management process, we present the risk control variable by reporting the point of time the risk management process starts again. This is usually related to risk reporting or a meeting of risk responsibilities. We find this relationship with the combination of the word 'risks' and a time component, such as yearly, monthly or quarterly.

We further add information relating to the usage of ERM. Firms typically do not explicitly disclose ERM usage (Horvey and Odei-Mensah 2023; Liebenberg and Hoyt 2003). Studies identify topics and keywords that are related to the implementation of ERM. To identify ERM firms, we follow previous studies and search for ERM-related keywords (Anton 2018; Chen et al. 2020; Eckles et al. 2014; Farrell and Gallagher 2015; Hoyt and Liebenberg 2011; Lechner and Gatzert 2018; Lin et al. 2012; Nguyen and Vo 2020; Pagach and Warr 2011). This approach is widely adopted in the literature (Horvey and Odei-Mensah 2023). We search the following keywords

including their synonyms and acronyms: 'enterprise risk management', 'chief risk officer', 'integrated risk management', 'holistic risk management', 'COSO II', and 'risk committee'. Each hit is coded as a binary variable, assigning a value of one to ERM firms and non-ERM firms with zero. The hits are reviewed on a random basis.[8] Although we would assume a long-term implementation of ERM after the first occurrence of a keyword, we also check the subsequent annual reports.

3.3 Control variables

We use several control variables: firm size, leverage, market-to-book value, earnings before interest and taxes, and the return on assets of firms. We measure size as the *Market Value* of the stock. We add *Leverage* to control for the capital structure and calculate it as the total debt over total assets and multiply the result by 100. The *Market-to-Book Ratio* (Market/Book) reflects a firm's growth opportunities (Liebenberg and Hoyt 2003; Pagach and Warr 2011). *Return on Assets* (ROA) is included as measure of profitability. To reduce skewness, we apply the natural logarithm to *Market Value*. We report all variables in Appendix A. We check for the correlations among the variables and find no evidence of multicollinearity.

3.4 Descriptive statistics

Table 1 presents the descriptive statistics for the 5,151 firm-year observations from 2002 to 2020. We report the mean, median, standard deviation, minimum, and maximum for the variables. The table shows that our sample firms, on average, disclose 35 risks. Almost 87% of the firms in our sample report the use of at least one risk adjustment strategy. In 24%, firms report their risk control and in 65%, the use of derivatives is disclosed. The implementation of ERM is reported by 17%. The average firm in our sample has *IVOL* of 9.52%. Since our dataset includes firms which are delisted over time, it is not surprising that there are negative values for ROA.

We then report the univariate statistics based on the ERM characteristics and focus on the differences between ERM firms and non-ERM firms in Table 2. The statistics incorporate differences in the mean of several variables and indicate significantly lower means for the idiosyncratic and total volatilities of firms reporting the ERM compared to firms without ERM-keywords. The differences are analyzed with T-tests for which we use Welch's (1947) formula; we also use a non-parametric Wilcoxon rank sum test with similar results. To ensure out identification resulted correctly classified the firms, we also report the control variables which show that ERM firms are significantly larger and show higher ROA. This result is in line with the literature showing that ERM is mostly implemented by larger firms which are more profitable (e.g., Gatzert and Martin 2015; Hoyt and Liebenberg 2011). This ensures the robustness of the textual analysis.

[8] We identify the use of several synonyms for a risk committee. One firm introduces a risk committee as a response to the financial crisis in 2008, but the keyword disappears from future reports.

Table 1 Summary statistics

	All firm-year observations					
	No	Mean	SD	Median	Min	Max
Dependent variables						
IVol_{t+1}	5,151	9.52	5.41	8.18	.12	37.98
TVol_{t+1}	5,151	10.05	5.43	8.69	.12	38.48
Risk disclosure variables						
RiskIdentification	5,151	35.23	24.43	31	0	141
RiskAdjustment	5,151	.87	.33	1	0	1
Insurances	5,151	1.57	1.61	1	0	10
Derivatives	5,151	.65	.48	1	0	1
Diversification	5,151	.44	.50	0	0	1
RiskControl	5,151	.24	.43	0	0	1
ERM	5,151	.17	.38	0	0	1
Control variables						
FirmSize	5,151	2,150.28	6,808.91	130.61	.32	46,202.06
Market/Book	5,151	2.08	2.61	1.57	−8.36	15.79
Leverage	5,151	73.38	143.86	43.51	−444.35	886.31
ROA	5,151	1.56	14.81	4.18	−78.22	36.84
Return	5,151	2.09	3.42	.75	−.70	43.00
Alpha	5,151	.71	2.05	.58	−8.93	15.97
Sentiment	5,151	−.34	.26	−.34	−3.93	2.15

This table shows the descriptive statistics for the variables used in the main analysis. We report the mean, median, standard deviation, minimum, and maximum. All variables are defined in Appendix A

3.5 Regression model

We use an OLS panel regression, which allows us to observe multiple firms over time, including fixed-effects for year, industry, and firm, to examine the relationship between the risk management disclosure variables or the ERM and firms' future *IVOL*. We use the following regression models:

$$IVol_{t+1} = \beta_0 + \beta_1 * \ RiskManagementStep_{i,t} + \beta_2 * \ Controls_{i,t} + FE + \ \varepsilon_{i,t} \quad (2)$$

$$IVol_{t+1} = \beta_0 + \beta_1 * \ RiskManagementStep_{i,t} + \beta_2 * \ ERM_{i,t} + \beta_3 * \ Controls_{i,t} + FE + \ \varepsilon_{i,t} \quad (3)$$

We analyze whether the risk management steps are valued by the market, as reflected in a lower *IVOL* in the following year. To compare our results with ERM reporting, we replace the $RiskManagementStep_{i,t}$ by the $ERM_{i,t}$ variable in Formula°2. In addition, we use Formula°3 to test the combined effects of reporting both risk management disclosure steps and ERM. For the regression models, we standardize the dependent variable. We consider fixed-effects after performing Hausman-test. To control for potential issues with multicollinearity, we report the maximum Variance Inflation Factor (VIF) for all variables of interest and control variables across all models in the respective tables. Only VIFs above 10 indicate potential multicollinearity problems, however, our regressions have VIFs below 10.

Table 2 Summary statistics ERM dummy

	Firm-year observations without ERM (N=4,268)					Firm-year observations with ERM (N=883)					Differences
	Median	Mean	SD	Min	Max	Median	Mean	SD	Min	Max	Mean
$IVol_{t+1}$	8.56	9.98	5.53	.12	37.98	6.28	7.31	4.16	1.42	35.40	2.67*** (16.34)
$TVol_{t+1}$	9.02	10.45	5.57	.12	38.48	7.19	8.14	4.20	1.45	35.99	2.31*** (14.00)
$FirmSize$	91.99	1,071.95	3,961.81	.32	46,202.06	1,857.91	7,362.41	12,725.75	3.68	46,202.06	−6,290.45*** (−14.54)
$Market/Book$	1.52	2.04	2.66	−8.36	15.79	1.81	2.25	2.29	−8.36	15.79	−.21** (−2.41)
$Leverage$	39.83	72.05	147.88	−444.35	886.31	54.46	79.80	122.46	−444.35	886.31	−7.75* (−1.65)
ROA	4.05	1.03	15.62	−78.22	36.84	4.72	4.13	9.50	−78.22	36.84	−3.10*** (−7.77)
$MonthlyRawReturn$	.79	2.26	3.59	−.70	43.00	.67	1.19	9.69	−29.85	130.91	1.02*** (10.91)
$Alpha$	.62	.74	2.13	−8.93	15.97	.45	.54	1.62	−7.79	9.70	.20*** (3.14)
Sentiment	−.34	−.34	.27	−3.93	2.15	−.36	−.35	.21	−1.09	.54	.01 (1.57)

This table shows the descriptive statistics for ERM-firms and non-ERM firms. We report the mean, median, standard deviation, minimum, and maximum of the variables as well as the absolute differences in means; ***,**, and* statistical significance at the 99%, 95%, and 90% confidence levels; statistical significance in means is based on a T-test. All variables are defined in Appendix A

4 Results and discussion

In Table 3, we regress $IVol_{t+1}$ on the different steps of the cybernetic risk management cycle. In models (1) to (3), we regress each risk management step separately, including time fixed-effects. The models show negative and significant coefficients for all risk management disclosure measures, indicating that an increase in the reporting of the risk management information reduces the *IVOL* of the following year. However, the results change when including control variable data in model (4) to (6). Due to the addition of control measures, the signs of the coefficients of *RiskIdentification* and *Diversification* change from negative to positive. We will further investigate the drivers of the sign change. We include industry fixed-effects and the results are very similar to the models without industry fixed-effects, suggesting that unobserved heterogeneity does not drive the results and sing change. Fixed-effects are introduced to mitigate the impact of endogeneity issues that might arise due to the omitted variables bias (Gormley and Matsa 2014). Model (7) estimates the effect of all three risk management disclosure steps on next year's idiosyncratic volatility ($IVol_{t+1}$) while controlling for unobserved time-invariant firm characteristics through firm-fixed effects. This allows the interpretation of coefficients to be interpreted as within-firm effects over time, abstracting from structural differences across firms (e.g., industry, size, or risk culture). The results indicate that an increase in *RiskAdjustment* is associated with a statistically significant reduction in $IVol_{t+1}$. This suggests that, within a firm, periods of more active or transparent adjustment-related risk management are followed by lower firm-specific volatility, supporting the view that proactive adjustment of risks helps stabilize firm-specific outcomes. Likewise, the coefficient on *RiskControl* remains negative and is significant in the model (7), indicating that greater emphasis on risk control corresponds with reductions in future *IVOL*. The effect of risk control practices on idiosyncratic volatility is driven by within-firm changes rather than between-firm differences. This implies that when a firm increases its emphasis on risk control practices, it tends to experience lower idiosyncratic risk in the next year. However, across firms, the level of *RiskControl* disclosure does not consistently explain variation in $IVol_{t+1}$ highlighting the importance of firm-specific dynamics in assessing the effectiveness of risk management. *RiskIdentification* is no longer significant when firm-fixed effects are included.

We investigate the observed sign change in the variables when control variables are included. A detailed examination, facilitated by a stepwise regression, attributes these sign changes primarily to the inclusion of *FirmSize* as a control variable. In response, we strategically remove *FirmSize* from the list of control variables and rerun the regressions from Table 3. The results show all coefficients for the risk management disclosure variables, except for *Insurances*, are negative and statistically significant. This is also the case for Risk Control, which remains statically significant when included alongside the other steps of risk management disclosure.

To deepen our understanding of firm size's impact, we use dummy variables for smaller and larger firms, where small firms are defined as those in the 10th percentile and large firms as those in the 90th percentile of the *FirmSize* distribution. First, we include both small and large firm dummies in a single regression to examine how future *IVOL* differs across firm sizes, independent of interaction effects. The results in

Table 3 Panel regression risk management steps

	Dependent variable: $IVol_{t+1}$						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
RiskIdentification	−0.011***			0.003***			0.001
	(0.001)			(0.001)			(0.001)
RiskAdjustment							−0.120***
							(0.045)
Derivatives		−0.581***			−0.140***		
		(0.028)			(0.024)		
Insurances		−0.018***			−0.003		
		(0.007)			(0.006)		
Diversification		−0.103***			0.048**		
		(0.023)			(0.019)		
RiskControl			−0.237***			−0.024	−0.050**
			(0.024)			(0.019)	(0.021)
FirmSize				−0.213***	−0.186***	−0.195***	
				(0.007)	(0.006)	(0.006)	
ROA				−0.015***	−0.015***	−0.016***	
				(0.001)	(0.001)	(0.001)	
Market/Book				0.012**	0.006	0.009*	
				(0.005)	(0.005)	(0.005)	
Leverage				0.000	0.000	0.000	
				(0.000)	(0.000)	(0.000)	
Constant	0.299***	0.359***	−0.035**	0.899***	0.948***	0.926***	−0.001
	(0.025)	(0.027)	(0.014)	(0.037)	(0.039)	(0.038)	(0.045)
Time-FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-FE				Yes	Yes	Yes	Yes
Firm-FE							Yes
No	5,151	5,151	5,151	5,145	5,145	5,145	5,105
Adj. R^2	0.172	0.214	0.122	0.477	0.478	0.474	0.594

The table presents the results of a panel regression on the risk disclosure variables with fixed-effects for time, industry and firm. The dependent variable is idiosyncratic volatility of the next year ($IVol_{t+1}$). We standardize the dependent variable. No. depicts the number of firm-year observations. We use the natural logarithm of *FirmSize* to control for skewness; robust standard errors are in parentheses to control for heteroscedasticity. The largest VIF for variables of interest and control variables is 1.74 across all models;

*$p<0.10$, **$p<0.05$, ***$p<0.01$

Table 4, Panel B, model (1) show that small firms exhibit significantly higher *IVOL*, while large firms have significantly lower *IVOL* in the following year. Importantly, risk identification disclosure is associated with lower *IVOL* across the entire sample, suggesting a general risk-reducing effect across firm sizes.

While model (1) captures size-related differences in baseline *IVOL*, we formally test whether the effect of disclosure on future *IVOL* differs by firm size in model (2). We include interaction terms between the disclosure variable and the large firm dummy. The findings in Panel B, model (2) show that risk management disclosure is perceived differently between smaller and larger firms. As expected, large firms continue to show significantly lower *IVOL* compared to smaller firms. For smaller firms, the disclosure of risk identification is associated with lower *IVOL* and a one-unit

Table 4 Panel regression with focus on control variables

	Dependent variable: $IVol_{t+1}$			
Panel A: All firms	(1)	(2)	(3)	(4)
RiskIdentification	−0.008***			−0.004***
	(0.001)			(0.001)
Derivatives		−0.447***		−0.382***
		(0.027)		(0.027)
Insurances		−0.012*		−0.002
		(0.007)		(0.006)
Diversification		−0.090***		−0.050**
		(0.021)		(0.021)
RiskControl			−0.201***	−0.084***
			(0.022)	(0.021)
ROA	−0.021***	−0.020***	−0.022***	−0.020***
	(0.001)	(0.001)	(0.001)	(0.001)
Market/Book	−0.015**	−0.020***	−0.014**	−0.019***
	(0.006)	(0.006)	(0.006)	(0.006)
Leverage	0.000**	0.000***	0.000	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.239***	0.300***	0.006	0.377***
	(0.027)	(0.029)	(0.018)	(0.031)
Time-FE	Yes	Yes	Yes	Yes
Industry-FE	Yes	Yes	Yes	Yes
No	5,145	5,145	5,145	5,145
Adj. R^2	0.322	0.347	0.300	0.355
	Dependent variable: $IVol_{t+1}$			
Panel B: Observations for smallest and largest firms and interaction	(1)	(2)	(3)	(4)
RiskIdentification	−0.003***	−0.008***		
	(0.000)	(0.000)		
Diversification			−0.034*	−0.130***
			(0.019)	(0.023)
Smallest Firms	1.146***		1.174***	
	(0.058)		(0.058)	
Largest Firms	−0.372***	−0.664***	−0.442***	−0.538***
	(0.239)	(0.058)	(0.021)	(0.043)
RiskIdentification * Largest Firm		0.006***		
		(0.000)		
Diversification * Largest Firm				0.105**
				(0.048)
Constant	−0.442**	0.248***		0.054***
	(0.213)	(0.029)		(0.020)
Controls	Yes	Yes	Yes	Yes
Time-FE	Yes	Yes	Yes	Yes
Industry-FE	Yes	Yes	Yes	Yes

Table 4 (continued)

	Dependent variable: $IVol_{t+1}$			
Panel B: Observations for smallest and largest firms and interaction	(1)	(2)	(3)	(4)
No	5,145	5,145	5,145	5,145
Adj. R^2	0.462	0.334	0.458	0.319

Panel A shows the results of a panel regression with fixed-effects for time and industry with focus on the control variables. We run the regression from Table 3 and exclude *FirmSize* from the control variables which is responsible for the sign change in *RiskIdentification*. In Panel B, we include an interaction variable to capture differences in the risk management disclosures between firm sizes. *Smallest Firms* are firms within the 10th percentile and *Largest Firms* are firms within the 90th percentile of the *FirmSize* distribution. *FirmSize* is again excluded from the control variables. The dependent variable in both panels is idiosyncratic volatility of the next year ($IVol_{t+1}$). We standardize the dependent variable. No. depicts the number of firm-year observations. Robust standard errors are in parentheses to control for heteroscedasticity. The largest VIF for variables of interest and control variables is and 6.80 across all models;

*$p<0.10$, **$p<0.05$, ***$p<0.01$

increase in *RiskIdentification* reduces *IVOL* by 0.0077. For larger firms, the interaction term is positive and significant, i.e., the effect of *RiskIdentification* on *IVOL* is less negative in larger firms (resulting in a total effect of -0.0077 + 0.0056 = − 0.0021). This suggests that while disclosure is still beneficial for large firms, its risk-reducing impact is lower compared to smaller firms. These findings suggest that the disclosure of risks is more effective for firms that are already perceived as risky. Market participants may already expect strong risk practices from larger firms, so the disclosure may provide only limited new information (e.g., Jo and Na 2012).

The results confirm a moderating role of *FirmSize* in the relationship between *RiskIdentification* and future *IVOL*. The findings suggest that both hypotheses are supported. Smaller firms benefit more from disclosure of risks by reducing uncertainty and mitigating the market's tendency to assume bad news in the absence of information. Larger firms are perceived as better able to manager a higher level of risk and expectations around risk management are already embedded in investor perceptions, therefore the disclosure has limited signaling power and only modest effects on *IVOL*. Consistent with these findings, we also find that the risk-reducing effect of *Diversification* disclosure is more pronounced for smaller firms, while it is weaker for larger firms (see Table 4, Panel B, model (3 and (4)). These results further support the view that the signaling value of disclosure is particularly relevant for firms that are otherwise perceived as riskier. Together, the models show that disclosure of risks serves a meaningful risk-reducing function, but its impact varies substantially by firm size.

In addition to the findings on *RiskIdentification*, the negative coefficients of *RiskAdjustment* and *RiskControl* from Table 3 are in line with the signaling hypothesis (H1). The reporting of several steps of a standard risk management process reduces the firm-specific uncertainty and thus reduces the *IVOL*. The growth opportunities (*Market/Book*) are also negatively related to *IVOL*. Analysts consider firms with lower growth perspectives to be more exposed to volatility (e.g., Bouslah et al. 2013). In line with prior evidence, higher *Leverage* is associated with higher *IVOL* (Abdel-

ghany 2005) and higher profitability (*ROA*) is associated with less risk (Jo and Na 2012).

The observation that *RiskAdjustment* strategies potentially influence financial metrics such as net income and earnings volatility may initially seem intuitive, given these strategies' direct impact on a firm's financial performance. However, the relationship between the use of derivatives and firm risk is not straightforward. Bae et al. (2018) provide a nuanced view by examining the impact of derivatives on firm risk within the context of specific derivatives in the manufacturing and service sectors of a developing country. Their findings challenge the assumption that derivatives uniformly reduce firm risk, highlighting the complexity of risk management outcomes. Our results imply that several steps in the disclosure of the risk management process are negatively related to future *IVOL*. This indicates that transparent disclosure of risk adjustment strategies. Unlike other studies that focus on the presence of risk-related language or quantify risk disclosure by counting sentences or pages, our research adopts a novel approach by using specific keywords associated with the risk management process. This methodology allows us to offer deeper insights into how the risk management process is perceived and evaluated by market participants. Our contribution to the existing literature lies in our detailed examination of the risk management process, providing valuable perspectives for managers, regulators, and investors alike.

Building on these results, our subsequent analysis delves into the dynamics between the ERM and *IVOL*. Recognizing the comprehensive nature of ERM as an advanced risk management framework, we do not further decompose it into individual components.[9] The outcomes of our regression analysis are presented in Table 5. As observed in earlier analyses, the introduction of control variables in model (2) leads to changes in the sign. Model (2) reveals a positive and significant coefficient for the ERM dummy variable when including control variables. However, when disaggregating the effect by firm size, we again observe heterogeneity in this relationship across firm sizes. Specifically, ERM disclosure is associated with lower *IVOL* in small and large firms, but with a positive and marginally significant association in mid-sized firms (see Online Appendix A). One possible interpretation is that, among mid-sized firms, ERM adoption may occur in response to elevated risk, whereas in small and large firms, it may reflect a proactive approach. It can also be interpreted as a signaling effect: while large firms are generally expected to have formal risk systems, like the ERM, the presence of ERM in small firms is rare and thus more informative to the market.

The ERM could be perceived differently when combined with standard risk management processes. Therefore, we add the risk management disclosure variables in model (3) to (6). First, we introduce each step of risk management disclosure separately, then we combine all risk management variables in model (6). The results show no changes in the coefficient of ERM compared to the stand-alone ERM analysis. As

[9] Mishra et al. (2019) explain the COSO ERM Framework and that: " […] the four objectives are integrated with eight interrelated components, which are: the internal environment, setting objectives, identifying events, assessing risk, responding to risk, control activities, information and communication and risk monitoring." (p. 165).

Table 5 Panel regression ERM and risk management steps

	Dependent variable: $IVol_{t+1}$					
	(1)	(2)	(3)	(4)	(5)	(6)
ERM	−0.340***	0.134***	−0.135***	−0.156***	−0.260***	0.109***
	(0.026)	(0.024)	(0.028)	(0.027)	(0.027)	(0.024)
RiskIdentification			−0.009***			0.004***
			(0.001)			(0.001)
Derivatives				−0.516***		−0.169***
				(0.028)		(0.024)
Insurances				−0.017**		−0.013**
				(0.007)		(0.006)
Diversification				−0.074***		0.017
				(0.023)		(0.019)
RiskControl					−0.204***	−0.049**
					(0.023)	(0.019)
FirmSize		−0.205***				−0.207***
		(0.007)				(0.007)
ROA		−0.016***				−0.015***
		(0.001)				(0.001)
Market/Book		0.011**				0.009*
		(0.005)				(0.005)
Leverage		0.000				0.000
		(0.000)				(0.000)
Constant	−0.034***	0.947***	0.236***	0.330***	0.001	0.952***
	(0.013)	(0.039)	(0.025)	(0.027)	(0.015)	(0.040)
Time-FE			Yes	Yes	Yes	Yes
Industry-FE			Yes	Yes	Yes	Yes
No	5,151	5,145	5,145	5,145	5,145	5,145
Adj. R^2	0.129	0.476	0.17	0.21	0.15	0.48

The table presents the results of a panel regression on the risk disclosure variables and the ERM with fixed-effects for time and industry. The dependent variable is idiosyncratic volatility of the next year ($IVol_{t+1}$). We standardize the dependent variable. No. depicts the number of firm-year observations. We use the natural logarithm of *FirmSize* to control for skewness; robust standard errors are in parentheses to control for heteroscedasticity. The largest VIF for variables of interest and control variables is 1.47 across all models;

*$p<0.10$, **$p<0.05$, ***$p<0.01$

ERM disclosure tends to remain stable once implemented, there is limited variation within firms over time. Therefore, we do not include firm fixed-effects as they may absorb a large proportion of the variance in ERM disclosure, making it more difficult to detect an effect in the fixed-effects specification.

We find support for H3 as well as for H4, i.e. the disclosure of ERM is related to higher future *IVOL* for the largest part of our sample (i.e., mid-sized firms), while only the smallest and the largest firms show a negative relationship between the ERM and future IVOL. Thereby, the results differ comparing the ERM disclosure and the risk management disclosure. This aligns with the observations of Lin et al. (2012), who raised concerns about the practical benefits of implementing ERM, especially when considering the associated costs. The benefits related to the ERM can be transferred to the argumentation of Stulz (2013) claiming that firms facing lower tail out-

comes may benefit from risk management or the ERM, while other firms could even destroy value by spending corporate resources on risk management. Furthermore, also the stock market participants face the problem of the variety of ERM definitions and activities (e.g., Bromiley et al. 2015) which complicates its evaluation. The effectiveness of risk management ultimately depends on the contribution to the risk management processes. The differentiation between ERM-firms and non ERM-firms suggests mutual exclusivity of the two risk management approaches. However, as explained before, the standard risk management and ERM are closely related and have impact on each other (Lin et al. 2012), and the stock market rewards standard risk management.

In summary, our findings suggest that disclosures about risk management hold valuable information for the market. Particularly those pertaining to risk adjustment strategies (see also e.g., Zou et al. 2003) and to the control of risks are associated with lower future *IVOL*. For the ERM and the RiskIdentification, the results vary by firm size.

5 Robustness

In our study, we employ a series of robustness tests to validate the robustness of our findings. Initially, we replace the 4-factor model proposed by Carhart (1997) with the more recent 5-factor model introduced by Fama and French (2015). This adjustment allows us to assess the robustness of our results against a broader set of market factors, including profitability and investment patterns alongside the original factors of market risk, size, value, and momentum. Next, we refine our analysis of risk by shifting the focus from *IVOL* to a measure of downside risk. For this approach, we calculate a semi-standard variance that exclusively considers returns falling below a predefined threshold, thereby isolating negative fluctuations and excluding positive deviations. This method offers a more targeted view of risk by emphasizing adverse outcomes. In addition, we include other risk measures besides the *IVOL*, namely beta (systematic risk) and the total volatility. We also test for reverse causality and expand our model to incorporate the sentiment expressed in annual reports. By analyzing the overall tone of these documents, we aim to determine whether the sentiment aligns with the market's assessment of next year's *IVOL*. This is based on the hypothesis that the narrative tone of corporate disclosures may influence or reflect investor perceptions of risk. Lastly, we explore the dynamics of the risk-return trade-off. This involves analyzing returns, given the direct correlation between the level of risk and potential return.

As idiosyncratic risk may be assessed by applying the more recent 5-factor model from Fama and French (2015), we additionally compute the *IVOL* with this model. The results remain stable for most disclosure variables. However, the coefficient for *RiskControl* becomes statistically insignificant, suggesting that its association with abnormal returns may be partially explained by profitability or investment-related characteristics. This finding does not undermine the broader results but highlights that the market's response to *RiskControl* disclosure may overlap with dimensions

already captured by the five-factor model. The results are displayed in Online Appendix B.

Our primary variable of interest, *IVOL,* takes into account both positive and negative deviations from the mean. To ensure the robustness of our findings, we assess the effect of shifting the focus from *IVOL* to a measure of downside risk that exclusively accounts for negative deviations. For this purpose, we select the semi-standard deviation as our preferred downside risk metric. To construct a yearly downside risk measure, we average monthly semi-standard deviations based on daily returns. This approach preserves the sensitivity of monthly risk dynamics while maintaining consistency with the annual panel structure used in the main analysis. We select semi-standard deviation over alternative downside measures such as lower partial moments, in order to avoid additional assumptions, such as specifying a target return. This approach provides a focused lens on negative volatility, allowing us to assess whether risk management disclosure is particularly effective in mitigating adverse market movements. The results (see Online Appendix C) show that the disclosure of derivatives remains significantly and negatively associated with future downside risk. However, other risk management disclosure steps are statistically insignificant under these more conservative specifications. This may suggest that risk management disclosure is less strongly associated with downside risk, and it may also reflect the inherently noisier and more concentrated nature of downside events, as well as potential differences in how investors interpret such information. These results do not contradict the main findings but rather suggest that the market's response to risk management disclosure may be more clearly reflected in *IVOL* than in downside risk. This may indicate that disclosure influences overall firm-specific uncertainty more strongly than it alters the distribution of extreme negative returns alone.

To provide a broader perspective, we extend the analysis by including alternative measures of firm risk. Specifically, we repeat the regressions using total volatility (*TVOL*) and beta as dependent variables. Total volatility captures both idiosyncratic and systematic risk components. The results for next year's total volatility closely mirror those for idiosyncratic volatility in both sign and statistical significance, suggesting that risk management disclosure is associated with overall firm risk.

In addition, we calculate beta to capture a firm's exposure to market-wide fluctuations, defined as the ratio of a firm's return covariance with the market to the variance of market returns. We use the CDAX index as the market benchmark, as it includes all firms in our sample and represents the relevant index for investors assessing German-listed firms. Analyzing the effect of risk disclosure on beta allows us to examine whether such disclosures influence the market's perception of a firm's sensitivity to systematic risk. In contrast to the *IVOL* and *TVOL* results, several coefficients lose statistical significance when using future beta as the dependent variable. The results are displayed in Table 6. This finding is consistent with the interpretation that risk management disclosure is primarily aimed at addressing firm-specific risks and does not substantially affect a firm's systematic risk exposure. This also supports the view that while disclosure may signal a firm's awareness of and response to internal risks, it does not change how the firm is correlated with broader market movements. The significant coefficient of *RiskIdentification* indicates that the disclosure of specific risks is informative for the market's assessment of a firm's exposure to systematic

risk. One explanation is that the risks also highlight macroeconomic vulnerabilities which are more closely related to systematic factors.

In addition to the model and variable checks above, we also acknowledge a potential timing caveat related to the construction of the dependent variable. While the analysis links risk management disclosure in year t with *IVOL* in year t+1, it is important to note that annual reports are typically published several months after the fiscal year ends. As a result, a portion of the volatility in the early part of the following year may occur before the disclosure becomes public. This could influence the estimated effect of risk management disclosure on *IVOL*, as not all market participants would have had access to the full disclosure content at the beginning of the following year. However, since both variables are defined on an annual basis, the precise timing of the report's release within the year is less critical. The effect of risk management disclosure is not expected to occur immediately, but rather to unfold over the year. Risk management disclosures often reflect forward-looking assessments and actions that may influence market perceptions and firm-specific risk throughout the subsequent year. As such, the exact timing of when market participants react to different aspects of the disclosure cannot be precisely identified at an annual level. Our approach is consistent with common empirical practice in the literature (see e.g., Düsterhöft et al. 2023). We thus believe our timing assumption is reasonable and in line with established research.

To address potential concerns about reverse causality, we regress the current risk management disclosure variables on lagged *IVOL* and control variables. In the reverse causality tests where disclosure variables are the dependent variables, firm-fixed effects are again included to control for unobserved firm-specific characteristics that are constant over time and may simultaneously influence risk management disclosure practices and firm-specific risk. The results, presented in Table 7, show that past *IVOL* is not significantly associated with either risk management disclosure steps or the ERM.

We add the sentiment of a firm's annual report as a further control variable. Empirical studies show a positive relationship between the sentiment of a firm's annual report and its future economic situation (e.g., Elshandidy and Kamel 2024) but this relationship is tested primarily for financially distressed firms (e.g., Jin et al. 2024; Lohmann and Ohliger 2020; Mayew et al. 2015). To extract sentiment, we apply SentiWS that is a publicly available German-language resource for a sentiment analysis that has been proven to be reliable (Remus et al. 2010). It contains 1,818 positive and 1,650 negative words and measures their semantic orientation as a weight within the interval of [−1; 1], for example, the word 'success' is weighted at 0.3446 and the word 'functionality' is weighted at 0.004. We measure sentiment by the proportion of positive over negative words. As firms could use negations in their annual report, we control for the sentiment measure using different negation windows *t*: a negation one, two, three, or six words before and after the keyword by using the following formula:

$$Sentiment_{t,i} = \sum Positiveword_i * Weight_i / Negativeword_i * Weight_i \, with \, t \{0; 1; 2; 3; 6\} \quad (4)$$

We additionally create a sentiment measure controlling for the length of an annual report as longer annual reports overall have more words. We use positive and nega-

Table 6 Panel regression with dependent variable beta

	Dependent variable:$beta_{t+1}$								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
RiskIdentification	0.006***				0.004***				0.004***
	(0.001)				(0.001)				(0.001)
Derivatives		0.058**				−0.028			−0.053
		(0.029)				(0.033)			(0.033)
Insurances		0.021***				0.019**			0.012
		(0.008)				(0.008)			(0.008)
Diversification		0.125***				0.080***			0.058**
		(0.026)				(0.027)			(0.027)
RiskControl			0.090***				0.035		0.007
			(0.029)				(0.029)		(0.029)
ERM				0.132***				0.010	−0.032
				(0.031)				(0.034)	(0.034)
FirmSize					0.041***	0.057***	0.060***	0.060***	0.045***
					(0.008)	(0.007)	(0.006)	(0.007)	(0.008)
ROA					−0.004***	−0.004***	−0.004***	−0.004***	−0.003***
					(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Market/Book					0.006	0.003	0.003	0.003	0.005
					(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Leverage					−0.000	0.000	0.000	0.000	0.000
					(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.494***	0.576***	0.679***	0.679***	0.351***	0.356***	0.380***	0.383***	0.337***
	(0.025)	(0.027)	(0.015)	(0.014)	(0.037)	(0.039)	(0.037)	(0.038)	(0.040)
Time-FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-FE					Yes	Yes	Yes	Yes	Yes

Table 6 (continued)

	Dependent variable:$beta_{t+1}$								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
No	4,627	4,627	4,627	4,627	4,622	4,622	4,622	4,622	4,622
Adj. R^2	0.059	0.049	0.042	0.044	0.068	0.065	0.063	0.063	0.068

The table presents the results of a panel regression on the risk disclosure variables with fixed-effects for time and industry. The dependent variable is beta of the next year ($beta_{t+1}$). No. depicts the number of firm-year observations. We use the natural logarithm of *FirmSize* to control for skewness; robust standard errors are in parentheses to control for heteroscedasticity. The largest VIF for variables of interest and control variables is 1.84 across all models;

*$p<0.10$, **$p<0.05$, ***$p<0.01$

Table 7 Reverse causality

Dependent variable:	RiskIdentification	RiskAdjustment	RiskControl	ERM
	(1)	(2)	(3)	(4)
$IVol_{t-1}$	0.638*	−0.009	−0.016	0.010
	(0.365)	(0.007)	(0.010)	(0.008)
$FirmSize_{t-1}$	3.353***	0.030***	0.027***	0.007
	(0.346)	(0.007)	(0.010)	(0.008)
ROA_{t-1}	−0.027	0.000	−0.000	−0.000
	(0.017)	(0.000)	(0.000)	(0.000)
$Market/Book_{t-1}$	−0.200*	−0.004*	−0.002	0.001
	(0.114)	(0.002)	(0.003)	(0.003)
$Leverage_{t-1}$	0.009***	0.000**	0.000**	0.000
	(0.002)	(0.000)	(0.000)	(0.000)
Constant	19.593***	0.737***	0.111**	0.140***
	(1.756)	(0.034)	(0.050)	(0.039)
Time-FE	Yes	Yes	Yes	Yes
Industry-FE	Yes	Yes	Yes	Yes
Firm-FE	Yes	Yes	Yes	Yes
Observations	4,608	4,608	4,608	4,608
Adj. R^2	0.756	0.426	0.378	0.518

The table presents the results of reverse causality examination including a panel regression with fixed-effects for time, industry, and firm and with dependent variables set as the steps of risk management disclosure and the ERM. No. depicts the number of firm-year observations. We use the natural logarithm of *FirmSize* to control for skewness; robust standard errors are in parentheses to control for heteroscedasticity;

*$p<0.10$, **$p<0.05$, ***$p<0.01$

tive words relative to all words in the annual report but excluding stop words.[10] We again use negation windows *t* and the following formula:

$$\begin{gathered} Sentiment_{t,i} = \\ \sum Positive\ word_i * Weight_i - Negativeword_i * Weight_i / (TotalWords - Stopwords) \\ with t \{0;1;2;3;6\} \end{gathered} \quad (5)$$

Initially, we conduct a comparative analysis of two sentiment measures through a regression framework that incorporates these sentiment metrics and financial control variables as the independent variables. The results from both sentiment measures are largely consistent and we use Formula°5 based on a slightly higher model fit. We integrate the sentiment measure to the regression model in Table 8. This addition unveils a significant and negative correlation with *IVOL* of the next year, i.e., firms with positive sentiment are associated with lower levels of *IVOL* in the next year. This finding suggests that, on average, firms are aware of their risk situation.

[10] Stop words are words with no information content, e.g., connectors, articles, and pronouns.

Table 8 Panel regression including sentiment

Panel A	*Dependent variable:IVol*$_{t+1}$							
	Sentiment (Formula°4): Positive / Negative				Sentiment (Formula°5): $\frac{\text{Positive}-\text{Negative}}{(\text{Total Words}-\text{Stopwords})}$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sentiment	−0.345***	−0.112***	−0.454***	−0.145***	−0.576***	−0.163***	−0.840***	−0.225***
	(0.026)	(0.021)	(0.025)	(0.021)	(0.048)	(0.038)	(0.047)	(0.039)
Constant	−0.315***	0.875***	−0.384***	0.814***	−0.293***	0.894***	−0.384***	0.831***
	(0.021)	(0.030)	(0.020)	(0.031)	(0.021)	(0.029)	(0.020)	(0.031)
Controls		Yes		Yes		Yes		Yes
Time-FE			Yes	Yes			Yes	Yes
No	5,120	5,120	5,120	5,120	5,120	5,120	5,120	5,120
Adj. R^2	0.03	0.42	0.16	0.47	0.03	0.42	0.16	0.47

Panel B	*Dependent variable:IVol*$_{t+1}$								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
RiskIdentification	−0.011***				0.003***				0.004***
	(0.000)				(0.001)				(0.001)
Derivatives		−0.562***				−0.151***			−0.173***
		(0.027)				(0.025)			(0.024)
Insurances		−0.021***				−0.005			−0.013**
		(0.007)				(0.006)			(0.006)
Diversification		−0.077***				0.051***			0.023
		(0.022)				(0.019)			(0.019)
RiskControl			−0.276***				−0.041**		−0.059***
			(0.024)				(0.019)		(0.020)
ERM				−0.313***				0.127***	0.108***
				(0.026)				(0.024)	(0.024)
Sentiment	−0.844***	−0.755***	−0.861***	−0.801***	−0.168***	−0.238***	−0.223***	−0.204***	−0.196***
	(0.052)	(0.049)	(0.054)	(0.054)	(0.047)	(0.044)	(0.046)	(0.045)	(0.046)

Table 8 (continued)

Panel B	*Dependent variable:* $IVol_{t+1}$								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Constant	0.017	0.081***	−0.320***	−0.313***	0.789***	0.836***	0.819***	0.846***	0.861***
	(0.027)	(0.030)	(0.019)	(0.019)	(0.041)	(0.042)	(0.041)	(0.042)	(0.043)
Controls					Yes	Yes	Yes	Yes	Yes
Time-FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-FE					Yes	Yes	Yes	Yes	Yes
No	5,151	5,151	5,151	5,151	5,151	5,145	5,145	5,145	5,145
Adj. R^2	0.225	0.256	0.176	0.177	0.480	0.481	0.477	0.479	0.487

The table presents in Panel A the results of two panel regressions with time fixed-effects and including sentiment. The dependent variable is idiosyncratic volatility of the next year ($IVol_{t+1}$). We report two sentiment measures by using formula°4 and °5. Panel B presents the results of panel regression comprising all components of the cybernetic cycle of risk management; the dependent variable is $IVol_{t+1}$. We measure sentiment using formula°5. The dependent variable is standardized. No. depicts the number of firm-year observations. We use the natural logarithm of *FirmSize* to control for skewness; robust standard errors are in parentheses to control for heteroscedasticity. The largest VIF for variables of interest and control variables is 1.90 across all models;

*$p<0.10$, **$p<0.05$, ***$p<0.01$

We already controlled for several issues by determining our final variables from a collection of different variations. We construct different ERM dummies as we identify several mentions of synonyms for risk committees. The comparison of the different ERM dummies, however, yields similar results; therefore, we use the broader ERM dummy. We furthermore expand our risk adjustment strategies with the concepts of outsourcing (which belongs to the category of diversification) and leasing. However, these strategies do not offer further insights. Firms mostly already show one of the other risk adjustment strategies and the objectives might be influenced by, for example, tax optimization.

We do not explicitly deal with reputational risks. The empirical literature highlights the increasing importance of corporate reputation but also shows that the measurement of reputational risks is difficult (e.g., Eckert 2017). However, our main argument is that reputational risks are primarily based on other, previously occurred risks.

Finally, we add the return perspective and consider monthly raw return and alpha as dependent variables. This is important as risk should be examined in the context of return. Moreover, it improves our understanding of firms' decisions to use derivatives. Our dataset covers listed firms, which can be assumed to have knowledge of the use of financial derivatives due to the existence of experts in risk and finance issues (e.g., in comparison to small and medium sized firms). The risk-adjusted returns are calculated as the regression intercept (α) from Carhart's 4-factor model. We apply the daily total return index of the first and the last day of each stock to calculate monthly returns. Firms with extremely low stock prices can have extreme returns; however, the absolute change in stock price is rather marginal. We therefore adjust our sample by excluding observations with daily stock prices lower than 0.5 EUR. The yearly variable is calculated as the mean of monthly returns.

First, we analyze the dependent variables in the same year (t). Our results related to raw returns indicate a negative and significant coefficient only for risk adjustment using derivatives. This aligns with the intuitive understanding that a decrease in risk typically correlates with a reduction in return potential. Interestingly, *RiskIdentification* is positively and significantly related to the raw return, suggesting that firms disclosing their risks tend to achieve higher market returns. This could be interpreted as a signaling effect. When changing the dependent variable to the future raw return, most relationships become insignificant (see Online Appendix D). The only exception is *RiskIdentification*, which remains positively related to future raw returns. This suggests that investors may reward transparent risk disclosure over time, possibly because it signals managerial awareness, credibility, or proactive governance, which are valued in the long term.

The results for alpha in the same year show a negative and significant relationship with *RiskIdentification, Derivatives, Insurances, and RiskControl*. This indicates that firms actively adjusting and controlling risks tend to achieve lower alpha. One possible explanation is that comprehensive risk management reflects a conservative strategic orientation, where firms prioritize risk reduction over aggressive value creation. While such practices may stabilize earnings and reduce downside volatility, they can also limit excess returns after adjusting for market risk. Additionally, firms with more comprehensive risk disclosures and tools may be operating in riskier environments, where achieving alpha is inherently more difficult, or where the cost of risk mitigation offsets potential excess performance. However, when using future alpha as the dependent variable, the only significant coefficient remains *RiskIdentification*, which is again positively related (see Online Appendix D). This suggests that investors may gradually come to view transparent firms as more credible, disciplined, or resilient, which over time contributes to positive abnormal returns. This underscores the possibility that the benefits of risk transparency accrue with a time lag, particularly in risk-sensitive environments.

6 Conclusion

This study utilizes data from the German stock market from 2002 to 2020 to examine the relationship between risk management disclosures and the idiosyncratic risk perceived by market participants. Our analysis, employing panel regression techniques with fixed-effects, reveals a negative and statistically significant relationship between the disclosure of information related to the cybernetic cycle of risk management and the *IVOL* of the next year. This relationship is particularly pronounced with respect to disclosures concerning risk adjustment strategies supporting the theoretical expectation that active financial hedging tools reduce market-perceived uncertainty. Other risk management steps, such as *RiskControl* and *RiskIdentification*, show more context-dependent effects. For instance, *RiskControl* is significantly associated with reduced risk in some specifications but not all, and the effect of *RiskIdentification* appears to vary with firm size. These patterns suggest that not all forms of disclosure are interpreted equally by the market. This reinforces our original aim of shedding a light on the different steps of the risk management process. The risk-reducing value of disclosure depends on both the type of information provided and the context in which it is disclosed. This finding also applies to the disclosing of ERM which is negatively related to future *IVOL* only for small and large firms but shows a positive relationship for the majority of the sample, namely the mid-sized firms. In our

robustness analysis, we incorporate the sentiment derived from firms' annual reports, which negatively relates to future *IVOL*, thereby positing that firms generally possess an awareness of their risk profile.

We acknowledge that industry-specific studies may yield more precise contributions to the particular industries. Our dataset encompasses German non-financial firms, and future research could explore the applicability of our results across different national contexts or specific industry sectors.

Moreover, our methodology introduces a novel approach of textual measures to analyze firm-level risk management disclosure and represents an exploratory approach within the field (see also Lang and Stice-Lawrence 2015). Identifying a suitable proxy for risk management remains a significant challenge in this domain, similar to other studies focused on risk management. The methods used to identify ERM practices and delineate the steps within the cybernetic risk management cycle are not as robust as traditional financial metrics. Although the practice of using keyword searches to identify firms with ERM systems is common, such approaches may introduce biases – for instance, the assumption that the presence of a CRO necessarily indicates the implementation of an ERM system, or the potential oversight of firms that implement ERM practices without reporting specific keywords (Grace et al. 2015).

Our study enriches the literature on risk disclosure by moving beyond aggregate risk-related word counts or tone analysis and examining how specific components of risk management processes are evaluated by the stock market. This finding holds considerable relevance for managers, regulators, and investors alike.

Appendix A

See Table 9

Table 9 List of all variables

Variable name	Measurement / definition	Source
Textual variables		
RiskIdentification	Number of different risks mentioned by a firm in its annual report	Textual analysis
RiskAdjustment	Dummy = 1 if at least one adjustment strategy is disclosed by a firm in its annual report	Textual analysis
Derivatives	Dummy = 1 if a specific financial instrument is disclosed or if at least 10 times general mentions of '∗derivat∗', '∗derivat∗' + 'financial instrument∗', 'hedging transaction' are disclosed	Textual analysis, see also Bartram et al. (2009)
Insurances	Number of different insurances mentioned by a firm in its annual report (creating coverage for the firm)	Textual analysis, see also Zou (2010)
Diversification	Dummy = 1 if the keywords 'diversification' or 'diversified' are disclosed	Textual analysis
RiskControl	Dummy = 1 if a the combination of 'risk∗' and a time component is disclosed	Textual analysis
ERM	Dummy = 1 if at least one keyword from: 'enterprise risk management', 'chief risk officer', 'integrated risk management', 'holistic risk management', 'COSO II', and 'risk committee' (including their synonyms and acronyms) is disclosed	Textual analysis, see also e.g., Hoyt and Liebenberg (2011), Pagach and Warr (2011), and Lechner and Gatzert (2018)
Control variables		
FirmSize	Market value of the stock (yearly)	Datastream
ROA	Return on assets (yearly); in percent	Datastream
Market/Book	Market-to-book ratio (yearly)	Datastream
Leverage	Total liabilities divided by total assets (yearly)	Datastream
Stock market variables		
IVol_{t+1}	Idiosyncratic volatility (*IVOL*) is estimated from the residuals of the Carhart four-factor model, applied to rolling 12-month windows of daily returns. The resulting monthly IVOL values are first annualized, then averaged within a calendar year to obtain a firm-year level *IVOL* measure. To ensure a forward-looking interpretation, we then shift the *IVOL* variable by one year ($IVol_{t+1}$)	Calculated from Datastream
TVol_{t+1}	Total volatility (*TVOL)* is calculated as the standard deviation of daily raw returns over rolling 12-month windows. The resulting monthly volatility values are first annualized, then averaged within a calendar year to obtain a firm-year level *TVOL* measure. To ensure a forward-looking interpretation, we then shift the *TVOL* variable by one year ($TVol_{t+1}$)	Calculated from Datastream

Table 9 (continued)

Variable name	Measurement / definition	Source
$\text{SemiStandard Variance}_{t+1}$	Semi-standard deviation is computed as the average of monthly values, where each monthly value is based on the standard deviation of daily stock returns below the firm's monthly mean return. For each month, only returns falling below the monthly average are included; returns above the average are treated as zero. To ensure a forward-looking interpretation, we then shift the variable by one year	Calculated from Datastream
Alpha	Regression intercept (α) from Carhart's 4-factor model	Calculated from Datastream
Return	Yearly raw return is measured as the mean of monthly return, which are the total return index of the first and the last day of a month for each stock	Calculated from Datastream
Sentiment	Application of SentiWS (dictionary with negative and positive words and their weights); differentiation between two calculations (see Sect. 5).	Textual analysis

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s11846-025-00944-4.

Funding Open Access funding enabled and organized by Projekt DEAL.

Declarations

Conflict of interest The authors have no competing interests to declare that are relevant to the content of this article. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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