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A Complementarity Perspective on How Control Systems Influence Risk Awareness

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ABSTRACT

Prompted by the weaknesses of standardized risk management approaches in the aftermath of the 2008 financial crisis, scholars, regulators, and practitioners alike emphasize the importance of creating a risk-aware culture in organizations. Recent insights highlight the special role of tone from the top as crucial driver of risk awareness. In this study, we take a systems-perspective on control system design to investigate the role of tone from the top in creating risk awareness. In particular, we argue that both interactive and diagnostic use of budgets and performance measures interact with tone from the top in managing risk awareness. Our results show that interactive control strengthens the effect of tone from the top on risk awareness, while tone from the top and diagnostic control are, on average, not interrelated with regard to creating risk awareness. To shed light on the boundary conditions of the proposed interdependencies, we further investigate whether the predicted interdependencies are sensitive to the level of perceived environmental uncertainty. We find that the effect of tone from the top and interactive control becomes significantly stronger in a situation of high perceived environmental uncertainty. Most interestingly, tone from the top and diagnostic control are complements with regard to risk awareness in settings of low perceived environmental uncertainty and substitutes at high levels of perceived environmental uncertainty.

Keywords

Tone from the top; risk awareness; interactive and diagnostic use of budgets and performance measures; perceived environmental uncertainty; SMEs

INTRODUCTION

Prompted by the weaknesses of standardized risk management approaches in the aftermath of the 2008 financial crisis (Bromiley et al., 2015), scholars, regulators, and practitioners alike emphasize the importance of creating a risk-aware culture in organizations (Lam, 2014; Collier, Berry, & Burke, 2007; Mikes, 2009; 2011). Although the concept of risk culture is still blurry (Zeier Roeschmann, 2014), consensus has emerged that risk awareness is one of the fundamental pillars of risk culture (Collier et al., 2007). Drawing on insights from a Delphi study among both practitioners and academics, Melnyk et al. (2014) conclude that managing risk awareness is already important today but will gain in value and impact in the future. Despite the attributed importance of risk awareness, we have little empirical evidence on its antecedents.

Risk awareness arises when all employees share and reflect on how their behavior and actions are related to causes and outcomes of potential risks to the firm (Braumann, 2018). In the case of high risk awareness, risk management becomes so engrained that it is almost invisible because all employees are managing risks already implicitly. Due to its intangibility, risk awareness per se cannot be implemented directly by a management decision, but management can take measures to raise risk awareness by creating an appropriate control environment. Recent insights highlight the special role of tone from the top[1] – a central form of cultural control (Merchant & Van der Stede, 2017) – as crucial driver of risk awareness (Collier et al., 2007; COSO, 2017). In this study, we take a systems-perspective on control system design (Grabner & Moers, 2013) to investigate the role of tone from the top in managing risk awareness.

[1] The terms *"tone at the top"* and *"tone from the top"* are used synonymously in prior literature. Throughout the course of this paper we stick to the term *"tone from the top"* because we believe that this better captures the trickle-down effects this construct exhibits on employees.

In the risk management context, tone from the top comprises two dimensions: (1) a top-down approach including top management communication of commitment and behavioral expectations with regard to risk management, and (2) an encouragement for bottom-up communication and escalation of risk issues. Hence, to create an appropriate risk awareness, the CEO must be fully supportive of risk management, and set the tone for risk management behavior through communication and expectations. In doing so, the CEO signals commitment to risk management (Lam, 2014).

We however argue that tone from the top in risk management does not work in isolation but rather in a system with other, more formal, control practices (Penno, 2019). In light of their widespread use and crucial importance in steering the firm, we focus on the interplay between the use of budgets and performance measures and tone from the top. Consistent with previous management accounting studies on risk management (Mikes, 2009; 2011), we look at budgets and performance measures through the lens of diagnostic and interactive control (Simons, 1995). In particular, we shed light on the interrelationship between tone from the top and both diagnostic and interactive use of budgets and performance measures.[2] Complementarity implies that the benefits of one control practice increase with the use of another control practice and vice versa (Milgrom & Roberts, 1995). We expect that interactive control increases the effectiveness of tone from the top, and vice versa (H1). In particular, we argue that the interactive use of budgets and performance measures provides an especially well-suited forum for top management to display their tone from the top, walk the talk, and communicate their attitude toward risks to employees, which will in turn increase risk awareness. At the same time, tone from the top encourages employees to actively raise risk issues in the interactive budgeting process which will consequently translate into higher

[2] In the remainder of the study, we use "*interactive (diagnostic) use of budgets and performance measures*" and "*interactive (diagnostic) control*" interchangeably.

risk awareness. Further, we present arguments for both, a complementary and substitutive interrelationship between tone from the top and diagnostic control. On one hand, we argue that the effect of tone from the top on risk awareness is strengthened by the use of diagnostic control as its monitoring nature communicates on which dimensions performance is desired, and hence gives employees a clear sense in which areas to reflect upon risk issues (Mundy, 2010; Merchant, 1985). On the other hand, we acknowledge that the use of diagnostic control might also dampen the effect of tone from the top on risk awareness, for example due to its focus on mistakes and negative variances (Henri, 2006). This focus limits the potential spectrum for risk-thinking by neglecting that, in terms of risk, areas of overperformance are often more informative than areas of underperformance (Van der Stede, 2009). Given that we are not able to theoretically determine ex-ante, which arguments prevail, we formulate a research question and let the empirics shed light on the interrelationship between tone from the top and use of diagnostic control.

To investigate the boundary conditions of our interaction effects, we further argue that the interrelationships are sensitive to the level of perceived environmental uncertainty (hereinafter, PEU). As PEU increases, a firm's environment becomes riskier and more turbulent (Bstieler, 2005). We posit that in this situation, the joint use of tone from the top and interactive control yields higher benefits in terms of risk awareness because predicting environmental changes and comprehending them becomes increasingly difficult (Bstieler, 2005). We therefore expect the complementarity between tone from the top and interactive control to be increasing under high PEU (H2a). With regard to diagnostic control, we expect that the positive features prevail in settings of low PEU (H2b), while the negative features prevail under high PEU (H2c). This implies that we predict a complementary relationship between tone from the top and diagnostic control for low levels of PEU (H2b), while we expect a substitution effect for high levels of PEU (H2c).

We test our hypotheses and research question using survey data on 198 small and medium-sized enterprises (hereinafter, SMEs). The context of SMEs provides an ideal setting to test our theory. The limited number of employees makes it more likely that there is only one risk culture (Roelofsen, Blok, & Wubben, 2015) and that the CEO can credibly assess risk awareness. Further, CEOs tend to have the greatest impact in smaller firms (Miller & Toulouse, 1986), which makes SMEs an especially well-suited context to study tone from the top. Lastly, literature indicates that smaller firms provide a clearer setting with less confounding factors, and hence allow researchers to better study the consequences (in our case risk awareness) of management control practices (Mitchell & Reid, 2000).

Supporting H1, we show that interactive control strengthens the effect of tone from the top on risk awareness, and vice versa. Regarding the interdependence of tone from the top and diagnostic control, our results yield an insignificant interaction effect on risk awareness. Taking a contingency perspective, our findings support H2a: the positive interaction between tone from the top and interactive control becomes significantly stronger in a situation of high PEU. Our results also support H2b and H2c, indicating that tone from the top and diagnostic control are complements in settings of low PEU while they are substitutes under high PEU.

Our study contributes to the management accounting literature in several related ways. First, we add to the emerging literature stream on the interdependence between management control practices (Grabner & Moers, 2013). We consciously chose to shed light on risk awareness as outcome variable to avoid using a broader productivity measure. The latter is rather problematic in cross-sectional studies given its potential to add systematic error (Grabner & Moers, 2013). Risk awareness has been argued to be a fundamental pillar of an appropriate risk culture (Lam, 2014; Collier et al., 2007). With risk awareness as dependent variable, we are thus able to more directly capture the intended objectives underlying the control system design choices for the purpose of

creating a sound risk culture. Further, by using two alternative approaches to capture complementarity, we investigate to what extent firms' average control system choices are consistent with their effectiveness in managing risk awareness. We also consider the contextual effects of PEU, providing a more detailed understanding of the boundary conditions regarding the proposed complementarities (Cassiman & Veugelers, 2006). In doing so, we follow up on recent calls that contingency-based arguments can be fruitfully expanded to the level of interactions in management control research (Grabner & Moers, 2013). This also ties to Cassiman and Veugelers (2006) positing that in addition to analyzing interdependencies between organizational practices per se it is of even more value to shed light on the contextual factors that drive these interdependencies.

Relatedly, we also contribute to prior risk management research. In considering the effect of tone from the top in a control system of broader sense, we follow the call of Janvrin et al. (2012) to provide insights into how tone from the top interacts with other control practices. We use the strengths of the SME context to capture tone from the top and elucidate its ramifications for risk awareness. In doing so, we follow the call to take a softer and more behavioral perspective on risk management (Landsittel & Rittenberg, 2010).

Moreover, based on factors such as information overload, bounded rationality and the complex nature of risks, recent studies illustrate the shortcomings of formal risk management tools and emphasize the importance of creating an appropriate risk culture with risk awareness being a fundamental constituent of such a culture (Zeier Roeschmann, 2014; Collier et al., 2007). Research on the cultural aspects in risk management, however, is still at an infant stage due to the inherent difficulties of studying culture in large organizations. In this respect, SMEs prove to be a fruitful research context thanks to their restricted size. In considering risk awareness as outcome variable, we investigate a fundamental pillar of risk culture that can be influenced by choices regarding the

control environment (Lam, 2014; Collier et al., 2007). Further, while the concept of tone from the top has been touched upon in fields such as internal control systems (e.g., Morales, Gendron, & Guénin-Paracini, 2014), financial reporting (e.g., Hope & Wang, 2018), ethics (e.g., Weaver, Treviño, & Cochran, 1999), and tax issues (e.g., Christensen, Dhaliwal, Boivie, & Graffin, 2015), it is surprising that empirical management accounting research lags behind in this regard. This is even more puzzling given that Merchant and Van der Stede (2017) identify tone from the top as a central form of cultural control.

THEORY DEVELOPMENT

The Importance of Risk Awareness

Scholars, regulators, and practitioners increasingly emphasize the importance of creating risk awareness among employees (Lam, 2014; Mikes, 2009; 2011; COSO, 2017; Melnyk et al., 2014; Collier et al., 2007). Risk-aware people proactively identify the key risks for the company and seriously think about the impact of the risks they are responsible for (Lam, 2014). Hence, risk awareness is the result of all employees sharing and reflecting on how their behavior and actions are associated with causes and outcomes of potential risks to the firm (Braumann, 2018).

When risk awareness is strong, company decision-makers can use this knowledge about key risks and be more responsive to changing environmental situations (Banks, 2012). Consequently, risk awareness, as a key cultural component of sound risk management, provides the very foundation for ERM success (Lam, 2014; Cormican, 2014). All employees in the company accept personal responsibility for the management of risk and encourage others to participate in this risk-aware approach (COSO, 2017). The embedded risk-thinking ensures that employees throughout the organization have a clear understanding of what top management expects from them with

regard to dealing with risks in all their activities, ranging from strategic planning to daily operations (Collier et al., 2007).

While conceptual and qualitative literature on risk management highlights the importance of risk awareness (Mikes, 2009; Aabo et al., 2005; Lam, 2014), empirical evidence providing insights into the drivers of risk awareness and its implications is limited (Braumann, 2018).

Tone from the Top as Driver of Risk Awareness

Tone from the top is viewed as an informal control practice that comprises common values, beliefs, and traditions and thus can direct the behavior of group members (Falkenberg & Herremans, 1995). It is a powerful form of cultural control (Merchant & Van der Stede, 2017) whose power emerges from its ability to manage the behavior of employees in ambiguous and/or unexpected situations where it addresses the limits of formal control systems that are however designed for specific and/or predictable events (Falkenberg & Herremans, 1995).

Recent insights emphasize the special role of tone from the top as crucial driver of a risk-aware culture (COSO, 2017; Collier et al., 2007). We thus conceptualize tone from the top as a control practice that focuses organizational attention toward risk (Henri, 2006) with the aim to strengthen risk awareness. In particular, we capture this broad concept of *tone from the top* by focusing on the CEO's attention toward risk management from two dimensions: a top-down approach including the communication of commitment and behavioral expectations respective risk management, and a bottom-up encouragement for communication and escalation of risk issues.

Regarding the former, to create an appropriate risk awareness, the CEO must dedicate her attention toward risk issues, be fully supportive of the risk management process, effectively convey expectations respective risk management behavior, and foster communication and escalation of risk issues (Lam, 2014; COSO, 2017). This tone from the top sets the stage that risk management per se matters, because if firm leaders believe in being risk-aware and dedicate their time, effort

and resources to risk issues, then others in the company will follow the lead. This top-down approach is important for leaders to establish their commitment and to communicate behavioral expectations toward risk issues to all levels (COSO, 2017; Zeier Roeschmann, 2014; Boultwood & Dominus, 2014). Regarding the latter, effective tone from the top further includes a bottom-up perspective where management motivates communication and escalation of risk issues from lower to upper levels. In doing so, management creates an atmosphere of transparency and trust (Amernic et al., 2010; Lam 2014), signals to be accessible and interested in open communication (Detert & Trevino, 2010), and encourages and supports openness to challenge (Banks, 2012; Lam, 2014).

Theory Development

Contemporary research suggests that tone from the top most likely does not work in isolation in creating risk awareness but rather in a system with other, more formal control and/or risk management practices (Grabner & Moers, 2013; Penno, 2019). Given that SMEs typically place less emphasis on enterprise risk management (ERM) than larger firms (Paape & Speklé, 2012; Beasley, Clune, & Hermanson, 2005), but instead use budgets and performance measures intensively for risk management purposes (Collier et al., 2007), we shed light on the interrelationship between tone from the top and the interactive and diagnostic use of budgets and performance measures.

The complementarity between tone from the top and interactive control

Interactive control entails the interpretation and discussion of performance measures and budget data in face-to-face meetings between top management and employees (Mundy, 2010). Top managers draw on the interactive use of budgets and performance measures to involve themselves regularly and personally in the decision activities of subordinates (Simons, 1995). At the same time, interactive control encourages reflection and learning throughout the organization since

attention is focused on the information contained in performance measures and budgets (Henri, 2006). While prior papers argue that top managers rely on interactive control to send signals throughout the organization (e.g., Widener, 2007; Henri, 2006), literature remains rather silent about the content nature of these signals. We argue that tone from the top sends a content-related signal in the sense that it explicitly puts risk issues on employees' agendas.

The use of interactive control reinforces the effect of tone from the top on risk awareness for the following reason. The interpretation and discussion of performance measures and budget data in face-to-face meetings between top management and employees enables the former to credibly display tone from the top and encourage employees to constantly reflect upon risk issues (Shapiro, 2016). While tone from the top gives employees the right mindset with regard to risk issues, the interpretation and analysis of the data generated by budgets and performance measures is also necessary for employees to promote learning and develop risk awareness. We hence argue that interactive control strengthens the effect of tone from the top on risk awareness.

At the same time, tone from the top is also likely to complement interactive control with regard to risk awareness. Interactive processes sometimes tend to be suppressed in the sense that debate and challenges are carefully managed to the executive's agenda (Roberts, 1990). Such a suppression carries the problem that risks and threats are addressed at the convenience of senior management, rather than at the most appropriate time for the firm (Mundy, 2010). This will also limit subordinates' motivation to share knowledge and participate in debates about risk issues, hampering the effectiveness of interactive control with regard to risk awareness. An appropriate tone from the top, however, establishes a set of values espoused by top management regarding risk management. In doing so, tone from the top puts risk issues on employees' agendas and indicates that top management expects employees to raise risk issues during interactive control (Lam, 2014; COSO, 2017). Through reinforcing a collective understanding that subordinates are highly

encouraged to reflect on risk and actively raise risk issues, interactive control will entail more trust and open communication between superiors and subordinates. Doing so, tone from the top increases the effect of the interactive use of budgets and performance measures on risk awareness by creating an environment that values openness and constructive challenge and debate (Simons, 1995).

Drawing on complementarity theory (Milgrom & Roberts, 1995), it hence follows that tone from the top and interactive control are complementary choices because the benefits (i.e., increased risk awareness) of tone from the top toward risk management increase with the increasing use of interactive control and vice versa (Grabner & Moers, 2013). Stated formally:

Hypothesis 1: Tone from the top and interactive control are complements with regard to risk awareness.

The interdependence of tone from the top and diagnostic control

Diagnostic control involves the use of budgets and performance measures to monitor the achievement of pre-defined targets (Simons, 1995). Typically, the focus is set on the accomplishment of goals by correcting deviations from pre-set performance standards. Critical performance variables are monitored to coordinate the implementation of intended strategies (Henri, 2006). Furthermore, diagnostic control establishes accountability and focuses on exception-based monitoring (Bedford, Malmi, & Sandelin, 2016). Due to its monitoring nature, diagnostic control is an effective means for communicating on which dimensions performance is desired (Merchant, 1985).

The interplay of tone from the top and diagnostic control with regard to risk awareness is not straightforward. On the one hand, tone from the top and diagnostic control might complement each other, meaning that in combination they are more useful for strengthening risk awareness. The use

of diagnostic control is a mechanism for top management to reinforce tone from the top by encouraging subordinates to look for performance improvements within an explicitly defined space laid out by budgets and performance measures (Mundy, 2010). The effect of tone from the top on risk awareness may thus be strengthened by the use of diagnostic control since it communicates desired performance dimensions and gives employees the motivation and direction on where to reflect upon risk issues (Widener, 2007; Bisbe & Otley, 2004). Equally, tone from the top can have implications for the effect of diagnostic control on risk awareness. Typically, diagnostic control gives employees leeway in how desired outcomes are to be achieved (Bedford et al., 2016), and consumes less top management attention compared to interactive control due to top management intervening only in the case of deviations (Widener, 2007). However, while employees might cherish this autonomy and absence of top management, this may have negative implications for risk awareness. The missing guidance when using diagnostic control only might attract employees' attention toward minimizing performance deviations in order to meet short-term targets (Bedford, 2015), and moreover draw their attention away from shifting circumstances, hence hampering risk awareness (Van de Ven, 1986). Tone from the top countervails these negative effects by providing guidance, setting expectations and reminding employees of the importance of not sacrificing reflection upon risk issues for delivering short-term performance.

On the other hand, tone from the top and diagnostic control may also be substitutes with regard to risk awareness. Diagnostic control focuses on mistakes and negative variances (Henri, 2006), thus limiting the potential spectrum for risk-thinking by neglecting that, in terms of risk, areas of overperformance are often more informative than areas of underperformance (Van der Stede, 2009). Therefore, the use of diagnostic control could dampen the effect of tone from the top on risk awareness because employees tend to place too much weight on negative deviations. Further, it could confuse employees when a firm has diagnostic control in place but also signals

through tone from the top the importance of being critical and challenging toward assumptions, beliefs, and associated risks. At the same time, discussions triggered by diagnostic control might at best lead to incremental corrective actions and at worst, cause discussions about unproductive topics such as the validity of the numbers (Henri, 2006). Thus, the joint use of both control practices might communicate conflicting expectations with regard to risk-related behavior and action and thus inhibit risk awareness.

These competing arguments result in tension regarding the interdependence of tone from the top and diagnostic control with regard to risk awareness. As illustrated above, no clear rationale exists for making inferences on both the existence of an interrelationship and the nature of such an interrelationship. Therefore, we propose the following research question:

Research Question: Are tone from the top and diagnostic control complements, substitutes or independent with regard to risk awareness?

The boundary effect of perceived environmental uncertainty

Given the important role of PEU as contextual factor in both management control (Chenhall, 2003) and risk management research (Gordon et al., 2009), we next use PEU to analyze the "boundary conditions" of our proposed interdependencies in the risk management context.

As PEU widens the gap between the information known and the information desired for decision-making (Gordon et al., 2009), organizations face a higher demand for information collection and information processing (Galbraith, 1973). Prior work hence suggests that using budgets and performance measures interactively is more effective in uncertain environments (Bedford, 2015; Widener, 2007). We extend this line of reasoning to the complementary relationship between tone from the top and interactive control. The need for information collection and processing, guidance and flexibility is more pressing in a situation of high PEU as compared

to a stable environment. In a setting of high PEU, employees will perceive more lack of direction (Grabner, Posch, & Wabnegg, 2018), perceive a greater risk of organizational failure, experience a lack of confidence and fear that their decisions could cause trouble (Agle, Nagarajan, Sonnenfeld, & Srinivasan, 2006; Bstieler, 2005). Thus employees will seek more guidance regarding risk. Given the obstacles employees face in uncertain environments, we expect that combining tone from the top with interactive control is more beneficial in giving this guidance and subsequently more effectively translates into risk awareness compared to low levels of PEU. Stated formally:

Hypothesis 2a: The complementarity between tone from the top and interactive control is stronger under high levels of perceived environmental uncertainty.

Previous literature indicates that the effectiveness of diagnostic control hinges on goals and critical success factors being stable enough to incorporate them accordingly in budgets and performance measures (Simons, 1995; Su, Baird, & Schoch, 2015). As this is the case in settings of low PEU, diagnostic control serves as reinforcement mechanism of tone from the top by giving employees direction and providing them with reliable decision-relevant information regarding risk-related behaviors. At the same time, tone from the top complements diagnostic control by setting boundaries to the short-term focus of diagnostic control and encouraging reflection about risk issues that goes beyond the typical scope of diagnostic control. In a setting of low PEU, we thus argue that the joint use of diagnostic control and tone from the top will complement each other with regard to risk awareness.

Following the notion that diagnostic control can be problematic in dynamic environments (Widener, 2007), we argue that the nature of the interrelationship between tone from the top and diagnostic control changes when companies face high levels of PEU. The presence of high levels of PEU significantly increases the need to process information, while employees also seek more guidance and direction for their risk-related behavior (Agle et al., 2006). This however, is at odds

with diagnostic control being characterized by highly structured channels of communication and restricted flows of information (Henri, 2006). By virtue of these two characteristics prior literature argues that diagnostic control might hamper learning and the generation of new knowledge (Henri, 2006). We suggest that high levels of PEU unlock this negative feature of diagnostic control. Furthermore, under high levels of PEU, budgets and performance measures become less precise and defining meaningful targets becomes more difficult (Govindarajan, 1984; Widener, 2007). Consequently, employees might struggle to interpret the information generated by diagnostic control and experience a misfit between tone from the top and diagnostic control. The lack of direction experienced by employees will consequently undermine the positive effect of tone from the top on risk awareness. This implies that the benefits of tone from the top in fostering risk awareness decrease with the increasing use of diagnostic control, and vice versa under high levels of PEU. We thus state formally:

Hypothesis 2b: Tone from the top and diagnostic control are complements under low levels of perceived environmental uncertainty.

Hypothesis 2c: Tone from the top and diagnostic control are substitutes under high levels of perceived environmental uncertainty.

EMPIRICAL STUDY

Empirical Setting and Sample Description

To test our hypotheses and research question, we collect data using a cross-sectional survey design. Prior to developing our survey instrument, we conducted several interviews with CEOs and CFOs of SMEs in different industries to identify their approaches to managing risk. In particular, we asked about the company's business environment, risk culture, risk management processes and tools, responsibilities and decision-making processes in risk management, and what factors

influence the development of risk management activities. From these interviews, we find that SMEs do not focus on implementing many risk management processes per se, but integrate risk management aspects into existing control processes. Furthermore, decision-making and design choices with regard to risk management are highly influenced by top management in order to control and ensure that employees think about their behavior in pursuing the company's goals. Our interview findings are consistent with the limited evidence in the literature (Collier et al., 2007; Falkner & Hiebl, 2015).

Survey data were collected by using an online questionnaire that was sent to CEOs of Austrian small and medium-sized non-financial companies. The selection of firms contacted was based on data obtained from the Aurelia database (Bureau van Dijk Electronic Publishing). For the purpose of this study, we defined companies with 25 to 250 employees as SMEs. The following industries are included in our sample (number of firms in brackets): manufacturing (76); wholesale trade (38); construction (34); retail trade (16); professional, scientific, and technical services (13); transportation and warehousing (10); and others (11).

The specifications described above resulted in a target population of 3,286 firms, out of which a random sample of 1,500 firms was drawn. We then hand-collected the contact information of the CEO in these organizations either from a public source, or by contacting the company directly. CEOs were chosen since it can be assumed that they are the most knowledgeable respondents with regard to risk management and management control decisions in SMEs (Grabner, 2014). Furthermore, they provide a reliable picture on tone from the top and how it translates into risk awareness. Given a lack of retrievable information on 65 managers, this process resulted in a total of 1,435 firms, which were contacted via e-mail and asked to fill in a structured online questionnaire in June and July 2016. Over this period, we sent out three reminder emails and conducted follow-up calls, achieving a total of 204 completed questionnaires and a resulting

response rate of 14.2%. Due to incomplete questionnaires, we deleted six observations resulting in a final sample of 198 companies. The average firm in our sample had 74.29 employees (s.d.: 62.50) and was 57 years old (s.d.: 67).

We addressed a potential non-response bias in two ways. First, we did not find any meaningful differences between early and late respondents in regard to the items used in the survey. Second, testing for the representativeness of the responding companies regarding industry distribution and company size, we find no meaningful differences compared to the target population. The results hence reveal that non-response bias should not pose a threat to the validity of our results.

A potential problem of survey studies is common method bias (CMB) (Podsakoff, MacKenzie, & Podsakoff, 2012). Upfront we note that interaction effects are less likely to be susceptible to common method bias since they are unlikely to be part of respondents' cognitive maps. Along these lines, Siemsen, Roth, and Oliveira (2010) demonstrate that the presence of common method bias can only deflate interaction effects. Therefore, Siemsen et al. (2010, 469) argue that "finding significant interaction effects despite the influence of CMB in the data should be taken as strong evidence that an interaction effect exists". We nevertheless address the potential problem of CMB ex-ante through the design of the survey instrument and ex-post using statistical controls in multiple ways. In line with Podsakoff et al. (2012), we attempt to countervail potential biases in responses through (1) psychologically separating the measurement of the dependent and independent variables; (2) protecting respondents' anonymity, and (3) counterbalancing the order of the measurement of the dependent and independent variables. Ex-post we follow the recommendations of Podsakoff et al. (2012). Next to the typical Harman's single-factor test (which suggests that CMB is not a problem in our dataset), we also apply both the unmeasured latent method factor technique and the marker variable method. To assess the potential effects of CMB,

we add an additional latent method factor to our structural model. We then allow all the manifest variables to load on both their theoretical constructs as well as on the latent method factor to assess the amount of variance in the measurement model that is caused by measuring all of the items using the same survey instrument. The results of this procedure indicate that the model fit was improved. However, the variance explained by the newly added latent variable amounts to .18, which is fairly below the recommended cutoff value of .50 (Posch & Garaus, 2019). Further, we also include "employee turnover" as a marker variable that is unrelated to our substantive variables of interest (Podsakoff et al., 2012). The marker variable is not significantly related to any of the variables in the model. Furthermore, the partial correlations between the substantive variables of interest remain statistically significant while controlling for the marker variable (Podsakoff et al., 2012). Finally, the average path coefficient between the latent marker variable and the constructs of the study amounts to only .11, which is well below the common threshold of .30 (Posch & Garaus, 2019). In light of the results of our statistical tests, and the fact that our analyses focus on interaction effects we hence feel confident that our findings are not driven by the presence of CMB in our dataset.

Variable Measurement

All variables in this study were collected through a structured survey with closed-ended questions. Where possible, existing multi-item constructs were adopted from prior literature and slightly adapted to fit the specific empirical setting. Most variables are multi-item constructs measured on a Likert scale with a range from 1 to 7. The respondents were asked to assess to what extent the statements applied in their organizations with the end points anchored as 1 "*does not apply*" and 7 "*fully applies*".

We took several further steps to establish the validity of the survey constructs. We conducted several rounds of pretests with four academics and two CEOs. While we instructed the academics

to focus on the academic quality of the questionnaire, the interviews with practitioners mostly aimed at clarifying the terminology and enhancing the comprehensibility of the questions. Furthermore, we use both exploratory and confirmatory factor analysis, calculate Cronbach's alpha, and review the item scale for our constructs to establish both content and construct validity. Table 1 Panel A reports the results of common factor analyses used to support the unidimensionality of the reflective constructs (the results of confirmatory factor loadings are very similar in terms of factor loadings). For the formative constructs we examine item weightings obtained from principal components analysis. The items on all formative constructs are positive and have weights above the recommended minimum of 0.30 (Bedford & Malmi, 2015; Hair et al., 2011). To arrive at the final score for our variables, we average the responses across the items of a construct for the formative constructs used. For the reflective constructs we use factor scores obtained from common factor analysis (Mahlendorf, Kleinschmit & Perego 2014).[3] Factor scores include only that part of the item that is shared with the other items, and excludes unique variance (Coltman, Devinney, Midgley, & Venaik, 2008). The descriptive statistics reported in Table 2 show that all variables comprise a broad range with a minimum close to 1 and a maximum close to 7. Furthermore, the multi-trait matrix presented in Table 3 provides further support for the discriminant validity of the survey constructs because the Cronbach's alphas on the diagonal exceed inter-construct correlations in all cases.

To further corroborate the discriminant validity between our key variables risk awareness, tone from the top (i.e., top-down communication, bottom-up escalation), interactive control, and diagnostic control, we perform a hierarchical model comparison using confirmatory factor analysis

[3] In an untabulated robustness check, we reran all our analyses with equally weighted means for all our constructs instead of using averages for formative constructs and factor scores for reflective constructs. All of the findings remain inferentially identical.

(Choi, Lee, & Yoo, 2010). Following Choi et al. (2010), we estimate three different comparison models: (1) a null model, (2) a single-factor model where all 22 items load on a single factor, and (3) a five-factor model with any correlation between the factors fixed to one. A comparison of differences in chi-square statistics reveals that the five underlying factors are different from one another and that the correlations between them are statistically different from unity (Choi et al., 2010). The results of this analysis thus suggest that risk awareness, top-down communication, bottom-up escalation, interactive control, and diagnostic control display satisfactory discriminant validity. Finally, we also applied the Fornell-Larcker criterion (1981) to analyze the discriminant validity between the focal constructs of our study. In line with the Fornell-Larcker criterion (1981), the square root of the AVEs for our constructs consistently exceeds the interconstruct correlations. Overall, the statistical analyses consistently underscore that our constructs display satisfactory discriminant validity.

---- Insert Table 1 about here ----
---- Insert Table 2 about here ----
---- Insert Table 3 about here ----

Outcome variable

Risk awareness (RA) is measured based on a scale adapted from Braumann (2018), and further refined based on conceptual, theoretical and practitioner studies (Lam, 2014; Boultwood & Dominus, 2014; Cormican, 2014; Collier et al., 2007). The variable comprises the following four dimensions: (1) employees are aware of what top management expects from them with regard to dealing with risks, (2) employees have embedded risk-thinking in their work modes, (3) employees take risk aspects into consideration in their decision-making process, and (4) risk-aware actions and behaviors sustainably influence business processes. All items load on one single factor with satisfactory reliability of $\alpha = 0.91$.

Control practices

Tone from the Top (TT) comprises two dimensions that are based on communication aspects of creating proper attention toward risk issues: (1) a top-down approach including top management communication of commitment and behavioral expectations with regard to risk management, and (2) an encouragement for bottom-up communication and escalation of risk issues. The construct is operationalized as higher-order latent variable (Becker, Klein, & Wetzels, 2012). It is measured as formative, second-order construct with two first-order reflective constructs: (1) *top-down communication*, and (2) *bottom-up escalation*.[4] Top-down communication is based on Cormican (2014) and captures the extent to which top management (1) actively communicates risks and activities to be avoided by subordinates, (2) communicates the importance of considering risks in business activities to all employees, and (3) emphasizes risk awareness as active component of the organization's culture. Bottom-up escalation captures the emphasis the CEO puts on ensuring the following aspects with regard to risk management: (1) open communication channels and the fast transfer of risk-related information, (2) informal and easy access to the top management team when it comes to important risk-related topics, (3) corporate culture that encourages employees to signal potential risks, (4) constructive challenge of beliefs, assumptions and associated risks, and (5) employees being comfortable about raising dissenting opinions with regard to risks. Due to the absence of an established survey-based measurement instrument in prior literature, the scale was purpose-developed based on interviews with practitioners, inspired by the constructs organic

[4] Following the recommendations of Becker et al. (2012), we rely on the repeated-indicator approach to estimate tone from the top. The second-order latent variable tone from the top is specified using all (eight) manifest items of the underlying first-order latent constructs top-down communication and bottom-up escalation. The manifest items are hence used twice: (1) for the first-order latent variables (1st order loadings) and (2) for the second-order latent variable (2nd order loadings).

innovative culture (Chenhall, Kallunki, & Silvola, 2011) and constructive conflict (Danneels, 2008).

As Panel B in Table 1 indicates, the first-order reflective constructs display good measurement properties. Furthermore, both constructs significantly contribute to the formative second-order construct tone from the top (as indicated by the significant and positive formative weights). Given the fact that the formative measurement model is based on multiple regression, it is important to investigate the presence of multicollinearity (Fayard et al., 2012). Since the VIFs obtained are below the suggested cut-off value of 3 (Hair et al., 2011), the parameter estimates of the second-order model are not unduly influenced by multicollinearity.

Interactive control (IC) is based on Bedford (2015) and covers the following five formative dimensions along which budgets and performance measures are used: (1) intensive use by top management, (2) intensive use by operating managers, (3) face-to-face challenge and debate, (4) focus on strategic uncertainties, and (5) non-invasive, facilitating and inspirational involvement (Bisbe, Batista-Foguet, & Chenhall, 2007). The wording of the five items is based on previous work on interactive control (Widener, 2007; Henri, 2006; Bisbe & Otley, 2004).

Diagnostic control (DC) is measured based on Bedford (2015) and covers the following five dimensions along which budgets and performance measures are used: (1) identify critical performance variables (i.e., factors that indicate achievement of current strategy), (2) set targets for critical performance variables, (3) monitor progress toward critical performance targets, (4) provide information to correct deviations from preset performance targets, and (5) review key areas of performance. All items load on one single factor with satisfactory reliability of $\alpha = 0.90$.

System-specific contextual variable

Perceived environmental uncertainty (PEU) is operationalized formatively based on an established scale adapted from Moers (2006), which measures the extent to which firms can predict (1) customer behavior, (2) competitor behavior, (3) technological changes in the industry, as well as the behavior and strategies of (4) suppliers, and (5) legal and/or political developments.[5]

Control Variables

Based on prior literature, we introduce several control variables to our model that might exhibit an influence on risk awareness and the investigated control practices.

Formal risk management (FRM) is measured formatively based on Cormican (2014) and captures the extent to which a given firm has an established and comprehensive risk management process in place. We capture a firm's strategic orientation in three different ways: The measures for *Exploration* and *Exploitation* are based on the work of Patel, Messersmith, and Lepak (2013) who developed items especially tailored to the context of SMEs. *Risk-taking climate* measures to what extent firms encourage employees to take calculated risks (García-Granero, Llopis, Fernández-Mesa, & Alegre, 2015).

Outcome history (of risky decisions) is measured in line with Sitkin and Weingart (1995) and captures firms' experience with taking risky decisions. *Competitive intensity* is measured in line with Jansen, Van den Bosch, and Volberda (2006), and captures the perceived degree of competition within the industry. The measurement properties of all constructs are satisfactory.

We operationalize *Size* as the natural logarithm of the number of employees of a given firm. While we measure *Growth* with a single item capturing the extent to which a firm experienced

[5] The 7-point Likert scale is reverse-coded (i.e., higher values indicate better predictability and hence lower levels of perceived environmental uncertainty). For all the analyses, we have recoded the variable so that higher scores imply higher levels of perceived environmental uncertainty.

significant growth in the past three years, *Foreign sales* is quantified as the percentage of sales generated abroad. To control for *Industry,* we introduce several dummy variables with manufacturing firms serving as baseline category. To control for time orientation, we use two dummy variables that capture medium time horizon (1 – 3 years) and long-term time horizon (more than 3 years) with short-term time horizon (up to 1 year) serving as baseline category. To control for ownership structure, we define a dummy variable *External Management* that takes on the value of 1 if the firm is a family firm (i.e., ownership exceeding 50%) and has a non-family CEO. Finally, we also control for *firm age*.

DATA ANALYSIS AND RESULTS

Empirical strategy

Following Grabner and Moers (2013), we use two alternative strategies to test for complementarity, that is, (1) the payoff-function approach to directly test whether the effect of one control practice on risk awareness increases in the use of the other practice, and (2) the demand-function approach to test whether the control practices, on average, are adopted as a system rather than in isolation. It is important to note that the general assumptions about optimality underlying each method are basically each other's mirror image, which implies that one of these two tests tends to be strong when the other is weak (Grabner & Moers, 2013; Aral, Brynjolfsson, & Wu, 2012).

At the one extreme, the demand-function approach assumes that all firms understand the benefits of the complementarity and hence, make optimal decisions by adopting the control practices as a system instead of adopting only one of them in isolation. This would minimize the performance difference (in our setting, the difference in risk awareness) between adopter and non-

adopter firms, thus leading to weak results on the payoff-function test. On the other extreme, ignorance of performance benefits of these choices on the part of managers would lead to weak results on the demand-function test but lend high power to the payoff-function test (Aral et. al, 2012). Between these two extreme cases, if firms are still experimenting with their choices but on average tend to make optimal decisions, the demand-function test will show a significant conditional correlation between the adoption choices but then there would still be enough variation in terms of performance and a significant premium for the adopters versus the non-adopters of this system. The cross-tables reported in Table 4 support our assumption that this scenario is applicable to our setting. While in both cases there are observations in each of the four cells (supporting the view that firms are still experimenting), the pattern of joint adoption of the respective control practices is also visible (given that the low-low and high-high cells are overpopulated).

---- Insert Table 4 about here ----

Regarding the payoff-function approach, we estimate the following model:

$$RA = \beta_0 + \beta_1 TT + \beta_2 IC + \beta_3 DC + \beta_4 TT*IC + \beta_5 TT*DC + \beta_6 FRM + \beta_7 GROWTH + \beta_8 AGE + \beta_9 SIZE + \beta_{10} OUTHIS + \beta_{11} PEU + \beta_{12} FOREIGN\ SALES + \beta_{13} EXPLORATION + \beta_{14} EXPLOITATION + \beta_{15\text{-}16} TIME\ HORIZON\_DUMMIES + \beta_{17} EXTERNAL\ MANAGEMENT + \beta_{18} RTC + \beta_{19} CI + \beta_{20\text{-}25} INDUSTRY\_DUMMIES + \varepsilon_{RA}$$

Following Hartmann and Moers (1999), we use hierarchical regression analysis to test the proposed interaction effects and the research question stated. We first report a model with only the control variables (Model 1), then include the main effects for tone from the top, interactive control, and diagnostic control (Model 2), and finally add the interaction terms (Model 3). In order to better interpret the main effects and avoid potential multicollinearity problems, all variables involved in interaction terms were mean-centered prior to the analyses (Hartmann & Moers, 1999).

Regarding the demand-function approach, we estimate conditional correlations between the respective control practices. In particular, we correlate the residuals of the following regressions:

$$TT = \beta_0 + \beta_1 GROWTH + \beta_2 AGE + \beta_3 SIZE + \beta_4 OUTHIS + \beta_5 PEU + \beta_6 FOREIGN\ SALES + \beta_7 EXPLORATION + \beta_8 EXPLOITATION + \beta_{9\text{-}10} TIME\ HORIZON\_DUMMIES + \beta_{11} EXTERNAL\ MANAGEMENT + \beta_{12} RTC + \beta_{13} CI + \beta_{14\text{-}19} INDUSTRY\_DUMMIES + \varepsilon_{TT}$$

$$IC = \beta_0 + \beta_1 GROWTH + \beta_2 AGE + \beta_3 SIZE + \beta_4 OUTHIS + \beta_5 PEU + \beta_6 FOREIGN\ SALES + \beta_7 EXPLORATION + \beta_8 EXPLOITATION + \beta_{9\text{-}10} TIME\ HORIZON\_DUMMIES + \beta_{11} EXTERNAL\ MANAGEMENT + \beta_{12} RTC + \beta_{13} CI + \beta_{14\text{-}19} INDUSTRY\_DUMMIES + \varepsilon_{IC}$$

$$DC = \beta_0 + \beta_1 GROWTH + \beta_2 AGE + \beta_3 SIZE + \beta_4 OUTHIS + \beta_5 PEU + \beta_6 FOREIGN\ SALES + \beta_7 EXPLORATION + \beta_8 EXPLOITATION + \beta_{9\text{-}10} TIME\ HORIZON\_DUMMIES + \beta_{11} EXTERNAL\ MANAGEMENT + \beta_{12} RTC + \beta_{13} CI + \beta_{14\text{-}19} INDUSTRY\_DUMMIES + \varepsilon_{DC}$$

Results

The results of the interaction regression are reported in Table 5. Our full specification (Model 3) displays a satisfactory level of predictive validity with an R^2 of 0.44. To assess whether multicollinearity poses a threat to the validity of our results, we computed Variance Inflation Factors (VIF), and the results suggest that multicollinearity is of no concern to the validity of our results.

Looking at the drivers of risk awareness, our findings in Table 5, Model 3 indicate that TT ($\beta = 0.34$, $p < .01$) exhibits a positive and significant main effect on risk awareness. Despite a positive regression coefficient, the effect of IC is not significant. Regarding the control variables, we find that FRM is significantly and positively associated with risk awareness ($\beta = 0.18$, $p < .01$). Furthermore, larger firms tend to display a higher level of risk awareness ($\beta = 0.16$, $p < .10$). On the contrary, competitive intensity is negatively associated with risk awareness ($\beta = -0.12$, $p < .10$).

---- Insert Table 5 about here ----

Panel A of Table 6 reports the regression results regarding the determinants of the control choices. TT and IC are positively and significantly associated with exploitation. Outcome history is positively and significantly associated with tone from the top. Interactive control is significantly and positively associated with risk-taking climate. Both size and a long-term time horizon exhibit positive and significant effects on all three control choices. IC and DC are positively related to competitive intensity. Panel B of Table 6 reports the conditional correlations between TT and IC and DC respectively.

---- Insert Table 6 about here ----

The complementarity between TT and IC (H1)

H1 predicts that the use of interactive control increases the effect of tone from the top on risk awareness, and vice versa. Looking at the interaction coefficients (Table 5, Model 3), we indeed find a significant and positive interaction effect between TT and IC ($\beta = 0.15$, $p < .05$). This finding is in line with H1 suggesting that interactive control complements tone from the top with regard to risk awareness. Further, the conditional correlation between the two control practices, as reported in Table 6, Panel B, is positive and significant ($\rho = 0.33$, $p < .01$). This suggests that in their control system design choices, firms on average treat these two control practices as complements and tend to adopt them as a system rather than in isolation. Overall, we hence find strong support for H1.

The interrelationship between TT and DC (RQ)

We state the interrelation of TT and DC with regard to risk awareness as research question. The interaction effect between TT and DC (Table 5, Model 3) is insignificant ($\beta = -0.07$, $p > .10$), indicating that there is, on average, no interrelationship between the two control practices with regard to risk awareness. In contrast, the conditional correlation between the two practices reported in Table 6 (Panel B) is positive and significant ($\rho = 0.21$, $p < .01$), indicating that, on average, firms

are more likely to adopt either both or none of the practices compared to only one of them. Interestingly, although the two control practices do not appear to be interrelated in terms of risk awareness, firms seem to treat them as complements in their control system design choices. Thus, we do not find conclusive evidence regarding the research question stated.

The role of PEU (H2)

H2a predicts that the complementarity between TT and IC is more pronounced in a situation of high PEU compared to a situation of low PEU. H2b suggests that TT and DC are complements when PEU is low and substitutes when PEU is high. To test these predictions, we split the sample at the mean of PEU, and repeat the previous analyses in the respective sub-samples. While Table 7 reports the results of the payoff-function test for high and low levels of PEU, respectively, Table 8 reports the results of the conditional-correlation analysis.

---- Insert Table 7 about here ----

---- Insert Table 8 about here ----

In line with H2a, the interaction effect between TT and IC is significantly stronger in the high PEU sample. In fact, the complementarity with regard to risk awareness is only observed in this sub-sample ($\beta = 0.37$, $p < .01$). The difference in the coefficients between the sub-samples is also statistically significant ($p < .01$). However, we do not observe a difference in the conditional correlations between contexts of high versus low PEU (p-value = 0.76; Table 8, Panel A). These results imply that TT and IC only reinforce each other in increasing risk awareness in settings of high PEU, however firms do not take the role of PEU as a system-specific contextual variable into account in their control system design choices. Our results from the payoff-function approach support both H2b and H2c, since we find that TT and DC display a positive and significant interaction effect on risk awareness in settings of low PEU ($\beta = 0.27$, $p < .05$) and a negative and

significant interaction effect in the case of high PEU ($\beta = -0.34$, $p < .05$). The difference between the interaction effects across the two subsamples is also statistically significant ($p < .01$). The conditional correlations between TT and DC, however, do not differ across the two subsamples (p-value = 0.86).

Moreover, we also tested to which extent our results for H2 are sensitive to capturing PEU in a continuous way. We run alternative specifications with PEU as continuous variable for both the payoff-function approach (Table 9) and the demand-function approach (Table 8, Panel B).

---- Insert Table 9 about here ----

Regarding the payoff-function approach we run a regression model with two three-way interaction terms (TT * IC * PEU and TT * DC * PEU) (Table 9). In line with H1, the results reveal that the two-way interaction between TT and IC is positive and significant ($\beta = 0.14$, $p < .05$). Corroborating H2a, the three-way interaction between TT, IC, and PEU is significant and positive ($\beta = 0.21$, $p < .01$). This indicates that the complementarity between TT and IC increases with higher PEU. In the case of DC the two-way interaction between TT and DC is not significant ($\beta = -0.06$, $p > .10$), corroborating our initial findings. The three-way interaction term between TT, DC, and PEU is negative and significant ($\beta = -0.26$, $p < .05$), thus lending further support to H2b and H2c.

With regard to the demand-function approach, we follow Grabner (2014) and test the extent to which there is a positive interaction effect between PEU and the residuals of IC and DC, respectively, on the residual of TT (Table 8, Panel B). Supporting our conclusion drawn from the demand-functions main analysis, we do not find any significant interaction terms. This suggests that firms do not take the role of PEU as a system-specific contextual variable into account in their control system design choices.

Robustness checks

We run several robustness checks to gauge the validity of our findings. Recently, papers on interrelationships between control practices have suggested using a modified payoff function that is more robust with regard to testing interrelationships between control practices (Masschelein & Moers, 2018; Bedford et al., 2016). This modified payoff equation adds context-control-practice interactions to the payoff function. In our case, we add product terms for PEU and TT, PEU and IC, as well as PEU and DC to the payoff function. The findings for H1 and the research question using the payoff-function approach remain robust using this regression specification.

It could also be the case that risk awareness is driven by the firm's exposure to different risks. To determine whether our results might be subject to an omitted-correlated-variable problem we regress risk awareness on risk categories firms are exposed to (i.e., strategic, operational, financial, IT, legal/regulatory, reputation, political). We then take the residuals obtained from this regression as measure for risk awareness, independent from the level of risks a company faces, and rerun all our analyses with this alternative dependent variable capturing risk awareness. The results remain both directionally and inferentially identical compared to the original analyses.

Another set of organizational design choices that might be correlated with both risk awareness and the studied control choices are delegation of decision rights and formalization.[6] To rule out that these potentially correlated omitted variables drive our results, we rerun all analyses including them as additional covariates. Again, all our findings and inferences remain unchanged.

[6] We measure DELEGATION with a 3-item scale based on Hughes and Morgan (2007) and Hage and Aiken (1967) that captures the degree to which employees can make their own decisions within their assigned areas of responsibility. Further, FORMALIZATION is measured with a 3-item scale adapted from Hage and Aiken (1967) that captures the degree to which formalized rules are of importance and define roles and procedures of an organization.

DISCUSSION OF RESULTS

In contrast to most prior complementarity studies in management accounting research, we use two alternative approaches to test for the interdependence of control practices. Thanks to this dual approach, we are able to investigate to what extent firms' average control system choices are consistent with their effectiveness in terms of managing risk awareness. We show that interactive control strengthens the effect of tone from the top on risk awareness, and that firms at the same time tend to adopt these two choices in combination. These results indicate that indeed the two control practices complement each other in increasing risk awareness, and that firms, on average, take this complementarity into account in the design of the control system.

On average there is no interrelationship between tone from the top and diagnostic control with regard to risk awareness (RQ) because the significant and positive interaction under low PEU (H2b) and the significant and negative interaction under high PEU (H2c) cancel each other out. We do, however, find that firms, on average, treat tone from the top and diagnostic control as complements in their control system design choices. This implies that firms' control system design choices with regard to these practices are not consistent with their effectiveness in managing risk awareness. These diverging results open the door for some interesting observations. One possible explanation for this divergence is that decision makers have a different control problem other than managing risk awareness in mind when choosing to combine tone from the top and diagnostic control. It is quite possible that control practices are used to address several control problems. However, different control problems have different implications for control system design because the costs and benefits of adopting control practices jointly as a system are likely to vary across different control problems. In other words, a set of control practices might be complements in addressing one control problem but work independently or as substitutes with regard to another

one. This, of course, puts a burden on decision makers to decide which control problem is the most pressing one and how to go about the implications of leaving subsidiary control problems unaddressed. We think this is a fruitful avenue for future research meriting scholarly attention.

Finally, the results regarding environmental uncertainty raise some interesting questions. Our results imply that TT and IC only reinforce each other in increasing risk awareness in settings of high PEU, while they are independent control choices when PEU is low. Furthermore, our analyses of demand functions for TT and DC reveals that firms do not adequately take the role of PEU into account when deciding upon the joint use of both control practices (assuming the underlying design consideration is indeed managing risk awareness). Upon closer investigation, it turns out that the non-significant interaction term between tone from the top and diagnostic control is driven by two opposing and significant effects offsetting one another. From the perspective of maximizing risk awareness, our results suggest that under low PEU both practices reinforce one another in driving risk awareness. In the context of high PEU, however, SMEs should either focus on tone from the top or diagnostic control but not use both controls simultaneously, since they are substitutes with regard to risk awareness in this setting. Our analyses of demand functions, however, reveals that there is no significant difference between the conditional correlations across low and high-PEU subsamples.

Despite the fact that environmental uncertainty is considered as one of the most important and most widely studied contextual factors (Chenhall, 2003), our results thus show that firms, at least when it comes to control practices related to managing risks, do not take the role of PEU adequately into account in their control system design choices (assuming the underlying design consideration is indeed managing risk awareness). This might suggest that firms over-invest in control practices in settings of low PEU, or again that another control problem is more intensely affected by PEU. While our dataset does not allow for a closer examination of the different findings

between payoff-function and demand-function approaches, we consider studies with a similar methodological approach as a promising avenue for future research.

CONCLUSION

This study investigates the drivers of risk awareness – a so far rather neglected outcome variable in prior research. Based on literature that casts doubt on the effectiveness of technocratic risk-management approaches (Paape & Speklé, 2012), we take a more behavioral perspective and investigate to what extent risk awareness is driven by the interplay between tone from the top and both interactive control and diagnostic control. Similar to prior studies in this area, we investigate the role of control system design to manage risks (Braumann, 2018; Posch, 2019; Ittner & Keusch, 2017) – an area that is according to Mikes (2009, 37) "riddled with possibilities and tensions".

It is important that the findings of this study are interpreted in the context of their limitations. The obvious drawback of cross-sectional surveys is that they do not allow for the claim of causality. Any statements of causality in this paper are hence purely based on theoretical positions. Second, we use the same informant to collect both dependent and independent variables. Despite careful development of our survey instrument, extensive pre-testing, and good statistical validity and reliability, the data we use is of perceptual nature and may thus contain noise. A fruitful avenue for future research would hence be developing and using a more robust measure of risk awareness but also using other measures for tone from the top, e.g., based on linguistic analysis on earnings-conference calls (Hope & Wang, 2018). Moreover, our analysis focuses on interactive and diagnostic use of budgets and performance measures only, which introduces a narrower focus on control practices compared to previous work (e.g., Bisbe & Malagueño, 2009). We leave it up to future studies to consider a broader range of control practices (e.g., strategic planning, guidelines

and rules, approval procedures, trainings, etc.). Relatedly, we acknowledge that our study only focuses on the use of budgeting for risk management purposes and hence abstracts away from other budgeting roles such as planning, performance evaluation and coordination (Arnold & Artz, 2019; Hansen & Van der Stede, 2004). Hence, future studies may investigate to what extent the risk-management use of budgeting is conflicting with other roles of budgeting. Furthermore, our study aims at measuring the effect of control practices on company-wide risk awareness, and it is not our intent to study the effect of control practices on the awareness of specific risk domains. Our conceptual use of risk is in line with specifications in updated versions of popular ERM frameworks (ISO, 2018; COSO, 2017) and thus coherent with current risk thinking. Nevertheless, literature may benefit from future studies differentiating between different risk categories and investigating which control practice(s) might be more effective than other control practice(s) in managing specific types of risks. Finally, both the country-specific context and the SME context of our study limit the generalizability of our results. A useful extension would thus be to find out whether our findings still hold in other empirical contexts. Bearing these limitations in mind, we believe our study makes an important contribution to management accounting research.

REFERENCES

Aabo, T., Fraser, J. R. S., & Simkins, B. J. (2005). The rise and evolution of the chief risk officer: Enterprise risk management at Hydro One. *Journal of Applied Corporate Finance, 17*(3), 62–75.

Agle, B. R., Nagarajan, N. J., Sonnenfeld, J. A., & Srinivasan, D. (2006). Does CEO charisma matter? An empirical analysis of the relationships among organizational performance, environmental uncertainty, and top management team perceptions of CEO charisma. *The Academy of Management Journal*, *49*(1), 161–174.

Amernic, J., Craig, R., & Tourish, D. (2010). *Measuring and assessing tone at the top using annual report CEO letters.* Great Britain: The Institute of Chartered Accountants in Scotland.

Aral, S., Brynjolfsson, E., & Wu, L. (2012). Three-way complementarities. Performance pay, human resource analytics, and information technology. *Management Science*, *58*(5), 913–931.

Arnold, M., & Artz, M. (2019). The use of a single budget or separate budgets for planning and performance evaluation. *Accounting, Organizations and Society*, *73*, 50–67.

Banks, E. (2012). *Risk culture. A practical guide to building and strengthening the fabric of risk management*. London, UK: Palgrave Macmillan.

Beasley, M. S., Clune, R., & Hermanson, D. R. (2005). Enterprise risk management: An empirical analysis of factors associated with the extent of implementation. *Journal of Accounting and Public Policy*, *24*, 521–531.

Becker, J.-M., Klein, K., & Wetzels, M. (2012). Hierarchical latent variable models in PLS-SEM: Guidelines for using reflective-formative type models. *Long Range Planning*, *45*(5-6), 359–394.

Bedford, D. S. (2015). Management control systems across different modes of innovation: Implications for firm performance. *Management Accounting Research, 28*, 12–30.

Bedford, D. S., & Malmi, T. (2015). Configurations of control: An exploratory analysis. *Management Accounting Research*, *27*, 2–26.

Bedford, D. S., Malmi, T., & Sandelin, M. (2016). Management control effectiveness and strategy: An empirical analysis of packages and systems. *Accounting, Organizations and Society*, *51*, 12–28.

Bisbe, J., & Malagueño, R. (2009). The choice of interactive control systems under different innovation management modes. *European Accounting Review*, *18*(2), 371–405.

Bisbe, J., & Otley, D. (2004). The effects of the interactive use of management control systems on product innovation. *Accounting, Organizations and Society*, *29*(8), 709–737.

Bisbe, J., J. M. Batista-Foguet, and R. Chenhall (2007). Defining management accounting constructs: A methodological note on the risks of conceptual misspecification. *Accounting Organizations and Society 32*(7-8), 789-820.

Boultwood, B., and M. Dominus. 2014. Developing an effective risk culture. *Electric Perspectives* 39 (3):57-60.

Braumann, E. C. (2018). Analyzing the role of risk awareness in enterprise risk management. *Journal of Management Accounting Research (2):241-268*.

Bromiley, P., McShane, M., Nair, A., & Rustambekov, E. (2015). Enterprise risk management: Review, critique, and research directions. *Long Range Planning*, *48*(4), 265–276.

Bstieler, L. (2005). The moderating effect of environmental uncertainty on new product development and time efficiency. *Journal of Product Innovation Management*, *22*(3), 267–284.

Cassiman, B., & Veugelers, R. (2006). In search of complementarity in innovation strategy: Internal R&D and external knowledge acquisition. *Management Science*, *52*(1), 68–82.

Chenhall, R. H. (2003). Management control systems design within its organizational context: Findings from contingency-based research and directions for the future. *Accounting, Organizations and Society*, *28*(2), 127–168.

Chenhall, R. H., Kallunki, J.-P., & Silvola, H. (2011). Exploring the relationships between strategy, innovation, and management control systems: The roles of social networking, organic innovative culture, and formal controls. *Journal of Management Accounting Research*, *23*(1), 99–128.

Choi, S. Y., Lee, H., & Yoo, Y. (2010). The impact of information technology and transactive memory systems on knowledge sharing, application, and team performance: A field study. *MIS Quarterly*, *34*(4), 855–870.

Christensen, D. M., Dhaliwal, D. S., Boivie, S., & Graffin, S. D. (2015). Top management conservatism and corporate risk strategies: Evidence from managers' personal political orientation and corporate tax avoidance. *Strategic Management Journal*, *36*(12), 1918–1938.

Collier, P. M., Berry, A. J., & Burke, G. T. (2007). *Risk and management accounting: best practice guidelines for enterprise-wide internal control procedures.* Burlington: Elsevier.

Coltman, T., Devinney, T. M., Midgley, D. F., & Venaik, S. (2008). Formative versus reflective measurement models: Two applications of formative measurement. *Journal of Business Research*, *61*(12), 1250–1262.

Cormican, K. (2014). Integrated enterprise risk management: From process to best practice. *Modern Economy*, *5*, 401–413.

COSO. (2017). *Enterprise risk management. Aligning risk with strategy and performance.* Committee of Sponsoring Organizations of the Treadway Commission.

Danneels, E. (2008). Organizational antecedents of second-order competences. *Strategic Management Journal*, *29*(5), 519–543.

Detert, J. R., and L. K. Trevino (2010). Speaking up to higher ips: How supervisors and skip-level leaders influence employee voice. *Organization Science 21*, 249-270.

Falkenberg, L., and I. Herremans (1995). Ethical behaviours in organizations: Directed by the formal or informal systems? *Journal of Business Ethics 14*, 133-143.

Falkner, E. M., & Hiebl, M. R.W. (2015). Risk management in SMEs: a systematic review of available evidence. *The Journal of Risk Finance*, *16*(2), 122–144.

Fayard, D., Lee, L. S., Leitch, R. A., & Kettinger, W. J. (2012). Effect of internal cost management, information systems integration, and absorptive capacity on inter-organizational cost management in supply chains. *Accounting, Organizations and Society*, *37*(3), 168–187.

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, *18*(1), 39–50.

Galbraith, J. (1973). *Designing complex organizations.* Reading, MA: Addison-Wesley Publishing Company.

García-Granero, A., Llopis, Ó., Fernández-Mesa, A., & Alegre, J. (2015). Unraveling the link between managerial risk-taking and innovation: The mediating role of a risk-taking climate. *Journal of Business Research*, *68*(5), 1094–1104.

Gordon, L. A., Loeb, M. P., & Tseng, C.-Y. (2009). Enterprise risk management and firm performance: A contingency perspective. *Journal of Accounting and Public Policy*, *28*(4), 301–327.

Govindarajan, V. (1984). Appropriateness of accounting data in performance evaluation: an empirical examination of environmental uncertainty as an intervening variable. *Accounting, organizations and society*, *9*(2), 125-135.

Grabner, I. (2014). Incentive system design in creativity-dependent firms. *The Accounting Review*, *89*(5), 1729–1750.

Grabner, I., & Moers, F. (2013). Management control as a system or a package? Conceptual and empirical issues. *Accounting, Organizations and Society*, *38*(6-7), 407–419.

Grabner, I., Posch, A., & Wabnegg, M. (2018). Materializing innovation capability: A management control perspective. *Journal of Management Accounting Research*. https://doi.org/10.2308/jmar-52062 (forthcoming).

Hage, J., & Aiken, M. (1967). Relationship of centralization to other structural properties. *Administrative Science Quarterly*, *12*(1), 72–92.

Hair, J. F., C. M. Ringle, & Sarstedt, M. (2011). PLS-SEM: Indeed a silver bullet. *Journal of Marketing Theory and Practice*, *19*(2), 139–152.

Hansen, S. C., & Van der Stede, Wim A. (2004). Multiple facets of budgeting: An exploratory analysis. *Management Accounting Research*, *15*(4), 415–439.

Hartmann, F. G., & Moers, F. (1999). Testing contingency hypotheses in budgetary research: An evaluation of the use of moderated regression analysis. *Accounting, Organizations and Society*, *24*(4), 291–315.

Henri, J.-F. (2006). Management control systems and strategy: A resource-based perspective. *Accounting, Organizations and Society*, *31*(6), 529–558.

Hope, O.-K., & Wang, J. (2018). Management deception, big-bath accounting, and information asymmetry: Evidence from linguistic analysis. *Accounting, Organizations and Society 70, 33-51*.

Hughes, M., & Morgan, R. E. (2007). Deconstructing the relationship between entrepreneurial orientation and business performance at the embryonic stage of firm growth. *Industrial Marketing Management*, *36*(5), 651–661.

ISO. (2018). ISO 31000:2018 *Risk management - guidelines.* Geneva, Switzerland: International Organization for Standardization, https://www.iso.org.

Ittner, C. D., & Keusch, T. (2017). Incorporating risk considerations into planning and control systems: The influence of risk management value creation objectives In P. Linsley, & M. Woods (Eds.), 150–172. *The Routledge Companion to Accounting and Risk.* London: Routledge.

Jansen, J. J. P., Van Den Bosch, Frans A. J., & Volberda, H. W. (2006). Exploratory innovation, exploitative innovation, and performance: Effects of organizational antecedents and environmental moderators. *Management Science*, *52*(11), 1661–1674.

Janvrin, D. J., Payne, E. A., Byrnes, P., Schneider, G. P., & Curtis, M. B. (2012). The updated COSO internal control—integrated framework: Recommendations and opportunities for future research. *Journal of Information Systems*, *26*(2), 189–213.

Lam, J. (2014). *Enterprise risk management: from incentives to controls.* New Jersey: Wiley.

Landsittel, D. L., & Rittenberg, L. E. (2010). COSO. Working with the academic community. *Accounting Horizons*, *24*(3), 455–469.

Lumpkin, G. T., Brigham, K. H., & Moss, T. W. (2010). Long-term orientation: Implications for the entrepreneurial orientation and performance of family businesses. *Entrepreneurship & Regional Development*, *22*(3-4), 241–264.

Mahlendorf, M. D., Kleinschmit, F., & Perego, P. (2014). Relational effects of relative performance information: The role of professional identity. *Accounting, Organizations and Society*, *39*(5), 331–347.

Masschelein, S., & Moers, F. (2018). Statistical methods for accounting systems. Working Paper presented at the *Accounting, Organizations and Society Conference on Management Control as System or Package*, Maastricht, Netherlands, 26-27 October 2018.

Melnyk, S. A., Bititci, U., Platts, K., Tobias, J., & Andersen, B. (2014). Is performance measurement and management fit for the future? *Management Accounting Research*, *25*(2), 173–186.

Merchant, K. A. (1985). *Control in business organizations*. Marshfield, MA: Pitman Publishing.

Merchant, K. A., & Van der Stede, Wim A. (2017). Management control systems: Performance measurement, evaluation, and incentives. (Fourth edition). Englewood Cliffs, NJ: Prentice Hall.

Mikes, A. (2009). Risk management and calculative cultures. *Management Accounting Research*, *20*(1), 18–40.

Mikes, A. (2011). From counting risk to making risk count: Boundary-work in risk management. *Accounting Organizations and Society*, *36*, 226–245.

Milgrom, P., & Roberts, J. (1995). Complementarities and fit strategy, structure, and organizational change in manufacturing. *Journal of Accounting and Economics*, *19*(2–3), 179–208.

Miller, D., & Toulouse, J. M. (1986). Chief executive personality and corporate strategy and structure in small firms. *Management Science*, *32*(11), 1389–1409.

Mitchell, F., & Reid, G. C. (2000). Problems, challenges and opportunities: The small business as a setting for management accounting research. *Management Accounting Research*, *11*(4), 385–390.

Moers, F. (2006). Performance measurement properties and delegation. *The Accounting Review*, *81*(4), 897–924.

Morales, J., Gendron, Y., & Guénin-Paracini, H. (2014). The construction of the risky individual and vigilant organization: A genealogy of the fraud triangle. *Accounting, Organizations and Society*, *39*(3), 170–194.

Mundy, J. (2010). Creating dynamic tensions through a balanced use of management control systems. *Accounting, Organizations and Society*, *35*(5), 499–523.

Paape, L., & Speklé, R. F. (2012). The adoption and design of enterprise risk management practices: An empirical study. *European Accounting Review*, *21*(3), 533–564.

Patel, P. C., Messersmith, J. G., & Lepak, D. P. (2013). Walking the tightrope: An assessment of the relationship between high-performance work systems and organizational ambidexterity. *Academy of Management Journal*, *56*(5), 1420–1442.

Penno, M. (2019). A theory of assurance: Balancing costly formal control with tone at the top (May 13, 209). Working Paper Available at SSRN: https://ssrn.com/abstract=2876700.

Podsakoff, P. M., MacKenzie, S. B., & Podsakoff, N. P. (2012). Sources of method bias in social science research and recommendations on how to control it. *Annual review of psychology*, *63*, 539–569.

Posch, A., & Garaus, C. (2019). Boon or Curse? A contingent view on the relationship between strategic planning and organizational ambidexterity. *Long Range Planning*. https://doi.org/10.1016/j.lrp.2019.03.004.

Posch, A. (2019). *A management-control perspective on risk management: The complementarity between risk-focused results controls and risk-focused information sharing.* Working Paper: University of Bern.

Roberts, J. (1990). Strategy and accounting in a U.K. conglomerate. *Accounting, Organizations and Society*, *15*(1-2), 107–126.

Roelofsen, M., Blok, V., & Wubben, E. F. M. (2015). Maintaining the CSR-identity of sustainable entrepreneurial firms. S. O. Idowu, C.S. Frederiksen, A. Y. Mermod, & M. E. J. Nielsen, *Corporate Social Responsibility and Governance* (pp. 63–88). Heidelberg, Germany: Springer Cham.

Shapiro, B. (2016). Using traditional narratives and other narrative devices to enact humanizing business practices. *Journal of Business Ethics*, *139*(1), 1–19.

Siemsen, E., Roth, A., & Oliveira, P. (2010). Common method bias in regression models with linear, quadratic, and interaction effects. *Organizational Research Methods*, *13*(3), 456–476.

Simons, R. (1995). *Levers of control. How managers use innovative control systems to drive strategic renewal*. Harvard Business School press, Boston, MA.

Sitkin, S. B., & Weingart, L. R. (1995). Determinants of risky decision-making behavior: A test of the mediating role of risk perceptions and propensity. *Academy of Management Journal*, *38*(6), 1573–1592.

Su, S., Baird, K., & Schoch, H. (2015). The moderating effect of organisational life cycle stages on the association between the interactive and diagnostic approaches to using controls with organisational performance. *Management Accounting Research*, *26*, 40–53.

Van de Ven, A. H. (1986). Central problems in the management of innovation. *Management Science*, *32*(5), 590-607.

Van der Stede, W. (2009). Enterprise governance. *Financial Management*, February, 38-40.

Weaver, G. R., Treviño, L. K., & Cochran, P. L. (1999). Corporate ethics programs as control systems: Influences of executive commitment and environmental factors. *The Academy of Management Journal*, *42*(1), 41–57.

Widener, S. K. (2007). An empirical analysis of the levers of control framework. *Accounting, Organizations and Society*, *32*(7-8), 757–788.

Zeier Roeschmann, A. (2014). Risk culture: What it is and how it affects an insurer'srRisk management. *Risk Management and Insurance Review*, *17*(2), 277–296.

TABLE 1 – Panel A
Construct validity [a]

Risk awareness (RA) (Reflectively measured)

Cronbach's α = 0.91	Composite reliability = 0.94	AVE = 0.79	Factor loadings
Employees are aware of what top management expects from them with regard to dealing with risks			**0.808**
Employees have embedded risk thinking in their work modes			**0.900**
Employees take risk aspects into consideration in their decision-making process			**0.920**
Risk-aware actions and behaviors sustainably influence our business processes			**0.726**

Interactive control (IC) (Formatively measured)

Cronbach's α: n/a	Composite reliability: n/a	AVE: n/a	PCA loadings
The top management team uses budgets and performance measures for the following:			
Provide a recurring and frequent agenda for top management activities			**0.417**
Provide a recurring and frequent agenda for subordinate activities			**0.458**
Enable continual challenge and debate of underlying data, assumptions and action plans with subordinates and peers			**0.465**
Focus attention on strategic uncertainties (i.e., factors that may invalidate current strategy or provide opportunities for new strategic initiatives)			**0.437**
Encourage and facilitate dialog and information sharing with subordinates			**0.458**

Diagnostic control (DC) (Reflectively measured)

Cronbach's α = 0.90	Composite reliability = 0.93	AVE = 0.73	Factor loadings
The top management team uses budgets and performance measures for the following:			
Identify critical performance variables (i.e., factors that indicate achievement of current strategy)			**0.849**
Set targets for critical performance variables			**0.803**
Monitor progress toward critical performance targets			**0.879**
Provide information to correct deviations from preset performance targets			**0.858**
Review key areas of performance			**0.666**

Formal risk management (FRM) (Formatively measured)

Cronbach's α: n/a	Composite reliability: n/a	AVE: n/a	PCA loadings
Our company has a standardized approach to determine the root cause of risks			**0.425**
Our company classifies identified risks using ex-ante defined risk categories			**0.448**
Our company estimates likelihood and impact of risks			**0.462**
Our company takes systematic measures if risks develop unfavorably			**0.458**
Our company regularly monitors the status of each risk			**0.441**

Growth (GROWTH)

Our firm experienced significant growth in the past three years	**n/a**

Outcome history (OUTHIS) (Reflectively measured)

Cronbach's α = 0.72	Composite reliability = 0.83	AVE = 0.63	Factor loadings
So far, we have not experienced any negative effects resulting from risky decisions			**0.548**
We have analyzed past risky decisions in most cases correctly			**0.771**
We have mostly had positive outcomes from risky decisions			**0.723**

Perceived environmental uncertainty (PEU) (Formatively measured)

Cronbach's α: n/a	Composite reliability: n/a	AVE: n/a	PCA loadings
How do you assess the predictability of changes in the following areas?			
Behavior and buying patterns of customers			**0.420**
Behavior/strategies of competitors			**0.502**
Technological developments in our company's primary industry			**0.412**
Behavior/strategies of your suppliers			**0.457**
Legal/political developments			**0.439**

Foreign sales (FS)

How much revenue do you generate abroad?	**n/a**

Exploration (EXPLORATION) (Reflectively measured)

Cronbach's α = 0.86	Composite reliability = 0.90	AVE = 0.64	Factor loadings
We look for novel technological ideas by thinking "outside the box"			**0.735**
We create products or services that are innovative to the firm			**0.802**
We look for creative ways to satisfy its customers' needs			**0.728**
We aggressively venture into new market segments			**0.741**
We actively target new customers groups			**0.690**

Exploitation (EXPLOITATION) (Reflectively measured)

Cronbach's α = 0.77	Composite reliability = 0.86	AVE = 0.55	Factor loadings
We commit to improve quality and lower cost			**0.718**
We continuously improve the reliability of our products and services			**0.746**
We constantly survey existing customers' satisfaction			**0.498**
We fine-tune what our firm offers to keep our current customers satisfied			**0.761**
We penetrate more deeply into our existing customer base			**0.592**

Risk-taking climate (RTC) (Reflectively measured)

Cronbach's α = 0.75	Composite reliability = 0.86	AVE = 0.67	Factor loadings
Pursuing new business ideas, we encourage employees to take calculated risks			**0.690**
We especially value both exploration and experimentation for opportunities			**0.723**
Employees receive support and encouragement when presenting new ideas			**0.614**

Competitive intensity (CI) (Reflectively measured)

Cronbach's α = 0.87	Composite reliability = 0.92	AVE = 0.79	Factor loadings
We face strong competitors in our industry			**0.777**
Competition in our main industry is extremely high			**0.924**
Price competition is a hallmark of our main industry			**0.769**

[a] Panel A of Table 1 illustrates the results of factor analyses for the constructs used in this study. Factor loadings > 0.400 used in the final measurement of reflective constructs are in bold. For reflectively measured constructs we report the factor loadings based on common factor analysis (i.e., factor loadings). In line with Bedford and Malmi (2015), we examine the factor loadings for formatively measured constructs through principal components analysis (i.e., PCA loadings) and analyze the variance inflation factors (VIF) to assess multicollinearity. Consistent with prior literature PCA loadings > 0.300 are in bold and used in the final measurement of the formative constructs. The maximum VIF for the items of the formatively measured constructs is 3.35 and is thus well below the general threshold of 10 (Bedford & Malmi, 2015). Furthermore, as items need not covary in formative constructs, conventional tests of validity and reliability are not appropriate (Bedford & Malmi, 2015). Thus, we do not calculate Cronbach's α, composite reliability and AVE for our formative constructs (as indicated by n/a).

TABLE 1 – Panel B
Reflective-Formative Measurement Model Validation
of Higher-Order Construct Tone From the Top [b]

Top-down communication (TT) (Formative weight 0.47***, VIF = 1.32)

Cronbach's α = 0.82	Composite reliability = 0.89	AVE = 0.74	Factor loadings	
Top management …			1st Order	2nd Order
… actively communicates risks and activities to be avoided by subordinates			**0.827**	**0.678**
… communicates the importance of considering risks in business activities to all employees			**0.913**	**0.759**
… emphasizes risk awareness as active component of the organization's culture			**0.834**	**0.628**

Bottom-up escalation (TT) (Formative weight 0.68***, VIF = 1.32)

Cronbach's α = 0.87	Composite reliability = 0.90	AVE = 0.65	Factor loadings	
As CEO I put special emphasis on ensuring …			1st Order	2nd Order
… open communication channels and the fast transfer of risk-related information			**0.699**	**0.663**
… informal and easy access to the top management team when it comes to important risk-related topics			**0.823**	**0.758**
… that our corporate culture encourages employees to signal potential risks			**0.815**	**0.749**
… a constructive challenge of beliefs, assumptions and associated risks			**0.862**	**0.781**
… that employees are comfortable about raising dissenting opinions with regard to risks			**0.820**	**0.725**

[b] Panel B of Table 1 illustrates the measurement properties of the formative higher-order construct tone from the top using the first-order reflective constructs top-down communication and bottom-up escalation. The formative weights of the reflectively measured first-order dimensions are reported in brackets next to the construct labels. Using the repeated-indicator approach implies that we use the manifest variables for both first-order and second-order constructs. Hence, for all items used we report both the loadings on the reflective first-order dimension and the loadings on the formative second-order dimension.

TABLE 2

Descriptive statistics for survey constructs [a]

Construct	Min	Mean	Median	Max	Std. dev.
Risk awareness (RA)	1.00	5.00	5.25	7.00	1.29
Tone from the top (TT)	2.88	5.68	5.75	7.00	0.86
Top-down communication	1.67	5.07	5.00	7.00	1.18
Bottom-up escalation	2.80	6.05	6.20	7.00	0.88
Interactive control (IC)	1.00	4.97	5.00	7.00	1.24
Diagnostic control (DC)	1.00	5.34	5.60	7.00	1.25
Formal risk management (FRM)	1.00	4.29	4.20	7.00	1.41
Growth (GROWTH)	1.00	3.51	4.00	7.00	1.93
Outcome history (OUTHIS)	1.00	4.86	5.00	7.00	1.17
Perceived environmental uncertainty (PEU)	1.60	3.87	4.00	6.20	0.90
Foreign sales (FS)	0.00	28.50	10.00	100.00	34.04
Exploration (EXPLORATION)	1.00	4.85	5.20	7.00	1.30
Exploitation (EXPLOITATION)	2.60	5.57	5.60	7.00	0.89
Risk-taking climate (RTC)	1.00	4.60	4.67	7.00	1.24
Competitive intensity (CI)	1.00	5.64	6.00	7.00	1.30

[a] We use factor scores for our reflectively measured constructs. For ease of interpretation, however, we report in this table the equally weighted means for the multi-item measures used.

TABLE 3
Multi-trait matrix [a]

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1 RA	**0.91**														
2 TT	0.519***	**n/a**													
3 IC	0.309***	0.472***	**n/a**												
4 DC	0.286***	0.341***	0.662***	**0.90**											
5 FRM	0.488***	0.488***	0.251***	0.347***	**n/a**										
6 Growth	0.182**	0.139*	0.069	0.091	0.152**	**n/a**									
7 Age	0.075	-0.012	0.057	0.065	0.059	-0.040	**n/a**								
8 Size	0.268***	0.186***	0.168**	0.200***	0.231***	0.048	0.038	**n/a**							
9 OUTHIS	0.114	0.291***	0.166**	0.106	0.235***	0.154**	0.052	-0.112	**0.72**						
10 PEU	-0.135*	-0.169**	-0.112	-0.078	-0.161**	-0.190***	0.060	-0.073	-0.065	**n/a**					
11 FS	0.205***	0.188***	0.089	0.064	0.174**	0.204***	0.052	0.269***	0.068	-0.078	**n/a**				
12 Exploration	0.244***	0.344***	0.335***	0.269***	0.220***	0.290***	-0.012	0.199***	0.088	-0.221***	0.350***	**0.86**			
13 Exploitation	0.287***	0.401***	0.349***	0.255***	0.303***	0.278***	0.008	0.220***	0.163**	-0.196***	0.252***	0.642***	**0.77**		
14 RTC	0.203***	0.341***	0.390***	0.289***	0.170**	0.070	-0.083	0.067	0.204***	-0.203***	0.219***	0.604***	0.376***	**0.75**	
15 CI	-0.107	-0.044	0.203***	0.282***	-0.067	-0.220***	0.148**	-0.064	-0.043	0.186***	-0.168**	-0.146**	-0.095	0.105	**0.87**

*, **, *** Indicate $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively, two-tailed test.
Please refer to Table 1 for a description of the multi-item constructs.
[a] The diagonal of the matrix shows the Cronbach's alpha for each variable. The other cells of the table report bivariate correlation coefficients. We do not calculate Cronbach's alpha for formative constructs and single-item constructs (as indicated by n/a).

TABLE 4
Cross-Tables[7]

	Low IC	**High IC**	*Total*
Low TT	**57** *(29%)*	**29** *(14%)*	86
High TT	**43** *(22%)*	**69** *(35%)*	112
Total	100	98	198

	Low DC	**High DC**	*Total*
Low TT	**59** *(30%)*	**27** *(13%)*	86
High TT	**41** *(21%)*	**71** *(36%)*	112
Total	100	98	198

[7] Observations were split at the mean values of *TT*, *IC*, and *DC*. Relative amount of observations per quadrants to total observations are in parentheses.

TABLE 5
Payoff-function approach

Hierarchical regression analysis – risk awareness as dependent variable

	Control variables only (Model 1)	**Main effects added (Model 2)**	**Interaction effects added (Model 3)**
Intercept	-1.509***	-1.290**	-1.351***
	(0.530)	(0.515)	(0.513)
FRM	0.262***	0.184***	0.184***
	(0.046)	(0.049)	(0.049)
Growth	0.023	0.029	0.035
	(0.033)	(0.032)	(0.032)
Age	0.000	0.001	0.001
	(0.001)	(0.001)	(0.001)
Size	0.202**	0.165*	0.162*
	(0.094)	(0.092)	(0.091)
Outcome history	-0.015	-0.075	-0.080
	(0.075)	(0.074)	(0.073)
PEU	-0.002	0.006	-0.009
	(0.069)	(0.066)	(0.067)
Foreign sales	0.002	0.002	0.002
	(0.002)	(0.002)	(0.002)
Exploration	-0.024	-0.057	-0.049
	(0.105)	(0.102)	(0.102)
Exploitation	0.113	0.048	0.040
	(0.090)	(0.089)	(0.089)
Medium time horizon	0.215	0.167	0.196
	(0.182)	(0.177)	(0.175)
Long-term time horizon	0.524**	0.344*	0.327
	(0.209)	(0.206)	(0.204)
External management	0.125	0.138	0.137
	(0.124)	(0.120)	(0.119)
Risk-taking climate	0.117	0.065	0.038
	(0.097)	(0.095)	(0.096)
Competitive intensity	-0.094	-0.111	-0.121*
	(0.070)	(0.071)	(0.070)
†Industry dummies			
Tone from the top		0.279***	0.335***
		(0.077)	(0.083)
Interactive control		0.030	0.010
		(0.069)	(0.069)
Diagnostic control		0.030	0.031
		(0.085)	(0.086)
Tone from the top * Interactive control			**0.154** (0.068)**
Tone from the top * Diagnostic control			**-0.070 (0.083)**

R^2	0.3575	0.4148	0.4358
F improvement of fit	4.93***	5.67***	3.20**
n	198	198	198

*, **, *** Indicate $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively, two-tailed test.
Standard errors are in parentheses.

† For ease of illustration, the coefficients for the industry dummies are not presented. Compared to manufacturing firms wholesale firms ($\beta \approx 0.315$, $p < 0.10$, two-tailed) display a significantly higher level of risk awareness.
This table reports the payoff-function approach to test hypothesis 1 and our research question.

Please refer to Table 1 for a description of the multi-item constructs.

TABLE 6
Demand-function approach

Panel A: Regression analysis

	Tone from the top	Interactive control	Diagnostic control
Intercept	-1.080**	-1.250**	-1.196**
	(0.463)	(0.579)	(0.463)
Growth	-0.019	-0.002	0.026
	(0.035)	(0.044)	(0.035)
Age	-0.001	0.000	0.000
	(0.001)	(0.001)	(0.001)
Size	0.185*	0.227*	0.219**
	(0.099)	(0.124)	(0.099)
Outcome history	0.281***	0.150	0.098
	(0.078)	(0.098)	(0.078)
PEU	-0.060	-0.050	-0.046
	(0.073)	(0.092)	(0.073)
Foreign sales	0.002	-0.002	-0.002
	(0.002)	(0.003)	(0.002)
Exploration	0.067	0.155	0.132
	(0.112)	(0.140)	(0.112)
Exploitation	0.269***	0.297**	0.095
	(0.095)	(0.119)	(0.095)
Medium time horizon	0.118	0.351	0.279
	(0.194)	(0.243)	(0.194)
Long-term time horizon	0.585***	0.538*	0.429*
	(0.222)	(0.278)	(0.222)
External management	-0.016	-0.251	-0.020
	(0.132)	(0.165)	(0.132)
Risk-taking climate	0.169	0.269**	0.111
	(0.104)	(0.130)	(0.104)
Competitive intensity	-0.005	0.258***	0.328***
	(0.074)	(0.093)	(0.074)
†Industry dummies			
R^2	0.3326	0.3206	0.2686
F-value	4.67***	4.42***	3.44***
n	198	198	198

Panel B: Conditional correlations

	ε_{TT}	ε_{IC}
ε_{IC}	0.325***	
ε_{DC}	0.211***	0.574***

*, **, *** Indicate $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively, two-tailed test.
Standard errors are in parentheses.

† For ease of illustration, the coefficients for the industry dummies are not presented in Panel A. Compared to manufacturing firms, firms offering professional, scientific, and technical services ($\beta \approx 0.554$, $p < 0.05$, two-tailed)

display a significant and positive effect on tone from the top. Regarding interactive control retail firms ($\beta \approx 0.699$, $p < 0.05$, two-tailed), firms in transportation and warehousing ($\beta \approx 0.690$, $p < 0.10$, two-tailed), and firms engaged in wholesale trade ($\beta \approx 0.413$, $p < 0.10$, two-tailed) display significantly higher levels compared to manufacturing firms.

This table reports the demand-function approach for tone from the top, interactive control, and diagnostic control. Panel A reports the regressions of tone from the top, interactive control, and diagnostic control on their joint determinants. Panel B reports the overall correlation of the residuals derived from the regressions in Panel A.

ε_{TT}, ε_{IC}, and ε_{DC} are the residuals obtained from regressing tone from the top (TT), interactive control (IC), and diagnostic control (DC) on their joint determinants.

Please refer to Table 1 for a description of the multi-item constructs.

TABLE 7
Payoff-function approach

Regression analysis for low-PEU and high-PEU subsamples – risk awareness as dependent variable

	Low PEU (< 3.87)	**High PEU (≥ 3.87)**
Intercept	-1.129**	-2.100***
	(0.518)	(0.719)
FRM	0.254***	0.205***
	(0.069)	(0.073)
Growth	0.025	0.029
	(0.041)	(0.055)
Age	-0.001	0.002
	(0.002)	(0.001)
Size	0.162	0.221
	(0.115)	(0.147)
Outcome history	-0.014	-0.130
	(0.093)	(0.122)
Foreign sales	0.001	0.004
	(0.003)	(0.003)
Exploration	-0.053	-0.288
	(0.136)	(0.178)
Exploitation	-0.029	0.154
	(0.112)	(0.151)
Medium time horizon	0.287	0.362
	(0.217)	(0.291)
Long-term time horizon	0.511*	0.356
	(0.260)	(0.321)
External management	0.143	0.250
	(0.175)	(0.190)
Risk-taking climate	0.205	0.025
	(0.144)	(0.143)
Competitive intensity	0.061	-0.247*
	(0.084)	(0.129)
†Industry dummies		
Tone from the top	0.368***	0.220*
	(0.111)	(0.129)
Interactive control	-0.040	0.117
	(0.089)	(0.110)
Diagnostic control	-0.106	0.001
	(0.116)	(0.139)
Tone from the top * Interactive control	**-0.089**	**0.374*** **
	(0.090)	**(0.114)**
Tone from the top * Diagnostic control	**0.265****	**-0.337****
	(0.121)	**(0.137)**

R^2	0.6007	0.4801
F-value	4.45***	2.96***
n	96	102

*, **, *** Indicate $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively, two-tailed test.
Standard errors are in parentheses.

† For ease of illustration the coefficients for the industry dummies are not presented. In the low-PEU subsample retail firms display a significantly higher level of risk awareness compared to manufacturing firms ($\beta \approx 0.459$, $p < 0.10$, two-tailed). In the high-PEU subsample firms engaged in wholesale trade ($\beta \approx 0.845$, $p < 0.01$, two-tailed) and in transportation and warehousing ($\beta \approx 0.670$, $p < 0.10$, two-tailed) display a significantly higher level of risk awareness compared to manufacturing firms.

This table reports the payoff-function approach to test hypotheses 2abc. Based on a sample split at the mean value of PEU two subsamples are created. The payoff function is then estimated separately in both subsamples and finally the regression coefficients on the interaction terms are compared. There is a positive and significant difference for the interaction effect between tone from the top and interactive control between the high-PEU and low-PEU subsamples (p-value = 0.0011, two-tailed), the difference for the interaction effect between tone from the top and diagnostic control is also significantly different across the high-PEU and low-PEU subsamples (p-value = 0.0003).

Please refer to Table 1 for a description of the multi-item constructs.

TABLE 8
Alternative test for hypothesis 2 (conditional correlations)

Panel A – comparison of pairwise condition correlations for high-PEU and low-PEU subsamples

	***PEU* ≥ 3.87**	***PEU* < 3.87**
	ε_{IC}	ε_{IC}
ε_{TT}	0.309***	0.349***

	***PEU* ≥ 3.87**	***PEU* < 3.87**
	ε_{DC}	ε_{DC}
ε_{TT}	0.205**	0.229**

Panel B – test of the complementary relationship between ε_{TT} and ε_{IC} as well as between ε_{TT} and ε_{DC}

	ε_{TT}
Intercept	0.000
	(0.055)
PEU	-0.007
	(0.062)
ε_{IC}	0.252***
	(0.054)
ε_{IC} * PEU	0.070
	(0.064)
R^2	0.1111
F-value	8.08***
n	198

	ε_{TT}
Intercept	-0.000
	(0.057)
PEU	-0.008
	(0.064)
ε_{DC}	0.199***
	(0.070)
ε_{DC} * PEU	0.130
	(0.085)
R^2	0.0560
F-value	3.84**
n	198

*, **, *** Indicate $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively, two-tailed test.

Panel A reports the complementarity analysis for the two pairs tone from the top and interactive control as well as tone from the top and diagnostic control. It shows the pairwise conditional correlations for the two subsamples split at the mean of PEU.

Panel B uses the residuals of tone from the top and interactive control as well as tone from the top and diagnostic control to investigate whether PEU as continuous variable displays an effect on the relationship between the residuals. ε_{TT}, ε_{IC} and ε_{DC} are the residuals obtained from regressing tone from the top, interactive control, and diagnostic control on their joint determinants.

TABLE 9
Payoff-function approach with three-way interactions

Regression analysis with PEU as continuous variable – risk awareness as dependent variable

	Risk awareness
Intercept	-1.533***
	(0.436)
FRM	0.187***
	(0.049)
Growth	0.036
	(0.032)
Age	0.001
	(0.001)
Size	0.160*
	(0.092)
Outcome history	-0.066
	(0.073)
Foreign sales	0.002
	(0.002)
Exploration	-0.053
	(0.102)
Exploitation	0.049
	(0.090)
Medium time horizon	0.309*
	(0.177)
Long-term time horizon	0.432**
	(0.205)
External management	0.165
	(0.122)
Risk-taking climate	0.040
	(0.096)
Competitive intensity	-0.115
	(0.070)
†Industry dummies	
Tone from the top	0.330***
	(0.083)
Interactive control	0.020
	(0.069)
Diagnostic control	0.010
	(0.086)
PEU	-0.033
	(0.082)
Tone from the top * Interactive control	0.143**
	(0.069)
Tone from the top * PEU	-0.049
	(0.083)

Interactive control * PEU	0.000
	(0.087)
Tone from the top * Interactive control * PEU	**0.214*** **
	(0.078)
Tone from the top * Diagnostic control	-0.059
	(0.085)
Diagnostic control * PEU	0.018
	(0.110)
Tone from the top * Diagnostic control * PEU	**-0.260** **
	(0.102)
R^2	0.4650
F-value	4.84***
n	198

*, **, *** Indicate $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively, two-tailed test.
Standard errors are in parentheses.

† For ease of illustration, the coefficients for the industry dummies are not presented. Wholesale firms ($\beta \approx 0.374$, $p < 0.05$, two-tailed) display a significantly higher level of risk awareness compared to manufacturing firms.

This table reports an alternative specification of the payoff-function approach to test hypotheses 2abc. Contrary to Table 7, the analysis reported in this table investigates to what extent PEU as continuous variable exhibits an influence on the interaction effects between tone from the top and interactive control and tone from the top and diagnostic control.

Please refer to Table 1 for a description of the multi-item constructs.