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ORIGINAL PAPER

How executive incentive design affects risk-taking: a literature review

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Abstract
This paper presents a review of research regarding the effects of monetary executive incentives on risk-taking. More precisely, we investigate executives' risk-taking (i) in response to the curvature (steepness, convexity, concavity) of the compensation function and (ii) with regard to reference points. Thereby, we refine and update common textbook knowledge. In this vein, we identify essential moderators at the personal, firm, or environmental level that can be used to assess the effectiveness of the incentive scheme in a specific context. Implications for incentive system design in practice and paths for future research are discussed.

Keywords Risk-taking · Risk behavior · Incentives · Management control systems

JEL M12 · M41 · M52

1 Introduction

Monetary incentives appear to be an effective mechanism to direct risk-taking behavior (Sprinkle and Williamson 2008). Managing risk-taking is necessary as employees' risk preferences do not, on average, match the firms' preferences (Baiman 1990). This is particularly important for executives in charge of long-range business decisions. If an executive prefers a lower or higher level of risk than the firm owners,

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risk-taking is too low or too high (i.e., excessive) from the firm's perspective.[1] Compensation should align both parties' interests (Ittner and Larcker 2001).

Various examples from business practice show that inappropriate incentives harm firm performance. The 2007–2009 financial crisis and the collapse of Lehman Brothers are bold examples of how excessive risk-taking can bankrupt financial institutions and affect the entire economy (Williams 2010). In retrospect, the public and many national governments claimed that high bonuses for bankers—sometimes referred to as the "Wall Street bonus culture"—fueled excessive risk-taking and, hence, the financial crisis.

While excessive risk-taking might destroy firms, the same holds when managers hesitate to take "economically reasonable" risks, as risk-taking is crucial for firms' survival and competitiveness (Shapira 1995). In a case study indicatively titled "Kodak and Xerox: How High Risk Aversion Kills Companies", Cuthbertson et al. (2015) arrive at a remarkable conclusion concerning the consequences of different risk strategies: The authors describe Kodak as having failed to engage in sufficient risk-taking. When new technologies such as digital photography emerged, Kodak's core market was cannibalized, and key parts of Kodak's core business had to be put on sale. Xerox faced a similar situation with regressing core markets. However, Xerox performed better due to a greater willingness to invest in risky R&D projects.

Behavioral and economic theories consider compensation a helpful instrument in improving firm performance by directing risk-taking behavior. Thus, we review the literature that investigates executives' risk-taking in response to the curvature of the compensation function and with regard to reference points. More precisely, we aim to accomplish the following objectives.

First, we provide a framework for the effects of monetary incentive design choices on risk-taking on a theoretical level. For this reason, we discuss *agency theory (expected utility theory), prospect theory, security-potential/aspiration (SP/A) theory*, and the *behavioral agency model (BAM)*. Understanding the underlying theoretical implications is critical for identifying the drivers of risk-taking and assessing how to maximize the effectiveness of incentives.

Our second goal is to detect and categorize incentive design choices concerning their potential to affect risk-taking behavior. We identify the compensation function and reference points as the core drivers of risk-taking.

Third, we review, describe, and compare studies from different literature streams, including accounting, economics, finance, management, and psychology. In addition, we provide graphical overviews that summarize significant moderating effects and the underlying mechanisms for each compensation scheme discussed. Finally, we identify and discuss directions for future research.

Our review makes several contributions to theory and practice. First, by collecting and presenting the various findings of empirical research, we refine and update the common understanding of the main effect of incentives on risk-taking. For example,

[1] The literature we review usually employs less-general definitions of excessive or too little risk-taking and relies on deviations from maximizing expected value. For example, Brink et al. (2017, p. 14) define excessive risk-taking as "a manager taking on more risk than is optimal for maximizing the expected value of the firm."

it appears textbook knowledge that concavity of the compensation function, induced, e.g., by capped compensation schemes, reduces risk-taking. While we provide an overview of empirical studies that are in line with this expectation, we also add unintuitive findings. A case in point is a study showing that a cap unintentionally reduces also the level of risk taken by those who are not economically affected by the cap and take too low levels of risk anyway (Kreilkamp et al. 2021).

Second, we also refine common knowledge by identifying moderators for the effect of incentives on risk-taking. Firms must be aware of these moderators to understand that incentive schemes do not follow a "one-fits-all" approach. For example, it is well known that stock options result in convex compensation functions and induce risk-taking. Our review of moderators reveals that, e.g., the risk-inducing effect of stock options is more pronounced for small compared to large firms. Reviewing prior research, we find that some moderators, such as firm size, tenure, or leverage, appear more important than others, as they prove significant in multiple studies. Firms should consider such moderators on three levels, i.e., personal, firm, and environmental. We collect and present moderators for these levels. Supervisory boards or others might use our summaries (Figs. 4, 5 and 6) to assess the effectiveness of the incentive scheme in place.

Third, while the first part of our review focuses on the compensation function, the second part illustrates that it is not only the compensation amount, structure, or timing that matters but also how it relates to important internal or external reference points (e.g., past compensation, peer compensation). Our review highlights a common feature of different compensation mechanisms such as option-based compensation and tournaments, i.e., reference point dependency. An important insight is that to understand or predict an executive's behavior in a specific situation, it is not sufficient to consider the incentive scheme and potential moderators. In addition, it is necessary to identify what reference points are likely to be taken into account by this executive. From a practical perspective, supervisory boards might use a poor ranking position or at-the-money stock options as red flags for an executive's predicted—potentially excessive—risk-taking.

Finally, our review provides avenues for future research. Future research might, e.g., compare different means to establish a certain level of risk-taking (e.g., caps and inside debt) or investigate the conditions under which one mechanism is more beneficial than the other.

The remainder of this paper proceeds as follows. Section 2 introduces our framework and elaborates on the theoretical background. In Sect. 3, we describe the study selection process (3.1) and present our review (3.2). In Sect. 4, we discuss practical implications and directions for future research. Section 5 presents our conclusions.

2 Background

2.1 Risk and risk-taking

Managerial decisions are associated with risk. Sitkin and Pablo (1992, p. 10) define risk "as the extent to which there is uncertainty about whether potentially signifi-

cant and/or disappointing outcomes of decisions will be realized." Uncertainty is, e.g., reflected by the variability of potential outcomes of a decision (Libby and Fishburn 1977). These outcomes do not necessarily have to be negative but may also be positive. However, they must have a sufficient magnitude to represent a significant risk for a decision-maker. Based on this understanding, we define risk-taking as the "degree of risk associated with the decisions made" (Sitkin and Pablo 1992, p. 10).

Empirical research uses different ways to operationalize risk and risk-taking. In particular, three approaches appear common: individual-based, firm-based, and market-based approaches. Individual-based measures typical for experimental studies use risk elicitation instruments (e.g., Kreilkamp et al. 2021). Participants' responses are interpreted as their willingness to take risks. A case in point is the bomb risk elicitation task (Crosetto and Filippin 2013). Researchers that employ firm-based approaches examine to what degree the firm's decisions are associated with risk. For example, when a firm has more R&D investments (e.g., Sanders and Hambrick 2007), engages less in hedging (e.g., Knopf et al. 2002), or makes more acquisition investments (e.g., Hou et al. 2020), firm risk and thus executives' willingness to take risks is judged to be higher. When market-based approaches are employed to operationalize risk, market measures such as stock return volatility are used (e.g., Baixauli-Soler et al. 2015).

2.2 The theoretical link between incentives and risk-taking

Firms employ incentives to address agency problems (Jensen and Meckling 1976) that arise because principals (e.g., firm owners) and agents (e.g., executives) have diverging interests, and information asymmetry exists (Baiman 1990). Information asymmetry may arise before or after a contract is signed. Problems of adverse selection result from pre-contractual information asymmetry, while moral hazard is associated with post-contractual information asymmetry (e.g., Macho-Stadler and Pérez-Castrillo 2001). Prior literature typically associates managerial risk-taking with moral hazard (e.g., Kadan and Swinkels 2008; Edmans and Liu 2011; Laux 2015). Moral hazard occurs if the principal cannot observe the agent's actions ("hidden action") or if the agent receives private information after the contract is signed ("hidden information"). If the agent's actions and the risk associated with these actions are not observable or if the agent receives private information about the risk associated with his actions, the agent may choose actions and risk levels that are not in the principal's interest. The principal must therefore provide incentives to steer agents' behavior.

2.3 Determinants of risk-taking

Theoretical economic models identify differences in managers' levels of wealth, degrees of personal diversification, hedging options, performance goal attainability, degrees of risk aversion, and other moderators for the effect of compensation on risk-taking (Smith and Stulz 1985; Lambert et al. 1991; Carpenter 2000; Brisley 2006). This review intends to support and complement this analysis by reviewing empirical research.

To do so, it is important to understand the determinants of risk-taking. Sitkin and Pablo (1992) propose a model that describes risk-taking as a function of risk propensity and risk perception. Risk propensity can be understood as the tendency to take or avoid risks and depends on risk preferences, inertia, and the outcome history of past decisions. Risk perception describes how risk is experienced in a specific situation. Sitkin and Pablo (1992) argue that risk perception is context-dependent and based on external factors. One determinant is an organization's control system (e.g., the incentive system), which can steer managers' attention. Consequently, it is valuable to understand how incentive design choices influence risk-taking through risk perception.

Decision-making is often driven by mental shortcuts (Luft and Shields 2009). Many irrationalities concerning risk are based on cumulative prospect theory (CPT). This theory predicts that risk-taking behavior is reference-point dependent and can be explained by an S-shaped utility function around the reference point (Kahneman and Tversky 1979; Tversky and Kahneman 1992). According to prospect theory, individuals are risk averse in a gain domain, while they seek risk in a loss domain. Additionally, individual reference points may vary over time, e.g., the relationship might be influenced by irrelevant external factors or framing. Consequently, firms should be aware of executives' reference points and framing effects when designing their compensation. We revert to these points in our discussion in Sect. 4.

SP/A theory extends the insights from prospect theory and focuses on emotional desires (Lopes 1987; Lopes and Oden 1999). In SP/A theory, S stands for security, P for potential, and A for aspiration. The notion of security refers to the tendency to avoid low levels of wealth. Aspiration describes the tendency to aim for predefined goals (reference points), and potential represents the desire to reach high levels of wealth. Unlike CPT, SP/A theory argues that managers assess risky decisions differently depending on whether a security or potential focus is triggered. The attention focus is dependent on the perceived probability of reaching the desired aspiration level. Managers increase risk-taking either if a certain level of compensation is perceived as safe and they shift their focus to the upside potential or if risk-taking is the only way to reach the level of aspiration. Therefore, managers' willingness to take risks depends on factors that influence compensation security and aspiration (e.g., defined by performance targets).

Last, the behavioral agency model (BAM) combines economic theory and shortcomings in human decision-making to leverage insights from both fields (Gomez-Mejia and Wiseman 1997; Wiseman and Gomez-Mejia 1998). The BAM drops the assumption of consistent risk preferences, advocating that risk-taking depends on the context of a decision. Specifically, the model considers external factors. Examples of such factors are the form and intensity of supervision, performance history, compensation mix, and behavioral evaluation criteria, such as factors that affect risk-taking through problem framing and risk-bearing (perceived wealth at risk).

2.4 Configuration and design of executive incentives

It is essential to systematize performance-contingent compensation to deduce suggestions for incentive design and comprehend the link between compensation and

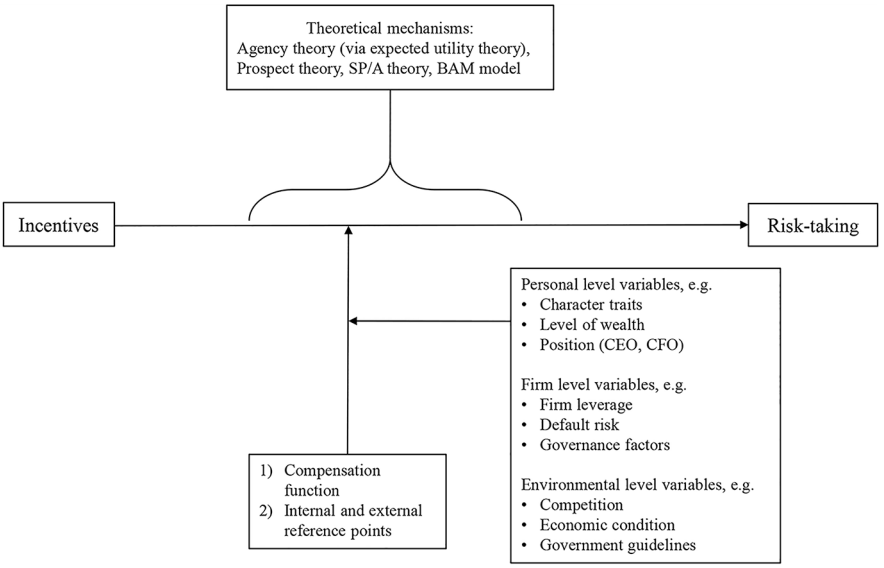


Fig. 1 Conceptual Framework

risk-taking. In addition to investigating how specific design features affect risk-taking (Beck et al. 2020), we aim to elucidate factors at the personal, firm, and environmental levels that moderate this relationship. Figure 1 presents a conceptual framework for the effects of executive compensation on risk-taking. Based on this framework, we develop a structure for the review in Sect. 3.2.

When compensation is linked to performance, firms have to define how performance is measured, the shape of the compensation function, and the type of rewards (Merchant and Van der Stede 2017). With respect to the latter, firms may use cash, equity-based, or debt-based compensation (Sundaram and Yermack 2007; Merchant and Van der Stede 2017). Cash is often used as part of short-term and long-term incentive plans and paid if one or more performance measures are met (Beck et al. 2020). Rewards are equity-based if compensation is either paid in stock (options) or depends on the stock price. A popular form is (restricted) stock. In this case, the executive does not have to pay for the shares but is only allowed to sell them after a certain period of time (Merchant and Van der Stede 2017). A variant of restricted stock is phantom shares that do not represent actual shares but reflect their value. Another form of stock-based compensation is stock options. In this case, the executive is entitled to buy shares of the firm at a predefined price after a vesting period and before the option expires. If the stock price exceeds the strike price, the executive can sell the option or buy the shares to realize a gain. Stock options reward gains but do not penalize losses (Merchant and Van der Stede 2017). Another reward type is debt-based compensation, usually referred to as inside debt (Sundaram and Yermack 2007). Inside debt, i.e., debt held by managers, consists of pensions and deferred compensation. It is argued that adding inside debt to executive compensation is beneficial, as it directs executives not only to consider the incidence of insolvency but also the value of assets in this case.

The type of reward affects the compensation function, e.g., stock options establish convexity, while debt compensation results in concavity. A compensation function is convex (concave) if an executive receives a greater (smaller) increase in compensation when firm performance moves from medium to high levels than from low to medium levels. We also refer to the relative share of fixed versus performance-contingent pay as convexity because of its similarity to options payouts. Below, we use the form of the compensation function instead of the type of reward to structure our review. This is also in line with empirical research investigating the direct effects of the compensation function on risk-taking. While a structure based on performance targets and measures would also be possible, we follow Wiseman and Gomez-Mejia (1998), arguing that performance targets and measures only indirectly affect risk-taking by framing.[2]

Below, we differentiate between the compensation function's steepness (3.2.1.) and its curvature (3.2.2). The steeper the compensation function is, the more firm performance affects executives' wealth. Theory suggests that curvature helps to manage risk-taking more precisely, i.e., firms can establish concavity and/or convexity. Compensation functions are typically convex for some performance levels and concave for others.

When we discuss the compensation function below, we review the literature investigating the effect of compensation on executives' *absolute* wealth. Each section addresses time aspects by differentiating between executives' annual compensation package (short term) vs. executives' overall compensation (mid and long term). CPT, SP/A theory, and the BAM suggest that—beyond the effect on absolute wealth—individuals' perceptions matter. In particular, executives evaluate their compensation *relative* to reference points and adjust their risk-taking respectively (Thaler et al. 1997; Wiseman and Gomez-Mejia 1998). These reference points (Sect. 3.2.3) can relate to individual or external factors.

3 Review

3.1 Study selection process

For the literature review, we follow the suggestion of Tranfield et al. (2003). The detailed review process is depicted in Fig. 2 (Fischer 2007).

First, we scan leading journals between 2013 and 2018 that cover relevant research and select all relevant studies.[3] These and further studies identified through an addi-

[2] Hence, we discuss studies that investigate performance targets and performance measures in Sect. 3.2.1.

[3] Leading journals that cover research analyzing the connection between executive compensation and risk-taking include the Journal of Applied Psychology, Management Science, Academy of Management Journal, Journal of Economic Behavior and Organization, Journal of Accounting and Economics, Journal of Accounting Research, The Accounting Review, Contemporary Accounting Research, Accounting, Organizations and Society, The Journal of Finance, Journal of Financial Economics, Administrative Science Quarterly, and American Economic Review.

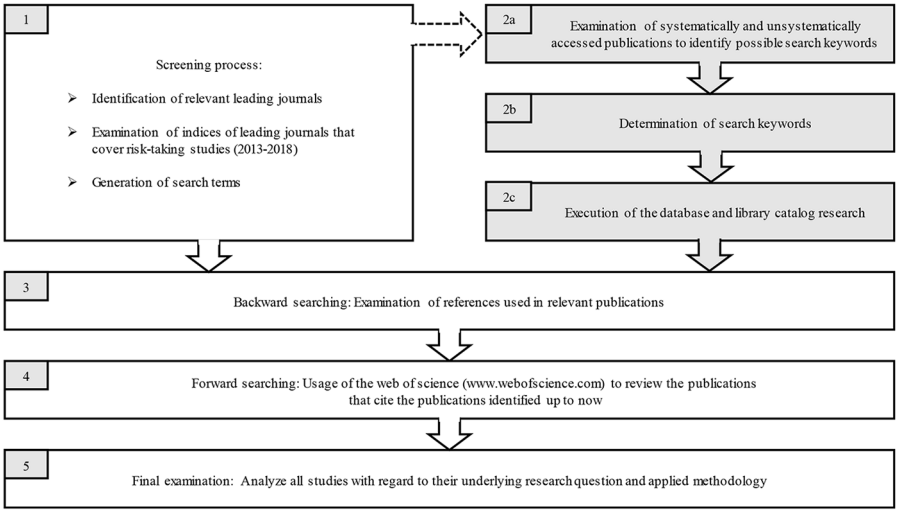


Fig. 2 Study Selection Process (cf. Fischer 2017)

tional web search are used to define appropriate search terms.[4] These keywords are employed to perform a database and library catalog search. We scan the studies' titles and abstracts for these keywords to identify relevant studies. Next, the bibliographies are checked to find additional studies. We then use scientific citation indexing services to find sources that cite already-identified studies.[5]

Finally, we analyze all studies concerning their research question and select only those empirical studies that are relevant.[6] Studies without a theoretical foundation are not included. We find a total of 76 studies. The majority of these studies were published in the last 15 years. Figure 3 lists the journals that published the studies included in this review. We present and discuss the results of the literature review in the next section.

3.2 Empirical findings

3.2.1 Compensation function steepness

The steepness of a compensation function describes the relationship between executives' wealth and future firm performance. The steepness can be directly modified by changing the slope of the compensation function or indirectly, e.g., by offering

[4] We employ the following search terms for executive incentives: bonus, compensation, contest, debt, equity, incentive, options, pensions, performance-contingent, performance-based, reference point, stock, tournament, variable pay. Our search terms for risk include, e.g., firm risk, risk behavior, risk investment, risk-taking.

[5] These include the following: The Web of Science, Google Scholar, Science Direct and EBSCO Discovery Service.

[6] We considered studies that are published in journals classified as A+, A or B by the German Academic Association for Business Research (VHB) "JOURQUAL 3".

Academy of Management Journal	Journal of International Money and Finance
Accounting Horizons	Journal of Management
Accounting, Organizations and Society	Journal of Management Accounting Research
Administrative Science Quarterly	Journal of Risk and Insurance
Behavioral Research in Accounting	Long Range Planning
Contemporary Accounting Research	Management Accounting Research
European Accounting Review	Management Science
Human Resource Management	Marketing Science
Journal of Accounting, Auditing & Finance	Organization Science
Journal of Accounting and Economics	Review of Finance
Journal of Accounting Research	Review of Financial Studies
Journal of Banking & Finance	Review of Managerial Science
Journal of Business Economics	Review of Quantitative Finance and Accounting
Journal of Business Finance & Accounting	Strategic Management Journal
Journal of Business Research	Strategic Organization
Journal of Corporate Finance	The Accounting Review
Journal of Economic Behavior & Organization	The Journal of Finance
Journal of Economic Psychology	The Quarterly Review of Economics and Finance
Journal of Financial and Quantitative Analysis	The Review of Financial Studies
Journal of Financial Economics	

[a] In alphabetical order; this list contains only journals we cite from as part of our literature review according to the selection criteria outlined in Section 3.1.

Fig. 3 List of journals included in our review

options instead of (restricted) stock. As future firm performance is risky, a steeper function transfers more firm risk to executives. However, theoretical arguments provide ambiguous guidance on how a steeper compensation function affects risk-taking—primarily dependent on assumptions on risk preferences.

Massa and Patgiri (2009) investigate the risk and performance effects based on a sample of mutual fund managers and find support for a risk-increasing effect. They report that a closer alignment of managers' incentives to their performance induces risk-taking and increases fund performance. Archival studies investigating the effect of compensation function steepness on risk-taking frequently analyze executive stock holdings, particularly *delta*. Delta is the change in executive wealth with a 1% change in stock price (Chava and Purnanandam 2010). Armstrong and Vashishtha 2012) find that a higher delta encourages managers to increase systematic and—surprisingly—idiosyncratic risks. Alessandri et al. (2018) add that this risk-increasing effect is less pronounced for firms with high family involvement. Uhde (2016) finds that excess variable pay, i.e., a steep compensation function, increases risk-taking based on a sample of European banks between 2000 and 2010. The findings of Guo et al. (2015) corroborate these results. These authors report a positive relationship between incentives and risk-taking in banks—which is robust for the periods before and during the financial crisis. In this vein, Boyallian and Ruiz-Verdú (2018) show that precrisis deltas are related to a greater probability of failure during the financial crisis, but only for highly leveraged firms. In contrast, based on data from large US financial institutions between 2005 and 2010, Iqbal and Vähämaa (2019) find no significant relationship between delta and managerial risk-taking.

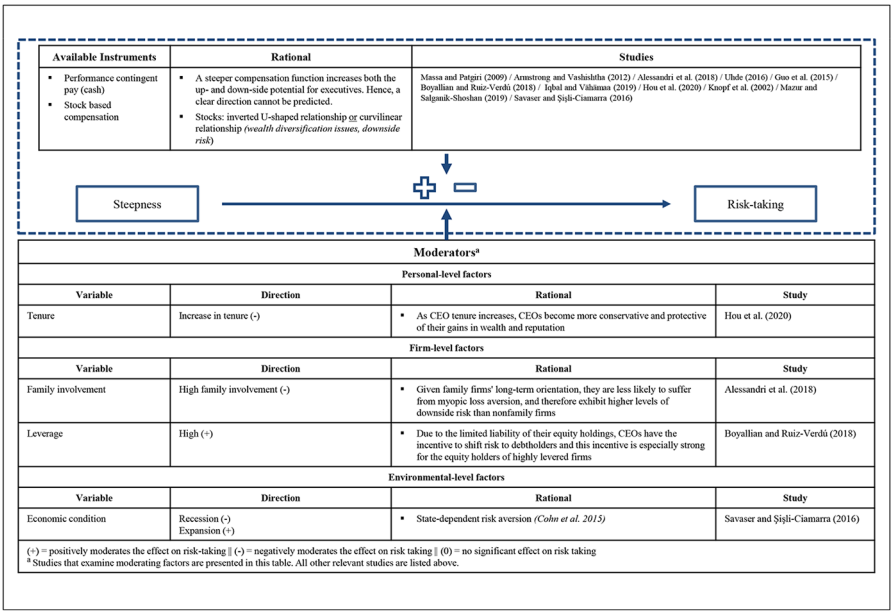


Fig. 4 The effect of compensation function steepness on risk-taking

Other studies, however, support a negative relationship between the steepness of the compensation function and risk-taking. For example, Devers et al. (2008) report a negative relationship between restricted stock holdings and strategic risk-taking. Investigating the risk-taking behavior of S&P 1,500 CEOs, Hou et al. (2020) find that increasing stock holdings reduces the likelihood of large losses. These authors conclude that a higher delta encourages lower variance investments. Analogously, Knopf et al. (2002) find that a higher delta leads to more hedging, i.e., less risk-taking. Mazur and Salganik-Shoshan (2019) also report a negative relationship between delta and firm risk for corporate spinoffs. Kim and Lu (2011) propose external governance as a moderator. In particular, the authors find a hump-shaped relationship between CEO equity holdings and R&D risk-taking for weak external governance but no relationship for strong external governance. Thus, strong external governance may help reduce risk aversion elicited by large equity holdings.

Based on these ambiguous results, solely offering incentives that provide executives with a higher pay-performance sensitivity (delta), i.e., increasing the compensation function steepness, does not reliably align executives' risk-taking to shareholders' interests. Thus, it appears reasonable to examine other instruments, i.e., establishing convexity (concavity) to manage risk-taking. This may also be the reason why studies on moderating effects on the relationship between steepness and risk-taking are scarce.[7] Figure 4 presents a summary of the main results concerning steepness.

[7] There are, in fact, a few studies that detect factors that moderate the effect of steepness on risk-taking. However, as those studies relate their results to findings regarding convexity, we address these effects when we discuss convex functions in Sect. 3.2.2.

3.2.2 Compensation function curvature

This section discusses two different curvatures of the compensation function, i.e., convex and concave functions. We first discuss convex functions where executives' marginal compensation increases when firm performance improves. Afterward, we focus on concave functions where marginal compensation decreases when firm performance increases.

Convex functions.

Firms often use convexity to counteract the tendency of stock holdings to elicit risk aversion that results from downside risk. Guay (1999, p. 66) suggests that stock holdings fail to induce risk-taking because "[t]he magnitude of the convexity provided by common stock is […] of little economic importance for most CEOs". Firms often use instruments that, relative to upside potentials, limit downside risks for executives. To establish convexity in an executives' compensation function, firms can—in the short term—decrease the share of fixed pay relative to performance-contingent pay. In the longer term, firms can provide executives with stock options ("long call") instead of (restricted) stock.

Empirical findings corroborate the risk-eliciting effect of convex compensation functions. Concerning short-term convexity, Wright et al. (2007), for example, find that a larger relative share of performance-contingent compensation is associated with higher risk-taking. Beyond that, Brink et al. (2017) show via an experiment that more performance-contingent compensation may even result in excessive risk-taking. These authors add that risk-taking appears to be sticky for a decrease in performance contingent compensation.

In the mid and long term—and particularly for option-based compensation—a larger amount of option possession increases the convexity of executives' compensation function. Comparing the convexity of stocks and options, Guay (1999) provides the first evidence that stock options yield more convex compensation functions and, therefore, are associated with higher risk-taking.

Empirical literature concerning equity incentives frequently refers to *vega*, defined as the ratio of change in executives' wealth to a 1% change in stock volatility (Chava and Purnanandam 2010). Several empirical studies provide evidence that convexity elicits risk-taking. For example, Coles et al. (2006) find that a higher vega is associated with riskier firm policies, more investments in R&D, less property plant and equipment (PPE) investments, and higher leverage, all of which indicate a preference for risk-taking. Furthermore, convexity motivates managers to employ riskier M&A activities (Sanders 2001) and tax strategies (Rego and Wilson 2012). In line with these findings, research also shows a positive relationship between the convexity of executives' compensation function and trade credit risk (Elsilä 2015) and exchange rate exposure (Francis et al. 2017) and a negative relationship with derivative holdings, which are typically used for hedging (Rogers 2002). Studies by Knopf et al. (2002) and Bakke et al. (2016) analogously find convexity associated with fewer hedging activities. In contrast, while claiming to investigate risk preferences, Doukas and Mandal (2017) find no correlation between the compensation function and hedging—neither for convex nor for concave compensation functions. Further studies show a positive relationship between convexity and risk-taking by investigat-

ing particular industries. Rajgopal and Shevlin (2002) show that convex incentive instruments (options) positively relate to future exploration risk-taking in the oil and gas industry. Chen et al. (2006) show a risk-increasing effect of options in commercial banks. Utilizing the M&A activities of acquiring US banks as a risk measure, Hagendorff and Vallascas (2011) arrive at the same conclusion. A risk-inducing effect of convexity was also found within the context of corporate spinoffs (Mazur and Salganik-Shoshan 2019). Additionally, Armstrong and Vashishtha (2012) reveal that a higher vega encourages executives to increase systematic risk and total risk, but not idiosyncratic risk. This is driven by executives' ability to hedge systematic but not idiosyncratic risk.

Overall, convex compensation functions affect firm risk through the amounts invested in risky projects and the outcome variance of investments (Sanders and Hambrick 2007). Concerning outcome variance, Sanders and Hambrick (2007) provide evidence that options are associated with more big losses than big gains, thus casting doubts about alignment with shareholder interests. In the same vein, Dong et al. (2010) show that options sometimes elicit financing strategies that are too risky and that exceed shareholders' willingness to take risks (excessive risk-taking).

Further factors affecting the relationship between the convexity of the compensation function and risk-taking are rooted in the personal, firm, and environmental spheres. Regarding personal characteristics, Benischke et al. (2019) show that executives who are high in extraversion, or openness, or who are low in conscientiousness react less sensitively to equity incentives. Moreover, the risk-inducing effect of equity incentives is less pronounced for firms with more female representatives in their top management (Baixauli-Soler et al. 2015). Hou et al. 2020) reveal tenure as an additional moderator. Compared to executives with shorter tenure, more tenured executives react less sensitively to equity incentives. Other studies explicitly differentiate between CEOs and CFOs. Chava and Purnanandam (2010) find a positive correlation between risk-eliciting equity incentives for CEOs and CFOs and the riskiness of financial policies. However, CEO incentives affect risk stemming from firm leverage and cash holdings, while CFO incentives primarily affect risk choices associated with debt maturity and accounting accruals. Utilizing market crash risk as their risk measure, Kim et al. (2011) report only weak evidence for an association between CEO equity incentives and market crash risk. However, they find a positive correlation between CFO equity incentives and market crash risk. These authors argue that CFOs are more relevant for decisions that require financial expertise and conclude that CFO incentives matter more than CEO incentives. Kim et al. (2011) also find that this effect is aggravated in noncompetitive industries and for firms with high leverage. Notably, market crash risk is an extreme, outcome-based risk measure. Using more moderate risk measures, other studies find leverage to affect the relationship between incentives and risk-taking in the opposite direction.

Concerning firm-level characteristics, leverage weakens the relationship between option incentives and risk-taking (Kim et al. 2017). These authors find that this effect was stronger during the financial crisis and driven by short- and long-term debt components. Milidonis and Stathopoulos (2014) corroborate these findings by showing that higher leverage, as well as a higher default probability, weaken the relationship between convexity and risk-taking. Another potential moderator is firm size. Based

on a merger sample, the risk-eliciting effect of options pay is found to be larger for smaller firms (Williams and Rao 2006). Using R&D spending as their risk measure, Wu and Tu (2007) provide evidence that higher availability of slack resources also increases the risk-eliciting effect of stock option pay. Last, Devers et al. (2008) reveal the board of directors as a moderator by showing that repricing and reloading activities may emphasize the risk-inducing effects of equity incentives.

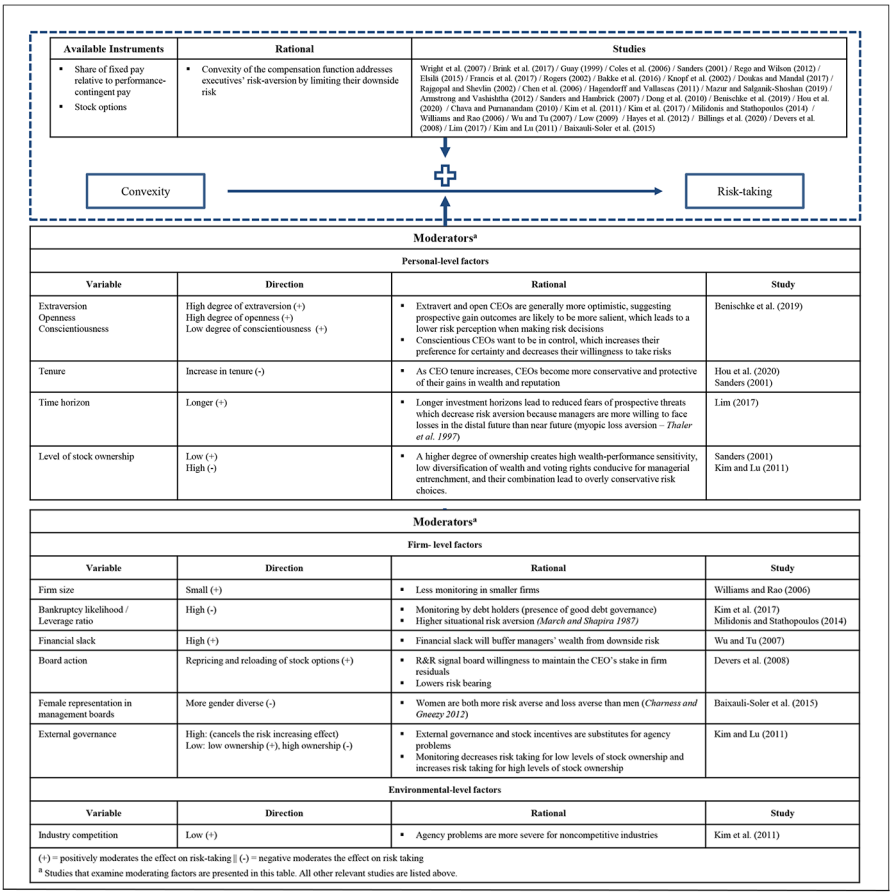
A few studies use external events to investigate the moderating effects of environmental factors. For example, Low (2009) proposes the effect of an increase in takeover protections in Delaware (US) as a moderator. She finds that, in response to this event, firms with low CEO vega reduce risk more than firms with stronger equity incentives. Hayes et al. (2012) also harness an external event as a reaction to which firms strongly decreased option pay (FAS 123R). The authors, however, find no evidence that this decrease in convexity led to subsequent reductions in risk-taking. Last, Savaser and Şişli-Ciamarra (2016) provide evidence that—due to state-dependent risk aversion (Cohn et al. 2015)—the relationship between incentives and risk-taking depends on the economic cycle. A given level of pay-for-performance incentives results in lower firm risk when the economy is in a downturn.

Notably, the studies presented thus far almost unanimously report a positive relationship between the convexity of compensation and risk-taking. However, according to the BAM, there are limits to the risk-inducing effects of convex compensation functions (Wiseman and Gomez-Mejia 1998). If options represent a large share of an executive's overall wealth, executives may lean toward greater risk aversion (Billings et al. 2020). Investigating R&D expenditures, Billings et al. (2020) provide the first evidence for this reasoning. The authors find that low to moderate levels of vega are associated with increases in investments and returns on R&D, while marginal returns decline as vega increases. Analogous to inducing executives to take excessive risks, this is another example of how stock options omit clean incentive alignment.

In conclusion, in line with the predictions of agency theory and prospect theory, establishing convexity in executives' compensation motivates risk-taking. In particular, an increase in the marginal utility of risk-taking encourages executives—who are, on average, risk averse—to take more risks. Figure 5 summarizes the main results concerning convexity. Notably, as we discuss in Sect. 3.2.2, relaxing this assumption of risk aversion allows more granular conclusions about the effects of equity incentives on risk-taking. Nonetheless, convexity may also result in excessive forms of risk-taking that exceed shareholder willingness to take risks. To counteract this effect, firms can employ instruments that add concave elements to executives' compensation functions, e.g., caps or debt compensation.

Concave functions.

Now, we focus on concave compensation functions. Concavity restricts the upside of executives' wealth generated through firm performance and serves as a counterbalance for the convex part of the compensation function. In particular, since convex compensation functions limit the downside risk for executives, using concavity in compensation functions aims to prevent excessive risk-taking. To influence short-term decision-making, firms can use compensation caps that limit the maximum salary of executives during a particular period (Murphy 2013). While economic theory equivocally predicts that caps prevent excessive risk-taking, potential pitfalls remain.



Moderators[a]

Personal-level factors

Variable	Direction	Rational	Study
Extraversion Openness Conscientiousness	High degree of extraversion (+) High degree of openness (+) Low degree of conscientiousness (+)	▪ Extravert and open CEOs are generally more optimistic, suggesting prospective gain outcomes are likely to be more salient, which leads to a lower risk perception when making risk decisions ▪ Conscientious CEOs want to be in control, which increases their preference for certainty and decreases their willingness to take risks	Benischke et al. (2019)
Tenure	Increase in tenure (-)	▪ As CEO tenure increases, CEOs become more conservative and protective of their gains in wealth and reputation	Hou et al. (2020) Sanders (2001)
Time horizon	Longer (+)	▪ Longer investment horizons lead to reduced fears of prospective threats which decrease risk aversion because managers are more willing to face losses in the distal future than near future (myopic loss aversion – *Thaler et al. 1997*)	Lim (2017)
Level of stock ownership	Low (+) High (-)	▪ A higher degree of ownership creates high wealth-performance sensitivity, low diversification of wealth and voting rights conducive for managerial entrenchment, and their combination lead to overly conservative risk choices.	Sanders (2001) Kim and Lu (2011)

Moderators[a]

Firm- level factors

Variable	Direction	Rational	Study
Firm size	Small (+)	▪ Less monitoring in smaller firms	Williams and Rao (2006)
Bankruptcy likelihood / Leverage ratio	High (-)	▪ Monitoring by debt holders (presence of good debt governance) ▪ Higher situational risk aversion *(March and Shapira 1987)*	Kim et al. (2017) Milidonis and Stathopoulos (2014)
Financial slack	High (+)	▪ Financial slack will buffer managers' wealth from downside risk	Wu and Tu (2007)
Board action	Repricing and reloading of stock options (+)	▪ R&R signal board willingness to maintain the CEO's stake in firm residuals ▪ Lowers risk bearing	Devers et al. (2008)
Female representation in management boards	More gender diverse (-)	▪ Women are both more risk averse and loss averse than men (*Charness and Gneezy 2012*)	Baixauli-Soler et al. (2015)
External governance	High: (cancels the risk increasing effect) Low: low ownership (+), high ownership (-)	▪ External governance and stock incentives are substitutes for agency problems ▪ Monitoring decreases risk taking for low levels of stock ownership and increases risk taking for high levels of stock ownership	Kim and Lu (2011)

Environmental-level factors

Variable	Direction	Rational	Study
Industry competition	Low (+)	▪ Agency problems are more severe for noncompetitive industries	Kim et al. (2011)

(+) = positively moderates the effect on risk-taking ‖ (-) = negative moderates the effect on risk taking

[a] Studies that examine moderating factors are presented in this table. All other relevant studies are listed above.

Fig. 5 The effect of compensation function steepness on risk-taking

Kreilkamp et al. (2021) provide evidence that—in addition to restricting excessive risk-taking—compensation caps unintentionally may also decrease the risk-taking of risk-averse executives. This unintended effect is magnified when justification pressure increases.

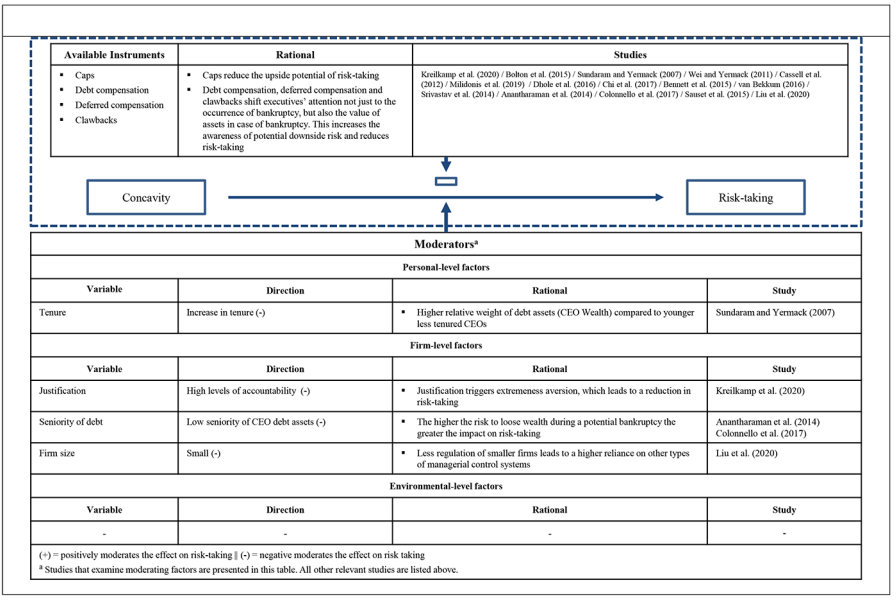
In the longer term, firms can use debt-like instruments to establish concavity. This can be achieved by using compensation that is tied to both stock price and credit default swaps (CDS) spreads (Bolton et al. 2015), by providing pensions (Sundaram and Yermack 2007), or by granting other forms of deferred compensation. In the case of bankruptcy, debt compensation is paid according to the value of assets. This shifts executives' attention not only to the occurrence of bankruptcy but also to the value of assets in the case of bankruptcy (Edmans and Liu 2011). Several empirical studies corroborate the risk-decreasing effect of debt compensation.

Sundaram and Yermack (2007) provide the first evidence that CEOs with higher debt holdings act more conservatively toward reducing default risks. This particularly applies to more tenured CEOs. In this vein, Wei and Yermack (2011) find that

debt compensation, i.e., CDS and pensions, is associated with lower firm risk. Notably, these authors also conclude that CEOs' large debt holdings decrease firm value and equity prices, indicating nonoptimal levels of risk-taking. Cassell et al. (2012) find a negative relationship between debt compensation and the volatility of stock returns, R&D expenditures, and leverage. In the same vein, these authors also find that debt compensation is positively associated with diversification and asset liquidity. Further studies provide similar findings by showing that debt compensation is associated with less risk (Milidonis et al. 2019), less risky firm policies (Dhole et al. 2016), and less tax sheltering (Chi et al. 2017). For financial institutions, Bennett et al. (2015) find that larger CEO inside debt holdings (relative to equity holdings) are associated with lower risk-taking and lower default risk during the financial crisis. They conclude that inside debt explains better performance during the financial crisis. Analogously, Van Bekkum (2016) finds that executives' precrisis debt holdings are related to lower stock value losses and a lower probability of distress during the financial crisis. Last, debt compensation is also found to be related to more conservative payout policies of banks (Srivastav et al. 2014).

Some studies also reveal firm and environmental factors that moderate the effect of debt compensation on risk-taking. Concerning compensation design, Anantharaman et al. (2014) argue that it is not the magnitude of debt compensation alone that matters but that debt compensation needs to be "truly debt-like". This implies that executives' debt assets are comparable to external debt-holder claims regarding the payout structure (e.g., the time horizon) and seniority. In line with this argument, Colonnello et al. (2017) find that inside debt only reduces risk-taking if payouts are unsecured, as is the case for external lenders. Sauset et al. (2015) utilize the introduction of new restrictions (such as bonus caps, clawbacks, or bonus deferral) for CEO compensation in the EU to investigate the joint effect of these concavity-inducing instruments. These authors find that firms that align their compensation to these rules more closely are associated with lower idiosyncratic and systematic risk-taking and even with better risk-adjusted performance. Furthermore, the risk-decreasing effect of clawbacks is stronger for smaller firms and those audited by Big 4 companies (Liu et al. 2020).

In summary, the empirical literature vastly supports the theoretical argument that debt compensation decreases firm risk-taking. From an agency and prospect theory perspective, this is not surprising. Assuming that executives are risk averse, they demand a risk premium to engage in risk-taking that affects their wealth. Concavity, in contrast, provides a negative risk premium by transferring downside risk to executives while not compensating for the upside potential. However, the effect of debt compensation on firm value seems less straightforward. For example, while Wei and Yermack (2011) find debt compensation to be negatively associated with firm value, Bennett et al. (2015) propose debt compensation to be a predictor of bank performance during the financial crisis. Such discordance suggests that further factors are essential to consider. As empirical research on moderators is still sparse, this reveals avenues for future research. This research may also consider how behavioral implications based on the BAM affect risk-taking. Figure 6 summarizes the main findings from this section.



Available Instruments	Rational	Studies
▪ Caps ▪ Debt compensation ▪ Deferred compensation ▪ Clawbacks	▪ Caps reduce the upside potential of risk-taking ▪ Debt compensation, deferred compensation and clawbacks shift executives' attention not just to the occurrence of bankruptcy, but also the value of assets in case of bankruptcy. This increases the awareness of potential downside risk and reduces risk-taking	Kreilkamp et al. (2020) / Bolton et al. (2015) / Sundaram and Yermack (2007) / Wei and Yermack (2011) / Cassell et al. (2012) / Mūlidonis et al. (2019) / Dhole et al. (2016) / Chi et al. (2017) / Bennett et al. (2015) / van Bekkum (2016) / Srivastav et al. (2014) / Anantharaman et al. (2014) / Colonnello et al. (2017) / Sanset et al. (2015) / Liu et al. (2020)

Moderators[a]			
Personal-level factors			
Variable	**Direction**	**Rational**	**Study**
Tenure	Increase in tenure (-)	▪ Higher relative weight of debt assets (CEO Wealth) compared to younger less tenured CEOs	Sundaram and Yermack (2007)
Firm-level factors			
Variable	**Direction**	**Rational**	**Study**
Justification	High levels of accountability (-)	▪ Justification triggers extremeness aversion, which leads to a reduction in risk-taking	Kreilkamp et al. (2020)
Seniority of debt	Low seniority of CEO debt assets (-)	▪ The higher the risk to loose wealth during a potential bankruptcy the greater the impact on risk-taking	Anantharaman et al. (2014) Colonnello et al. (2017)
Firm size	Small (-)	▪ Less regulation of smaller firms leads to a higher reliance on other types of managerial control systems	Liu et al. (2020)
Environmental-level factors			
Variable	**Direction**	**Rational**	**Study**
-	-	-	-

(+) = positively moderates the effect on risk-taking ‖ (-) = negative moderates the effect on risk taking
[a] Studies that examine moderating factors are presented in this table. All other relevant studies are listed above.

Fig. 6 The effect of compensation function concavity on risk-taking

3.2.3 Relativity of executive compensation

In addition to the risk-taking effects of executives' absolute wealth, behavioral theories such as the BAM highlight the importance of executives' perception of their compensation *relative* to certain reference points (Hack and Von Bieberstein 2015). The reference points can be either internal (e.g., an executive's compensation in the prior year or a self-set target) or external (comparison to peers or tournaments). We first discuss internal reference points.

Based on the idea of internal reference points, Larraza-Kintana et al. (2007) disentangle different forms of risk-bearing. They show that variability in compensation is related to more risk-taking, while the intrinsic value of stock options (with its inherent downside risk) is associated with lower risk-taking. Furthermore, incentives work differently in a loss than in a gain context (Wiseman and Gomez-Mejia 1998). Devers et al. 2008) find that CEOs increase strategic risk-taking dependent on the accumulated value of unexercisable option holdings, while the relationship between exercisable options and strategic risk-taking is curvilinear. These findings highlight executives' trade-off between potential future gains and losses (Martin et al. 2013). Based on R&D expenditures as a risk measure, Lim (2015) finds that negative deviations from a reference point increase risk-taking, while positive deviations decrease risk-taking. Similarly, at-the-money stock options elicit more risk-taking than in-the-money stock options, as the latter represents a gain frame (Sawers et al. 2011). Lim 2017) corroborates this reasoning by showing that the risk-eliciting effect of options on CEO risk-taking depends on CEOs' wealth in relation to their reference points. She further finds that in the context of a negative deviation from a reference point (loss context), a higher likelihood of bankruptcy fosters risk-taking. Furthermore,

slack resources induce risk-taking in a gain context, i.e., a positive deviation from a reference point.

Sprinkle and Williamson (2008) arrive at similar results in a different setting. These authors find a U-shaped function between budget levels and risk-taking; particularly, low budget goals, as well as stretch budget goals, elicit risk-taking. Linked to the results of Lim (2017), low budget goals are easy to achieve (gain context) and create slack resources, while stretch budget goals are barely achievable (loss context) and convey the possibility of receiving nothing. This analogy highlights firms' opportunities to manage risk-taking beyond determining executives' compensation function. Other than target setting, firms have further options to influence how executives perceive their compensation, such as framing variability as a bonus or penalty. In this regard, Oblak et al. (2017) find that framing a contract as a penalty induces more risk-taking than framing as a bonus. Zolotoy et al. (2019) extend this reasoning by showing that a positive affective state intensifies this relationship.

As a result, while there is room for more research concerning internal reference points, the empirical results suggest that neglecting executives' perceptions of their compensation may lead to inaccurate risk management. Furthermore, research also shows that compensation design impacts risk-taking through individuals' perception of their compensation (function). Bringing personal perceptions to the table may also shed additional light on some of the ambiguous findings for the effect of steepness on risk-taking.

In addition to reference points that relate to personal aspects, the external context creates the opportunity to compare wealth and compensation to peers. Lim (2018) refers to such comparisons as social reference points. As executives have the opportunity to change employers, comparisons can create implicit tournament compensation. Notably, we refer to an implicit tournament as a system that is not deliberately designed as a tournament but where an individual's compensation relative to peers creates a tournament-like situation. In contrast, an explicit tournament is an incentive system where a firm provides a bonus pool and divides this pool based on participants' performance. In the following, we first present results concerning implicit tournaments before we focus on explicit tournaments. While explicit tournaments are not a regular form of executive compensation, evidence based on explicit tournaments may reveal implications that also apply to implicit tournaments.

The empirical literature generally agrees on a risk-inducing effect of tournament compensation, which is in line with the predictions of theoretical models (Hvide 2002). Concerning implicit tournaments, Coles et al. (2018) find that a larger pay gap between a CEO and the highest-paid CEO in the same industry is associated with higher risk-taking and that this effect is stronger when CEO mobility increases. Based on the pay gap between executives and higher-paid executives in the same area, Ma et al. (2020) provide similar evidence for local tournaments. These authors find that larger pay gaps between local peers are related to higher CEO and CFO risk-taking.

Similar mechanisms occur within a firm. Implicit tournaments that result from pay gaps and promotion incentives within a firm also affect risk-taking. Using an archival study, Kini and Williams (2012) investigate the pay gap between senior managers and the firm's CEO as a natural promotion tournament and show that larger price

spreads are associated with higher risk-taking. Hence, larger pay gaps between top executives increase firm risk, as senior managers follow riskier policies. Patel et al. (2018) arrive at a similar conclusion by finding that higher pay dispersion in top management teams is associated with higher risk-taking. This effect is even stronger with a history of underperformance or for very opaque firms (Jia 2018). However, Sayre et al. (1998) suggest that managers anticipate the strategic opportunities of job promotions based on an experimental study. They show that tournament contestants recognize the strategic implications and consequences of a promotion tournament and respond opportunistically.

Concerning explicit tournaments, Eriksen and Kvaløy (2014) experimentally show that the negative effect of myopic loss aversion (i.e., risk aversion that is fueled by frequent evaluations of investments) can be crowded out by a tournament. In line with the risk-inducing effect of tournaments, this study suggests that frequent assessment of an investment enhances risk-taking under a tournament incentive system. Hence, tournaments can serve as a measure to promote risk-taking among risk-averse employees. Gaba and Kalra (1999) experimentally show that, in the case of a low proportion of tournament winners, individuals tend to choose more risky strategies when deciding on a sales distribution plan. This finding is confirmed by Schedlinsky et al. (2016), who show that a low proportion of tournament winners elicits excessive risk-taking. Additionally, investigating excessive risk-taking, Eriksen and Kvaløy (2016) find that differences arise from competitiveness within tournaments. More precisely, in a tournament where the dominant strategy is to take no risk, these authors find that individuals take more excessive risks when the number of tournament contestants increases or when the winner is made public.

In addition to factors concerning tournament design, other factors indirectly drive risk-taking. If intermediate relative performance feedback is provided during the tournament, an important factor for risk-taking is an individual's current rank. Nieken and Sliwka (2010) show that the current tournament rank influences risk-taking. They find for a two-person tournament that the larger the correlation between the participants' risky outcomes, the more (less) likely it is that the leading (trailing) person chooses a risky strategy. Investigating a greater number of tournament participants, Bothner et al. (2007) show differences in the potential directions of ranking shifts. Using NASCAR race data, they find that facing the threat of falling behind elicits higher risk-taking than facing the opportunity to climb up in ranking positions. Additionally, the authors document that the more established the ranking is, i.e., the more participants have acknowledged their ranking position, the more risk participants accept to maintain their current rank. Kirchler et al. (2018) corroborate this reasoning by finding that underperformers in tournaments take more risks than overperformers. Furthermore, Schedlinsky et al. (2016) identify simplified decision rules, i.e., basing decisions on expected values instead of systematic optimization, as a driver for excessive risk-taking in tournaments.

In summary, the empirical literature on the risk-inducing effects of tournaments highlights the necessity of considering explicit and implicit tournaments in executive compensation. When designing executives' compensation, firms must not see the respective executive in isolation but relative to peers inside and outside the firm.

4 Discussion

Our review reveals important insights for practitioners and fruitful avenues for future research. From a practitioner's perspective, our review may serve as a framework to use executive compensation as a core instrument to support a firm's strategy ("pay follows strategy"). For example, firms in rapidly growing markets that pursue a strategy of steep growth (e.g., tech start-ups) require their executives to take significantly more risks than more mature firms. Our framework suggests that such firms may want to establish convex compensation functions (i.e., use stock options) while refraining from concave compensation functions (i.e., pensions). The Second Shareholders' Rights Directive (ARUG II) requires all publicly listed firms in Germany to have their shareholders vote on the executive compensation system. Our review provides a guideline for evaluating the compensation system against the strategy and highlights potential moderators (e.g., leverage).

Supervisory boards or others in charge of designing compensation packages should be aware of the behavioral effects outlined in this review. For example, when a firm moves from a growth to a mature phase of the firm life cycle or vice versa, the incentive scheme should reflect a change in the firm's risk strategy. However, behavioral theory and empirical evidence suggest a stickiness effect (Brink et al. 2017, p. 15): "Changing from the low power to the high power incentive significantly increases excessive risk taking, but changing from the high power to the low power incentive does not significantly decrease excessive risk taking." Compensation design should therefore take such behavioral effects into account, e.g., by using a concave compensation function when moving from high to low power incentives.

Another example of how firms can use this review relates to reference points. As outlined earlier, executives consider multiple reference points, including internal (e.g., the current option value) and external reference points (e.g., peer compensation). Again, the studies and behavioral theory presented before show how reference points affect risk-taking (e.g., when an executive falls behind in compensation). Interestingly, firms can direct executives' attention to certain reference points, thereby indirectly steering their risk-taking. For example, Volkswagen's supervisory board explicitly states that the compensation of board members of specific peer firms such as BMW, Tesla, SAP, or Hitachi should be considered when designing executive compensation at Volkswagen (Volkswagen 2020).

From a theoretical perspective, our review may help identify research opportunities. For example, studies that assert how the steepness of the compensation function affects risk-taking arrive at ambiguous results. Therefore, future studies may want to shed more light on moderators, including behavioral aspects such as individual perceptions.

From a risk-management perspective, further investigation of compensation function aspects that intend to shift risk-taking in specific directions seems particularly promising. In the 1990s, in an attempt to motivate executives to take more risks, firms started employing instruments that resulted in convex compensation functions. Since then, a considerable body of research has provided evidence for the positive association between convexity and risk-taking and revealed important moderators at the individual, firm, and environmental levels. As a reaction to excessive risk-taking

triggered by large option portfolios, firms started granting debt-based compensation (in addition to equity) to add concavity to executives' compensation functions. Beginning in the mid-2000s, debt compensation is a relatively young research field. Hence, many moderators still need to be investigated. While most research corroborates the risk-decreasing effects of debt-based compensation, it remains unclear for what types of executives, for which firms, and at what magnitude debt compensation might backfire.

Importantly, executive compensation usually consists of a mixture of instruments that create each of the previously discussed shapes—i.e., steepness, convexity, and concavity—to a certain extent. Notably, while some instruments such as options naturally affect steepness and convexity, firms face the challenge of balancing the use of risk-inducing and risk-decreasing instruments to motivate executives to entrepreneurially exploit business opportunities on the one hand and refrain from excessive risk-taking on the other hand. Hence, while there is some research on interactions between different types of rewards (Devers et al. 2008), the need to further investigate the combined effects of different instruments (including moderators) is one of the most important conclusions to be drawn from this review. This includes the development of new instruments and the adaptation of established instruments to align firms' and executives' interests and risk preferences.

Exploring interaction effects may also require other measurement approaches. In this vein, Anderson and Core (2018) suggest a new sensitivity measure. These authors propose a measure that captures the sensitivity of executives' debt, stock, and options holdings to firm volatility and find that their measure explains risk-taking better than vega or other relative measures used in prior research. Using this measure in future research may be helpful in investigating the joint effects of instruments that establish steepness, convexity, and concavity. Concerning specific instruments, firms increasingly employ performance vesting instead of time vesting (Bettis et al. 2018). Future research may want to empirically investigate how performance vesting affects executive risk-taking and how this instrument interacts with other mechanisms such as debt compensation. In this regard, it also seems interesting to identify the performance measures that best fit firms' intentions.

Another important factor is time. Future research should elaborate more on the type of reward used to direct risk-taking, particularly by differentiating between short-term (operational) risk-taking and long-term (strategic) risk-taking. For example, to motivate risk-taking, a firm can increase the share of performance-contingent (cash) pay relative to fixed compensation or grant more stock options. The former may particularly induce short-term risk-taking, while options elicit a longer-term focus, particularly if associated with long vesting periods. Analogously, while compensation caps and debt both restrict excessive risk-taking, the circumstances under which each instrument is more effective are unknown. As risk-taking does not simply add up, it is also crucial to further study such differences in the scope of risk-taking and their joint effects to assess the overall effects on firm risk and firm performance (Arrfelt et al. 2018).

Last, one explanation for the ambiguous results for steepness may be an insufficient consideration of executives' perceptions and internal reference points. Therefore, in addition to archival studies that represent the core part of studies in this

review, future research should employ more survey research, lab experiments, and mixed-method approaches to expand our understanding of cognitive responses to risk-taking incentives. Moreover, as firms usually tie compensation packages of top-management executives very closely to the respective person, additional research that investigates the role of individual characteristics such as personal risk preferences, past experiences, or gender seems helpful (Charness and Gneezy 2012; Baixauli-Soler et al. 2017). While previous research suggests that external references matter through implicit tournaments, future research should try to better understand the interrelations between executives' compensation function and implicit tournaments. For example, it is unclear whether providing debt compensation may be feasible in reducing excessive risk elicited by implicit tournaments.

5 Conclusion

Performance-contingent rewards are an effective measure to align executives' interests with those of the firm. We review research on the effects of executive incentives on risk-taking. In general, our review suggests that firms that aim to manage risk-taking via compensation should not just provide stock options, as their effect on risk-taking is ambiguous. Rather, convexity (concavity) in their executives' compensation function increases (decreases) risk-taking. Importantly, research has identified various moderators that firms should consider when designing their executive compensation. To avoid extreme risk behavior, firms should implement both convexity and concavity to a certain extent in executives' compensation functions. The optimal mixture of different instruments to design executives' compensation is where we see the greatest potential for future research.

Finally, even though our review focuses solely on risk-taking, the effects on effort should not be ignored. Thus, firms should always choose their compensation systems based on the available findings as to how the incentive system affects risk-taking and effort.

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