Relative exploration orientation and real options reasoning

survey evidence from Denmark

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Abstract

Purpose: We aim to extend the understanding of how real options reasoning (ROR) is associated with downside risk, and how a firm's portfolio (explore and exploit) of investment activities affects managers' ability to effectively apply ROR in relation to downside risk.

Design/Methodology: The survey method is used. It is applied to a population of Danish firms, which in 2018 had more than 100 employees. The CFO was the target respondent.

Results: We find that a higher level of ROR is associated with lower levels of downside risk. ROR's association with lower levels of downside risk is also moderated by the level of relative exploration orientation in a negative direction.

Originality: The field of real options reasoning (ROR) research on downside risk and portfolio subadditivity has been dominated by research focused on multinationality. We extend extant literature on ROR by studying ROR as a multidimensional construct of firm action, which is associated with lower levels of downside risk, also when studied outside of a multinationality setting. This is the case when ROR is implemented as a complete system. This paper also applies a framework of exploitation and exploration to show that findings on subadditivity in options portfolios caused by asset correlations extend outside the scope of multinationality and into one of product/service innovation.

Key words: Real options reasoning, relative exploration orientation, downside risk, capital budgeting

1. Introduction

Our aim in this paper is to extend the understanding of how real options reasoning (ROR) is associated with downside risk, and how a firm's portfolio of investment activities affects managers' ability to effectively apply ROR. We are motivated by the literature on downside risk and subadditivity. Formally, downside risk is a probability-weighted function of below-target performance outcomes (Reuer and Leiblein, 2000), and for the purpose of this study, it is considered as failure to meet an aspired to level of performance. Subadditivity considers the effectiveness of ROR when investment activities have correlated uncertainty profiles (Belderbos *et al.*, 2014, 2019; Belderbos and

Zou, 2009; Ioulianou *et al.*, 2020; Li and Chi, 2013; McGrath, 1997; McGrath and Nerkar, 2004; Vassolo *et al.*, 2004).

Compared to static resource allocation regimes such as net present value (NPV), ROR is appealing to managers because it considers the value of managerial flexibility as an investment project develops (Bowman and Hurry, 1993). ROR provides options to defer or commit to a small investment, which can provide an option to take advantage of potential future opportunities, while reducing the financial commitment and thus lower downside risk in the event that conditions unfold unfavorably (Ipsmiller *et al.*, 2019; McGrath, 1997). Theory suggests that real options are associated with lower levels of downside risk because real options enable firms to benefit from uncertainties by flexibly managing them to their own advantage (Bowman and Hurry, 1993; McGrath, 1997). This inherent flexibility can enable firms to benefit from the environmental uncertainty that they face by proactively approaching the uncertainty in terms of how it affects the value of its strategic investments. Real options resemble financial options in that the underlying asset's volatility positively relates to the option value since the potential gains increase, while the costs remain constant. Potential profits thus increase while potential losses remain fixed to the cost of the option. The same is true for a real option, though for a real option it is the variance of assets' expected returns, which drives the potential profits, thus making uncertainty an accelerator for real option value (McGrath, 1999). Firms that operate under uncertainty may commit small sums of capital to investments, which provides options to act on future contingent opportunities (Ipsmiller *et al.*, 2019). Small initial commitments limit financial loss, thus limiting the downside risk if events unfold unfavorably (McGrath, 1997). ROR is intended to aid managers' decision-making under uncertain conditions (Ipsmiller *et al.*, 2019). The flexibility that ROR builds into the capital budgeting process allows managers to make future adjustments to investment decisions in order to protect firms from downside risk while maintaining access to upside potential (Copeland and Keenan, 1998; Krychowski and Quélin, 2010).

The extant empirical ROR literature has paid substantial attention to testing the relationship between ROR and downside risk. This relationship has mostly been studied in the context of multinational enterprises (MNE) based on the premise that MNEs possess real switching options, which for example allows them to shift production between sites in order to optimize changing macroeconomic conditions, and thereby reduce downside risk (Reuer and Leiblein, 2000). This relationship has been studied and confirmed in various contexts (see e.g. Reuer and Tong (2007); Andersen (2011, 2012); Driouchi and Bennett (2011)), and more recent studies has shown that the relationship is contingent on low correlation between MNE's switching options (Belderbos *et al.*, 2014; Ioulianou *et al.*, 2020). While RORs relation to downside risk has been mainly occupied by MNE researchers, other ROR scholars have studied the individual constructs of ROR such as low initial commitment, sequential investments, and reallocation policies in the context of other strategic investments such as product/service innovation (Cuypers and Martin, 2010; Klingebiel and Adner, 2015). Further, survey research within ROR such as Verdu *et al.* (2012) has also considered the case of product/service innovation and found that in a context of high environmental uncertainty, ROR increases firms' innovativeness. As such, prior research on ROR and downside risk is largely limited to the context of MNEs. Recent results also suggest that if multiple options in a portfolio are correlated, they may interact negatively, causing the portfolio to be considered subadditive, which means that the option value of the portfolio is smaller than the sum of the options considered individually (Belderbos *et al.*, 2014; Girotra *et al.*, 2007; McGrath, 1997; Vassolo *et al.*, 2004).

We propose two hypotheses: 1) a higher level of ROR is associated with lower levels of downside risk, and 2) ROR's association with lower levels of downside risk is moderated by the level of relative exploration orientation in a negative direction. A key question in this paper is whether the relationship between higher levels of ROR and lower levels of downside risk extends outside the context of MNEs and into the context of ROR as a multidimensional construct, where companies´ simultaneous use of these constructs is required to produce the expected benefits. Further, whether the negative moderating effect of correlation in the options portfolio extends into the context of product/service innovation. We believe these are important questions to address in order to advance research on ROR. Studies on MNEs and studies of ROR as multidimensional constructs represent two separate lines of ROR research. ROR research on MNEs and JVs (e.g. Andersen (2011, 2012); Driouchi and Bennett (2011); Elango (2010); Tong and Reuer (2007)) studies the effect of having an asset that may constitute a real option, but not necessarily how a firm manages such asset. Studies on ROR as a multidimensional construct (e.g. Klingebiel and Adner (2015)) study whether managerial behavior is consistent with ROR. Because methods for real options valuation are complex and may require multiple sets of complex calculations (Bowman and Moskowitz, 2001), only few firms explicitly assess the financial value of real options (Rigby, 2001). As a result, many firms engage in ROR as a way to guide their strategic investments, meaning that they recognize their existence and behave in ways consistent with capturing real option value (Barnett, 2008; Busby and Pitts, 1997; McGrath and Nerkar, 2004). While prior studies have already shown some of the effects of possessing assets with real option-like features, there is still much to discover about how managers translate ROR behavior into tangible outcomes.

The data used in this study comes from a questionnaire distributed to Danish companies with more than 100 employees. We expand on the data collected in the empirical section. To test the hypotheses, we relied on conceptual constructs already known in the ROR literature, but as survey research in ROR is scarce, the survey items are newly developed for the purpose of this study. We find support for both our hypotheses. As such, this paper extends the literature on ROR and downside risk outside the context of MNEs and into the literature of ROR as a multidimensional construct. Extending findings on the relationship between ROR and downside risk outside the scope of MNEs is important as it addresses the distinguishment of two separate ROR approaches to managing uncertainty. The two ROR approaches pertain to 'wait and see' and 'act and see' (Adner and Levinthal, 2004a; Barnett, 2008). ROR in the context of MNEs represents a 'wait and see' strategy, meaning a two-step approach to 1) obtain an option position for a period of time and 2) exercise or abandon the position (Barnett, 2008; Bowman and Moskowitz, 2001). Specifically, an MNE would wait and see if the macroeconomic conditions changed in a way that would make it preferable to switch production sites. Since macroeconomic fluctuations are outside the scope of a firm's influence, no active action would be taken to further the exercisability of the option. We specifically model into our measure the 'act and see' approach to ROR. This means that management takes an active effort to increase the likelihood of a project's success (Barnett, 2008; McGrath, 1997). We thus contribute with empirical findings showing that the relationship between ROR and lower levels of downside risk extends from a 'wait-and-see' to an 'act-and-see' ROR regime. We also extend the literature on the role of option portfolio correlation, and its moderating effect on ROR's relation to downside risk (Belderbos *et al.*, 2014; Ioulianou *et al.*, 2020), into the context of product/service innovation by applying March's (1991) framework of exploitation and exploration activities. Extending the literature into the context of product/service innovation further strengthens the contribution of showing ROR's impact on downside risk in an 'act-and-see' regime because product/service innovation explicitly represents an 'act-and-see' option (Cuypers and Martin, 2010). Our paper also contributes to the area of ROR research in the context of product/service innovation (Cuypers and Martin, 2010; Klingebiel and Adner, 2015; Verdu *et al.*, 2012), which has not yet studied the effect of ROR on downside risk. As we study ROR in a context of balancing exploration with exploitation to show that ROR firms will favor from exploring well beyond current activities, we also add empirical insight to the discussion of antecedents in favor of ambidexterity (Berard and Fréchet, 2020). We believe that this is an important topic as exploration and exploitation activities are important strategic decisions for firms' long-term survival (Raisch and Birkinshaw, 2008), and as ROR has downside risk-reducing properties their combination may be particularly important for efficient capital allocation. Inefficient allocation of scarce resources will likely lead to value destruction (Arnold and Hatzopoulos, 2000), and as such, strong financial management is a crucial element in a firm's long-term success and survival (Bennouna *et al.*, 2010), and the allocation of resources among alternative capital investment projects is one of the most pressing top management priorities, when implementing strategy (Bowman and Hurry, 1993; McGrath *et al.*, 2004).

The remainder of this paper contains four sections. In section 2, we review the background literature on ROR and develop our hypotheses. Section 3 describes the research method, including data collection and variable measurement. Section 4 presents the results, and in section 5, we discuss the results and concludes the paper.

2. Background and hypotheses

Empirical studies on ROR have been dominated by strategic management scholars (Ipsmiller *et al.*, 2019), where the logic behind ROR is used rather than the determination of actual option value (Driouchi and Bennett, 2012). Such studies mainly focus on the value drivers of ROR, such as uncertainty. Examples include the line of research on multinationality, as discussed in the introduction, as well as other proxies of real options, such as joint ventures, equity alliances, acquisitions, etc. (Folta, 1998; Folta and Miller, 2002; Kogut, 1991; Leiblein and Miller, 2003; Tong and Li, 2013). One of the most researched outcomes of ROR is downside risk. This literature has been dominated by studies using multinationality and international joint ventures (IJV) as proxies for switching and growth options, respectively. Reuer and Leiblein (2000) argued that multinationality resembles a real option in that it enables managerial flexibility. Firms with multiple production sites can in the event of fluctuating exchange rates shift production between sites to optimally hedge their exposures and consequently reduce downside risk (Reuer and Leiblein, 2000). Additionally, changes in local demand may instead mean that multinationality can proxy a growth option, as the firm will be able to stage investments in local markets where demand is increasing (Reuer and Leiblein, 2000). Tong and Reuer (2007) confirmed the relationship and showed that cultural differences in firms' portfolios may exaggerate the coordination costs of operating a multinational corporation (MNC). Reasons include limits to leveraging brand, technology, and other knowledge, as well as issues of post-merger integration or additional costs in connection with international acquisitions (Tong and Reuer, 2007).

Reuer and Leiblein (2000) initially failed to confirm a significant relationship between multinationality and downside risk and pointed out that failure to confirm the relation could include a lack of control for management's actual adoption of an options approach to investments, that is, even though the company owns what could constitute a real option, there is no guarantee that management recognizes its value. The importance of such managerial awareness has later been highlighted by various scholars (Driouchi and Bennett, 2011; Ioulianou *et al.*, 2020). Driouchi and Bennett (2011) for example, included a measure of a firm's exposure to managerial training on the topic of real options. Their results showed that investment in knowledge acquisition of real options leads MNCs to outperform competitors with a lack of real option training in terms of downside risk.

While the literature has shown that managerial awareness of strategic options is an important factor in realizing returns to ROR, prior research has also shown that managers' ability to effectively realize returns to ROR is dependent on the firm's portfolio of investment activities. The results of prior studies suggest that if multiple options in a portfolio are correlated, they may interact negatively, causing the portfolio to be considered subadditive, which means that the option value of the portfolio is smaller than the sum of the options considered individually (Belderbos *et al.*, 2014; McGrath, 1997). As such, if a firm's strategic options overlap or duplicate because their uncertainty profiles are correlated, then the option value of the portfolio is reduced (Belderbos and Zou, 2009; Girotra *et al.*, 2007; Vassolo *et al.*, 2004). Belderbos *et al.* (2014) argue that multinational firms' option portfolios will suffer from subadditivity when the economic conditions of the host countries are positively correlated. Such correlation decreases the flexibility to shift operations across countries. They find that the relationship between multinationality and downside risk is negatively moderated by the level of subadditivity.

Similarly, Ioulianou *et al.* (2020) argue that the geographic dispersion of MNE affiliates increases the dispersion of possible likely outcomes, and that this lowers the portfolio correlation. They show that higher dispersion (lower correlation between affiliates) increases MNE's ability to reduce downside risk.

2.1. Hypotheses

As the above review of empirical ROR research suggests, there has been much interest in testing the relationship between ROR and lower levels of downside risk. In this paper, we are interested in expanding our understanding of this relationship, and because we utilize a newly developed conceptualization of ROR, we find it important to validate this conceptualization by confirming the base case finding of prior studies – that ROR is associated with lower levels of downside risk outside the context of MNEs. Complementarity theory specifies that the interaction and change in different organizational choice variables influence organizational performance (Roberts, 2007). Many interactions could be of interest when studying ROR (see for example Barnett (2008)), where in this paper we are particularly interested in portfolio constellation. Developing survey constructs to measure ROR opens an array of opportunities to study specific pairs of variables and how they interact with ROR, which could greatly improve our understanding of how firms successfully implement ROR.

ROR firms will make sequential investments by initially only committing small amounts of capital to learn about an opportunity if uncertainty is high (McGrath, 2001; McGrath *et al.*, 2004). This provides the firm with the option to wait or postpone action until further knowledge about the profitability is obtained (Copeland and Keenan, 1998; Krychowski and Quélin, 2010). As such, in contrast to resource allocation regimes such as NPV, which assumes deterministic futures (Dixit and Pindyck, 1994), ROR firms recognize that there is value in maintaining the flexibility to abandon the investment if events unfold unfavorably (Li and Chi, 2013; O'Brien and Folta, 2009; Vassolo *et al.*, 2004). To maintain such flexibility, ROR firms will develop routines designed to develop knowledge about the value of their strategic investments (Barnett, 2008). Thus, rather than launching a project and assuming that its developmental trajectory is static, ROR firms will take an active role in developing the project towards knowledge and certainty about its profitability (Barnett, 2005). If a project has developed unfavorably, such knowledge about a project's profitability allows the firm to shield its downside risk by abandoning the project with only a limited initial commitment, and instead reallocate resources to more promising projects. While both sequential capital commitment and uncertainty resolving routines are subject to managerial biases (Adner, 2007; Adner and Levinthal, 2004b; Cuypers and Martin, 2010; Klingebiel and Adner, 2015), ROR firms mitigate such biases through reallocation policies. Reallocation policies aim to mitigate the problem of escalation of commitment that arises when negative information about an investment's development is occasionally interrupted by positive developments. Such occurrences tend to escalate the probability that managers pursue opportunities that should otherwise have been abandoned (Adner, 2007). Consequently, appropriate implementation of ROR includes explicitly defined circumstances under which an investment project is allocated further capital or is abandoned (Adner, 2007). Explicit boundaries aid managers in mitigating the issue by informing them when an option is no longer worth pursuing (Song *et al.*, 2015), thus preserving the value of abandonment. Consequently, ROR firms should experience lower levels of downside risk.

H1: *A higher level of ROR is associated with a lower level of downside risk.*

In this study, we are interested in how a firm's portfolio of investment activities may affect managers' ability to effectively manage options in their strategic investments. Cuypers and Martin (2010) and Klingebiel and Adner (2015) considered firms' investments in product/service innovation as real options, and we follow this line of thought by applying March's (1991) concepts of exploitation and exploration, which are both fundamental concepts in firms' attempts to be competitive in changing environments (Jurksiene and Pundziene, 2016). Exploitation is defined as investments in activities such as refinement, production, efficiency, implementation, and execution, whereas exploration captures investments such as search, variation, experimentation, discovery, and innovation (March, 1991). There is a greater variance of payoffs attached to exploration investments, and prior research shows that exploitation and exploration have opposite relations with environmental dynamism (uncertainty). Exploitation efforts yield higher performance when environmental dynamism is low, while exploration efforts yield higher performance effects when environmental dynamism is high (Raisch and Birkinshaw, 2008). Therefore, when a firm invests in exploitation, it builds on a portfolio of activities that thrives under the current environmental conditions. Contrary, investing in exploration means that the firm is building on a portfolio of activities that will only thrive if the current environmental conditions change. Consequently, if the environmental conditions change in favor of exploration activities, this likely means that exploitation activities will no longer be worth pursuing (Raisch and Birkinshaw, 2008). If exploration activities become profitable due to an environmental change that leaves exploitation activities with lower or no profits, it must mean that exploration and exploitation activities have either low or no correlation. (March, 1991) argues, and empirical studies (Cao *et al.*, 2009; He and Wong, 2004) show that maintaining a balance between exploitation and exploration activities is optimal for performance. The balance may also have implications for the use of ROR in the extent to which a firm emphasizes exploration activities over exploitation activities, which we will term 'relative exploration orientation', as in Uotila *et al.* (2009). Firms with a low degree of relative exploration orientation primarily conduct exploitation activities, while firms with a high degree of relative exploration orientation primarily conduct exploration activities. Given the above discussion, firms with a low degree of relative exploration orientation will have a portfolio of investment activities optimized to benefit from current environmental conditions and will thus consist of activities with cash flows highly correlated with current operations. As the relative exploration orientation increases, the portfolio becomes increasingly optimized to benefit from environmental changes, i.e., changes that will likely seize cash flows from exploitation activities. As such, a higher extent of relative exploration orientation will yield a lower correlation between cash flows in the portfolio of investment activities and the current operations.

Dixit and Pindyck (1994) have suggested that a reasonable assumption for firms pursuing a ROR strategy would be that firms favor exploratory research well beyond the scope of current activities, and further, that decisions regarding investments ought to be studied in the context of a portfolio of investments. Correlation is suggested to be one of the key mechanisms that affect the value of options embedded in a portfolio of activities (Girotra *et al.*, 2007; Johnson, 1987; Margrabe, 1978; Stulz, 1982; Trigeorgis, 1993, 2005). A high positive correlation between options means that they are likely exercisable at the same point in time, thus having the same underlying factors driving their respective returns. A high negative correlation, on the other hand, means that an option is not likely exercisable at the time where another option is exercisable due to differences in the underlying factors driving their respective returns (Li and Chi, 2013). As such, a key factor affecting the combined value of multiple options is the correlation between factors that drives the exercisability of the different options. This means that in a portfolio with multiple options, the correlation between the return on the assets determines the likelihood that they will be exercisable at the same time. Portfolios with a high positive correlation between returns constitute a poor hedge against risk, as the portfolio faces the risk of being completely left 'out of money' if the 'right' circumstances present themselves (Li and Chi, 2013).

The benefits of ROR with regard to lower levels of downside risk are realized through the managerial discretion to withdraw or scale down a project (Li and Chi, 2013; McGrath, 1997), which we argue is determined by the correlation among projects in the portfolio of investment activities. Lower levels of portfolio correlation increase the dispersion of possible outcomes, which is characteristic of environments with high uncertainty (Ioulianou *et al.*, 2020). This is optimal for a portfolio with higher levels of relative exploration orientation (Raisch and Birkinshaw, 2008). Prior research shows that when correlations among portfolio projects are high, firms are found to have higher termination rates (Belderbos and Zou, 2009; Vassolo *et al.*, 2004). A project termination has a direct effect on losses and thus the level of downside risk, but firms with a high relative exploration orientation will likely find that effect less severe. Exploratory projects most often involve considerable uncertainty and are distant from the firm's core capabilities (March, 1991; Vassolo *et al.*, 2004). As the option value of a project increases with the level of environmental uncertainty, the option value of exploratory projects should be higher than that of an exploitative project. Exploratory projects have a higher chance of developing into profitable projects when environmental uncertainty is high (Raisch and Birkinshaw, 2008). With higher exposure to exploratory projects, the portfolio variety increases, and thus the chance of advantage under uncertainty (McGrath and Nerkar, 2004). As such, ROR firms will prefer to maintain the option open to gain future possible rents. In the case, that an exploratory project is indeed withdrawn from, a ROR firm has invested with the downside limiting behavior of small initial investments, which reduces the downside risk (Bowman and Hurry, 1993; Ipsmiller *et al.*, 2019;

McGrath and Nerkar, 2004). However, we believe that ROR firms with low levels of relative exploration orientation will have difficulties in limiting the downside risk. As exploitation builds on the competencies close to the firm's current operations, a low relative exploration portfolio will be prone to duplication, and thus projects with higher correlation to current operations. Such duplication makes the portfolio more vulnerable to environmental uncertainty, and thus a less effective hedge against downside risk (Li and Chi, 2013). The more overlap a project has with existing operations, the more redundant is its option value (Belderbos and Zou, 2009). Because changes due to environmental uncertainty are likely to negatively affect or seize profitability of exploitation projects, ROR firms will find only little or no option value in maintaining the options open (Belderbos and Zou, 2009). Hence, ROR firms will have a higher propensity to withdraw from such projects, but ROR firm's risk-limiting behavior of investing with small initial commitments will be less impactful for exploitation projects because the correlation with existing operations will likely mean that the firm is abandoning a project in which it is already heavily invested. We consequently predict that managers' ability to effectively manage a ROR approach is moderated by the level of relative exploration orientation.

H2: *ROR's association with lower levels of downside risk is moderated by the level of relative exploration orientation in a negative direction.*

3. Methods

3.1. Data

For this study, we administered an online questionnaire addressed to CFOs in Danish companies with more than 100 employees. The questionnaire was distributed in the summer period of 2018. Firms with more than 100 employees were chosen to increase the chance of obtaining data from firms with formalized policies regarding investments. We originally sent the questionnaire to 1056 organizations and we used the recommendations for survey research by Dillman *et al.*, (2014). To encourage participation, the respondents could opt-in for a summary of the findings by the end of the survey. We distributed an e-mail targeted directly to the target person (CFO), when possible, and otherwise to the e-mail address listed in the organization's contact information. The e-mail contained an electronic link to the questionnaire. After three weeks, we sent out a reminder accompanied by a signed letter. We sent out two further reminders, each with three weeks in between, where we supplemented the former by contacting the respondents through telephone to increase interest in the study. We obtained a final sample of 94 firms, and thus a usable response rate of 8.9%, which is similar to other survey-based ROR studies (e.g. Brouthers and Dikova (2010) and Verdu *et al.* (2012)). The respondents had an average tenure of 10.6 years in the organization, and 7.2 years in their current position. We included a question about involvement in the organization's investment decisions as a way of ensuring that the responses originated from appropriate sources in the organizations. We assessed the involvement on a scale from 1-7 (1 = no involvement at all, 7 = extremely high involvement), and we obtained an average score of 6.0 for the sample.

We rely on a single method in our study, so the data may be subject to common method bias, although this may not necessarily be the case (Speklé and Widener, 2018). We took several design measures to limit the potential of common method bias. We designed the questionnaire with a temporal separation, meaning that we introduced a time lag between measuring the dependent and the independent variables. Temporal separation has the benefit of reducing the saliency of contextually provided retrieval cues, and it reduces the respondent's ability to use the previous answer as a guide to later answers (Podsakoff *et al.*, 2003). We also ensured the respondents that we would protect their anonymity, which should reduce respondents' apprehension to answer more socially desirable, lenient, acquiescent, and consistent (Podsakoff *et al.*, 2003). At last, common method bias is especially distortive in bivariate correlations (Speklé and Widener, 2018). While we are interested in bivariate relationships, all regressions used in this study are multivariate, which mitigates the occurrence of common method bias as long as the additional variables exhibit low to moderate correlation (≤ 0.30) with the dependent and independent variables (Speklé and Widener, 2018). This is confirmed by examining the correlation matrix in Table 6, except for the relationship between environmental dynamism and relative exploration orientation, which we know from the extant literature to be highly correlated (Raisch and Birkinshaw, 2008). Since the sample size and response rate are relatively low, we made a range of non-response bias tests to establish proof of sample representativeness. As in other small sample size survey studies (e.g. Bedford *et al.* (2019) and Hall (2008)), we compared industry representativeness and firm size of our sample firms to that of the full list of firms that originally received the questionnaire. We assess the difference in mean firm size between the two groups with a t-test. The comparison of our sample mean firm size ($\bar{X}$ = 392) to the full list mean firm size ($\bar{X}$ = 406), do not differ by statistical significance (t = 0.58, p > 0.10). We used a χ^2-test to test for differences in the industry proportions between our sample and the full list of firms. The results indicate that our industry proportions are representative of the full list, as the test produces insignificant differences (χ^2 = 11.73, degrees of freedom = 8, p > 0.10). We present the industry classifications for the sample firms in Table 1. We conduct a final test for late response bias, comparing the scores for all variables between the first 25% and last 25% of responses. We executed the tests with t-test (results not reported here) and found no significant differences for any variables. For all financial accounting-based variables used in the study, we obtained data from Navne og Numre Erhverv, a Bisnode administered comprehensive database for firm level data on Danish firms.

[Insert Table 1: Industry classification]

3.2. Variable measurement

We applied a mix of variables in this study, some of which are previously developed and empirically tested constructs, while others are newly developed measures. New measures pertain to the four constructs of ROR as well as two measures of perceived downside risk. The following subsections describe all constructs. All survey items were measured on a seven-point Likert scale, and we provide labels for each point on the scale to reduce measurement error and response bias. Eutsler and Lang (2015) conclude that this approach is superior to five- or nine-point Likert scales and that labeling is superior to scales that only labels at the ends. It pertains to all survey constructs, formative and reflective, that they are computed as the average of their items.

Dependent variables

Downside risk: Reuer and Leiblein (2000) argue that "formally stated, downside risk is a probability-weighted function of below-target performance outcomes". In a review of variance-based measures of risk in finance theory, behavioral decision theory, and management research, Miller and Reuer (1996) find several rationales for moving toward a downside conceptualization of risk. Reuer and Leiblein (2000) argue that in particular, a downside conceptualization incorporates reference levels, which are identified as determinants of risk preferences in behavioral decision theory, thus indirectly controlling for risk appetite. The reason being that performance and aspiration constructs are central to managers' concept of risk (Miller and Leiblein, 1996). They reviewed past surveys of managers' perception of risk and mention studies such as March and Shapira (1987), who found that negative outcomes were the sole focus of risk consideration for 80 percent of the surveyed executives. March and Shapira (1987) argue that managers' decision-making considers risk not as variance in outcomes, but rather as negative outcomes. Further, out of seven definitions of risk, Baird and Thomas (1990) found that financial analysts considered size and probability of loss as the most important. As such, Miller and Leiblein (1996) argue that the surveys suggest that failure to meet an aspired to level of performance is the best-suited conceptualization of downside risk. Further, Reuer and Leiblein (2000) argue that the downside conceptualization is a particularly good fit for studying the outcomes of real options theory, as real options reasoning seeks to cushion only against the downside of variation.

For our operationalization of downside risk [DSR], we apply both traditional measures used in prior ROR studies, while also responding to calls for increased use of perceived measures in ROR research (e.g. Ipsmiller *et al.* (2019)). While several measures of downside risk have been used in the past, Miller and Reuer (1996) argue that while variance considers the entire distribution of outcomes, downside risk measures should explicitly incorporate a reference level, such as a target or aspiration. Studies that have used downside risk operationalization with such reference features include Andersen (2011, 2012), Reuer and Leiblein (2000), and Tong and Reuer (2007). We follow this convention and use one of the measures introduced by Reuer and Leiblein (2000), where the firm's prior year return on assets (ROA) and return on equity (ROE) are used as reference levels.

$$Downside\ risk, ROA_i = \sqrt{\frac{1}{2} \sum_{ROA_i < BROA_i} (BROA_i - ROA_i)^2}$$

Where ROA_i is firms i's ROA, and $BROA_i$ (benchmark ROA) is firm i's ROA in the preceding year. The squared difference term is summed over the two years 2016-2017[1], in those years where the firm fell short of this benchmark. We use a similar conceptualization, Downside risk, ROE, where we apply the same method but replace ROA with ROE.

We also apply two newly developed constructs that have been adapted from other contexts. These are intended to measure downside risk in terms of the managerially perceived chance of obtaining below target performance outcomes on the organization's investment activities. To operationalize such perceived chances of obtaining outcomes from investments that fall below the objectives, we sought distant works of literature for items with similar intentions. We draw on Grewal *et al.*'s (1994) operationalization of Bauer's (1960) definition of performance risk. "Perceived performance risk refers to the possibility that the product will not function as expected and/or will not provide the desired benefit" - (Grewal *et al.*, 1994). We modify the measure to fit the purpose of this paper with two different conceptualizations. We term the first construct, Perceived downside risk, business ($DSR_{business}$), and define three items intended to assess an investment's risk in terms of the perceived chance of performing in accordance with expectations set at the time of investment (bdsr1). Additionally, the chance of an investment performing the expected features (bdsr2), and the chance of an investment performing with the expected functionality (bdsr3). For ease of interpretation, we reverse code the items to reflect that more downside risk corresponds to a higher score. We term the second construct, Perceived downside risk, financial ($DSR_{financial}$), and ask the respondents to assess the perceived overall risk of allocating capital to an investment project (fdsr1). The risk of a capital allocation to an investment project due to events that will increase operational costs (fdsr2), and the perceived risk of a capital allocation to an investment project given the financial costs associated with the average investment project (fdsr3).

Independent variables

Real options reasoning [ROR]. In this paper, we have developed four new constructs to conceptualize a measure of ROR. We reviewed the literature on ROR to establish the basis for the scale development of ROR. In doing so we followed the guidance of Bisbe *et al.* (2007) and Hinkin (1998) for defining survey constructs. Based on a total of 12 survey items, the constructs pertain to (1) option awareness, (2) sequential low commitment, (3) active uncertainty resolution, and (4) reallocation. The use of multiple constructs is not entirely new in the ROR literature. Klingebiel and Adner (2015) for

[1] The period chosen matches the period in which investments in relative exploration orientation is measured.

example applied multiple constructs. In this paper, we are not particularly interested in the relationships between the individual ROR constructs, but rather the effect of ROR in connection with exploration and exploitation investments. As such, we choose to collapse the individual constructs into a single measure. In collapsing the constructs into a single composite, we exclude option awareness and treats this separately from the other constructs. This mirrors the practice of prior research including an option awareness measure such as Driouchi and Bennett (2011) and Ioulianou *et al.* (2020). Option awareness is not a key variable in developing the hypotheses relating ROR to outcome variables. We, therefore, believe that option awareness is an important control variable, but not a core part of linking ROR to outcomes. In the following, we introduce the constructs used in this paper.

Sequential low commitment [SLC] refers to the resource allocation policy applied in the context of ROR. In contrast to the static assumptions used in resource allocation regimes such as NPV (Bowman and Hurry, 1993; Dixit and Pindyck, 1994), ROR firms do not assume deterministic futures, and will invest in projects sequentially and with low initial commitment which allows a firm to reduce downside risk, if the events unfold unfavorably, but maintains the option of taking advantage of future opportunities, if events unfold favorably (Ipsmiller *et al.*, 2019; Li and Chi, 2013; Vassolo *et al.*, 2004). As such, the theory suggests that there is value in deferring full commitment to an investment project until the underlying uncertainty is resolved (Song *et al.*, 2015). We operationalize sequential low commitment with items intended to assess the degree to which management uses uncertainty to assess the size of capital commitments (slc1 and slc2), as well as the effect of resolving uncertainty on exercising options (slc3).

Active uncertainty resolution [AUR] refers to actions that will maintain an organization's access to opportunities, which means establishing routines that maintain and develop knowledge about an option's value (Barnett, 2008). While the NPV technique fundamentally assumes that the project will be launched and then left on its own, ROR expects managers to take an active role throughout the lifetime of the project, where managers exert an ongoing effort to respond to changing conditions to maximize the assets' potential (Barnett, 2005). If such management of options is not executed, or if management misuses its discretion over investment decisions, the theoretical value of real options may never be realized (Barnett, 2008; Coff and Laverty, 2008; Song *et al.*, 2015). As such, a key part of ROR is to establish practices that produce the knowledge necessary to adapt to uncertainty (Driouchi and Bennett, 2012) and a flow of information that reduces uncertainty (Janney and Dess, 2004; McGrath and Nerkar, 2004). We ask about the extent to which management continuously observes the environment to make assessments of the value of the firm's options (aur1 and aur2), and we assess the extent to which management puts continuous effort into creating value from its options (aur3)

Reallocation [REAL] refers to how managerial boundaries are set with regard to capital commitments after the initial investment has been made. Reallocation has especially been promoted by Adner and Levinthal (2004a), who argue that to create value from ROR, firms must restrict the area in which their real options are defined. Appropriate implementation of ROR includes explicitly defined circumstances under which an investment project is allocated further capital or is abandoned (Adner, 2007). The justification of a well-specified reallocation policy is found in the managerial biases inherent in policies of both low initial commitment and endogenous uncertainty resolution. (Adner and Levinthal, 2004) argue that information about the value of an investment may improve managerial decision-making, but the flexibility is revealed in the abandonment decision. An option is flexible because, in the event of information about negative outcomes, it can be abandoned. However, low initial commitment often leads to escalation of commitment where there are no proper de-escalating procedures in place (Klingebiel and Adner, 2015). Reasons for such biases may be explained by a focus on sunk costs, personal interest, aversion to failure, and overconfidence (Camerer and Lovallo, 1999; Klingebiel and Adner, 2015; McGrath, 1999; Samuelson and Zeckhauser, 1988). As such, the effectiveness of sequential low commitment is conditional on firm procedures that ensure efficient reallocation of capital at later stages of the investment process. Further, actively resolving uncertainty may also lead to escalation of commitment in the absence of well-specified reallocation procedures (Adner and Levinthal, 2004a). Barnett (2008) argue that ROR firms will seek to reduce the uncertainty of a project from the time of the initial investment to the time of a potential subsequent investment, which implies a flow of information seeking to reduce adverse effects of uncertainty (Janney and Dess, 2004; McGrath and Nerkar, 2004). However, negative information about the development of an investment may not arrive all at once but be interrupted by occasional positive developments. According to Adner (2007), this escalates the chance that managers are convinced that an opportunity is worthy of continuation rather than abandonment. To mitigate such effects, ROR firms should set explicit boundaries for real options to ensure that managers abandon options that are no longer worth pursuing (Song *et al.*, 2015). We operationalize reallocation by the extent to which management clearly specifies an asset's embedded options prior to investment in the said asset (real1), the extent to which circumstances for abandonment (real2), and further capital allocation (real3), are specified ex-ante of option acquisition.

Relative exploration orientation: We apply nine survey items for the exploitation [EXPLOIT] and exploration [EXPLORE] constructs, which were originally developed by Atuahene-Gima (2005) and are focused on product/service innovation. The constructs are recently empirically validated by Bedford *et al.* (2019), who modified the items to reflect ex-ante objectives, which is consistent with He and Wong (2004). We further refine the framing of the questions to fit the context of the current study by asking the respondents to state the extent to which the organization has prioritized capital investment projects in exploration and exploitation. We treat the items as reflective indicators of the two constructs. We compute a balanced dimension, which constitutes our measure of relative exploration orientation [RelExp], which we operationalize with the ratio method used in

Jancenelle (2019), Uotila *et al.* (2009), and Wang and Dass (2017), where the level of exploration is divided by the total level of exploration and exploitation[2].

Control variables

We include a number of control variables in the model. McGrath (2001) argues that size may have important implications for measures of innovation and thereby willingness to take on options. Sorensen and Stuart (2000), for example, showed that larger firms tend to put heavier reliance on previous work for innovations. Additionally, larger firms are likely to have more resources available for slack purposes (Lubatkin *et al.*, 2006). We take a measure of size [SIZE] as the logarithm of the number of employees. Multiple scholars have argued that performance effects on exploration and exploitation are affected by environmental factors, such as unpredictability and competitiveness (Birkinshaw and Gibson, 2004; Levinthal and March, 1993; Siggelkow and Levinthal, 2003). To account for the environmental factors, we apply environmental dynamism and environmental hostility. Both measures are previously empirically validated in studies such as Bedford (2015) and Jansen *et al.* (2006). Environmental hostility is a measure of competitiveness and the degree of pressure for market demand, resources, and growth opportunities (Dess and Beard, 1984; Miller and Friesen, 1983). Hostility increases the attractiveness of exploitation while limiting profitability from exploration due to increased risk (Levinthal and March, 1993; Zahra, 1996). Environmental hostility may also have implications for ROR, as it may decrease the managers' focus on venturing into new areas (Wang and Dass, 2017), thus reducing the variance of expected outcomes. While firms may be encouraged to increase innovativeness to compete (Drechsler and Natter, 2012; Weerawardena *et al.*, 2006), tense competition increases the challenges of finding unique opportunities to act on and therefore makes the search, learning, and action more costly (Wang and Dass, 2017). Based on Miller and Friesen (1983) and Tan and Litschert (1994), environmental hostility [HOST] is constructed as an index of three dimensions. A central concept in the ROR literature is the concept of uncertainty, which refers to an inability to anticipate future developments that may have a material impact on the firm (Song *et al.*, 2015). Song *et al.* (2015) argue that the measure chosen for uncertainty should relate to the context in which managers make investment decisions, and measures should be taken to find a measure that represents meaningful sources of uncertainty, which are relevant to decision-makers. As such, for this study, we apply environmental dynamism [DYN] as a proxy for uncertainty, which has been empirically validated in Bedford (2015) and Jansen *et al.* (2006). Environmental dynamism measures the predictability of the firm's environment (Dess and Beard, 1984). Dynamism is measured as an index of five dimensions, as in Chenhall and Morris (1993) and Gordon and Narayanan (1984). The dimensions do not necessarily relate to each other, hence, we measure them as a formative construct. Jahanshahi and Zhang (2015) argue that ROR studies should include firm age [AGE] as an important control variable. Younger firms tend to pursue radical innovations to a higher degree than their older counterparts. Firm age can be measured as the natural logarithm of the number of years that the firm has been in existence

[2] Relative exploration orientation = exploration/(exploration + exploitation).

(Jahanshahi and Zhang, 2015). We follow this convention. Short-term horizon may impede the firm's benefits from ROR, as it focuses managerial attention on viewing volatility only in terms of its downside (Wright *et al.*, 2007). This can lead to an avoidance of pursuing longer-term payoffs involving greater uncertainty (Hoskisson *et al.*, 1993; Shijun, 2004). Indeed, Alessandri *et al.* (2012) find that short-term incentives impede incentives to pursue valuable growth opportunities. We consequently control short-term horizon and growth opportunities. We measure managerial short-term horizon [SHORT], as in Merchant (1990), by the percentage of resources allocated to activities that will show up in the income statement within one year. We measure growth opportunities [GROWTH] as two item constructs intended to assess the managerially perceived growth opportunities for the organization and within the industry as in Abernethy *et al.* (2004). Organizational slack may be an important determinant of organizational responses, and Miller and Leiblein (1996) argue that any model of downside risk should include a measure of slack. We follow previous conventions and take a measure of organizational slack [SLACK] as SG&A over sales. Last, we control for *Option awareness* [AWARE], which refers managers' awareness of opportunities to acquire option-generating resources (Barnett, 2008). Adner and Levinthal (2004b) argue that the underlying logic of real options is that future opportunities are contingent on past investments and Bowman and Hurry (1993) note that organizations develop as they pursue strategic opportunities, but that these opportunities are contingent on their resources. Bowman and Hurry (1993) argue that such opportunities for change only exist to the degree that managers recognize that investments in resources hold strategic opportunities. Driouchi and Bennett (2011) showed that managerial awareness of real options were important for MNC's ability to reduce their downside risk. They argue that shadowing is the firm's managerial aptitude to actually recognize that its assets hold embedded real options, which can be proxied by the extent to which managers pay attention to option-like opportunities (Barnett, 2005, 2008). Options awareness is operationalized with three items, covering management's consideration of an investment's options, such as abandonment, expansion, etc. (aware1). We further asked about the importance of acquiring options (aware2), and the degree to which the firm recognize that future opportunities are contingent on prior investments in resources (aware3).

3.3. Exploratory and confirmatory factor analyses

Our measures for ROR and perceived downside risk are based on newly developed scales, while the remaining constructs are previously validated. We assess the latent factors for the new measures using exploratory factor analysis (EFA) with maximum likelihood extraction with Varimax rotation.

[Insert Table 2: Exploratory factor analysis (ROR)]

Results of the analyses are reported in Tables 2 and 3. The EFA analysis for ROR, reported in Table 2 shows four factors with eigenvalues above 1, and with 72%

cumulative variance explained. We obtain a KMO of sampling adequacy of 0.79, and Bartlett's test of sphericity that is significant at $p < 0.000$ which is thus within the generally accepted levels (Hair Jr. *et al.*, 2014). The factors exhibit a Cronbach's α between 0.72 and 0.87, thereby confirming acceptable reliability for all ROR constructs (see Table 4). Table 3 reports the results of the EFA for the perceived downside risk measures. Cumulative variance explained is 60%, KMO is 0.75, and we obtain Cronbach's α between 0.87 and 0.69.

[Insert Table 3: Exploratory factor analysis (Downside risk)]

We report the results of a confirmatory factor analysis (CFA) in Table 4[3]. As recommended by Kline (2011), we evaluate the model fit with a range of fit indices. We assess the Comparative Fit Index (CFI) (Bentler, 1990), the Tucker Lewis Index (TLI) (Tucker and Lewis, 1973), and Incremental Fit Index (IFI) (Bollen, 1989). All three indices are evaluated based on their closeness to 1 and are all at acceptable levels since all are above 0.9 (Bentler, 1992; Kline, 2011). The root mean square error of approximation (RMSEA), as well as the standardized root mean square residual (SRMR) are both at satisfactory levels as RMSEA is below 0.08, and SRMR is below 0.1 (Browne and Cudeck, 1993; Kline, 2011; Schermelleh-Engel *et al.*, 2003). The χ^2 to degrees of freedom is below 3, and thereby indicating an acceptable fit (Kline, 2011). The model reports composite reliability (CR) levels above 0.6, and can consequently be accepted as reliable (Hair Jr. *et al.*, 2014). Further, all standardized coefficients (factor loadings) are above 0.5 (Bagozzi and Yi, 1988). Discriminant validity is supported, as the square root of the average variance extracted (AVE) is greater than any correlations among the reflective factors (Chin, 1998). We present all correlations in Table 6 and descriptive statistics in Table 5.

[Insert Table 4: Confirmatory factor analysis]

[Insert Table 5: Descriptive statistics]

[Insert Table 6: Correlation matrix]

3.4. Regression

We apply two types of cross-sectional regression models to test the hypotheses, depending on the dependent variable in question. For the perceived measures of risk, we apply ordinary least squares (OLS) regression analysis. As such, the OLS analyses pertain to models including $DSR_{business}$ and $DSR_{financial}$. For regressions including the downside risk measures based on ROA and ROE, a large part of the observations are suppressed to a lower level, in this case, zero, which may cause bias in OLS analysis (Wooldridge,

[3] Table 4 reports the results of a CFA with $DSR_{business}$ as the only outcome variable. We performed separate CFAs including the other outcome variable, $DSR_{financial}$. The results obtained with the other outcome variables do not alter the conclusions regarding reliability and validity.

2002). Instead, we apply a Tobit regression model, which is a censored regression model. Such models apply when the dependent variable is partly continuous, but with a positive probability mass at one or more points (Wooldridge, 2002), which in this case would be at zero. The Tobit model was used for the same purpose in Reuer and Leiblein (2000). For our ROR measures, we construct a binary variable, ROR, that takes the value of 1 if [SLC], [AUR], and [REAL] are all above the median value, and 0 otherwise. The reason being that ROR is a system with separate elements that should all be implemented to gain the expected benefits. SLC for example is not unique to ROR and is also descriptive of other path-dependent capital allocation regimes (Adner and Levinthal, 2004a), and due to the behavioral biases of both SLC and AUR, we would not expect our predictions to hold if not in combination with REAL. In a systems view, all design elements are expected to be implemented as a response to optimize some outcome (Grabner and Moers, 2013), here downside risk. The method of defining a binary variable to represent the simultaneous implementation of system elements has previously been applied in accounting studies such as Grabner (2014). The regression model to test H1 takes the form:

$$Outcome_i = \alpha + \beta_1 ROR_i + \beta_2 RelExp_i + \beta_{...} Ctrls_i + \epsilon_i$$

, and the regression model to test H2 takes the form:

$$Outcome_i = \alpha + \beta_1 ROR_i + \beta_2 RelExp_i + \beta_3 ROR_i * RelExp_i + \beta_{...} Ctrls_i + \epsilon_i$$

, where $Outcome_i$ refers to the dependent variables, which are the various conceptualizations of downside risk.

4. Results

Prior to estimation, we follow traditional conventions and winsorize all financial accounting variables at the 5th and 95th percentile level based on two-digit industry classification[4]. We mean center independent and moderator variables prior to estimating the regression to eliminate issues of multicollinearity (Cohen *et al.*, 2003). Table 7 reports the results of the regression models pertaining to H1. The results in Table 7 provide support for H1 with regard to the perceived measures of downside risk. ROR is significantly negatively associated with $DSR_{business}$ ($\beta = -0.60$, $t = -3.1$, $p < 0.01$) and $DSR_{financial}$ ($\beta = -0.58$, $t = -2.86$, $p < 0.05$). However, while the results reported in Table 7 provides coefficients in the predicted direction, the analyses fail to provide a significant association between ROR and the accounting-based measures of DSR, and H1 is thus only partially supported.

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[4] We also test for the alternative specification with winsorization at the 1st and 99th percentile level. The alternative specification does not alter the conclusions of the study.

In Table 8, we present the results pertaining to H2. We find a significant negative moderation effect (β = -5.66, t = -1.97, $p < 0.10$) for $DSR_{business}$. Likewise, for $DSR_{financial}$ we observe a negative and significant moderation effect (β = -6.41, t = -2.17, $p < 0.05$).

[Insert Table 7: Regression results H1]

We thus find support for H2 based on the perceived measures of downside risk. For DSR_{ROA}, we obtain a significant moderation effect (β = -0.29, t = -1.94, $p < 0.10$), as predicted. For DSR_{ROE} we also obtain a significantly negative moderation effect (β = -0.89, t = -1.76, $p < 0.10$), and the Wald statistic borderline significant at p = 0.106.

[Insert Table 8: Regression results H2]

The results are in partial support of H1, where the results show that higher levels of ROR is significantly associated with lower levels of perceived $DSR_{business}$ and $DSR_{financial}$. While we do obtain coefficients in the predicted direction, the results are insignificant for the association between ROR and DSR_{ROA} and DSR_{ROE}. For H2, we find support across all measures of downside risk, though the regression model including DSR_{ROE} is only borderline significant at p = 0.106[5].

Figure 1 illustrates the moderation effects obtained from the regressions in Table 8. Figure 1 illustrates that the interaction effect in the models with perceived DSR measures is monotonic (Burkert *et al.*, 2014), meaning that the effect of ROR on DSR is negative across all levels of relative exploration, but more so when relative exploration is high. The moderation effect for the ROA and ROE based measured of DSR shows a symmetrical non-monotonic interaction (Gerdin and Greve, 2008), meaning that ROR is actually increasing DSR at low levels of relative exploration while decreasing at high levels of relative exploration. As such, for all the obtained moderation fits, the moderator variable alters the form of the relationship between ROR and downside risk in the expected direction.

[Insert Figure 1: Illustration of moderation effects]

Alternative specification

Since we have collapsed our ROR measure into a binary variable, we report a second set of regressions, where we include the individual effects of each part of the ROR system

[5] We specified the regressions in Table 7 and Table 8 with the inclusion of the exploration and exploitation variable, while we did not hypothesize on their direct effects. We included the variables to ensure that it is the ratio between them that drives the results and to control for the level of exploration and exploitation. For robustness, we also specified regressions excluding the exploration and exploitation measures. The results did not alter the conclusions, but the interaction term ROR * Relative exploration in Table 8 for the insignificant model with DSR_{ROE} as dependent variable becomes insignificant, which highlights the importance of controlling for the level of exploration and exploitation.

to show that the model is robust. As such, Tables 9 and 10 report results where we include the individual measures of SLC, AUR, and REAL to show the incremental effect of the ROR variable.

The model is robust to the inclusion of the individual effects. While we do observe an increase in the strength of significance levels, the results do not alter the conclusions obtained in the section above, with the exception that for H2, the model including DSR_{ROE} is now significant at $p < 0.10$ rather than only borderline significant[6].

[Insert Table 9: Alternative regression results H1]

[Insert Table 10: Alternative regression results H2]

5. Conclusion

In this study, we show that firms with a high degree of ROR experience lower levels of downside risk. We also studied how this relationship is affected by other choice variables related to the characteristics of the capital investment portfolio, as measured by relative exploration orientation. We show that the negative association between ROR and downside risk is moderated by the level of relative exploration orientation. Table 11 summarizes our findings.

[Insert Table 11: Results]

Our findings extend the literature on ROR and downside risk, by confirming that the relationship is robust outside the scope of research on multinationality (Andersen, 2011, 2012; Driouchi and Bennett, 2011; Elango, 2010; Ioulianou *et al.*, 2020; Reuer and Leiblein, 2000; Reuer and Tong, 2007). We extend the literature by showing that the relationship is robust in the context of ROR as a multidimensional construct of firm action (Cuypers and Martin, 2010; Klingebiel and Adner, 2015). We also contribute to the literature on portfolio correlation and subadditivity in the ROR literature (Belderbos and Zou, 2009; Ioulianou *et al.*, 2020; Li and Chi, 2013; McGrath and Nerkar, 2004; Vassolo *et al.*, 2004; Ziedonis, 2007). By applying March's (1991) exploration and exploitation framework, we extend this literature into the context of product/service innovation (Cuypers and Martin, 2010; Klingebiel and Adner, 2015; Verdu *et al.*, 2012). In doing so, we also respond to some calls for research in the ROR literature. Trigeorgis and Reuer (2017) promote the collection of more primary data in order to examine the managerial decision-making aspects of ROR. Similarly, Ipsmiller *et al.* (2019) call for increased focus on perceptual measures in the ROR literature. We

[6] Due to the limited sample size, we also ran a specification for all the models where we sought to collapse a range of control variables into a single factor. EFA analyses did not allow us to produce any meaningful factors, but for completeness, we collapsed the variables; Growth opportunities, Size, and Age into a single variable computed as the average of the three. These specifications did not alter the conclusions.

respond to such calls with the development of a survey-based instrument to assess the multidimensionality of ROR, and we adopt alternative risk outcome measures based on managerial perception. Our study also contributes with practical implications that inform managers about the potential benefits of implementing a ROR investment approach. Our study informs managers that the outcome of ROR depends on the portfolio of capital investment activities and that the portfolio, optimal for ROR, reflects one of high relative exploration orientation. The allocation of resources among alternative capital investment projects is one of the most pressing top management priorities when implementing strategy (Bowman and Hurry, 1993; McGrath *et al.*, 2004). Long-term survival will likely be dependent on an efficient capital allocation among both exploration and exploitation activities. However, each such activity introduces risk, and strong financial management is a crucial element for long-term survival and success (Bennouna *et al.*, 2010). In this paper, we show that ROR can be a key element for managers to reduce the downside element of risk, with important implications as to how managers can balance their exploration and exploitation activities when implementing ROR.

There are several limitations to the study, and the results should be interpreted in terms of these limitations. We apply several new survey instruments in this study, and while they exhibited satisfactory properties, future research should further develop and validate both the perceived risk measures and the ROR instruments. We apply cross-sectional data to test the hypotheses, which has implications for the causal inference. Though we let prior empirical studies, as well as theory, inform our choice of control variables, we cannot rule out that variables not included in the model drive the evidence. We conduct the study on a small sample size with a relatively low response rate, and while tests of non-response bias indicate a representative sample, the size and response rate is a limitation to the study. Additionally, some paths in our statistical models show only weak levels of statistical significance. While the determination of significance can be somewhat arbitrary, Chenhall *et al.* (2011) argue that results in the range of p-value 0.05-0.10 should at least be acknowledged as indicators of interest that are not completely due to chance[7].

Our study builds on the idea that exploratory activities have a lower correlation among projects. Theoretically, each such project should all be experimenting with new alternatives (March, 1991), and exploration only has a certain depth before it turns into exploration (Zollo and Winter, 2002). However, the breadth and depth of exploration and exploitation are not directly observable from our survey measures, and future studies could explore the implications of these concepts when studying ROR in combination with exploration and exploitation. Readers may have noticed from the correlation matrix in Table 6, that ROR correlates positively with exploitation, which may seem counterintuitive to our hypotheses. Prior literature has shown that exploitation and exploration are complementary in enhancing firm performance (Raisch and Birkinshaw,

[7] Reporting findings at the $p < 0.10$ significance level is not uncommon in management accounting research (see e.g. Chapman and Kihn (2009), Ittner, Larcker and Meyer (2003) and Ittner, Larcker and Randall (2003)).

2008), and we also observe a correlation in our data. Our results should not be seen as a promotion to abandon exploitation activities, but that ROR firms will benefit increasingly from exploring well beyond current activities. Exploration and exploitation are both important activities for firms' long-term survival (March, 1991), and future studies may examine the role of exploitation activities for ROR firms.

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6. Appendix: List of survey items

[Insert Table A1: Real options reasoning]

[Insert Table A2: Environmental hostility]

[Insert Table A3: Environmental dynamism]

[Insert Table A4: Growth opportunities]

[Insert Table A5: Short-term horizon]

[Insert Table A6: Exploration and exploitation]

[Insert Table A7: Perceived downside risk, business]

[Insert Table A8: Perceived downside risk, business]

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Figure 1: Illustration of moderation effects

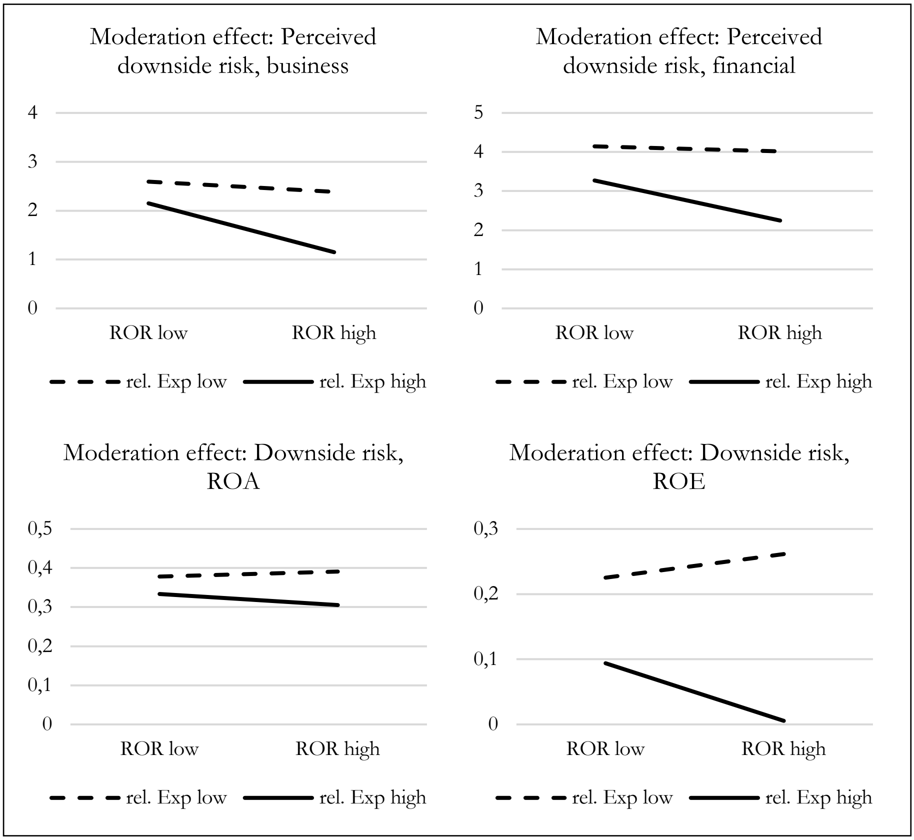

Table 1: Industry classification

DB07* industry classification	Frequency	%
Administrative services	6	6%
Construction and civil engineering	8	9%
Wholesale and retail	15	16%
Real estate	2	2%
Manufacturing	33	35%
Liberal, scientific and technical services	6	6%
Information and communication	5	5%
Accommodation facilities and restaurants	1	1%
Transportation and freight handling	7	7%
Other	11	12%
Total sample	**94**	**100%**

Note:
[i] *DB07 - Danish standard industry classification

Table 2: Exploratory factor analysis (ROR)

	REAL	AWARE	SLC	AUR
aware1		0.738		
aware2		0.465		
aware3		0.915		
aur1				0.608
aur2				0.651
aur4				0.589
slc1			0.841	
slc2			0.602	
slc3			0.567	
real1	0.570			
real2	0.883			
real3	0.875			
Eigenvalue	4.668	1.520	1.452	1.035
Cum. variance explained	0.390	0.510	0.640	0.720
KMO	0.786			
Bartlett's test of spherecity	0.000			

Note:
[i] Maximum likelihood extraction with Varimax factor rotation. Loadings lower than 0.4 suppressed

Table 3: Exploratory factor analysis (Downside risk)

	Perceived downside risk, business	**Perceived downside risk, financial**
bdsr1	0.78	
bdsr2	0.82	
bdsr3	0.90	
fdsr1		0.91
fdsr2		0.41
fdsr3		0.66
Eigenvalue	2.723	1.563
Cum. variance explained	0.360	0.600
KMO	0.751	
Bartlett's test of spherecity	0.000	

Note:

[i] Maximum likelihood extraction with Varimax factor rotation. Loadings lower than 0.4 suppressed

Table 4: Confirmatory factor analysis

Latent variable indicators	Standardized loadings	z-value (all sig. at p < 0.01)	Composite reliability	Cronbach's alpha	Square root of average variance extracted (AVE)
AWARE			0.777	0.761	0.736
aware1	0.772				
aware2	0.928	7.323			
aware3	0.548	5.330			
AUR			0.738	0.742	0.697
aur1	0.688				
aur2	0.656	5.388			
aur3	0.757	5.939			
SLC			0.757	0.717	0.727
slc1	0.91				
slc2	0.626	5.112			
slc3	0.541	4.600			
REAL			0.888	0.864	0.858
real1	0.618				
real2	0.928	7.071			
real3	0.941	7.081			
EXPLOIT			0.782	0.813	0.731
exploit1	0.856				
exploit2	0.671	6.692			
exploit3	0.503	4.694			
exploit4	0.778	7.774			
EXPLORE			0.849	0.880	0.765
explore1	0.693				
explore2	0.818	7.314			
explore3	0.732	8.088			
explore4	0.899	7.942			
explore5	0.646	5.818			
$DSR_{business}$			0.870	0.864	0.832
bdsr1	0.801				
bdsr2	0.822	8.636			
bdsr3	0.884	9.016			

Note:

[i] RMSEA: 0.063, SRMR: 0.076, CFI: 0.925, TLI: 909, IFI: 0.928, Chi-squared to degrees of freedom: 1.39 (314.895/227).

[ii] Blank cells in z-value column indicates loadings fixed to 1.

Table 5: Descriptive statistics

	Mean	Median	St.dev	Min	Max
Size (log)	5.55	5.22	0.76	4.61	7.38
Age (log)	3.66	3.58	0.62	0.00	4.61
Slack	2.30	1.15	3.72	0.02	27.72
Growth opportunities	5.24	5.50	0.87	2.50	7.00
Short-term horizon	66.54	77.50	29.88	0.00	100.00
Hostility	4.80	5.00	0.72	2.00	6.33
Dynamism	4.34	4.40	0.82	2.20	6.60
Option awareness	5.68	6.00	0.77	3.67	7.00
Reallocation	4.16	4.00	1.31	1.00	7.00
Active uncertainty resolution	4.71	4.67	1.14	1.67	7.00
Sequential low commitment	4.31	4.33	1.10	2.00	6.33
Exploration	4.58	4.80	1.31	1.00	7.00
Exploitation	5.06	5.25	1.06	2.00	7.00
Relative exploration	0.47	0.48	0.07	0.24	0.58
Perceived downside risk, business	2.85	3.00	0.88	1.00	5.33
Perceived downside risk, financial	3.23	3.17	0.87	1.67	5.00
Downside risk, roe	8.27	4.75	12.21	0.00	90.71
Downside risk, roa	3.37	1.90	4.98	0.00	34.32

Table 6: Correlation matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
(1) Size (log)	-																	
(2) Age (log)	0.00	-																
(3) Slack	0.21	0.01	-															
(4) GROWTH	-0.06	-0.1	0.1	-														
(5) SHORT	-0.03	-0.03	0.09	-0.02	-													
(6) HOST	0.08	-0.08	0.1	0.27	0.1	-												
(7) DYN	-0.04	-0.20	-0.01	0.06	0.16	0.54	-											
(8) AWARE	0.12	-0.02	0.15	0.29	0.05	0.23	0.17	-										
(9) REAL	0.24	-0.1	0.06	0.08	-0.12	0.08	0.21	0.39	-									
(10) AUR	0.27	-0.14	0.08	0.26	-0.1	0.28	0.23	0.45	0.51	-								
(11) SLC	0.12	-0.04	0.08	0.01	-0.12	0.13	0.24	0.2	0.35	0.42	-							
(12) EXPLORE	0.21	-0.14	0.1	0.05	-0.15	0.22	0.50	0.29	0.21	0.33	0.22	-						
(13) EXPLOIT	0.16	-0.09	0.16	0.07	-0.04	0.21	0.27	0.33	0.18	0.25	0.18	0.6	-					
(14) RelExp	0.13	-0.06	0	0.05	-0.09	0.14	0.41	0.13	0.10	0.20	0.12	0.71	-0.1	-				
(15) $DSR_{Business}$	-0.06	0.18	-0.13	-0.29	-0.20	-0.26	-0.07	-0.33	-0.25	-0.33	-0.21	-0.1	-0.23	0.03	-			
(16) $DSR_{Financial}$	-0.05	0.13	0.05	0.13	-0.17	0.18	0.23	0.03	0.07	0.09	-0.03	0.19	0.18	0.09	0.23	-		
(17) DSR_{ROE}	0.04	0.12	-0.1	-0.01	0.05	0.01	-0.05	0.16	-0.03	0.03	0.13	-0.16	-0.21	-0.03	0.01	0.04	-	
(18) DSR_{ROA}	0.03	0.03	-0.08	-0.1	-0.12	0.03	0.13	-0.06	0.02	-0.01	0.08	0.12	0.08	0.07	0.08	0.1	0.48	-
(19) ROR*	0.22	-0.07	0.01	0.11	-0.08	0.05	0.23	0.28	0.65	0.52	0.49	0.29	0.25	0.06	-0.3	-0.2	-0.1	-0.06

Note:
i Correlation at and above |0.20| significant at $p < 0.05$
** ROR is a dummy variable, taking the value of 1 if REAL, AUR and SLC are all above their mediian and 0 otherwise*

Table 7: Regression results H1

Dependent variable	Perceived DSR, business		Perceived DSR, financial	
	beta	t value	beta	t value
Intercept	3.053	1.924*	1.105	0.674
Size	0.063	0.491	-0.078	-0.591
Growth opportunities	-0.096	-0.908	0.200	1.828*
Short-termism	-0.007	-2.262**	-0.007	-2.022**
Age	0.259	1.847*	0.343	2.362**
Slack	-0.015	-0.619	-0.007	-0.288
Hostility	-0.335	-2.164**	-0.048	-0.301
Dynamism	0.356	2.178**	0.331	1.963*
Option awareness	-0.145	-1.122	0.013	0.099
Exploitation	-0.207	-0.683	-0.103	-0.330
Exploration	0.091	0.263	0.322	0.901
Relative exploration	-2.288	-0.422	-5.236	-0.934
ROR	-0.602	-3.097***	-0.575	-2.859**
Adj. R-squared		0.227***		0.146**

Dependent variable	DSR_{ROA}		DSR_{ROE}	
	beta	z value	beta	z value
Intercept	0.288	3.441***	-0.396	-1.397
Size	-0.001	-0.138	0.016	0.711
Growth opportunities	-0.005	-0.815	-0.006	-0.336
Short-termism	0.000	-0.142	0.000	0.533
Age	0.006	0.764	0.013	0.514
Slack	-0.002	-1.159	-0.006	-1.143
Hostility	-0.011	-1.396	-0.009	-0.334
Dynamism	0.020	2.308**	0.039	1.323
Option awareness	0.009	1.355	0.059	2.525**
Exploitation	-0.008	-0.487	-0.053	-0.994
Exploration	0.013	0.698	0.020	0.329
Relative exploration	-0.266	-0.935	-0.772	-0.813
ROR	-0.007	-0.710	-0.024	-0.693
Log-likelihood		118		25
Wald		85***		26.81

Note:
[i] * = p < 0.1, ** = p< 0.05, *** = p< 0.01

Table 8: Regression results H2

Dependent variable	**Perceived DSR, business**		**Perceived DSR, financial**	
	beta	t value	Beta	t value
Intercept	2.894	1.858*	0.925	0.577
Size	0.104	0.818	-0.031	-0.240
Growth opportunities	-0.090	-0.865	0.207	1.940*
Short-termism	-0.007	-2.399**	-0.007	-2.176**
Age	0.240	1.741*	0.321	2.264**
Slack	-0.021	-0.854	-0.014	-0.544
Hostility	-0.347	-2.286**	-0.062	-0.398
Dynamism	0.328	2.038**	0.300	1.812*
Option awareness	-0.127	-1.000	0.034	0.258
Exploitation	-0.369	-1.196	-0.287	-0.906
Exploration	0.267	0.761	0.522	1.447
Relative exploration	-3.169	-0.594	-6.234	-1.137
ROR	-0.604	-3.169***	-0.577	-2.943***
ROR * Rel. Exploration	-5.655	-1.970*	-6.411	-2.173**
Adj. R-squared		0.252***		0.188**

Dependent variable	**DSR_{ROA}**		**DSR_{ROE}**	
	beta	z value	Beta	z value
Intercept	0.284	3.450***	-0.406	-1.46
Size	0.001	0.163	0.023	1.002
Growth opportunities	-0.004	-0.769	-0.005	-0.293
Short-termism	0.000	-0.252	0.000	0.445
Age	0.004	0.611	0.009	0.356
Slack	-0.002	-1.372	-0.007	-1.344
Hostility	-0.012	-1.511	-0.011	-0.42
Dynamism	0.018	2.117**	0.032	1.122
Option awareness	0.010	1.534	0.062	2.683**
Exploitation	-0.017	-1.015	-0.080	-1.466
Exploration	0.023	1.214	0.051	0.815
Relative exploration	-0.319	-1.139	-0.938	-1.001
ROR	-0.008	-0.777	-0.026	-0.777
ROR * Rel. Exploration	-0.293	-1.935*	-0.890	-1.762*
Log-likelihood		119.9		26.54
Wald		91.87***		30.55

Note:
[i] * = p < 0.1, ** = p< 0.05, *** = p< 0.01

Table 9: Alternative regression results H1

Dependent variable	**Perceived DSR, business**		**Perceived DSR, financial**	
	beta	t value	beta	t value
Intercept	3.325	1.996**	0.826	0.497
Size	0.060	0.453	-0.118	-0.897
Growth opportunities	-0.109	-0.986	0.194	1.762*
Short-termism	-0.008	-2.298**	-0.006	-1.784*
Age	0.257	1.785*	0.370	2.585**
Slack	-0.012	-0.489	-0.006	-0.237
Hostility	-0.332	-2.082**	-0.063	-0.394
Dynamism	0.368	2.19**	0.316	1.888*
Option awareness	-0.128	-0.890	-0.119	-0.832
Exploitation	-0.199	-0.642	-0.063	-0.203
Exploration	0.076	0.215	0.298	0.843
Relative exploration	-2.048	-0.369	-4.863	-0.880
ROR	-0.503	-1.853*	-0.924	-3.417***
Reallocation	-0.030	-0.320	0.181	1.922*
Active uncertainty resolution	0.008	0.075	0.110	1.047
Sequential low commitment	-0.058	-0.610	-0.038	-0.398
Adj. R-squared		0.193**		0.176**

Dependent variable	**DSR_{ROA}**		**DSR_{ROE}**	
	beta	z value	beta	z value
Intercept	0.257	3.028***	-0.507	-1.777*
Size	0.000	0.018	0.020	0.870
Growth opportunities	-0.003	-0.560	-0.002	-0.123
Short-termism	0.000	0.009	0.000	0.699
Age	0.005	0.750	0.012	0.487
Slack	-0.002	-1.462	-0.008	-1.467
Hostility	-0.013	-1.537	-0.015	-0.562
Dynamism	0.020	2.282**	0.038	1.312
Option awareness	0.010	1.391	0.064	2.548**
Exploitation	-0.009	-0.570	-0.058	-1.126
Exploration	0.014	0.763	0.025	0.421
Relative exploration	-0.292	-1.047	-0.888	-0.961
ROR	-0.012	-0.854	-0.039	-0.849
Reallocation	-0.002	-0.437	-0.013	-0.773
Active uncertainty resolution	-0.001	-0.209	0.001	0.066
Sequential low commitment	0.009	1.892*	0.034	2.079**
Log-likelihood		119.9		27.49
Wald		91.34***		32.31

Note:
[i] * = p < 0.1, ** = p< 0.05, *** = p< 0.01

Table 10: Alternative regression results H2

Dependent variable	**Perceived DSR, business**		**Perceived DSR, financial**	
	beta	t value	beta	t value
Intercept	3.209	1.967*	0.718	0.440
Size	0.109	0.823	-0.073	-0.556
Growth opportunities	-0.102	-0.938	0.201	1.855*
Short-termism	-0.008	-2.473**	-0.006	-1.933*
Age	0.233	1.648	0.348	2.465**
Slack	-0.018	-0.728	-0.011	-0.455
Hostility	-0.342	-2.188**	-0.072	-0.458
Dynamism	0.340	2.061**	0.290	1.758*
Option awareness	-0.092	-0.646	-0.085	-0.602
Exploitation	-0.373	-1.182	-0.225	-0.711
Exploration	0.264	0.734	0.472	1.312
Relative exploration	-3.015	-0.553	-5.761	-1.057
ROR	-0.457	-1.714*	-0.882	-3.304***
Reallocation	-0.051	-0.548	0.161	1.737*
Active uncertainty resolution	-0.010	-0.095	0.093	0.902
Sequential low commitment	-0.057	-0.610	-0.037	-0.393
ROR * Rel. Exploration	-5.902	-1.999**	-5.479	-1.855*
Adj. R-squared		0.227***		0.205**

Dependent variable	**DSR_{ROA}**		**DSR_{ROE}**	
	beta	z value	beta	z value
Intercept	0.255	3.075***	-0.508	-1.831*
Size	0.002	0.375	0.027	1.233
Growth opportunities	-0.003	-0.504	-0.001	-0.073
Short-termism	0.000	-0.146	0.000	0.566
Age	0.004	0.549	0.006	0.272
Slack	-0.003	-1.668*	-0.009	-1.681*
Hostility	-0.013	-1.670*	-0.018	-0.681
Dynamism	0.018	2.105**	0.031	1.114
Option awareness	0.013	1.704*	0.071	2.851***
Exploitation	-0.018	-1.147	-0.089	-1.68*
Exploration	0.024	1.318	0.060	0.977
Relative exploration	-0.348	-1.27	-1.076	-1.186
ROR	-0.010	-0.713	-0.032	-0.724
Reallocation	-0.003	-0.712	-0.018	-1.087
Active uncertainty resolution	-0.002	-0.337	0.000	-0.015
Sequential low commitment	0.009	1.926*	0.034	2.15**
ROR * Rel. Exploration	-0.309	-2.061**	-0.983	-1.986**
Log-likelihood		122		29.43
Wald		99.38***		37.01*

Note:
[i] * = p < 0.1, ** = p< 0.05, *** = p< 0.01

Table 11: Results

	H1	**H2**
$DSR_{Business}$	+	+
$DSR_{Financial}$	+	+
DSR_{ROA}	%	+
DSR_{ROE}	%	(+)

Table A1: Real options reasoning

Please rate the extent to which your organization's investment behavior is in accordance with the following statements
Option awareness
Prior to an investment, we consider the potential future trajectories of its inherent opportunities (e.g. deferment, expansion, flexibility, redeployment, etc.)
Future opportunities are important for the decision to make an initial investment
The firm's future opportunities are contingent on our prior investments
Active uncertainty resolution
We observe our environment on a continual basis to assess if an opportunity has become profitable
We observe our environment on a continual basis to assess if an opportunity is about to expire (e.g. patent expiration, competitive entry, etc.)
We put continual effort into creating value from the opportunities that are embedded in our investments
Sequential low commitment
When the uncertainty about an investment's outcome is resolved/low, we commit larger sums of capital
When the uncertainty about an investment's outcome is high, we commit smaller sums of capital
We realize our opportunities when we feel certain that we have resolved the uncertainty about its outcome
Reallocation
We clearly define which opportunities are inherent in an investment before committing capital to the initial investment
We clearly define under which circumstances an opportunity should be deferred or abandoned before committing capital to the initial investment
We clearly define under which circumstances an opportunity can be allocated further capital prior to the initial investment

Note:
[i] Scale: 1 = Very low extent; 2 = Low extent; 3 = Somewhat low extent; 4 = Neither low/high extent; 5 = Somewhat high extent; 6 = High extent; 7 = Very high extent

Table A2: Environmental hostility

Over the past two years…
How intense you rate the competition for your primary products/services (1 = very low intensity, 7 = very high intensity)
How difficult has it been to acquire the necessary input for your business (1 = very low difficulty, 7 = very high difficulty)
How many strategic opportunities have been available for your business (1 = extremely few, 7 extremely many)

Table A3: Environmental dynamism

Over the past two years, how predicable or unpredictable have important changes in your external environment been with regard to the following?
Customer (e.g. demand, preferences)
Suppliers (e.g. key markets, quality of resources)
Competitors (e.g. competitors entering/exiting, tactics, strategies)
Technology (e.g. R&D, process innovations)
Regulations (e.g. economics, processes)

Note:
[i] Scale: 1 = Very predictable; 2 = Predictable; 3 = Somewhat predictable; 4 = Neither predictable/unpredictable; 5 = Somewhat unpredictable; 6 = Unpredictable; 7 = Very unpredictable

Table A4: Growth opportunities

What are your expectations of the growth opportunities that exist in the industry that you compete in?
What are your expectations of the growth opportunities that your organization has?

Note:
i Scale: 1 = Strong decrease, 2 = Decrease, 3 = Somewhat decrease, 4 = Neither decrease/increase, 5 = Somewhat increase, 6 = Increase, 7 = Strong Increase

Table A5: Short-term horizon

Please rate the percentage of time used on activities that will show in the income statement within… (Sum must be 100)
1 month or less
1 month to 1 quarter
1 quarter to 1 year
1 year to 3 years
3 years to 5 years
More than 5 years

Table A6: Exploration and exploitation

Please indicate the extent to which the following have been prioritized investments of the organization that you lead over the last 2 years:
Exploration
Acquiring entirely new skills that are important for product/service innovation (such as identifying emerging markets and technologies; coordinating and integrating R&D, marketing, manufacturing, and other functions; managing the product development process)
Learning product/service development skills and processes entirely new to your industry (such as product design, prototyping new products, timing of new product introductions)
Acquiring product/service technologies and skills entirely new to the organization
Learning new skills in key product/service innovation-related areas (such as funding new technology, staffing R&D function, training and development of R&D, and engineering personnel for the first time)
Strengthening product/service innovation skills in areas where it had no prior experience
Exploitation
Upgrading current knowledge and skills for familiar products/services and technologies *
Investing in enhancing skills in exploiting mature technologies in your industry that improve productivity of current product/service innovation operations
Enhancing competencies in searching for solutions to customer problems that are near to existing solutions
Upgrading skills in product/service development processes in which the firm already possesses significant experience
Strengthening knowledge and skills for projects that improve efficiency of existing product/service innovation activities.

Note:
[i] Scale: 1 = Very low extent; 2 = Low extent; 3 = Somewhat low extent; 4 = Neither low/high extent; 5 = Somewhat high extent; 6 = High extent; 7 = Very high extent
[ii] * Dropped items

Table A7: Perceived downside risk, business

How do you rate the chance that an average investment project will in your organization…
Reaches the performance expectations set at the time of the investment
Has the functionality expected at the time of the investment
Will overall function as expected at the time of the investment

Note:
[i] Scale: 1 = Very low chance; 2 = Low chance; 3 = Somewhat low chance; 4 = Neither low/high chance; 5 = Somewhat high chance; 6 = High chance; 7 = Very high chance
[ii] All items are reverse coded

Table A8: Perceived downside risk, financial

How much overall risk is associated with allocating capital to an average investment project in your organization? (1 = very low risk, 7 = very high risk)
Please rate how likely you find the following statements (1 = very unlikely, 7 = very likely)
A capital allocation to an average investment project in your organization will lead to higher risk due to events that will lead to higher than expected operational costs?
A capital allocation to an average investment project in your organization will lead to higher risk due to events that will lead to higher than expected financial costs?