



## Entrepreneurial Orientation: The Dimensions' Shared Effects on Explaining Firm Performance

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# **ENTREPRENEURIAL ORIENTATION: THE DIMENSIONS' SHARED EFFECTS IN EXPLAINING FIRM PERFORMANCE**

**Abstract.** We shed new light on the structure of the relationship between entrepreneurial orientation (EO) and firm performance and how this relationship varies across contexts. Using commonality analysis, we decompose the variance in performance—in terms of the effects of innovativeness, proactiveness, and risk taking—into parts that are attributable to unique variations in these dimensions (unique effects) and those attributable to covariation between these dimensions (shared effects). By demonstrating the empirical relevance of unique, bilaterally shared, and commonly shared effects in a heterogeneous sample of low-tech, high-tech, and multi-sector firms, we consolidate existing conceptualizations of EO and propose an extension of the extant theoretical views of the construct.

## **INTRODUCTION**

Entrepreneurial orientation (EO) is a strategy-making process that provides organizations with a basis for entrepreneurial decisions and actions with the purpose of creating a competitive advantage (e.g., Covin & Slevin, 1989; Lumpkin & Dess, 1996; Rauch, Wiklund, Lumpkin, & Frese, 2009). There is broad empirical evidence supporting a positive relationship between EO and firm performance (for an overview, see the meta-analysis by Rauch et al., 2009, and a recent literature review by Wales, Gupta, & Mousa, 2013a). Miller (1983), who is credited with the introduction of the EO concept to the scholarly discussion (Covin & Lumpkin, 2011), conceived EO as the exhibition of innovativeness, risk taking, and proactiveness. Based on Miller's work, two dominant but diverging conceptualizations of EO have emerged (e.g., Covin & Lumpkin, 2011; Covin & Miller, 2014). One conceptualization is a unidimensional conceptualization, which is most commonly associated with the work of Miller (1983) and Covin and Slevin

(1989). This conceptualization emphasizes the common, or shared effect of the dimensions of EO such that “EO can be understood as a sustained firm-level attribute represented by the singular quality that risk taking, innovative, and proactive behaviors have in common” (Covin & Lumpkin, 2011, p. 863). The second is a multidimensional conceptualization, which is most commonly associated with the work of Lumpkin & Dess (1996), within which EO exists as a set of independent dimensions, with each dimension having its own effect on firm performance (Covin & Lumpkin, 2011).

Undoubtedly, both conceptualizations have independently led to theoretically and practically significant contributions to the entrepreneurship literature (Covin & Lumpkin, 2011). However, each also has its challenges. Applying the unidimensional conceptualization—and thus focusing on, in statistical terms, the effect of “the common or shared variance among risk taking, innovativeness, and proactiveness” (Covin & Lumpkin, 2011, p. 862)—restricts the analysis of EO consequences in explaining variations in outcomes based on covariation in innovativeness, risk taking, and proactiveness (Covin, Green, & Slevin, 2006; Covin & Wales, 2012). Empirical analyses based on this conceptualization might hide or inaccurately attribute effects resulting from variations in only a single dimension of EO. Alternatively, applying the multidimensional conceptualization typically focuses on, in statistical terms, the independent effects of risk taking, innovativeness, and proactiveness (George & Marino, 2011; Kreiser, Marino, Kuratko, & Weaver, 2013). Empirical studies following this conceptualization usually focus on the analysis of EO’s consequences in explaining variations in firm performance based on unique variations in each of the three dimensions. Regression analyses used to test these relationships usually examine the effect of one dimension while keeping the other two dimensions constant. Such analyses hide the effects that may result from covariation between two, or all of the dimensions.

As both conceptualizations are unquestionably legitimate (Covin & Miller, 2014), it is not a matter of which conceptualization is correct or incorrect, but, rather, how these perspectives can co-exist or even be combined. Arguing that sometimes “the components of EO are more telling than the aggregate index” (p. 880), Miller (2011) encourages research to analyze both the effects of single EO dimensions and the overall EO by pointing out that “in some research contexts, the best of both worlds may entail analyses that present results for the EO construct and for each of its components” (p. 880). Building on Miller’s arguments we submit that even combining both conceptualizations is likely to be insufficient, as it does not consider the effects attributable to the covariation between sets of only two of the three dimensions of EO, which we refer to as bilaterally shared effects.

To provide a more complete understanding of how EO affects firm performance, we propose a consolidated and extended approach that will further advance our theorizing about EO. Going beyond the simultaneity of the two dominant views, we explicitly include the yet unexplored performance effects that are based on the covariation of only two of the dimensions (i.e., proactiveness and risk taking, innovativeness and proactiveness, or innovativeness and risk taking). Furthermore, building on prior research that demonstrated industry-related differences in the strength of the EO-performance relationship (e.g., Rauch et al., 2009), we investigate whether shared effects vary between industries. Specifically, we compare the structure of the EO-performance relationship between high-tech, low-tech, and multi-sector firms.

## **THEORETICAL BACKGROUND**

### **Entrepreneurial Orientation: Dimensions and Their Covariation**

Entrepreneurial orientation (EO) refers to a firm’s strategic organizational posture, capturing specific entrepreneurial aspects of decision-making styles, methods, and behavior

(Lumpkin & Dess, 1996; Wiklund & Shepherd, 2003; Wales et al., 2013a). As such, it is a driving force for the organizational pursuit of entrepreneurial endeavors and activities (Covin & Wales, 2012). EO is one of the most frequently applied firm-level constructs in entrepreneurship research (Anderson, Kreiser, Kuratko, Hornsby, & Eshima, 2015; Wales, Monsen, & McKelvie, 2011; see, for an overview, the 2011 special issue on EO in *Entrepreneurship Theory and Practice*, Covin & Lumpkin, 2011). Consistent with the majority of the extant EO research, we consider EO to encompass three dimensions, namely innovativeness, proactiveness, and risk taking (cf. Kreiser et al., 2013; see also the recent literature review by Wales et al., 2013a). These three dimensions best represent the conceptual view of an entrepreneurial orientation (George & Marino, 2011), even though other conceptualizations add additional dimensions (e.g., Lumpkin & Dess, 1996) or exclude individual dimensions (e.g., Merz & Sauber, 1995).

Within the EO framework, *innovativeness* refers to a tendency to engage in creative processes, experimentation, and the introduction of new products and services, thereby deviating from established practices (Lumpkin & Dess, 1996; Rauch et al., 2009). *Proactiveness* refers to an opportunity-seeking, forward-looking behavior that incorporates acting on future needs and trends ahead of competitors, thereby actively entering new product/market spaces, creating first-mover advantages, and seeking market leadership positions (Lumpkin & Dess, 1996; Wiklund & Shepherd, 2003; Anderson et al., 2015). *Risk taking* refers to a tendency toward engaging in high-risk activities with chances of high returns, and also in bold actions in uncertain environments (Covin & Slevin, 1989; Rauch et al., 2009).

Several theoretical (e.g., Basso, Fayolle, & Bouchard, 2009) and empirical (e.g., Kreiser, Marino, & Weaver, 2002) attempts have been made to identify whether EO is most appropriately conceptualized as a unidimensional construct or as a multidimensional construct. We argue that

focusing on either of these conceptualizations is insufficient, as neither addresses the role of *all* of the dimensions' effects in explaining firm performance and other outcomes, especially effects attributed to covariation of only two dimensions are either not or only implicitly addressed.

### **Bilaterally Shared Effects**

Theoretically, the shared effects of the dimensions of EO in explaining firm performance can be described as the extent to which changes in firm performance are due to changes in at least two of the dimensions of EO, i.e., performance variation that is associated with covariation between only two dimensions of EO. Such an overlap in the explanatory power of dimensions of EO can only be observed if dimensions of EO are correlated. While the observation of shared effects requires correlated dimensions of EO, it does not require these dimensions to relate causally to one another, such that one leads to the other.

When interpreting shared effects we can say that the effect of one dimension of EO on firm performance is conditioned on variation in other dimensions of EO. For example, a shared effect between innovativeness and proactiveness would imply that changes in innovativeness only affect firm performance when accompanied by changes in proactiveness. Hence, the alignment between innovativeness and proactiveness requires a corresponding change in both dimensions.<sup>1</sup>

Extant literature has extensively provided rationales for the unique and independent effects

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<sup>1</sup> To illustrate the difference between shared effects and interaction effects, let us assume that there is a theoretical reason to expect that a firm characteristic, e.g., risk taking, affects firm performance. The strength of the relationship between risk taking and firm performance could be theorized to depend on another firm characteristic, e.g., innovativeness. For moderation and interaction effects, the condition would refer to the *level* of innovativeness. A difference in risk taking may, for instance, only have an effect on firm performance for more innovative firms. For an interaction effect to be observed, the interacting variables do not need to be correlated. For a shared effect, the condition would not refer to the level but to a *change* in innovativeness. A change in risk taking then only has an effect on firm performance if it is associated with a change in innovativeness. This would capture the idea that risk taking only has a positive effect if the firm gets more innovative along with taking more risks (independent of the actual level of risk taking). For such a shared effect to be observed we would not need to observe an interaction effect, but only that risk taking and innovativeness co-vary, that is, they are correlated, and conjointly affect firm performance.

of innovativeness, risk taking, and proactiveness (see Lumpkin & Dess, 1996, as an example). Previous literature also has emphasized the commonly shared effect captured by the unidimensional operationalization, i.e., effects attributed to the covariation, of innovativeness, risk taking, and proactiveness, which implies that only the simultaneous engagement in each of these three dimensions is effective in boosting performance through entrepreneurial behavior (e.g., Miller, 1983; Covin et al., 2006). Empirical research has likewise extensively examined the performance implications of these different effects (see Rauch et al., 2009, for an overview). Within the literature, however, there are some arguments that implicitly suggest performance effects derived from the covariation of (only) pairs of two of the dimensions. However, these effects have neither been explicitly hypothesized nor empirically tested to date. In the following, we will argue for the importance of considering the bilaterally shared effects of innovativeness and risk taking, innovativeness and proactiveness, and risk taking and proactiveness, respectively.

#### *Shared Effect between Innovativeness and Proactiveness*

Anderson et al. (2015, p. 1583) state “while innovation is a necessary condition for entrepreneurship, it is not sufficient, nor is it meaningfully independent from proactiveness.” They argue (p. 1583) that “entrepreneurial firms do not simply create; entrepreneurial firms create with the intent of employing those creations to establish market leadership positions, to develop new markets, and to preempt competitors.” Andersen et al. attribute the effect of innovativeness and proactiveness to the covariation between both dimensions (as reflected in letting innovativeness and proactiveness be subsumed in a singular reflective latent construct) independently from the risk taking dimension. Thereby, they describe a shared effect of innovativeness and proactiveness. Likewise, Rosenbusch et al. (2013) implicitly suggest an alignment between these two dimensions without the necessity to accept higher levels of risk.

According to them, and with reference to Schumpeter (1934), firms “need to proactively seek new combinations of resources that can be applied to different contexts to transform the opportunities associated with complex environments into above-average performance levels. Such resource combinations require a high degree of innovativeness” (Rosenbusch et al., 2013, p. 638). Thus, a *proactive* introduction of *new products and services* protects firms from obsolete existing knowledge and competencies (see Leonard-Barton, 1992; March, 1991), and hence reduces vulnerability and increases firm “performance in the long run by continuously innovating and, thus, sustaining entry barriers against other firms.” (Rosenbusch et al., 2013, p. 638). This logic suggests that the covariation between proactiveness and innovativeness is what eventually affects firm performance, independently of variations in risk taking.

#### *Shared Effect between Risk Taking and Proactiveness*

Implicitly assuming a shared effect between risk taking and proactiveness that is independent from innovativeness, Hughes and Morgan (2007) argue that firms combine opportunity-seeking behavior, i.e., proactiveness, with constructive risk taking to increase their performance. They further claim that “[r]isk aversion renders firms passive to developing new market opportunities, which is likely to deteriorate performance in an age of rapid change.” (Hughes & Morgan, 2007, p. 653). In a similar vein, Kreiser et al. (2013) assume superior SME performance to be based on risky activities that are deliberately undertaken to capitalize (and hence, to prevent missing out) on emerging market opportunities. These arguments suggest that the effect of risk taking has to be aligned with the effect of proactiveness but not with any change in innovativeness.

#### *Shared Effect between Risk Taking and Innovativeness*

Rosenbusch et al. (2013) suggest that firms should not implement a strategic orientation characterized by high risk taking and experimentation when facing difficulties in acquiring



resources and intense price-based competition. They separate risky innovations from non-risky innovations by arguing that risky innovations are developments whose failure can cause the demise of the firm (see also Zahra & Bogner, 2000). Li, Zhao, Tan, and Liu (2008) suggest that “the risk taking orientation can manifest itself as the tendency to [...], or [to] bring new products into new markets” (p. 119) and thereby link risk taking to innovativeness independently from proactive behavior. Furthermore, in explaining international performance, Frishammar and Andersson (2009, p. 62) use “launching new products,” i.e., innovativeness, as an example when explaining the effects of risk taking. Thus, by aligning the effects of variation in risk taking with variations in innovativeness, these arguments describe a shared effect of both (and only) these two dimensions.

Taken together, previous theorizing provides a cogent set of arguments that delineate how bilaterally shared effects between EO dimensions affect performance. Therefore, we propose the following:

*Hypothesis 1: Beyond performance effects that are explained by either unique effects or commonly shared effects, there are variations in firm performance that can only be explained by bilaterally shared effects, i.e., effects that are attributed to covariation in any set of two of the three dimensions of EO.*

### **Context-dependency of Shared Effects**

A context-dependency of the link of EO and its constituent dimensions with firm performance has been established from the earliest work on EO (e.g., Miller, 1983, 2011; Covin & Slevin, 1989, 1991; Lumpkin & Dess, 1996). EO is considered to be more beneficial as technology or customer preferences change rapidly and extensively and may further vary with the extent to which the environment affects the availability of resources and information

necessary for entrepreneurial strategies (Rauch et al., 2009; Lumpkin & Dess, 1996; Covin & Slevin, 1991). Underlying this idea of context dependency is the notion that EO enables firms to appropriately respond to challenging environmental conditions, such as those present in high-tech industries, by innovating, exhibiting proactive behaviors, and taking risks to gain competitive advantages (Covin & Slevin, 1991). Because environmental factors such as dynamism, hostility, complexity, or munificence vary across industries, comparisons between different types of industries, e.g., low-tech versus high-tech industries, can provide deeper insight into how EO functions (see the meta-analysis by Rauch et al., 2009).

In addition to the degree to which EO affects firm performance, the structure of this effect may also vary across industries. Lumpkin and Dess (1996, p.151), for instance, postulate that “[t]he salient dimensions of an entrepreneurial orientation [...] may vary independently of each other in a given context.” Extending this notion, we expect that not only the importance of certain dimensions but also the extent to which different dimensions need to be aligned to actually affect firm performance may vary between industries. That is, the importance of dimensions and the importance of their shared effects may differ between industries. Similar to Rauch et al. (2009), who find differences in the EO-performance relationship between high-tech and non-high-tech industries, we focus our discussion on the distinction between high-tech and low-tech firms and additionally draw attention to firms that are neither solely high-tech nor low-tech or operate in multiple industries (for simplicity, we refer to them as multi-sector firms).

Especially in high-tech industries, innovation compared to the other dimensions has been shown to have the strongest effect on performance (Yoo, 2001; Kollmann & Stöckmann, 2014). In the uncertain environment of the high-tech industry, innovativeness seems to be particularly

important as it enables a firm to provide more competitive products in changing markets (Miller, 1988). Accordingly, innovativeness is often considered to be the core concept of EO (Covin & Miles, 1999). Proactiveness may further support the positive performance effect of innovativeness when the reconfiguration of resources into new product-market offerings, i.e., innovativeness, meets anticipated changes in customer needs, i.e., proactiveness (Kraus et al., 2012). Such an alignment of innovativeness and proactiveness in high-tech industries is also suggested by Miller's description of an entrepreneurial firm as one that is "first to come up with 'proactive' innovations" (1983, p. 771). A proactive innovation strategy that enables a firm to stay ahead of the competition without the necessity to take excessive risk may be especially salient in fast changing and uncertain high-tech environments. Thus, a shared effect between innovativeness and proactiveness might be especially important in high-tech industries.

In low-tech industries, however, the structure of how EO affects firm performance can be expected to differ. Environmental conditions, such as rapid and extensive technology changes, that call for high levels of EO (Wiklund & Shepherd, 2005; Rosenbusch et al., 2013) are often absent or less salient in low-tech industries. Lower customer expectations concerning technological sophistication and progress do not require the highest levels of innovativeness. In fact, the resource investments associated with innovativeness and risk taking may not pay off when the fit between the entrepreneurial characteristics and the environment the firm operates in is not given (Covin & Slevin, 1991). Instead, proactive behavior might be crucial, such as acting in anticipation of future demands, including the continuous search for market opportunities, and filling existing or creating new niches in the market ahead of competitors (Venkatraman, 1989; Lumpkin & Dess, 1996). Thus, proactiveness might be most important in low-tech industries and shared effects between innovativeness and proactiveness might not be needed to leverage firm

performance.

Being active in multiple sectors or not being associated with a specific industry raises the complexity for a firm as customer needs are more diverse and ambiguous, and the number of market segments served might be higher (Van Gelderen et al., 2000) than if the firm served a single sector. Not only does such a multifaceted, demanding, and complex environment very likely call for both innovative and proactive strategies, it additionally changes the role of risk taking. Such an environment can be assumed to require all facets of EO, i.e., the simultaneous exhibition of proactiveness, innovativeness, and not the least important risk taking. In such environments, firms need to proactively generate new knowledge and resources, and proactively apply them to different contexts with different needs (Rosenbusch et al., 2013). Multi-sector firms might also be able to more efficiently employ risk taking strategies as their multi-sector structure is likely to hedge against negative aspects of risk taking (Lubatkin & Chatterjee, 1994), which for these firms renders risk taking a possibly more beneficial strategy. Taken together the arguments on the context-dependency of the effect of EO, we propose:

*Hypothesis 2: The structure of the effect of EO's dimensions on firm performance is context-dependent, i.e., differences in the structure of the EO-performance relationship exist when contrasting high-tech, low-tech, and multi-sector firms.*

## **RESEARCH METHOD**

### **Sample**

Our data builds on a survey of firms that was collected by the Strategic Alliance Research Group. The data consists of small- and medium-sized enterprises in six countries: Australia, Finland, Mexico, the Netherlands, Norway and Sweden. To be included in the sample, a company

had to be an independent private company. A key informant design was utilized in which the owner or general manager of each firm was asked to complete the survey. There is strong theoretical support that firms of this size are extensions of the individuals that are in charge (Lumpkin & Dess, 1996). Survey items, developed originally in English, were translated with care through a back-translation process (Brislin, 1980). Teams of experts reviewed the final survey translation for meaning and consensus was reached in the development of the final survey instrument.

Every attempt was made to make the survey process equivalent in each of the countries, but due to local constraints, methodologies did vary slightly. Lists of companies meeting the study requirements in each country were developed utilizing databases and organizational affiliation lists of commercial firms. Firms included in the study were randomly selected across industry groups. In five countries (Australia, Finland, Norway, the Netherlands, and Sweden) the surveys were mailed. In Mexico, surveys were hand delivered because past research had very low response rates for mailed surveys. Surveys were delivered to all selected firms in two waves. The second wave went to non-responding firms and excluded bad-address and out-of-business returns. The representative nature of the final country samples was assessed first through a series of analyses of variance used to test for significant differences across waves. A second assessment involved a random telephone survey of a selected group of 50 non-respondent firms in each country collecting a limited number of demographic items. These firms were then compared with those firms responding to the original survey. No significant differences were observed between the responding and non-responding firms.

Surveys were mailed or delivered to 973 firms in Australia, 400 in Finland, 2,465 in Norway, 300 in the Netherlands, 650 in Mexico and 600 in Sweden. The survey process resulted in 206 returned mail surveys in Australia (21.2%), 121 surveys in Finland (30.2%), 433 in

Norway (17.6%), 131 in the Netherlands (43.7%), 363 in Mexico (55.8%) and 180 in Sweden (30.0%). Overall 1,434 responses were received from the 5,388 firms surveyed for a 26.6% response rate. After excluding firms with less than five and more than 500 managers and employees and excluding those with missing data, there were 1,024 SMEs that enter our analyses.

### **Dependent Variable: Firm Performance**

We measured firm performance with a modified version of a multi-faceted instrument suggested by Gupta & Govindarajan (1984), which acknowledges the presence of highly diverse performance criteria across industries, countries, and individual firms. That is, different facets of performance, e.g., sales level, sales growth or ROI, might be of different relevance for different firms. As a consequence, judgments regarding achievements on each of the different facets are weighted based on the importance assigned to the facet. Such instruments have been employed in previous EO research (e.g., Tang, Kreiser, Marino, & Weaver, 2010; Kollmann & Stöckmann, 2014). For seven facets, i.e., sales level, sales growth rate, cash flow, gross profit margin, net profit from operations, return on investment, and the ability to fund business growth from profits, participants were asked to report the importance that the firm's top managers attach to it (on a 5-point scale from not to extremely important) and the degree to which top managers are satisfied with respect to each facet (on a 5-point scale from not to extremely satisfied). To create a *subjectively weighted performance* measure, we sum up the satisfaction scores weighted with the importance scores divided by the sum of the importance scores.<sup>2</sup>

### **Independent Variables:**

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<sup>2</sup> While we assume that the weighted performance measure is meaningful, we have also run our analyses with the not weighted performance measure. The correlation between weighted and not weighted performance measures is 0.996 and our results do not change in any significant way.

### *Entrepreneurial Orientation*

We measured EO based on the deconstruction of the popular Miller/Covin and Slevin EO scale (Covin & Slevin, 1989) into its three salient dimensions of proactiveness, risk taking, and innovativeness. We employed the eight-item version of the instrument with responses from one to five, which has been used in several studies before (e.g., Kreiser et al., 2002; Tang et al., 2008; Kreiser et al., 2013). Kreiser et al. (2002) focused on the factor analytic structure and the validation of the entrepreneurial orientation measurement and demonstrated cross-cultural validity of this measurement instrument. The sum scores of responses to the corresponding items constitute three variables: innovativeness (three items,  $\alpha=0.64$ ), proactiveness (three items,  $\alpha=0.71$ ), and risk taking (two items,  $\alpha=0.74$ ).

### *Industry*

With respect to industry effects, we employed a classification that identified firms in twelve industries: food, wood products, printing, rubber/plastics/polymers, chemicals, transport equipment, industrial equipment, electronics, computer programming/software, textiles, service, and others. The twelve industry groups were assigned to high-tech and low-tech industries based on a categorization scheme provided by the Organization for Economic Co-Operation and Development (OECD): the Science, Technology and Industry Scoreboard (2003). A third group comprises firms that indicated they are neither solely high-tech nor low-tech, many of which operated in multiple industries.

### **Control Variables**

We controlled for the effects of several variables extraneous to our research question. We controlled for firm size as the logarithm of the number of managers and employees. We also included a dummy variable, subsidiary, to indicate whether the firm operated independently or

was owned by another firm. We also controlled for country and industry effects to reduce threats from unobserved heterogeneity given that we have heterogeneous multi-industry and multi-country data. We included dummy variables for Australian, Swedish, Mexican, Norwegian, Finnish, and Dutch firms (the group of Australian firms was used as base group). When controlling for industry fixed effects we did not use the high-tech/low-tech distinction, but include dummy variables for each of the above-mentioned 12 industries (food was used as base group).

### **Analytical Procedures**

As a first step of our analysis, we ran hierarchical ordinary least square regression analyses of firm performance on the three dimensions of EO—innovativeness, proactiveness, and risk taking—as well as on our control variables. We especially focused on the incremental variance explained variance (R-squared) when adding the three EO dimensions to a model that included the control variables (CV) only.<sup>3</sup> The increment when including all dimensions of EO quantifies how much variance in firm performance can be attributed to variations in any of the three dimensions of EO, including variations unique to single dimensions (unique variance) and to covariation between two or all dimensions (shared variance). We refer to this increment in variance conjointly explained by all dimensions of EO as the EO dimensions' *total effect* ( $T = R^2_{y \cdot cv, i, j, k} - R^2_{y \cdot cv}$ ).

We then decomposed the EO dimensions' total effect (T) into all dimensions' unique effects ( $E_i$ ,  $E_p$ , or  $E_r$ ) and their shared effects, including the bilaterally shared effects ( $E_{ip}$ ,  $E_{ir}$  and  $E_{pr}$ ) and the commonly shared effect ( $E_{ipr}$ ). The subscripts i, p, and r refer to the dimensions of

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<sup>3</sup> The following description applies to linear and non-linear effects of dimensions of EO. To address non-linear effects of a dimension, the related linear term is complemented with a non-linear, e.g., quadratic, term.



innovativeness, proactiveness, and risk taking, respectively. The *dimensions' unique effects* ( $E_i$ ,  $E_p$ ,  $E_r$ ) are the variation in the dependent variable that can be explained only by variations in a single dimension when all other dimensions remain constant (Cohen, Cohen, West, & Aiken, 2003). A dimension's unique effect is quantified as the increase in explained variance when adding this dimension to a model that includes the other two dimensions (see Figure 1), e.g.,  $E_i = R^2_{y \cdot cv, i, p, r} - R^2_{y \cdot cv, p, r}$ . Unique effects are well-known from hierarchical regression analyses.

Besides unique effects, the EO dimensions' total effect (T) includes effects that cannot be attributed to any unique variation in individual dimensions but only to shared variation between two ( $E_{ip}$ ,  $E_{ir}$ ,  $E_{pr}$ ) or between all three dimensions ( $E_{ipr}$ ). The amount that cannot be attributed to unique variations in individual EO dimensions, which is the *sum of shared effects*, is reflected in the difference between the total effect (T) and the sum of the dimensions' unique effects ( $E_i + E_p + E_r$ ), i.e.,  $E_{ip} + E_{ir} + E_{pr} + E_{ipr} = T - (E_i + E_p + E_r)$ . Note that the sign of a shared effect does not indicate the direction of the shared effects, but only indicates whether or not the directions of shared and unique effects are the same. Positive shared effects imply that the effect of a dimension when aligned with other dimensions has the same direction as the effect when not being aligned, i.e., the unique effect. A negative shared effect implies that these effects differ in sign.<sup>4</sup>

To further decompose the sum of shared effects ( $E_{ip} + E_{ir} + E_{pr} + E_{ipr}$ ) into parts that are shared by the different pairs ( $E_{ip}$ ,  $E_{ir}$ ,  $E_{pr}$ ) and commonly shared by all dimensions of EO ( $E_{ipr}$ ),

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<sup>4</sup> Statistically, a negative shared effect indicates a suppression effect (Velicer, 1978; Schoen et al., 2011): That is, when excluding, for example, innovativeness and proactiveness, which are positively correlated with risk taking, the effect of risk taking seems to vanish in our data (Table 5, compare column 1 with 1a). In fact, the related coefficient (Table 5, column 1a) reflects both a positive effect that is shared with the two other dimensions and the negative unique effect of risk taking (Table 5, column 1). As these two effects are opposing, they cancel one another and we are left without any observable effect. However, when including the other dimensions and estimating the effect when keeping these other two dimensions constant (i.e., focusing on the unique effect), we observe a negative unique effect (Table 5, column 1a).

we employed commonality analysis (Mood, 1971; Seibold & McPhee, 1979). Commonality analysis will not increase the explanatory power of EO for a given study, but it will shed new light on the structure underlying the explanatory power of EO dimensions for firm performance. Like hierarchical regression analysis, commonality analysis builds on simple regression analyses and compares explained variance of models containing different subsets of explanatory variables. In fact, commonality analysis can be seen as an extension of hierarchical regression analyses (Cohen et al., 2003). In comparison to hierarchical regression analyses, however, commonality analysis not only compares explained variances (R-squared) between two nested regression models, but—to quantify shared effects—employs linear combinations of multiple, not necessarily nested, regression models. We implemented commonality analysis based on formulas provided by Seibold and McPhee (1979). To reduce the threat from spurious correlations between EO and performance, which might bias commonality analysis, we extended their original formulas to allow the inclusion of control variables (see Figure 1).

To isolate the bilaterally shared effects of two dimensions' we took the effect of both dimensions, i.e., the incremental change in R-squared when adding these two dimensions to a model that already includes the third dimension, and subtracted both dimensions' unique effects (see Figure 1), e.g.,  $E_{ip} = R^2_{y \cdot cv, i, p, r} - R^2_{y \cdot cv, r} - (E_i + E_p)$ . To derive the commonly shared effect, we subtracted all unique and all bilaterally shared effects from the EO dimensions' total effect, i.e.  $E_{ipr} = T - (E_i + E_p + E_r + E_{ip} + E_{ir} + E_{pr})$ .

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 Insert Figure 1 here  
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To calculate the statistical significance of unique and shared effects, we followed the recommendations of Graf and Alf (1999) and Nimon and Oswald (2013). Unique effects ( $E_i$ ,  $E_p$ ,

$E_r$ ) and all dimensions' total effect (T) represent specific forms of linear combinations of squared multiple correlations that *can* be represented by a difference of explained variance of two nested models (see calculations of T,  $E_i$ ,  $E_p$ , and  $E_r$  in Figure 1). Due to the nested structure, we can base significance tests of these effects on corresponding individual and joint F-tests. Note that t-tests for coefficients in OLS regression analyses are equivalent to F-tests for the corresponding unique effects (Cohen et al., 2003). Thus, the significance of unique effects is equivalent to the individual significance of the corresponding coefficients in an OLS regression analysis.<sup>5</sup>

Shared effects are linear combinations of squared multiple correlations that *cannot* be represented by a difference of explained variance of two nested models (see calculations of  $E_{ip}$ ,  $E_{ir}$ ,  $E_{pr}$ , and  $E_{ipr}$  in Figure 1). Related significance test, therefore, cannot be based on F-tests. We, thus, followed the recommendation of Nimon and Oswald (2013) and employed bootstrapping methods. When analytical expressions for calculating standard errors are quite complicated, which is the case here (compare the already complicated expressions for a commonality analysis without control variables as reported in Schoen et al., 2011), bootstrapping in conjunction with asymptotic refinement can provide better estimates of standard errors (Cameron & Trivedi, 2010, p. 429). Bootstrapping methods provide estimates of standard errors based on resampling from the observed sample. The idea is that a sub-sample from the observed sample relates to the observed sample in the same way as the observed sample is related to the population (Cameron & Trivedi, 2010). Building on this assumption one can derive confidence intervals for point estimates. We constructed bias-corrected and accelerated confidence intervals, and significance

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<sup>5</sup> If individual effects comprise multiple terms, e.g., an additional non-linear effect, then all related coefficients' joint significance reflects the significance of these unique effects.

levels are assumed to be equal to the level of the largest confidence intervals not including zero (Cameron & Trivedi, 2010).<sup>6</sup>

Note that, as the vast majority of EO studies (see review by Rauch et al., 2009), our study relies on single informants and self-reported performance measures. This inevitably introduces the risk of common method variance (CMV), which represents a correlation of measurement errors across the measurements of different variables (Podsakoff, et al., 2003). Conducting the Harman's one-factor test, we run three factor analyses (using principle component analysis): all model variables (control variables excluded), all items used for measuring all model variables, and all items used for measuring the dimensions of EO. In all analyses, the first factor explains less than fifty percent of the explained variance indicating that CMV is not a dominant factor. Furthermore, CMV would not only inflate the effects of the dimensions of EO (cf., Podsakoff et al., 2003), but it would also inflate correlations between these dimensions (Rauch et al., 2009) and thereby the size of the commonly shared effect (Schoen et al., 2011). Thus, common method variance particularly inflates the commonly shared effect. The results of our analyses, which reveal no commonly shared effect for low-tech industries, therefore suggest that CMV is unlikely distorting our analyses.

## RESULTS

Table 1 reports the summary statistics and correlations. The results show substantial shared variance (i.e., covariation) between the dimensions of EO, i.e., correlations range from 0.44 to 0.49. We further observe that firm performance displays positive and statistically significant

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<sup>6</sup> For the statistical software STATA, the second author can provide a program that implements a full commonality analysis including significance tests based on bootstrapping procedures for up to five dimensions including control variables and possibly non-linear effects of dimensions of EO.

correlations with proactiveness ( $r=0.21$ ,  $r\text{-squared}=0.043$ ), innovativeness ( $r=0.15$ ,  $r\text{-squared}=0.023$ ), and risk taking ( $r=0.08$ ,  $r\text{-squared}=0.006$ ). These correlations reflect the relationships without statistically controlling for firm size, being a subsidiary, industry and country effects. The absolute levels of the correlations are comparable or slightly larger than those reported in the meta-analysis by Rauch et al. (2009). In terms of effect sizes, our sample is, thus, consistent with previous studies. Finding that risk taking has the smallest zero-order correlation with performance is consistent with findings from the meta-analysis by Rauch et al. (2009) and those in more recent publications (e.g., Anderson et al., 2015). Our observation that proactiveness displays, on average, a larger correlation with performance than does innovativeness deviates from the meta-analysis by Rauch et al. (2009), which is—as our subsample analysis will show below—possibly caused by the subsample of low-tech firms.

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Insert Tables 1 and 2 here  
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Table 2 reports the results for the OLS regression analyses for the overall sample of firms. The total effect of all dimensions of EO (T) after controlling for firm size, subsidiary, country, and industry effects, i.e., the increment in explained variance when adding the three EO dimensions (Column 1), is statistically significant. Thus, the combined effect of all three dimensions of EO explains significant parts of the variation in firm performance. Considering the individual coefficients of each dimension (Column 1), we observe that only proactiveness is statistically significant and, thus, affects firm performance when the other dimensions are kept constant. That is, only proactiveness has a unique effect on firm performance. The effects of each dimension when not controlling for the other two dimensions (which is the sum of a dimension's unique effect plus all shared effects related to this dimension, e.g., for innovation this sum is

$E_i + E_{ip} + E_{ir} + E_{ipr}$ ), however, are statistically significant (Table 2, Columns 2–4). Based on these differences, we may suspect that there are substantial bilaterally or commonly shared effects. By solely interpreting OLS estimations, however, we do not know whether these shared effects are statistically significant nor do we know which dimensions share these effects.

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Insert Table 3 here  
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To assess the extent to which the three EO dimension's effects are shared between any of the respective sets of two dimensions or the combination of all three dimensions, Table 3 (Column 1) reports results of a commonality analysis. By definition, the unique effects (Lines 1-3) display the same levels of statistical significance as the related coefficients; that is, only proactiveness shows a statistically significant unique effect on firm performance. Supporting our hypothesis, we do find statistically significant shared effects (Lines 4-7). Summing up all shared effects ( $0.008 - 0.001 - 0.001 + 0.003 = 0.010$ ), we see that about one-third of the EO dimensions' total effect (Line 8: 0.030) is explained by shared effects. As indicated by the decomposition of the shared effects, the largest part of shared effects is a statistically significant bilaterally shared effect between proactiveness and innovativeness (Line 4). Furthermore, we observe a statistically significant commonly shared effect (Line 7).

We conducted additional analyses to check (Table 3, Columns 2-4) the robustness of our results. First, focusing on linear effects is quite common in research conducted on EO, but there is initial evidence for possibly non-linear effects of the dimensions of EO on firm performance (cf. Tang et al., 2008; Wales, Patel, Parida, & Kreiser, 2013b; Kreiser et al., 2013). To test the robustness of our conclusions when including non-linear effects, we ran our analysis while including squared effects of each dimension of EO (Table 2, Column 5). The EO dimensions'

total effect (Line 13) increased by an insignificant amount and none of the squared effects was statistically significant (Lines 10-12). Furthermore, results of the related commonality analysis (Table 3, Column 2) do not substantially differ from those with linear effects (Table 3, Column 1). Thus, considering non-linear effects over our linear approach is not warranted for our data.

Second, the multivariate delta method (see Hedges & Olkin, 1981; Graf & Alf, 1999) is an alternative way to test the significance of shared effects (Schoen et al., 2011). The multivariate delta method considers the expressions used to calculate the shared effects as linear transformations of normally distributed random variables and based on these assumptions constructs standard errors and confidence intervals (Azen & Sass, 2008; Graf & Alf, 1999). The method works best for expressions with components that can reasonably be assumed to asymptotically approach multivariate normal distributions. The adaptation of the multivariate delta method to the commonality analysis, as provided by Schoen et al. (2011), does not allow the inclusion of control variables or non-linear effects and has a low power for smaller samples sizes (cf., Azen & Sass, 2008). As a robustness check, we nevertheless compared results from this alternative method (Table 3, Column 3) with results from bootstrapping an equivalently reduced model (i.e., without control variables and with only linear effects, Column 4). We find that results do not substantially change; that is, those parts that are considered statistically significant based on bootstrapping are also significant (though at a slightly smaller degree) based on the multivariate delta-method.

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Insert Tables 4 and 5 here  
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To investigate our second hypothesis, we re-ran the commonality analyses for each of the

three subsamples of high-tech and low-tech firms and those that cannot be assigned to single sectors (see Table 4). As the commonality analysis only reports the degree to which a variable predicts firm performance but not the sign of the relationship, Table 5 reports related OLS regression analyses as supplementary information. In line with our second hypothesis, we see clear differences between these three subsamples.

For low-tech firms, we observe that the unique effect of proactiveness explains almost the entire effect of the three dimensions of EO. That is, there is no shared effect with any of the other dimensions. Unique variation in proactiveness explains almost all (96%) of the EO dimensions' total effect (see Table 4, Column 2, Line 2); thus, proactiveness affects firm performance, especially when it is not aligned with more innovativeness or risk taking. If we only compared the OLS regression for the low-tech subsample (Table 5, Column 2) with the corresponding analysis of the overall sample (Table 2, Column 1), we might have thought that, qualitatively, the results do not differ. However, the absence of shared effects in the low-tech subsample (Table 4, Column 2, Line 7) makes a difference to the overall sample (Table 3, Column 1, Line 7).

For high-tech firms, we observe that all dimensions uniquely contribute to explaining firm performance; the unique effect of innovativeness, however, is the largest (Table 4, Column 1, Line 1). Yet, even larger is the shared effect between innovativeness and proactiveness (Line 4). We also observe negative shared effects of risk taking with innovativeness (Line 5) and also—though statistically not significant but of similar size—with proactiveness (Line 5). Note that the overall effect of risk taking as the sum of its unique and shared effects is almost zero (Lines 3, 5-7:  $0.006-0.003-0.003-0.001=-0.001$ ), which implies that, on average and when not separating unique from shared effects, risk taking does not seem to have any explanatory power. Excluding innovativeness and proactiveness from the analysis (Table 5, Column 1a), and thereby quanti-



ying the overall effect of risk taking without keeping the other dimensions constant, reveals that—consistent with the conclusion from the commonality analysis—risk taking does not have an overall effect, i.e., the coefficient is almost zero and is statistically not significant. Yet, the negative sign of the shared effects of risk taking with innovativeness and proactiveness indicates that the effect of risk taking on firm performance is different when aligned with these other dimensions compared to when not aligned with them (a positive shared effect had implied that the effect has the same sign for these two conditions). To determine the specific direction of these effects, we need to look at the OLS regression analyses (Table 5). The negative sign of risk taking (Table 5, Column 1) indicates that its unique effect, i.e., the effect when it is not aligned with innovativeness or proactiveness, is negative. The effect of risk taking when aligned with innovativeness and proactiveness is opposite and, thus, positive.<sup>7</sup> In sum, in high-tech industries we face a large performance effect of EO that cannot be clearly attributed to either innovativeness or proactiveness. In the discussion section, we will further elaborate on the special role of risk taking.

For multi-sector firms, we observe another very interesting case: there is a large and statistically significant commonly shared effect (Table 4, Column 3). Besides this commonly shared effect, we also observe a statistically significant (although relatively small) bilaterally shared effect for innovativeness and proactiveness as well as a moderate unique effect for proactiveness. In contrast to high-tech firms, we observe that all of the effects that risk taking

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<sup>7</sup> The empirical observation of a negative shared effect and a related downward shift of a positive or zero overall association of risk taking with firm performance (Table 5, Columns 1a and 3a) to no respectively negative effects when controlling for innovativeness and proactiveness (Table 5, Columns 1 and 3) can also be observed in other studies relating entrepreneurial orientation to, e.g., firm performance of family firms (e.g., Naldi, Nordqvist, Sjöberg, & Wiklund 2007) or job stress and employee retention (Monsen & Boss, 2009).

shares with other dimensions are positive and the commonly shared effect is statistically significant. Considering the OLS regression analyses (Table 5, Columns 3 and 3a), we see that risk taking has a positive effect when the other dimensions are excluded and that it has no effect once they are included. Thus, as in the case of high-tech firms, we have a positive effect of risk taking when it is aligned with innovativeness and proactiveness, but contrary to high-tech firms, unique variations in risk taking do not harm diversified multi-sector firms.

## **DISCUSSION**

Our primary intention in this study was to advance the knowledge about EO by revealing more of the structure of the relationship between EO and firm performance. Our approach facilitates a clear attribution of the effects of proactiveness, risk taking, and innovativeness on firm performance to variations in individual dimensions and to their common or bilateral covariation. Supporting Hypothesis 1, we found that variance shared between only two dimensions of EO explains variation in firm performance. Furthermore, we reveal that not only does the strength of the relationship between EO and firm performance vary between industries (Rauch et al., 2009), but—as we demonstrate—also the structure, i.e. the relevance of the different unique, bilaterally shared, and commonly shared effects (Hypothesis 2). Our discussion and empirical observations make important theoretical and methodological contributions and enable us to derive relevant practical implications.

### **EO Dimensions' Unique and Shared Effects and Their Context-dependency**

Observing both commonly shared and unique effects in the overall sample and substantial differences in the relevance of these effects across different contexts supports Miller (2011), and suggests that the unidimensional and multidimensional approaches should be consolidated to better understand the consequences of EO. Commonly shared variance explains significant parts

of variations in firm performance in the overall sample and it is, indeed, the most important component of EO in terms of predicting firm performance for multi-sector firms. This latter result for multi-sector firms support suggestions by Miller (1983) and Covin and Slevin (1989) that the simultaneous pursuit of risk taking, proactiveness, and innovativeness positively affects firm performance. That is, at least for these firms, a significant part of the positive effect of promoting one dimension of EO will only be realized when the other dimensions change accordingly. Yet, the unique effect of proactiveness in the overall sample as well as its dominant effect across low-tech firms also calls for a multi-dimensional perspective that acknowledges dimension-specific effects (Lumpkin & Dess, 1996). The observed industry-related differences thereby suggest that the importance of different conceptualizations of EO may depend on the industry in which a firm operates or on other environmental or firm characteristics.

Our analyses additionally reveal the existence of not yet explicitly considered bilaterally shared effects between the dimensions of EO, which suggests an extension of the two dominant conceptualizations of EO. Despite the marginally significant unique effects of innovativeness and proactiveness, especially for high-tech firms, a large effect of the dimensions of EO can only be attributed to the covariation between these two dimensions. This observation is consistent with Lumpkin and Dess' (1996) suggestion that in different contexts, different dimensions of EO may matter. It is also consistent with a recent conceptualization of EO by Anderson et al. (2015), which suggests that innovation and proactiveness should be merged into a single dimension and thereby—translated into our terminology—focuses on only these dimensions' shared variance. Observing that risk taking displays shared effects with both innovativeness and proactiveness mirrors Anderson et al.'s theorizing that firms enact their proclivity for risk either through innovative or proactive activities. Going beyond Anderson et al.'s view, however, we observe

that variations in risk taking that are not aligned with variations in either proactiveness or innovativeness, i.e., risk taking's unique variance, can negatively affect firm performance. Thus, future research should further develop the two dominant approaches into a more comprehensive approach that incorporates the notions of bilaterally shared effects and—not least important—opposing unique and shared effects of dimensions of EO.

### **The Risk Taking Dimension in EO**

The potential problems resulting from differences in the theorizing and testing unique rather than shared effects, or vice versa, are best illustrated based on our results on the effects of risk taking. For high-tech industries we observe that a variation in risk taking that is not aligned with concomitant variations in other dimensions might have a diametrically opposite effect on performance, compared to a variation in this dimension when it is aligned with the other dimensions. Extending Lumpkin and Dess (1996), who emphasize that excessive risk taking can lower performance in some contexts, we argue that more risk taking can also lower performance when it is not aligned with increasing innovativeness and proactiveness. For firms in high-tech industries, risk taking as an inherent part of developing and commercializing new products, or when proactively entering a new market without knowing all the consequences, might be considered a precursor of superior performance given the necessities of such industries (Miller, 1983; Zahra, 1993). However, accepting risks unrelated to innovativeness or proactiveness could be detrimental to firm performance (see Kollmann & Stöckmann, 2014, for a comparable logic) and should be avoided. Multi-sector firms might be able to buffer the potentially negative effects of excessive risk taking through related portfolio effects and the availability of slack resources (Bradley, Wiklund, & Shepherd, 2011; Bradley, Shepherd, & Wiklund, 2011). For such firms, taking some risks unconnected to innovativeness or proactiveness won't necessarily cause

negative overall performance effects (Lubatkin & Chatterjee, 1994). Future research needs to address these contingencies related to the effects of risk taking on firm performance.

Considering the details of regression analyses provides new insights into the role of risk taking in the context of EO. As our analyses reveal, the estimated effects for individual dimensions of EO might differ depending on whether or not researchers control for the other dimensions, that is, whether they test unique or overall effects (i.e., the unique plus bilaterally and commonly shared effects) of a dimension. The difference between unique and shared effects not only needs to be considered when interpreting regression results but also—to ensure a fit between theorizing and empirical tests—when theorizing about the effects of the dimensions of EO. For instance, future research should not hypothesize a positive risk taking effect based on the consideration that it is part of becoming more innovative or proactive (this implies theorizing about *shared* effects), and then test all three dimensions' *unique* effects on firm performance using a regression analysis that simultaneously includes all the other dimensions (e.g., Hughes & Morgan, 2007). Correspondingly, finding negative effects of risk taking when controlling for innovativeness and proactiveness should not be taken as suggesting that risk taking hinders performance in the observed context (e.g., Hughes & Morgan, 2007; Naldi et al., 2007). Rather, it can be concluded that only risk taking that is not aligned with an increase in proactiveness or innovativeness hinders performance. This finding should resonate with most EO researchers, and might explain seemingly inconsistent findings regarding risk taking within the context of EO.

### **Introducing Commonality Analysis to Entrepreneurship Research**

While our theoretical reasoning of shared effects helps future research to make explicit what has been previously only implicitly assumed we also provide a method for empirically testing this reasoning. Specifically, we suggest a more careful interpretation of results derived

from regression analyses. Future research should more thoroughly consider the potential impact of bilaterally and commonly shared effects and consider post-hoc commonality analyses when dimensions of constructs are moderately or highly correlated. By means of a commonality analysis researchers can quantify the degree to which effects cannot be attributed to individual dimensions but instead to covariation between these dimensions and it can provide statistical tests of significance. Thereby commonality analysis allows a more detailed interpretation of data that is based on the idea that covariation between variables carries explanatory power.

Commonality analysis is not only useful in the context of EO; it can also be applied to many other contexts relevant to entrepreneurship and management research in which covariation between variables may carry explanatory power. For example, it may help to investigate whether it is meaningful to simultaneously engage in both, exploration and exploitation (cf., Gupta, Smith, & Shalley, 2006; Lubatkin, Simsek, Ling, & Veiga, 2006). Ambidexterity can be defined as "exploiting existing competencies as well as exploring new opportunities with equal dexterity" (Lubatkin et al., 2006, p. 647). This would be consistent with Lubatkin et al. (2006) operationalizing ambidexterity as the variance shared between the items reflecting exploration and exploitation. Resulting effects on firm performance would be attributed to the shared variance between exploration and exploitation. In such a context, commonality analysis may provide a quantitative answer about the extent to which variation in performance can be attributed to unique variations in exploration or exploitation, or to their covariation.

### **Managerial Implications**

In addition to our contribution to research, our results also have important practical implications. Most notably, our research shows that firms should not blindly implement all of the dimensions of EO, or even individual dimensions based on the assumption that EO and all of its

dimensions are universally beneficial. The effects of each dimension of EO need to be carefully interpreted in relation to the context in which the firm is operating as well as in relation to the other dimensions of EO. More specifically, our findings provide practitioners with a framework to help them calibrate the EO of their firm in a more fine-grained way to help them achieve superior performance. This will help firms carefully invest their limited resources and engage in activities that leverage EO in a manner that contributes to performance. For example, proactive behavior allows firms to anticipate and act in advance of environmental changes, thereby shaping the direction of these changes. For firms in low-tech industries, our findings suggest that this behavior should be encouraged, whereas additional investments in innovativeness or risk taking are not as beneficial. In a high-tech context, however, firms should align proactiveness with innovativeness. Finally, decision-makers in firms should be aware of the importance of differentiating between necessary and essential risk taking as part of innovation because risks that are not aligned with innovativeness and proactiveness might be detrimental to performance.

### **Limitations**

While we believe that analyzing shared effects and the application of commonality analysis to shared effects can contribute significantly to research on EO, our results should be interpreted within the limitations of our study design. The first limitation refers to potential concerns regarding causality. While the cross-sectional data we employ in this study is the dominant type of data employed in research on EO (Rauch et al., 2009), it does not allow conclusions related to causality. Second, and as with most studies, our conclusions might be specific to our sample. Using a large international sample from low-tech, high-tech, and multi-sector firms, and controlling for country and industry fixed effects, we believe that our results do provide some meaningful insight into the relationship between EO and firm performance. As demonstrated by

our subsample analysis, we do not claim that the analysis of the overall sample generalizes across all contexts. We clearly observe that effects differ between low-tech, high-tech, and multi-sector firms. Based on these observations, we believe that EO research should control for such sector differences. We encourage other EO researchers to replicate our findings and to expand our research to other contexts (e.g., business startups), which might—following Miller (2011)—reveal even more nuanced structures of the relationship between EO and firm performance.

### **CONCLUSION**

To conclude, we hope that expanding the examination of the phenomenon of EO beyond a single conceptual perspective can inspire and promote future research on the EO-performance relationship. Future research should build on the assumption that effects of EO dimensions can relate to variations in individual dimensions and to their common or bilateral covariation and that this structure may vary across industries. We believe that commonality analysis is a meaningful tool supplementing regression analyses in settings where explanatory variables are substantially correlated, and where bilaterally or commonly shared effects may carry significant portions of these variables' explanatory power.



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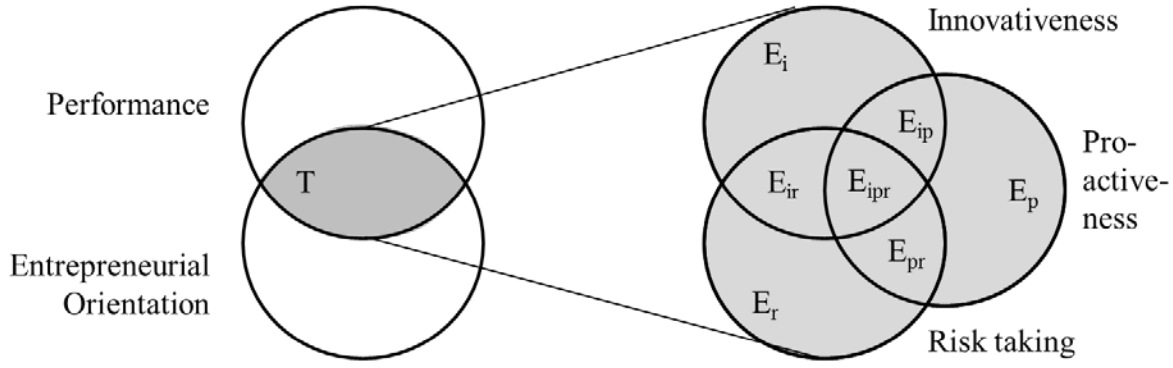
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**FIGURE 1: DECOMPOSITION OF TOTAL VARIANCE IN FIRM PERFORMANCE EXPLAINED BY THREE DIMENSIONS OF ENTREPRENEURIAL ORIENTATION**



T – Variance explained by Entrepreneurial Orientation (=total effect)

$E_i, E_p, E_r$  – unique effect  
 $E_{ip}, E_{ir}, E_{pr}$  – bilaterally shared effect  
 $E_{ipr}$  – commonly shared effect

*Total effect:*

$$T = R^2_{y \cdot cv, i, j, k} - R^2_{y \cdot cv} = E_i + E_p + E_r + E_{ip} + E_{ir} + E_{pr} + E_{ipr}$$

*Unique effects:*

$$E_i = R^2_{y \cdot cv, i, p, r} - R^2_{y \cdot cv, p, r}$$

$$E_p = R^2_{y \cdot cv, i, p, r} - R^2_{y \cdot cv, i, r}$$

$$E_r = R^2_{y \cdot cv, i, p, r} - R^2_{y \cdot cv, i, p}$$

*Bilaterally shared effects:*

$$E_{ip} = R^2_{y \cdot cv, i, p, r} - R^2_{y \cdot cv, r} - (E_i + E_p)$$

$$E_{ir} = R^2_{y \cdot cv, i, p, r} - R^2_{y \cdot cv, p} - (E_i + E_r)$$

$$E_{pr} = R^2_{y \cdot cv, i, p, r} - R^2_{y \cdot cv, i} - (E_p + E_r)$$

*Commonly shared effect:*

$$E_{ipr} = T - (E_i + E_p + E_r + E_{ip} + E_{ir} + E_{pr})$$

**Notes:**  $R^2_{y \cdot var}$  is defined as R-squared of a regression of y (here: firm performance) on the variables listed after the dot. If no control variable is included, then  $R_{y \cdot cv, var} = R_{y \cdot var}$  with  $R_{y \cdot cv}$  equal to zero; in this case all our equations replicate those reported by Seibold and McPhee (1979). Note that depending on the underlying model, variables r, p, and i can refer to either only the linear or to both linear and squared effects of the corresponding dimension.



**TABLE 1: SUMMARY STATISTICS AND BINARY CORRELATIONS**

	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1 Performance	3.21	0.82	(0.81)															
2 Innovativeness	8.85	2.81	.15***	(0.77)														
3 Proactiveness	10.15	2.69	.21***	.49***	(0.69)													
4 Risk taking	5.57	1.91	.08*	.44***	.45***	(0.85)												
5 Size (employees, log)	3.44	1.06	.05+	.14***	.20***	.15***	1											
6 subsidiary	0.10	0.30	-.04	.05	.03	.03	.17***	1										
<i>Countries</i>																		
7 Australia	0.09	0.29	-.02	.01	-.02	-.08*	-.19***	.04	1									
8 Sweden	0.14	0.35	-.16***	.04	-.03	.07*	-.03	-.13***	-.13***	1								
9 Mexico	0.22	0.41	.03	-.01	.16***	.09**	.38***	-.03	-.17***	-.21***	1							
10 Norway	0.34	0.48	.12***	-.06+	-.02	-.09**	-.14***	-.08**	-.23***	-.29***	-.38***	1						
11 Finland	0.10	0.30	.11***	.12***	.03	.08**	-.05+	.12***	-.11***	-.13***	-.17***	-.24***	1					
12 The Netherlands	0.10	0.31	-.13***	-.05	-.16***	-.06*	-.04	.17***	-.11***	-.14***	-.18***	-.25***	-.11***	1				
<i>Industries</i>																		
13 FOOD	0.09	0.29	-.03	.01	.03	-.04	.14***	.01	-.06+	.01	.17***	-.05	-.05	-.06*	1			
14 WOOD	0.06	0.25	-.05+	-.13***	-.15***	-.08**	-.03	-.05	-.07*	.10**	-.09**	.04	-.02	.03	-.08**	1		
15 PRINT	0.09	0.29	-.07*	-.08*	-.08*	-.05	-.07*	-.04	.00	.08*	-.13***	.04	-.07*	.09**	-.10**	-.08**	1	
16 RUBBER	0.05	0.22	.02	.03	-.02	-.01	-.04	.01	-.02	.01	-.04	.04	-.02	.02	-.07*	-.06*	-.08*	1
17 CHEMI	0.06	0.23	.06*	.03	.04	-.01	-.01	.02	-.05	-.06*	-.02	.13***	-.02	-.03	-.07*	-.06*	-.08*	-.06+
18 TRANS	0.03	0.17	-.05	-.04	.04	-.01	-.02	-.00	.13***	.02	.03	-.13***	.04	-.02	-.06+	-.04	-.06+	-.04
19 MACHIN	0.09	0.29	.00	.06*	.03	.06+	-.03	.02	.11***	.05	-.02	-.16***	.09**	.03	-.10**	-.08**	-.10**	-.07*
20 ELECTRO	0.11	0.31	.05+	.04	-.00	.01	-.08*	-.02	.01	-.11***	-.09**	.23***	-.04	-.08*	-.11***	-.09**	-.11***	-.08**
21 PROGRAM	0.14	0.34	.07*	.14***	.08**	.09**	-.06+	.02	-.06+	.02	-.17***	.24***	-.06*	-.05+	-.13***	-.10***	-.13***	-.09**
22 TEXTILE	0.01	0.08	.02	.02	.01	-.02	-.02	-.04	.06*	-.03	.08**	-.06+	-.03	-.03	-.02	-.02	-.02	-.02
23 SERVICE	0.02	0.15	-.03	-.06+	.06+	-.00	.04	.01	.30***	-.06*	.05+	-.11***	-.05+	-.05+	-.05	-.04	-.05	-.04
24 OTHER	0.24	0.43	-.02	-.05	-.01	.01	.11***	.07*	-.11***	-.03	.22***	-.26***	.14***	.09**	-.18***	-.15***	-.18***	-.13***
			17	18	19	20	21	22	23	24								
18 TRANS			-.04	1														
19 MACHIN			-.08*	-.06+	1													
20 ELECTRO			-.09**	-.06*	-.11***	1												
21 PROGRAM			-.10**	-.07*	-.13***	-.14***	1											
22 TEXTILE			-.02	-.01	-.02	-.03	-.03	1										
23 SERVICE			-.04	-.03	-.05	-.06+	-.06*	-.01	1									
24 OTHER			-.14***	-.10**	-.18***	-.20***	-.22***	-.04	-.09**	1								

**Notes:** N=1024. For sum scores, Cronbach's alphas are reported in parentheses on the diagonal

\* p<0.05 \*\* p<0.01 \*\*\* p<0.001

**TABLE 2: OLS REGRESSION ANALYSES (FULL SAMPLE)**

Column	1	2	3	4	5
<sup>1</sup> Constant	-0.002 (0.140)	-0.030 (0.140)	-0.023 (0.138)	-0.101 (0.140)	0.004 (0.144)
<u>Control variables</u>					
<sup>2</sup> Firm size, log	0.025 (0.032)	0.036 (0.033)	0.029 (0.032)	0.050 (0.033)	0.025 (0.033)
<sup>3</sup> Subsidiary	0.078 (0.106)	0.087 (0.107)	0.077 (0.106)	0.087 (0.107)	0.082 (0.106)
<sup>4</sup> Country effects	incl.	incl.	incl.	incl.	incl.
<sup>5</sup> Industry effects	incl.	incl.	incl.	–	incl.
<sup>6</sup> Delta R-squared (F)	0.076 (4.56) <sup>***</sup>	0.076 (4.56) <sup>***</sup>	0.076 (4.56) <sup>***</sup>	0.076 (4.56) <sup>***</sup>	0.076 (4.56) <sup>***</sup>
<u>Entrepreneurial Orientation</u>					
<sup>7</sup> Innovativeness	0.058 (0.037)	0.121 (0.032) <sup>***</sup>			0.059 (0.037)
<sup>8</sup> Proactiveness	0.165 (0.037) <sup>***</sup>		0.177 (0.032) <sup>***</sup>		0.164 (0.038) <sup>***</sup>
<sup>9</sup> Risk taking	-0.035 (0.035)			0.056 (0.031) <sup>+</sup>	-0.035 (0.036)
<u>Squared effects</u>					
<sup>10</sup> Innovativeness (squ.)					0.013 (0.027)
<sup>11</sup> Proactiveness (squ.)					0.002 (0.025)
<sup>12</sup> Risk taking (squ.)					-0.022 (0.026)
<sup>13</sup> Delta R-squared (F)	0.030 (11.41) <sup>***</sup>	0.013 (14.38) <sup>***</sup>	0.028 (31.39) <sup>***</sup>	0.003 (3.01) <sup>+</sup>	0.031 (5.84)
<sup>14</sup> Total R-squared (F)	0.106 (5.66) <sup>***</sup>	0.089 (5.14) <sup>***</sup>	0.104 (6.11) <sup>***</sup>	0.079 (4.50) <sup>***</sup>	0.107 (4.98) <sup>***</sup>
<sup>15</sup> Observations	1024	1024	1024	1024	1024

**Notes:** Dependent variable = firm performance. Estimated coefficients and standard errors in parentheses reported for the full model. We report increments in R-squared and related F tests when adding the related block of variables; delta R-squared for entrepreneurial orientation (line 13), thus, reflects the explained variance that can be solely attributed to the effects reported in lines 7 to 13.

Significance levels: + p<0.10 \* p<0.05 \*\* p<0.01 \*\*\* p<0.001

**TABLE 3: VARIANCE DECOMPOSITION (TOTAL SAMPLE)**

	<i>Robustness checks</i>			
	<i>1</i> <i>(bootstrapping)</i>	<i>2</i> <i>(bootstrapping, dimensions with linear and squared effects)</i>	<i>3</i> <i>(multivariate delta method without control variables)</i>	<i>4</i> <i>(bootstrapping without control variables)</i>
<u>Unique effects</u>				
<sup>1</sup> Innovativeness	0.002 (7%)	0.002 (8%)	0.004 (9%)	0.004* (9%)
<sup>2</sup> Proactiveness	0.017*** (58%)	0.017*** (56%)	0.025** (52%)	0.025*** (52%)
<sup>3</sup> Risk taking	0.001 (3%)	0.001 (5%)	0.001 (3%)	0.001 (3%)
<u>Bilaterally shared effects</u>				
<sup>4</sup> Innovativeness & Proactiveness	0.008** (26%)	0.008** (25%)	0.013** (27%)	0.013*** (27%)
<sup>5</sup> Innovativeness & Risk taking	-0.001 (-2%)	-0.001 (-2%)	-0.001 (-2%)	-0.001 (-2%)
<sup>6</sup> Proactiveness & Risk taking	-0.001 (-3%)	-0.001 (-2%)	-0.001 (-2%)	-0.001 (-2%)
<u>Commonly shared effect</u>				
<sup>7</sup> Inno. & Proa. & Risk.	0.003+ (11%)	0.003+ (11%)	0.007+ (14%)	0.007* (14%)
<sup>8</sup> <u>Total effect</u> (=unique plus shared effects)	0.030*** (100%)	0.031*** (100%)	0.048** (100%)	0.048*** (100%)

**Notes:** Commonality analysis of the total effect of the three dimensions of EO on firm performance while controlling for firm size (log), firm subsidiary, and country and industry effects. Cells report explained variance and in parentheses they report explained variance relative to variance explained by all three dimensions of EO. Significance levels for total and unique effects based on F tests, which for unique effects is equivalent to t-test in OLS regression analyses. Significance levels for shared effects based on bias-corrected and accelerated bootstrapped confidence intervals, level of the largest confidence interval not including zero is assumed to indicate the significance level. The total effect may, due to rounding, not perfectly mirror the sum of unique, bilaterally shared, and commonly shared effects.

Significance levels: + p<0.10 \* p<0.05 \*\* p <0.01 \*\*\* p <0.001, <sup>na</sup> not available

**TABLE 4: INDUSTRY-SPECIFIC VARIANCE DECOMPOSITION (SUBSAMPLES)**

Column	1	2	3
Subsample	<i>High-tech</i>	<i>Low-tech</i>	<i>Multi-sector</i>
<u>Unique effects</u>			
<sup>1</sup> Innovativeness	0.011* (35%)	0.002 (4%)	0.004 (9%)
<sup>2</sup> Proactiveness	0.007+ (22%)	0.039*** (96%)	0.011+ (23%)
<sup>3</sup> Risk taking	0.006+ (20%)	0.002 (4%)	0.003 (5%)
<u>Bilaterally shared effects</u>			
<sup>4</sup> Innovativeness & Proactiveness	0.013** (43%)	- 0.001 (-3%)	0.007+ (14%)
<sup>5</sup> Innovativeness & Risk taking	-0.003+ (- 9%)	0.001 (-2%)	0.005 (11%)
<sup>6</sup> Proactiveness & Risk taking	-0.003 (-9%)	-0.001 (-3%)	0.004 (7%)
<u>Commonly shared effect</u>			
<sup>7</sup> Inno. & Proa. & Risk.	-0.001 (-2%)	- 0.000 (-1%)	0.015 ** (32%)
<sup>8</sup> <u>Total effect</u> (=unique plus shared effects)	0.030** (100%)	0.041** (100%)	0.048** (100%)

**Notes:** Commonality analysis of the total effect of the three dimensions of EO on firm performance while controlling for firm size (log), firm subsidiary, and country and industry effects. Cells report explained variance and in parentheses they report explained variance relative to variance explained by all three dimensions of EO. Significance levels for total and unique effects based on F tests, which for unique effects is equivalent to t-test in OLS regression analyses. Significance levels for shared effects based on bias-corrected and accelerated bootstrapped confidence intervals, level of the largest confidence interval not including zero is assumed to indicate the significance level. Using the multivariate delta method for significance tests of shared effects (in a model without including control variables) leads to same conclusions for shared effects. Negative values represent suppression effects; they are discussed in the main text. The total effect may, due to rounding, not perfectly mirror the sum of unique, bilaterally shared, and commonly shared effects.

Significance levels: + p<0.10 \* p<0.05 \*\* p <0.01 \*\*\* p <0.001

**TABLE 5: INDUSTRY-SPECIFIC OLS REGRESSION ANALYSES (SUBSAMPLES)**

Column	1	1a	2	3	3a
Subsample	High-tech	High-tech	Low-tech	Multi-sector	Multi-sector
<sup>1</sup> Constant	0.083 (0.187)	0.076 (0.189)	0.292 (0.448)	-0.145 (0.291)	-0.277 (0.288)
<u>Control variables</u>					
<sup>2</sup> Firm size, log	0.051 (0.051)	0.067 (0.052)	0.051 (0.063)	0.014 (0.066)	0.037 (0.066)
<sup>3</sup> Subsidiary	0.142 (0.169)	0.108 (0.172)	0.087 (0.213)	0.038 (0.190)	0.038 (0.192)
<sup>4</sup> Country effects	incl.	incl.	incl.	incl.	incl.
<sup>5</sup> Industry effects	incl.	incl.	incl.	–	–
<sup>6</sup> Delta R-squared (F)	0.059 (2.40)**	0.059 (2.40)**	0.095 (2.86)**	0.074 (2.76)**	0.074 (2.76)**
<u>Entrepreneurial Orientation</u>					
<sup>7</sup> Innovativeness	0.128 (0.058)*		-0.052 (0.067)	0.086 (0.081)	
<sup>8</sup> Proactiveness	0.105 (0.060) <sup>+</sup>		0.258 (0.070)***	0.121 (0.070) <sup>+</sup>	
<sup>9</sup> Risk taking	-0.090 (0.054) <sup>+</sup>	0.001 (0.049)	-0.047 (0.063)	0.066 (0.078)	0.170 (0.063)**
<sup>10</sup> Delta R-squared (F)	0.030 (4.65)**	0.000 (0.00)	0.041 (4.67)**	0.048 (4.41)**	0.027 (7.20)**
<sup>11</sup> Total R-squared (F)	0.089 (2.93)***	0.065 (2.43)**	0.135 (3.33)***	0.122 (3.34)***	0.100 (3.38)**
<sup>12</sup> Observations	435	435	313	251	251

**Notes:** Dependent variable = firm performance. Estimated coefficients and standard errors in parentheses reported for the full model. We report increments in R-squared and related F tests when adding the related block of variables; delta R-squared for entrepreneurial orientation, thus, reflects the explained variance that can be solely attributed to dimensions of entrepreneurial orientation, i.e. the total effect.

Significance levels: + p<0.10 \* p<0.05 \*\* p <0.01 \*\*\* p <0.001