Entrepreneurial Orientation:

An Investigation of the Stability of a Firm's Fundamental Strategic Posture and Its Links to Imitation Behavior and Sustainability

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Preface

My dissertation is centred around Entrepreneurial Orientation (EO) and includes three main studies, as well as a small additional contribution regarding a dataset that I mostly rely on. I begin with a general introduction regarding EO and a chapter overview. Chapter one presents the dataset I use for the first two studies. There I contribute to the validation of the used EO measurement scale. Following are the three main studies. In chapter two, I discuss the stability of EO on a short and medium horizon. The 3rd chapter analyses the effect of EO on innovation and imitation outcomes. Chapter four investigates the relationship between EO and sustainability indicators in stock-listed German companies. I finish with a short and summarizing discussion and conclusion.

The first three chapters rely on data from the IAB/ZEW Startup Panel which is provided by the Centre for European Economic Research (ZEW) in Mannheim, Germany. Chapter one makes a small contribution by providing a validation of the utilized scale in the panel. It is the basis for a short but slightly extended article, which I will publish together with my supervisor Prof. Bönte and Prof. Urbig as well as Sandra Gottschalk. While I conducted the textual work, Prof. Urbig looked at the data together with me and participated in finalizing the code for the statistical analyses.

Chapter two investigates the stability of EO in the firms in the IAB/ZEW Startup Panel. This chapter was solely written by me, still I got feedback from my supervisor Prof. Bönte. Although it is not written with co-authors, I use “we” to not disrupt the flow of reading.

The 3rd chapter is currently in the review process as an article in an academic journal. While it is a co-work between Prof. Bönte, Prof Urbig, Prof. Vivien Procher, Dr. Sandra Gottschalk and me, it is hard to allocate specific parts to one of the authors. I went to Mannheim together with Prof Bönte and Diemo Urbig and started analysing the data on-site. Later, I wrote the first version of the paper which went through multiple rounds of reformulations and recommendations from the other authors and me. This means, I participated in the analysis, delivered the first article version, reformulated it multiple times and participated in the final refinement of the work. The paper was presented at a conference at the ZEW and received feedback there, which we implemented.

The basis for chapter four is an article, which I wrote together with my dear friend and colleague Markus Thomanek where we utilized a relatively new approach to measure EO via

analysing public firm documents in computer-aided text analysis (CATA). We handed in the article for a conference and got feedback from two reviewers, which we appreciated and implemented. We developed the needed German keyword list together, while all textual work was done by me, I also handled the data analyses, while Markus Thomanek took care of the data access, and all the coding needed to process the large number of documents. Prof. Bönte also gave us feedback, which we also implemented in our article.

This thesis extends the research regarding EO by exploring new relations of it and other firm characteristics. It also allows researchers to access a validated EO measurement in a large panel dataset. I hope that this thesis will find some applications in the world of business and not only in academic discussions.

Any mistakes are the result of my natural human imperfection

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I Introduction

I.I Motivation and Research Questions

Entrepreneurial orientation (EO) has become one of the most established constructs in entrepreneurship research and beyond (Wales, 2016). Firms with a prominent EO have often been found to be better performing regarding financial indicators, compared to others with a lower EO (Rauch et al., 2009), which might explain the high interest in EO research, especially over the last twenty-five years. Several literature reviews and meta-analyses (e.g. Rauch et al., 2009; Wales et al., 2011; Wales, 2016; Montiel-Campos, 2018) are now available and one might assume that there are no more unresolved research questions left, given the existing extensive research on EO.

However, leading scholars in the field have identified several open questions and promising research avenues. One of these is the potential (in)stability of EO, as the literature provides potential reasons to advocate for both (Wales et al., 2011; Wales, 2016; Covin and Lumpkin, 2011, Covin and Wales, 2012). Yet, no study has focused on answering this open question empirically. In this context, it is also important to ask whether EO potentially changes as a whole or only parts of it. According to Miller (1983), firms can be considered entrepreneurial if they are innovative, engage in risky activities and stay ahead of competition.

Based on this fundamental strategic orientation of firms, EO was later established by Covin and Slevin (1989) as an independent construct which describes the entrepreneurial strategic posture as the core of a firm. They formalize the earlier characterization by Miller (1983) into subordinated EO dimensions. This conceptualization of EO contains three of these dimensions: First *innovativeness,* which refers to the engagement of a firm to seek novelty in processes and products or business practices (Covin and Slevin, 1989; Wiklund and Shepherd, 2005). The second dimension is *proactiveness* which describes a firm's will to seek and utilize opportunities, putting themselves ahead of the competition and trying to identify and adapt to future needs (Covin and Slevin, 1989; Wiklund and Shepherd, 2003). Lastly, *risk-taking* describes the firm's acceptance and willingness to carry out risk-related business activities (Covin and Slevin, 1989; Wiklund and Shepherd, 2005). Based on this approach, EO is stable even if the individual dimensions change but outweigh each other, as EO is treated to be a *unidimensional* construct.

Another conceptualization, mostly associated with Lumpkin and Dess (1996) considers two additional dimensions to be part of EO and treats EO as a *multidimensional* construct. *Competitive aggressiveness* refers to the tendency of a firm to outperform competitors and to defend the current market position (Lumpkin and Dess, 2001). While staying ahead and outperforming competitors could be understood in the same way as proactiveness, competitive aggressiveness refers to a responsive or reactive behavior to competitor actions, while proactiveness refers to the opposite, a proactive behavior (Lumpkin and Dess, 2001). The last dimension *autonomy* describes the degree of freedom of actions and decisions an employee has, without the need to ask for permission or follow complex decision processes (Lumpkin and Dess, 1996). Hence, as it is seen multidimensionally, EO would be unstable if one or more dimensions change over time. This empirical question also has implications for research. EO researchers face the problem that on the one hand, there is the request to rely on panel data to soften endogeneity problems and move into an area of causality rather than correlation (Wales 2016; Anderson et al., 2022). On the other hand, the availability of such panel data containing EO is very limited. Sophisticated methods to analyse panel data often rely on the assumption that the independent variables are subject to changes between the points of measurement (Wooldridge, 2010). If they do not change or just do slightly, researchers can face problems in the application of such sophisticated analysis methods (Lancaster, 2000). The question of the (in)stability of EO is not only relevant from a methodological point of view but arises in all empirical studies dealing with EO. Since a change in EO can only be observed if the underlying dimensions change, this dissertation is intended to provide answers to the following first research question:

Are the EO dimensions rather stable or unstable over time?

The next research opportunity is rooted in the early conceptualization by Miller (1983). According to him, firms are not entrepreneurial if they only copy the products or services of other firms. Hence, the research regarding EO and its influence on the introduction of innovations has focused on novelties, which are new to the world or the *generation* of innovations (e.g. Pérez-Luño et al., 2011; Bucktowar et al., 2015). However, firms can introduce novelties which are new to a smaller scale and still profit from advantages like growth (Peng et al, 2021) or cost advantages (Sajeva, 2013). For example, the novelty could be only new to the region or country of the introducing firm, hence *imitating* an innovation. Posen et al. (2023) argue that many of the innovations introduced are somehow alternations of existing products or services, thus they are imitations. They provide a dynamic model of

imitation which allows for different imitation strategies and not a binary strategic choice between innovating and imitating, which was prominent in the research regarding the imitation behavior of firms. Thus, if firms opt for an imitating approach, they can also choose the degree of their imitation like the timing and geographic scope, which are strategic choices themselves and influence the difficulty of imitating. So far, the literature has established a link between EO and innovation but little research regarding EO and imitation in general and especially the degree of imitation has been done. Thus, EO as a firm's strategic posture could not only influence the decisions regarding the generation of innovations but also the imitation behavior of firms and therefore, could influence the diffusion of novelties within and across counties. This leads to the second research question:

Is heterogeneity in firms' imitation behavior linked to EO dimensions?

The last research question of this thesis emerges from the call to use alternative approaches to measure EO (Wales, 2016). As EO is typically measured by questionnaires at the top management level, researchers often face low response rates (Mellahi and Harris, 2016; Cycyota and Harrison, 2006). Thus, alternative approaches could potentially overcome the problem of resulting small datasets. But only using an alternative measurement approach does not justify research by itself. Particularly in the last two decades, the interest in sustainability issues is rising, not only by consumers and regulators (Galbreth and Ghosh, 2013; Buerke et al., 2017; Garcia et al., 2019; Giacomarra et al., 2021) but also by investors who seek sustainable investments (Eyraud et al, 2013; Chitimiea et al., 2021). Hence, how firms deal with sustainability is related to their strategic posture. For example, by applying a wait-and-see approach or staying ahead of competition. The literature suggests that EO positively influences sustainability (Hooi et al. 2016; DiVito and Bohnsack, 2017; Marshall et al. 2015) but no study conducted research on all five EO dimensions. In this context, large companies have the greatest impacts on sustainability issues in absolute terms (Azar et al., 2021), but at the same time can be relatively more efficient than small companies (Cole et al., 2013). Of special interest are firms listed on stock exchanges as they are first, the target of many recent regulations (e.g. the Non-Financial Reporting Directive [NFRD] in the Europea Union) and forced those firms to publish sustainability-related data. Second, investments and divestments are much easier for investors compared to firms which are off the stock exchanges. Hence, we will answer the last research question which is:

How do the EO dimensions influence the sustainability of large stock-traded firms?

These research questions already tease that EO research is not in its final state. Firms differ in the expression of their strategic posture across the board and make this research so interesting and relevant, not only for academia but also for real-world applications.

I.II Methodology and Contributions

I.II.I Chapter one

In the first chapter, titled “Is less enough? Validation of a shortened Scale to measure Entrepreneurial Orientation in Startups”, we introduce the dataset that is used for the following two studies. The data is collected in the IAB/ZEW Startup Panel, a panel dataset that consists of young German startups, and offers researchers recurring data points like financial data or data about employment. Typically, the questionnaire contains a special field of interest, which is only present for a limited number of waves, like in this case EO data. The chapter itself is quite short and follows more of an additional introductory purpose. However, the used EO scale is shorter than more established scales like the ones of Covin and Slevin (1989) or Lumpkin and Dess (2001) and uses just two questions per EO dimension. A validation of this scale was yet missing, and the results were just accepted as another EO assessment. In this chapter, we address this issue by presenting a validation for the used EO scale and thus, increase the trust and reliability of the collected EO data. To do so, we run a confirmatory-factor analysis on a 116-firm sample with the IAB/ZEW Startup EO scale and established EO items.

As the results show, the used EO scale is not only shorter by utilizing only two items per dimension, but it also reaches a high level of fit as established scales like the ones developed by Covin and Slevin (1989) and Lumpkin and Dess (2001). Thus, the IAB/ZEW Startup Panel is one of only a few longitudinal datasets containing validated EO data.

While the data from the IAB/ZEW Startup Panel already existed before this thesis, no study showed in detail that the EO scale was measuring the same construct as established EO scales. The result of our confirmatory-factor analysis allows researchers to conduct all kinds of following research by increasing the reliability of a large dataset, which is not only rich in observations but also in variables measured.

I.II.II Chapter two

“Entrepreneurial Orientation: relatively stable over Time or rapidly changing?” is the title of Chapter two. In this chapter, we explore the stability of EO by taking advantage of the panel structure of the IAB/ZEW Startup Panel data. If EO turns out to be a stable characteristic, one

might start to investigate the changes of EO in young firms as they tend to show more dynamic business models (Teece and Pisano, 1994; Fort et al. 2013) compared to established companies which show less change to their strategic traits (Reeves and Deimler, 2012). Additionally, we present the distribution of the original unidimensional EO construct by Covin and Slevin (1989) across various industries, as well as the individual dimensions and the additional dimensions following a multidimensional approach proposed by Lumpkin and Dess (1996). The analyses rely on 2950 firms for which we can access multiple EO observations.

To identify potential changes, we simply calculate the difference between both EO measurements for each firm. To make these results more accessible, tables and graphical illustrations are the main drivers of insights in Chapter two, and to show differences between the full sample and sub-groups like the individual industries. To check for systematic differences between the industries, we use analysis of variance (ANOVA). At the end, we additionally run some ordinary least square regressions (OLS) to identify potential causes for observable changes.

As a first result, we can point out that a lot of changes are indeed observable in the unidimensional EO construct. However, these changes mostly follow a bell shape and are centred around zero, meaning that a non-change is the most observed change. The individual dimensions do not follow the bell-shaped nature of the unidimensional construct's changes but like before, a change of zero is by far the most prominent change present. The second interesting result focuses on the difference between the industry sectors. While graphically the distribution of changes seems to differ, the ANOVAs do not reveal systematic variation between the industries.

The study contributes to the general discussion about the stability of EO (Anderson et al., 2022; Wales et al. 2011; Wales, 2016; Covin and Lumpkin, 2011; Covin and Wales, 2012) by showing that EO tends to be stable on short to medium observation periods. Additionally, it adds to the general request to use longitudinal data by showing that cross-sectional data can be sufficient if the variation within the EO data is limited. Lastly, as industries are named as an essential control variable to capture industry-specific effects (Anderson et al. 2022) it shows that the distributions across the sectors and that those do not differ significantly. As a side note, it also adds to the few studies that investigate the EO in startups (e.g. Linton, 2019).

I.II.III Chapter three

Chapter three is titled “Heterogeneity in the Imitation Behavior of Startups and the Dimensions of Entrepreneurial Orientation“. It utilizes the dataset introduced in Chapter one as well and as the title suggests, this chapter explores the link between the individual EO dimensions and two types of innovative outcomes: new-to-the-world innovations (innovation generation) and imitative innovations with a focus on the latter ones.

To distinguish these different types of innovation, the concept of the innovation ladder is introduced, where the innovations are ranked by the degree of newness and their geographic scope. Firms with no innovations at all build the non-innovators group. The next rung on the ladder consists of all firms that introduced an innovation that is new to the firm. Meaning, that they adapt or copy a novelty, which is already present in other firms in their home region. The following are firms, which introduce a novelty new to their region, hence, that novelty is already used somewhere in the country. The new-to-the-country innovators build the next rung on the ladder, which copy a product or service from abroad. Lastly, the innovation-generating firms with new-to-the-world products or services form the highest rung of the ladder.

To test the various hypotheses, we use a sequential multinomial logit model (Cameron and Trivedi, 2005) and apply it to nested dichotomies. The idea is to test a base group against another part of the sample, for example, non-innovators versus innovators. While non-innovators are the lowest rung on our ladder, the innovator group is formed by all four rungs above it. Thus, allowing us to look for the potential effects of the EO dimensions on any kind of innovation. Our next comparison is to exclude all non-innovators and remodel all imitative innovators as the base group, while the new to the world rung above is the comparison group. In total, our analyses contain four dichotomies and show different effects of the individual EO dimensions across the dichotomies.

While it could be argued that linking innovation outcomes with the innovativeness dimensions is tautological (Covin and Wales, 2019; Pérez-Luño et al., 2011) the results show that indeed innovativeness is linked to innovation generation but additionally, to all imitative dichotomies too. Moreover, by excluding the new-to-the-world innovators, we find that innovativeness is still relevant for all dichotomies, although only weakly for the transition between firm- and regional imitation and non-innovation to a firm-level imitation. This is not contradictory as Chapter three will show. The other dimensions show unique effects as well:

proactiveness is linked to new-to-the-world innovations, as well as transitioning from non-innovation to any innovation. It is also linked to innovations that are above the firm level, but not for the step between a regional and a national innovator. Competitive aggressiveness is only linked to the transition from non-innovation to becoming an innovator but after excluding innovativeness additional effects of competitive aggressiveness become visible. Risk-taking is associated with the introduction of any imitation or innovation, other of its effects are mostly driven by the association with innovativeness. Finally, autonomy is excluded in our study as we focus on startups where this dimension is less pronounced than in established firms.

The different effects of the EO dimensions on innovations are the two main contributions of this study. First, previous literature focused on innovation generation, while the link between imitative behavior and EO was less of interest and thus allows us to close this research gap. Second, we analyse the link between the EO dimensions and the degree of product novelty. Additionally, we contribute to the discussion of the separation between proactiveness and competitive aggressiveness opened by Lumpkin and Dess (1996, 2001) by presenting the different effects of those two dimensions and showing that these dimensions have distinct effects. Furthermore, our results show the relevance of EO regarding the diffusion of novelties across and within countries. Finally, the chapter also adds to the small number of studies focusing their EO research on startups.

I.II.IV Chapter four

Chapter four is titled “Entrepreneurial Orientation shaping Sustainability: Insights from German large Enterprises”. Unlike the previous two chapters, the underlying data does not relate to startups, but to large established enterprises, which are listed on the German stock market. In this part of this dissertation, we explore how a firm’s EO, represented by the individual EO dimensions influences a firm’s sustainability and involvement in controversial behavior.

To gain access to the EO measurements of the stock listed we decided to use a relatively new approach: we analysed the letters to the shareholders (LTS) in the annual financial reports. This approach and a corresponding EO keyword list were first introduced by Short et al. (2010) but are designed for firms out of the Anglo-American economic sectors. We translated and adapted the keywords for each dimension to German and ran a computer-aided text analysis (CATA) on the LTS to measure the EO for multiple years, creating a panel structure.

In total, we gathered 612 EO observations from 132 firms. The data regarding sustainability and controversies is accessed by using a database provided by the London Stock Exchange Group (LSEG), formerly known as Refinitv or Refinitiv Eikon.

To analyse the data, we use three different models. First an ordinary least squares regression. This is followed by two more sophisticated approaches, a fractional response probit model (FRAC) first and a random effects panel regression second (REPR). Our results suggest that contrary to previous literature (Hooi et al., 2016; DiVito and Bohnsack, 2017; Marshall et al., 2015) where EO in total is linked to sustainability, only competitive aggressiveness has a positive influence in our study while the other dimensions are not related to it. Regarding controversies, only innovativeness has an effect here, as it increases the number of controversies which firms face.

The study adds two contributions to the literature regarding EO and sustainability. First, we further clarify the relationship between EO and sustainability by investigating EO multidimensionally and show that not all dimensions matter in this context. This also contributes to the discussion of the separation between proactiveness and competitive aggressiveness (Lumpkin and Dess, 1996; 2001), as we show that proactiveness is not statistically relevant in our study, but competitive aggressiveness is. Second, it enriches the number of papers that circumvent the low number of responses in direct measurement approaches like questionnaires by applying the promising (Wales, 2016) indirect approach of CATA. In this context, we highlight some potential problems of this approach, especially regarding the EO dimension of autonomy. This helps other researchers who want to use this alternative approach to overcome the identified problems and strengthen the acceptance and reliability of this alternative measurement.

1. Chapter one

Is less enough? Validation of a shortened Scale to measure Entrepreneurial Orientation in Startups[1]

[1] Co-written with Prof. Dr. Werner Bönte and Prof. Dr. Diemo Urbig. A more extensive version of this chapter is in progress to be published later as a short article.

1.1 Introduction

Established enterprises have been the focus of EO research since its introduction as a construct (i.e. Covin and Slevin, 1989; Lumpkin and Dess, 1996; Wiklund and Shepherd, 2003; Wales et al. 2011; Ribau et al., 2017) and thus, EO was typically measured by asking the top-level manager about the firm and the corresponding firm characteristics (Wales, 2016). Conducting research on EO in startups is a relatively new phenomenon and as such, data regarding EO and startups is yet limited. However, the IAB/ZEW Startup Panel, a dataset established in 2008 regarding German new ventures up to the age of seven years old, contains such EO measurements after we were able to insert a shortened and adjusted EO scale into the questionnaire.

The data is collected by the Centre for European Economic Research (ZEW) via telephone interviews and contains a static part where questions are repeated in each wave (i.e. firm demographics including financial data) as well as a varying part where the questions depend on the current research agenda, like in this case EO[2]. In 2014 and 2017 all startups answered EO-related questions, while in 2015 and 2016 EO only newly surveyed startups were asked about their EO. This means that the maximum number of EO observations is two with a minimum of one year and a maximum of three years between the two measurements. In total over 11500 observations exist regarding EO over multiple sectors (see Appendix 1.A for the industry classification). Additionally, we slightly changed the wording to fit the items of established scales in a startup context. To account for founding teams instead of single founders, two versions of each item were developed as the German language requires a different address of the second person singular and plural. Our adjusted scale consists of ten items (two per dimension) instead of 13 (see Appendix 1.B for both sets and 1.C for the translations). Each item is designed as a five-point Likert scale on which the interviewee can categorise their company between two statements A and B where A represents one point and statement B five points. This means that a minimum of two and a maximum of ten points can be achieved per dimension.

For this validation, we excluded the dimension of autonomy. Lumpkin and Pidduck (2021) argue that autonomy can be a motive to found a startup. However, this autonomy refers to the

[2] Ventures resulting from mergers and subsidiaries are not included. Dencker et al. (2009, p. 1131) consider the data "a highly accurate source of statistical information on newly founded firms (all legally independent new firms founded in the private sector) in Germany over time". For a detailed description of the panel and its design, see Fryges et al. (2009).

founders, not to employees, and thus does not correspond to the original understanding of autonomy in the context of EO according to Lumpkin and Dess (1996). For startups with a limited number of employees and thus no or very flat hierarchies, the amount of autonomy does not vary substantially. Indeed over 61 per cent of the startups within the first EO wave did not report any personnel. If no personnel was reported, the measurement of autonomy was then taken by asking for a hypothetical level of decision freedom if employees existed. This contrafactual measurement can never be a reliable base for research.

The IAB/ZEW Startup Panel is an established and reliable source for startup research, as such the data is part of very recent publications (i.e. Vazynte and Andries, 2019; Berger and Hottenrott, 2021; Chapman and Hottenrott, 2022, 2024; Alt et al., 2023; Murmann et al., 2023). With this small chapter, we enable researchers to rely on the EO data in the IAB/ZEW Startup Panel as we externally validate the adjusted EO scale. Access to such a big database opens new research opportunities regarding startups and pays tribute to EO as an important construct in entrepreneurial science. The results of our validation show that it is indeed possible to shorten the established scales and demonstrate that the EO questions used in the IAB/ZEW Startup Panel are a reliable way to get insights into the strategic posture of young firms.

1.2 Material and Methods

For the validation of the shortened EO measurement scales, we conducted a confirmatory factor analysis on the shortened and an established set of items, taken from Covin and Slevin (1989), Lumpkin and Dess (2001) and Lumpkin et al. (2009). To collect the necessary data, we ran a survey which included both sets of questions besides other firm-related data. The survey was conducted via an online survey tool (LimeSurvey). Various sources were used to identify potential firms. The webpage deutschestartups.de which lists new German ventures (also used by Häsel et al., 2010), a local incubator and personal networks resulted in 833 initially contacted firms. These firms do not only contain startups but are a sample of the general firm population as the original items were developed to research established companies. Our final sample consists of 116 firms where over 40 per cent are older than ten years and around 20 per cent are less than five years old. Firm size also varies as 55 per cent report less than ten employees and 17 per cent more than 50 employees. The two sets of questions were separated within the survey by other questions. The scores per item in each

scale were then added to obtain a single score per dimension. Additionally, the sum of all dimensions was calculated to obtain a total EO score for both scales.

1.3 Results

First, we present the correlations between the two sets of EO dimensions, as well as the summed-up total EO score (all dimensions) in Table 1. While the correlations between the original items and their adjusted counterpart are high (considered at > 0.70), the correlations between the remaining adjusted items and an original dimension are medium or in the case of original competitive aggressiveness and adjusted innovativeness and adjusted proactiveness low (0.22 and 0.34). We observe the highest correlation between both competitive aggressiveness measurements (0.93) and the summed-up EO measurements (0.90). In total these results already suggest that both scales measure the same construct.

Table 1: Correlations between original and adjusted EO dimensions

	Adjusted items				
Original items	Innovativeness	Proactiveness	Risk-taking	Competitive aggr.	Total EO
1. Innovativeness	**0.71*****	0.61***	0.56***	0.37***	0.72***
2. Proactiveness	0.43***	**0.77*****	0.59***	0.36***	0.67***
3. Risk-taking	0.61***	0.54***	**0.79*****	0.38***	0.74***
4. Competitive aggr.	0.22*	0.34***	0.51***	**0.93*****	0.66***
5. Toal EO	0.66***	0.73***	0.79***	0.63***	**0.90*****

Significance levels: *** p < 0.001, ** p < 0.005, * p < 0.05

Next, we run a confirmatory factor analysis and calculate the comparative fit index (CFI) for both sets of items and a varying number of underlying dimensions. We include all EO items into four separate dimensions to start our analysis (4 dimensions). The next step is to combine innovativeness, proactiveness and risk-taking and separate competitive aggressiveness, resulting in the Covin and Slevin EO (1989) approach plus competitive aggressiveness as a separate dimension (2 dimensions). Lastly, we assume four item sets to uniformly form EO (1 dimension).

A four-dimensional approach fits best for the original items with a CFI of 0.929 (Root mean squared error of approximation [RMSEA] = 0.098; Standardized root mean squared residual [SRMR] = 0.061) and for the adjusted items it results in a CFI of 0.974 (RMSEA = 0.075, SRMR = 0.044). After confirming the four-dimensional approach, we combined the two sets of dimensions into one model where the residuals are allowed to correlate (CFI = 0.932, RMSEA = 0.088, SRMR = 0.061) and identified the covariations between original and

adjusted items (e.g. adjusted innovativeness and original innovativeness) which are all close to one. Fixing the covariations to one results in a similar fit (CFI = 0.933, RMSEA = 0.085, SRMR = 0.061) of the model. A likelihood-ratio test between the models with and without fixed covariance remains insignificant and shows that the two models do not differ substantially ($\chi^2(4)=2.27$, $p=0.687$). All these results are shown in Table 2, where we additionally present Akaike's information criterion (AIC) and the Bayesian information criterion (BIC) which both support our findings. We also analysed the first EO measurement in the ZEW panel data, where we observe a high CFI (0.96) as well.

An exemplary look into the unidimensional EO3 distribution

To show the richness of the dataset, we present a first view of the unidimensional EO construct EO3 (the sum of innovativeness, proactiveness and risk-taking), which is used by researchers following the Covin and Slevin (1989) approach. The average level of the first EO3 observation is presented in Figure 1, as well as the 95 per cent confidence intervals as horizontal extensions. A table containing all results is presented in Appendix 1.D. By design of the measurement scale, the highest possible EO3 value is 30, while the lowest one is six points. Software firms show the highest EO3 value with an average of 20.66, while construction firms have the lowest with only 14.73 points, which is a difference of around 40.26 per cent. The average of all 8583 firms is given by 17.59. These differences allow us to follow different research questions where indicators of only some specific industries are of interest or to research differences between the sectors. The dataset would also allow to follow the Lumpkin and Dess (1996) approach as well, as the dataset also contains competitive aggressiveness. The measurements are presented in Appendix 1.E to Appendix 1.H.

Figure 1: Distribution of the first EO3 measurement

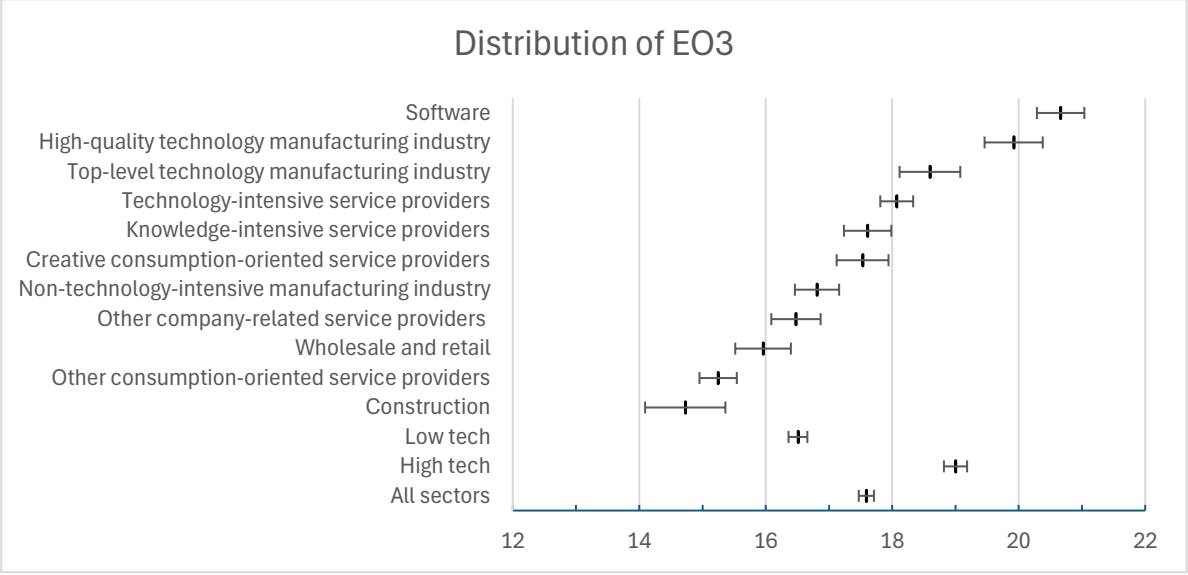


Table 2: Results of the confirmatory factor analysis

Model	Observations	Degrees of freedom	χ^2	CFI	RMSEA	SRMR	AIC	BIC
Original items								
4 dimensions	116	38	80.04	0.929	0.098	0.061	3297.666	3405.056
2 dimensions		43	154.74	0.812	0.150	0.080	3362.368	3455.990
1 dimension		44	229.95	0.687	0.192	0.104	3435.583	3526.452
Adjusted items								
4 dimensions	116	14	23.01	0.974	0.075	0.044	2607.329	2689.937
2 dimensions		19	34.24	0.956	0.084	0.059	2608.564	2677.404
1 dimension		20	94.24	0.786	0.180	0.094	2666.561	2732.647
Combined model with 4 dimensions								
Allowed correlation	116	116	218.57	0.932	0.088	0.061	5408.593	5664.677
Fixed covariation		120	220.84	0.933	0.085	0.061	5402.859	5647.928
ZEW panel data								
4 dimensions	8583	14	326.34	0.960	0.051	0.026	250473.316	250685.042
2 dimensions		19	719.98	0.911	0.066	0.039	250856.954	251033.392
1 dimension		20	1619.90	0.796	0.097	0.059	251754.874	251924.255

Note: AIC = Akaike's information criterion, BIC = Bayesian information criterion

1.4 Conclusion

Our analysis shows that the shortened and startup-context-adjusted items capture the same conceptualization of EO as the original items and thus, enable researchers to rely on the IAB/ZEW Startup Panel data when conducting research on EO in startups. Furthermore, we deliver empirical evidence that the unidimensional conceptualization of Covin and Slevin (1989) is rich in the dataset when separating competitive aggressiveness from the other dimensions, thus allowing both main scholars to benefit from the panel.

Appendix

Appendix 1.A: Industry Classification by the ZEW

Abbreviation	Branch	Technology level
STW	Top-level technology manufacturing industry	High tech sectors
HTW	High-quality technology manufacturing industry	
TDL	Technology-intensive service providers	
Software	Software	
wissDL	Knowledge-intensive service providers	Low tech sectors
NTW	Non-technology-intensive manufacturing industry	
UDL	Other company-related service providers	
Krea_KDL	Creative consumption-oriented service providers	
Sons_KDL	Other consumption-oriented service providers	
Bau	Construction	
Handel	Wholesale and retail market (without trade agents)	

Appendix 1.B: Original and adjusted English Items

Label	Original item	Adjusted item [5)]
I1	[In general, the top managers of my firm favor] A:…a strong emphasis on the marketing of tried-and-true products or services B:…a strong emphasis on R&D, technological leadership, and innovations	[My firm puts a strong emphasis on…] A: the marketing of tried-and-true products or services B: innovation, technological leadership, and R&D.
I2	A:…Changes in product or service lines have been mostly of a minor nature B:…Changes in product or service lines have usually been quite dramatic.	[I follow the strategy that changes in product or service lines to be…] A: of a minor nature B: be quite dramatic and fundamental.
I3[1)]	[How many new lines of products or services has your firm marketed in the past 5 years?] A:…No new lines of products or services B:…Very many new lines of products or services.	-
P1	[In dealing with its competitors, my firm…] A:…typically responds to action which competitors initiate B:…typically initiates actions which competitors then respond to.	[In dealing with its competitors, my firm's strategy is to…] A: respond to action which competitors initiate B: initiate actions which competitors then respond to.
P2[2)]	[In dealing with its competitors, my firm…] A:…is very seldom the first business to introduce new products/ services, administrative techniques, operating technologies, etc. B:…is very often the first business to introduce new products/services, administrative techniques, operating technologies, etc.	[When introducing new products/services, administrative techniques, operating technologies into my firms' markets, my firm…] A: does not need to be is the first one. B: wants to be the first one.
P3[3)]	[In general, the top managers of my firm have…] A:…a strong tendency to "follow the leader" in introducing new products or ideas B:…a strong tendency to be ahead of other competitors in introducing novel ideas or products	-
R1	[When confronted with decision-making situations involving uncertainty, my business unit] A:… typically adopts a cautious, 'wait and see' posture in order to minimize the probability of making costly decisions B:… typically adopts a bold. aggressive posture in order to maximize the probability of exploiting potential opportunities	[In order to achieve the firm objectives in situations involving uncertainty, my business…] A: adopts a cautious, 'wait and see' posture B: adopts a bold aggressive posture.
R2	[In general, the top managers of my business unit have] A:…a strong proclivity for low-risk projects (with normal and certain rates of return) B:… a strong proclivity for high risk projects (with chances of very high returns).	[My business has a strong proclivity for projects with…] A: low risk and thereby normal but certain rates of return B: high risks and thereby chances of very high returns.

Label	Original item	Adjusted item [5]
R3	[In general, the top managers of my firm believe that…] A: owing to the nature of the environment, it is best to explore it gradually via timid, incremental behaviour. B: owing to the nature of the environment, bold, wide-ranging acts are necessary to achieve the firm's objectives.	-
C1	A: My firm is very aggressive and intensely competitive B: My firm makes no special effort to take business from the competition	[My firm…] A: makes no special effort to take business from the competition. B: is very aggressive and in tensely competitive.
C2[4]	[In dealing with its competitors, my firm…] A: typically seeks to avoid competitive clashes, preferring a "live-and-let-live" posture B: typically adopts a very competitive "undo-the-competitors" posture	[My firm…] A: seeks to avoid competitive clashes, preferring a "live-and-let-live. B: … does not avoid competitive clashes to challenge the competitor's market position.
A1[5]	[In general, the top managers of my firm believe that…] A: The best results occur when individuals and/or teams decide for themselves what business opportunities to pursue. B: The best results occur when the CEO and top managers provide the primary impetus for pursuing business opportunities.	[I generally believe that the best results are achieved when...] A: employees have a say in deciding which business ideas and projects are pursued. B: I as the managing director alone decide which business ideas and projects are pursued.
A2[6]	[In my firm…] A: Individuals and/or teams pursuing business opportunities make decisions on their own without constantly referring to their supervisor(s). B: Individuals and/or teams pursuing business opportunities are expected to obtain approval from their supervisor(s) before making decisions.	[In my company...] A: Employees make decisions on their own without constantly checking back with me. B: Employees always have to check with me when making decisions.

Note: 5-point scale, ranging from "fully agree with A" (1), "tend to agree with A" (2), "indifferent" (3), "tend to agree with B "(4), "fully agree with B "(5), and "don't know/answer denied" (coded as missing value). I = Innovativeness, P = Proactiveness, R = Risk-taking, C = Competitive aggressiveness. Original items taken from Covin and Slevin (1989), Lumpkin and Dess (2001) and Lumpkin et al. (2009).

[1] Omitted because of reference to 5 years, which does not work for very young firms and which refers to realized. outcomes of an innovative strategic posture rather than a general strategic orientation.

[2] Adjusted to capture only the firm's strategy and not the outcome which depends on competitors' behavior.

[3] Covin and Slevin (1991) originally had C2 as proactiveness item, which was then replaced with this one by Lumpkin and Dess (2001).

[4] Covin and Slevin (1991) used this item to measure proactiveness and it was assigned to the new dimension competitive aggressiveness by Lumpkin and Dess (2001).

[5] We report the items for single foundations; for team founders, those items with "I" are adjusted to apply to team founders with "we".

[6] Autonomy items are based on the Lumpkin et al. (2009) scale.

Appendix 1.C: German Items

Label	Original translation	Adjusted German item
I1	[Im Allgemeinen neigen die Top-Manager meiner Firma…] A: zur Vermarktung von bewährten Produkten oder Dienstleistungen B: zu Forschung & Entwicklung, Technologieführerschaft und Innovationen.	[Mein Unternehmen konzentriert Sich auf…] A: die Vermarktung bewährter Produkte oder Dienstleistungen. B: Innovation, Technologieführerschaft und Forschung und Entwicklung.
I2	A: Veränderungen in unseren Produktlinien oder Dienstleistungskategorien waren meist kleinerer Natur. B: Veränderungen in unseren Produktlinien oder Dienstleistungskategorien waren meistens ziemlich weitreichend.	[Ich verfolge die Strategie, an meinen Produkten oder Dienstleistungen…] A: eher kleine, schrittweise Veränderungen vorzunehmen. B: möglichst weitreichende, grundlegende Veränderungen vorzunehmen.
P1	[Im Umgang mit der Konkurrenz…] A: reagiert meine Firma üblicherweise auf Initiativen der Konkurrenz B: ergreift meine Firma üblicherweise die Initiative, worauf die Konkurrenz dann reagieren muss.	[Im Umgang mit der Konkurrenz verfolgt mein Unternehmen die Strategie...] A: auf Initiativen der Konkurrenz zu reagieren. B: selbst die Initiative zu ergreifen, worauf die Konkurrenz dann reagieren muss.
P2	[Im Umgang mit der Konkurrenz ist meine Firma...] A: sehr selten das erste Unternehmen, das neue Produkte/Dienstleistungen, Verwaltungsprozesse, Technologien etc. einführt. B: sehr häufig das erste Unternehmen, das neue Produkte/Dienstleistungen, Verwaltungsprozesse, Technologien etc. einführt.	[Bei der Einführung neuer Produkte oder Dienstleistungen, Geschäftsprozesse oder Technologien will ich mit meinem Unternehmen in meinem Marktumfeld…] A: nicht unbedingt einer der Ersten sein. B: einer der Ersten sein.
R1	[In Entscheidungssituationen unter Unsicherheiten verhält sich meine Firma ...] A: typischerweise vorsichtig und abwartend, um das Risiko teurer Fehlentscheidungen zu minimieren. B: typischerweise mutig und offensiv, um Chancen auf potentiell lukrative Geschäfte zu maximieren.	[Um auch in unsicheren Situationen die Unternehmensziele zu erreichen, geht mein Unternehmen ...] A: eher vorsichtig und abwartend vor, um Fehlentscheidungen zu vermeiden. B: eher mutig und offensiv vor, um möglichst keine Geschäftsgelegenheiten zu verpassen.
R2	[Im Allgemeinen haben die Topmanager meiner Firma ...] A: eine starke Neigung zu Projekten mit geringem Risiko (und damit normaler, aber sicherer Rendite). B: eine starke Neigung zu Projekten mit hohem Risiko (und damit Chancen auf sehr hohe Renditen).	[Mein Unternehmen hat eine starke Neigung zu Projekten mit ...] A: geringem Risiko und damit normaler, aber sicherer Rendite. B: hohem Risiko und damit Chancen auf sehr hohe Rendite.

Label	Original translation	Adjusted German item
C1	[Meine Firma ...] A: macht keine besonderen Anstrengungen, um der Konkurrenz Umsatz abzujagen. B: ist sehr angriffslustig und außerordentlich wettbewerbsorientiert.	[Mein Unternehmen ...] A: macht keine besonderen Anstrengungen, um der Konkurrenz Umsatz abzujagen. B: ist sehr angriffslustig und wettbewerbsorientiert.
C2[4)]	[Beim Umgang mit Wettbewerbern ...] A: versucht meine Firma typischerweise Konflikte zu vermeiden und folgt dem Motto "Leben und Leben lassen". B: nimmt meine Firma typischerweise eine sehr wettbewerbsorientiere, auf die Verdrängung von Wettbewerbern ausgerichtete Position ein.	[Mein Unternehmen ...] A: vermeidet nach Möglichkeit Konflikte mit Wettbewerbern und folgt eher dem Motto „Leben und Leben lassen“. B: scheut keinen Konflikt, um der Konkurrenz die Marktposition streitig zu machen.
A1a	[Im Allgemeinen glauben die Topmanager meines Unternehmens, dass...] A: die besten Ergebnisse werden erzielt, wenn Einzelpersonen und/oder Teams selbst entscheiden, welche Geschäftsmöglichkeiten verfolgt werden sollen. B: die besten Ergebnisse werden erzielt, wenn der CEO und die Topmanager den Hauptimpuls für die Verfolgung von Geschäftsmöglichkeiten geben.	[Ich glaube grundsätzlich, dass die besten Ergebnisse entstehen, wenn…] A: Mitarbeiter mitentscheiden, welche Geschäftsideen und Projekte verfolgt werden. B: ich als Geschäftsführer allein entscheide, welche Geschäftsideen und Projekte verfolgt werden.
A2a	[In meinem Unternehmen…] A: können Einzelpersonen und/oder Teams Geschäftschancen wahrnehmen und eigenständig Entscheidungen treffen, ohne sich ständig an ihre(n) Vorgesetzte(n) zu wenden. B: wird von Einzelpersonen und/oder Teams, die Geschäftsmöglichkeiten wahrnehmen erwartet, dass sie die Genehmigung ihres/ihrer Vorgesetzten einholen, bevor sie Entscheidungen treffen.	[In meinem Unternehmen…] A: treffen Mitarbeiter Entscheidungen auf eigene Faust, ohne sich ständig bei mir rückzuversichern. B: müssen sich Mitarbeiter bei allen Entscheidungen stets bei mir rückversichern.
A1b[1)]	-	[Ich glaube grundsätzlich, dass die besten Ergebnisse entstehen, wenn…] A: Mitarbeiter mitentscheiden, welche Geschäftsideen und Projekte verfolgt werden. B: ich als Geschäftsführer allein entscheide, welche Geschäftsideen und Projekte verfolgt werden.
A2b[1)]	-	[In meinem Unternehmen…] A: würden Mitarbeiter Entscheidungen auf eigene Faust treffen, ohne sich ständig bei mir rückzuversichern. B: müssten sich Mitarbeiter bei allen Entscheidungen stets bei mir rückversichern.

[1] If the startup has no employees, the interviewee was asked to imagine that this would be the case.

Appendix 1.D: First EO3 Measurement

Sector	Observations	Mean	Std	Ci low	Ci upp
All sectors	8,583	17.59	5.63	17.47	17.71
High tech	3837	19.00	5.79	18.82	19.18
Low tech	4746	16.45	5.23	16.30	16.60
Construction	238	14.73	4.97	14.09	15.36
Other consumption-oriented service providers	991	15.25	4.71	14.95	15.54
Retail	514	15.96	5.08	15.52	16.40
Other company-related service providers	716	16.48	5.34	16.09	16.87
Non-technology-intensive manufacturing industry	966	16.81	5.48	16.46	17.16
Creative consumption-oriented service providers	531	17.53	4.84	17.12	17.94
Knowledge-intensive service providers	790	17.61	5.36	17.24	17.99
Technology-intensive service providers	1,786	18.07	5.61	17.81	18.33
Top-level technology manufacturing industry	644	18.60	6.20	18.12	19.08
High-quality technology manufacturing industry	564	19.92	5.57	19.46	20.38
Software	843	20.66	5.54	20.29	21.04

Appendix 1.E: First Innovativeness Measurement

Sector	Observations	Mean	Std	Ci low	Ci upp
All sectors	8,583	4.74	2.64	4.68	4.79
High tech	3837	5.52	2.74	5.43	5.61
Low tech	4746	4.10	2.38	4.03	4.17
Other consumption-oriented service providers	991	3.59	2.02	3.46	3.72
Retail	514	3.79	2.22	3.60	3.98
Construction	238	3.83	2.17	3.55	4.11
Other company-related service providers	716	4.01	2.41	3.83	4.18
Creative consumption-oriented service providers	531	4.37	2.35	4.17	4.57
Non-technology-intensive manufacturing industry	966	4.38	2.60	4.22	4.55
Knowledge-intensive service providers	790	4.58	2.48	4.40	4.75
Technology-intensive service providers	1,786	5.00	2.64	4.88	5.12
Top-level technology manufacturing industry	644	5.58	2.80	5.36	5.79
High-quality technology manufacturing industry	564	6.00	2.78	5.77	6.23
Software	843	6.26	2.65	6.08	6.44

Appendix 1.F: First Proactiveness Measurement

Sector	Observations	Mean	Std	Ci low	Ci upp
All sectors	8,583	7.68	2.34	7.63	7.73
High tech	3,837	7.98	2.25	7.91	8.05
Low tech	4,746	7.45	2.38	7.38	7.51
Construction	238	6.85	2.59	6.52	7.18
Other consumption-oriented service providers	991	7.16	2.41	7.01	7.31
Other company-related service providers	716	7.42	2.34	7.25	7.59
Retail	514	7.52	2.37	7.32	7.73
Non-technology-intensive manufacturing industry	966	7.55	2.36	7.40	7.70
Knowledge-intensive service providers	790	7.56	2.32	7.40	7.72
Technology-intensive service providers	1,786	7.78	2.28	7.68	7.89
Top-level technology manufacturing industry	644	7.79	2.41	7.60	7.97
Creative consumption-oriented service providers	531	7.85	2.28	7.66	8.05
Software	843	8.31	2.05	8.17	8.45
High-quality technology manufacturing industry	564	8.32	2.19	8.14	8.50

Appendix 1.G: First Risk-Taking Measurement

Sector	Observations	Mean	Std	Ci low	Ci upp
All sectors	8,583	5.17	2.61	5.12	5.23
High tech	3,837	5.50	2.66	5.42	5.58
Low tech	4,746	4.91	2.53	4.83	4.98
Construction	238	4.04	2.35	3.74	4.34
Other consumption-oriented service providers	991	4.50	2.46	4.35	4.66
Retail	514	4.65	2.45	4.43	4.86
Non-technology-intensive manufacturing industry	966	4.88	2.50	4.72	5.03
Other company-related service providers	716	5.05	2.59	4.86	5.24
Top-level technology manufacturing industry	644	5.23	2.74	5.02	5.44
Technology-intensive service providers	1,786	5.29	2.58	5.17	5.41
Creative consumption-oriented service providers	531	5.31	2.55	5.09	5.52
Knowledge-intensive service providers	790	5.48	2.54	5.30	5.65
High-quality technology manufacturing industry	564	5.60	2.69	5.38	5.82
Software	843	6.09	2.66	5.91	6.27

Appendix 1.H: First Competitive Aggressiveness Measurement

Sector	Observations	Mean	Std	Ci low	Ci upp
All sectors	8,583	5.09	2.78	5.03	5.15
High tech	3,837	5.22	2.79	5.13	5.30
Low tech	4,746	4.99	2.76	4.91	5.06
Construction	238	4.29	2.61	3.95	4.62
Creative consumption-oriented service providers	531	4.77	2.57	4.55	4.99
Other consumption-oriented service providers	991	4.90	2.78	4.73	5.07
Technology-intensive service providers	1,786	4.99	2.72	4.86	5.11
Knowledge-intensive service providers	790	5.00	2.69	4.81	5.19
Non-technology-intensive manufacturing industry	966	5.04	2.84	4.86	5.22
Other company-related service providers	716	5.14	2.87	4.93	5.35
Software	843	5.22	2.81	5.03	5.41
Retail	514	5.36	2.76	5.12	5.59
Top-level technology manufacturing industry	644	5.49	2.87	5.23	5.71
High-quality technology manufacturing industry	564	5.63	2.79	5.40	5.86

2. Chapter two

Entrepreneurial Orientation: relatively stable over Time or rapidly changing?

2.1 Introduction

Particularly, the link between EO and organizational performance has attracted considerable interest in research regarding EO (Wales et al., 2013). However, most empirical studies in this research area are based on cross-sectional data, which raises concerns about potential endogeneity issues due to unobserved heterogeneity (Wales 2016). More recently, entrepreneurship scholars have proposed using longitudinal data instead of cross-sectional data to improve the identification of causal relationships between EO and firm performance through more sophisticated panel data analyses (Anderson et al. 2022).

However, the analysis of panel data only significantly improves the identification of causal effects if EO varies not only between organizations but especially within organizations over time. In other words, the more profound question is whether and to what extent EO as a basic strategic posture is relatively stable over time or can also change quite rapidly. From a theoretical perspective, there are compelling reasons to assume both. First, the fundamental strategic orientation of an organization can change relatively quickly (Wales et al. 2011; Wales, 2016) and second, EO is quite stable over time (Covin and Lumpkin, 2011; Covin and Wales, 2012). Ultimately, this is an empirical question, and the answer could have important implications for empirical but also theoretical research in the field of EO. However, only a few empirical studies have implicitly or explicitly addressed this question. The fact that the longitudinal dimension of the data is not considered in most empirical studies on EO can be explained by the fact that EO is traditionally measured using survey data, but it is extremely difficult to track EO longitudinally using surveys with validated items (Gali et al., 2024). For this reason, some empirical studies use alternative approaches to measure EO, such as the use of financial indicators (Miller and Le Breton-Miller, 2011; Kreiser et al., 2020, Gali et al, 2024) or the use of computerized text analysis of letters to shareholders (Engelen et al., 2015; Gupta and Gupta, 2015; Keil et al, 2017), but out of all these studies only two mention the stability of EO. First, Kreiser et al. (2020) find that the average EO in firms listed on the New York Stock Exchange declined between 1998 and 2017. This decline is not a steady process, yet strong decreases happened at the dotcom bubble burst (2000-2002) and the financial crisis (2008-2009) with strong increases after those shocks. Since 2011, the decline has become a more gradual process. The second study addressing the stability of EO is the one by Gali et al. (2024), who focus on the relation between firm failure and EO and identify an increasing risk of failure after a large and abrupt EO change but do not show the changes in detail. Yet, both studies rely on financial indicators and not on a direct EO measurement. Hence, this

study is not only one of the few analysing the changes in EO, but it also uses a direct and validated EO measurement scale. This is particularly relevant as financial indicators or performance measurements in general are the results of entrepreneurial action, in contrast, EO is the firm's strategic posture that hovers above these actions. Thus, it can be argued that economic circumstances sometimes force firms to take short-term oriented actions (e.g. during an economic shock) which may be contrary to their long-term strategic orientation and thus, the resulting financial indicators are not representative of a firm's strategic posture anymore (Lumpkin and Dess, 1996; Wiklund and Shepherd, 2005).

This study moves the discussion regarding EO's stability forward by investigating EO over time, using a direct and validated measurement scale. Most EO research is conducted regarding established companies, which tend to exhibit less change to their organizational structure and strategic attitude (Reeves and Deimler, 2012). If EO varies, it is therefore more likely to observe changes in a firm's startup phase as new ventures tend to have more dynamic and adaptable business approaches (Teece and Pisano, 1994; Fort et al. 2013). As Anderson et al. (2022) suggest, there should be changes visible in the EO of young firms and this study simply investigates if changes are occurring in the underlying data.

To provide insights about the changes in EO, we use data from a sample consisting of 2950 German startups for which we can rely on two EO measurements. These firms are part of the IAB/ZEW Startup Panel provided by the Centre for European Economic Research (ZEW) where young firms are questioned regularly up to the age of 7 years. First, this sample allows us to describe the changes on an aggregated level and an industry level. The quality of the dataset is considered high as it has been and is still used by other publications like Vaznyte and Andries (2019); Chapman and Hottenrott (2022, 2024) and Murmann et al. (2023).

This study adds serval contributions regarding the question of a changing EO and the resulting implications on researching EO. Regarding the discussion on the stability of EO (Anderson et al., 2022; Wales et al. 2011; Wales, 2016; Covin and Lumpkin, 2011; Covin and Wales, 2012) this study can simply help to understand if EO tends to be a stable or an unstable firm characteristic, at least for short to medium observation periods. This is especially true for the case of young firms, where Anderson et al. (2022) expect a higher level of changes to occur than for established firms. The results suggest that there are EO changes indeed, but these changes are small, seem randomly distributed and on average close to zero. Second, this study adds to the discussion regarding the use of cross-sectional data versus the benefits of panel

data. While the use of panel data and corresponding methods which take advantage of these datasets are without a doubt beneficial to encircle causal effects, for EO this call might not be the general solution. If EO does not vary, the additional explanatory value of panel data is limited when using methods which rely on variation in the independent variables. This results either in the need for extended observation periods to observe the slow but occurring changes in EO or softens the arguments against the use of cross-sectional data in researching EO. Third, while this is a general problem for any study, measurement error (Griliches and Hausman, 1986) could be particularly relevant in EO research as the observed EO changes seem to be random. As Anderson et al. (2022) state, the use of panel data does not fix this issue by itself and has to be treated separately. This is especially true for cases where changes of variables are of interest as those are particularly vulnerable to measurement error (Wooldridge, 2010; Bertrand et al., 2004). Fourth, the data opens the possibility to identify differences between industries, as industries and the resulting industry effects are an essential control variable (Anderson et al. 2022) of EO research or can alter the predictions made by theory (McKenny et al., 2018a), thus, all results are presented on an industry and an aggregated basis.

The chapter is organized as follows. We start by presenting the conceptual background of this study. Then we shortly describe the sample taken from the IAB/ZEW Startup Panel. We continue by presenting some descriptive statistics, the changes in EO and a small analysis regarding one potential driver of those changes. The study continues with a discussion of the result and closes with a conclusion.

2.2 Conceptual Background

EO is extensively researched and over time associated with various performance indicators (e.g. Rauch et al., 2009). The stability of EO is yet a surprisingly under-discussed topic. Some parts of the literature argue that EO is expected to be a stable trait as entrepreneurial activities executed only over time can manifest a strategic posture (Covin and Lumpkin, 2011; Anderson et al., 2015; Anderon et al., 2022). However, there are reasons why EO could change. Wales et al. (2011) argue that firms adjust their EO to internal and external needs as different challenges over time result in different approaches to overcome them. This could for example end in a cyclical EO manifestation (Wales, 2016) where EO swings between higher and lower states of strategic posture.

Independent of following a unidimensional or multidimensional approach, a change in EO can only be observed if the underlying dimensions change. In the unidimensional approach, a change might be even rarer to observe as the change of one dimension could be outbalanced by the change of another dimension. Thus, both main EO scholars face different prerequisites regarding EO stability.

Another aspect regarding the stability of EO is the type of firm which is observed. Most EO research is conducted on established firms, where a change in the strategic posture might be harder to execute due to limiting factors like bureaucracy, firm culture and best practices (Reeves and Deimler, 2012). In a startup, those factors might play less of a role and allow for an easier reply to current needs (e.g. during the COVID-19 pandemic: Silva et al, 2023) or simply, the suitable amount of EO is manifested after some initial time of trial and error. Thus, if researchers look for changes in EO, young firms might be the best starting point. If, however, EO is a relatively stable trait in startups, one should not expect EO to vary even more in established firms.

From a methodological perspective, the change of EO is of interest as well. Given the discussion regarding the identification of causal effects and thus, the urge to use panel data, taking advantage of panels comes with its challenges. Longitudinal data allows the identification of variation between agents by allowing to calculate the variation within agents first. There exist multiple approaches to identify their differences, most prominent are random and fixed effect estimations. While fixed effect models assume that unobserved heterogeneity is time-invariant or not correlated to the regressors, random effect estimators assume a correlation between the unobserved heterogeneity and the regressors (Gardiner et al., 2009). Thus, choosing the appropriate estimator depends on the assumptions regarding the model and the corresponding data. However, fixed effect estimators in nonlinear panel data can be biased and inconsistent if there is little variation in explanatory data, known as the incidental parameter problem (Lancaster, 2000), meaning that even if the appropriate approach would be a fixed effect estimator, the data would only allow use a random effects estimation. Another approach to identifying causal effects in EO research would simply be a regression on changes (Anderson et al., 2022). However, independent of the chosen approach, changes can only be measured if the variable of interest is indeed changing.

2.3 Materials and Methods

Like in Chapter one, the data is taken from the IAB/ZEW Startup Panel. Although the EO data of the IAB/ZEW Startup Panel have been used in previous empirical studies (i.e., Vaznyte and Andries, 2019; Chapmann and Hottenrott, 2022, 2024; Murmann et al., 2023), this is the first study that focuses on the longitudinal dimension of EO. While over 11,500 observations exist regarding an initial EO measurement, the final sample which includes all variables of interest consists of 2,950 firms and their calculatable change in EO due to startups dropping out of the sample before receiving a second EO data point. Like in Chapter one, we decided to exclude the autonomy dimension because many startups in the sample (over 30 per cent) reported that they do not have any employees. Second for those with employees, most startups reported 1.25 or fewer (full-time equivalent) employees, meaning that the establishment of clear hierarchies might be limited. Nevertheless, we included the changes of autonomy in the appendix (Appendix 2.F) for curious researchers.

2.4 Results

Levels of EO and its dimensions

Before presenting the changes in the respective EO dimensions, we briefly describe the levels of the EO dimensions and the unidimensional EO3 construct for the first and second measurements, as no existing study to our knowledge presents a distribution of EO and its dimensions across different sectors. Starting with innovativeness, we observe an average score of 4.95 in the first and 4.98 in the second measurement (see Table 3). Software firms form the upper end with an average of 6.34 in the first and 6.75 in the second EO wave. The other consumption-oriented service providers form the lower end of the spectrum in the first (3.67) and construction firms in the second EO wave with an average score of 3.77. This already shows that the within-sector variation is larger than for the whole sample.

Proactiveness drops from a score of 7.87 to 7.65 for the full sample. Within the branches, we can identify the construction sector as the lower (7.32) and the high-quality technology manufacturing industry with a score of 8.44 as the upper end. In the second measurement, the respective numbers are 6.79 for construction and 8.42 for the high-quality technology manufacturing industry.

For risk-taking, the average scores are 5.31 and 5.32. The construction firms show the lowest risk appetite (4.38 and 4.21), while Software firms have the highest (6.22 and 6.10) in both measurements.

Lastly, the most competitive aggressive sectors are high-quality technology manufacturing firms in the first measurement (5.84) and the top-level technology manufacturing industry with 5.66 in the second measurement. The other end other the spectrum is formed by the construction sector (4.76 and 4.26), while the averages for all sectors are 5.19 and 4.91.

The ZEW also classifies the branches into high tech and low tech firms (see Appendix 1.A of Chapter one). Within all dimensions the high tech firms score higher compared to low tech firms, thus independent of the uni- or multidimensional approach, the high tech firms show a more prominent EO.

For the unidimensional construct (Table 4) a similar picture arises. High tech firms show a more prominent EO trait than low tech firms, with software companies being on the top level in both measurements, while construction companies show the lowest EO.

Table 5 shows the correlations between the first and second measurements of the EO dimensions and the unidimensional construct[3]. While for all dimensions the correlations with themselves are the highest, they still are on a weak (proactiveness with $0.20 < r < 0.39$) or moderate level (innovativeness, risk-taking and competitive aggressiveness with $0.40 < r < 0.59$). The inter-dimension correlations are even weaker. These correlations might already point out, that the two levels of each EO dimension are relatively unrelated. However, the unidimensional EO measurement shows a higher correlation between both measurements of 0.63.

[3] I.e. the correlation between the 1st innovativeness and 2nd proactiveness measurement is different from the 1st proactiveness and 2nd innovativeness measurement.

Table 3: First and second dimension measurements

Variable		Innovativeness				Proactiveness				Risk-taking				Competitive aggressiveness			
Measurement		1st		2nd		1st		2nd		1st		2nd		1st		2nd	
Sector	N	**Mean**	Std	**Mean**	Std	**Mean**	Std	**Mean**	Std	**Mean**	Std	**Mean**	Std	**Mean**	Std	**Mean**	Std
All sectors	2,950	**4.95**	2.70	**4.98**	2.58	**7.87**	2.29	**7.65**	2.25	**5.31**	2.60	**5.32**	2.56	**5.19**	2.77	**4.91**	2.65
High tech	1,384	**5.69**	2.76	**5.78**	2.63	**8.08**	2.21	**7.88**	2.20	**5.63**	2.65	**5.68**	2.59	**5.30**	2.76	**5.11**	2.67
Low tech	1,566	**4.29**	2.46	**4.27**	2.31	**7.68**	2.34	**7.43**	2.27	**5.04**	2.52	**5.00**	2.50	**5.10**	2.78	**4.74**	2.62
Software	295	**6.34**	2.60	**6.75**	2.38	**8.37**	2.06	**8.11**	2.08	**6.22**	2.66	**6.10**	2.59	**5.06**	2.74	**5.07**	2.46
High-quality technology manufacturing industry	192	**6.07**	2.76	**5.94**	2.65	**8.44**	2.13	**8.42**	2.04	**5.96**	2.68	**6.04**	2.67	**5.84**	2.75	**5.58**	2.72
Top-level technology manufacturing industry	247	**5.78**	2.86	**5.96**	2.71	**7.91**	2.36	**7.73**	2.36	**5.30**	2.75	**5.47**	2.61	**5.77**	2.80	**5.66**	2.82
Technology-intensive service providers	650	**5.25**	2.72	**5.22**	2.56	**7.91**	2.21	**7.68**	2.20	**5.39**	2.55	**5.46**	2.52	**5.07**	2.72	**4.77**	2.65
Knowledge-intensive service providers	309	**4.61**	2.52	**4.68**	2.46	**7.60**	2.27	**7.67**	2.08	**5.50**	2.49	**5.58**	2.57	**5.02**	2.65	**4.87**	2.67
Creative consumption-oriented service providers	188	**4.57**	2.49	**4.28**	2.22	**7.98**	2.30	**7.82**	2.21	**5.15**	2.54	**5.24**	2.43	**4.78**	2.63	**4.51**	2.44
Non-technology-intensive manufacturing industry	319	**4.72**	2.67	**4.63**	2.45	**7.85**	2.26	**7.71**	2.22	**5.07**	2.56	**5.22**	2.56	**5.12**	2.75	**4.89**	2.70
Other company-related service providers	219	**4.19**	2.37	**4.21**	2.42	**7.67**	2.37	**7.05**	2.41	**5.18**	2.54	**4.97**	2.51	**5.23**	2.84	**4.94**	2.78
Wholesale and retail	167	**3.95**	2.34	**3.96**	2.02	**7.84**	2.30	**7.54**	2.26	**4.80**	2.40	**4.52**	2.37	**5.62**	2.75	**4.80**	2.52
Other consumption-oriented service providers	91	**3.67**	2.20	**3.81**	2.06	**7.47**	2.36	**7.59**	2.30	**5.22**	2.67	**5.16**	2.40	**5.67**	3.13	**5.10**	2.67
Construction	273	**3.75**	2.19	**3.77**	2.02	**7.32**	2.49	**6.79**	2.29	**4.38**	2.38	**4.21**	2.26	**4.76**	2.84	**4.26**	2.44

Table 4: First and second EO3 measurements

Variable		EO3			
Measurement		1st		2nd	
Sector	N	**Mean**	Std	**Mean**	Std
All sectors	2,950	**18.13**	5.61	**17.95**	5.64
High tech	1,384	**19.40**	5.76	**19.35**	5.74
Low tech	1,566	**17.01**	5.22	**16.71**	5.25
Software	295	**20.93**	5.49	**20.96**	5.36
High-quality technology manufacturing industry	192	**20.47**	5.76	**20.40**	5.58
Top-level technology manufacturing industry	247	**18.93**	6.20	**19.16**	6.05
Technology-intensive service providers	650	**18.54**	5.53	**18.37**	5.62
Creative consumption-oriented service providers	188	**17.70**	4.85	**17.34**	5.07
Non-technology-intensive manufacturing industry	319	**17.65**	5.54	**17.56**	5.29
Knowledge-intensive service providers	309	**17.07**	5.28	**17.93**	5.42
Other company-related service providers	219	**17.04**	5.45	**16.24**	5.48
Wholesale and retail	167	**16.59**	4.96	**16.02**	4.92
Other consumption-oriented service providers	91	**16.36**	4.64	**16.57**	4.66
Construction	273	**15.46**	4.83	**14.77**	4.70

Table 5: Intertemporal correlations

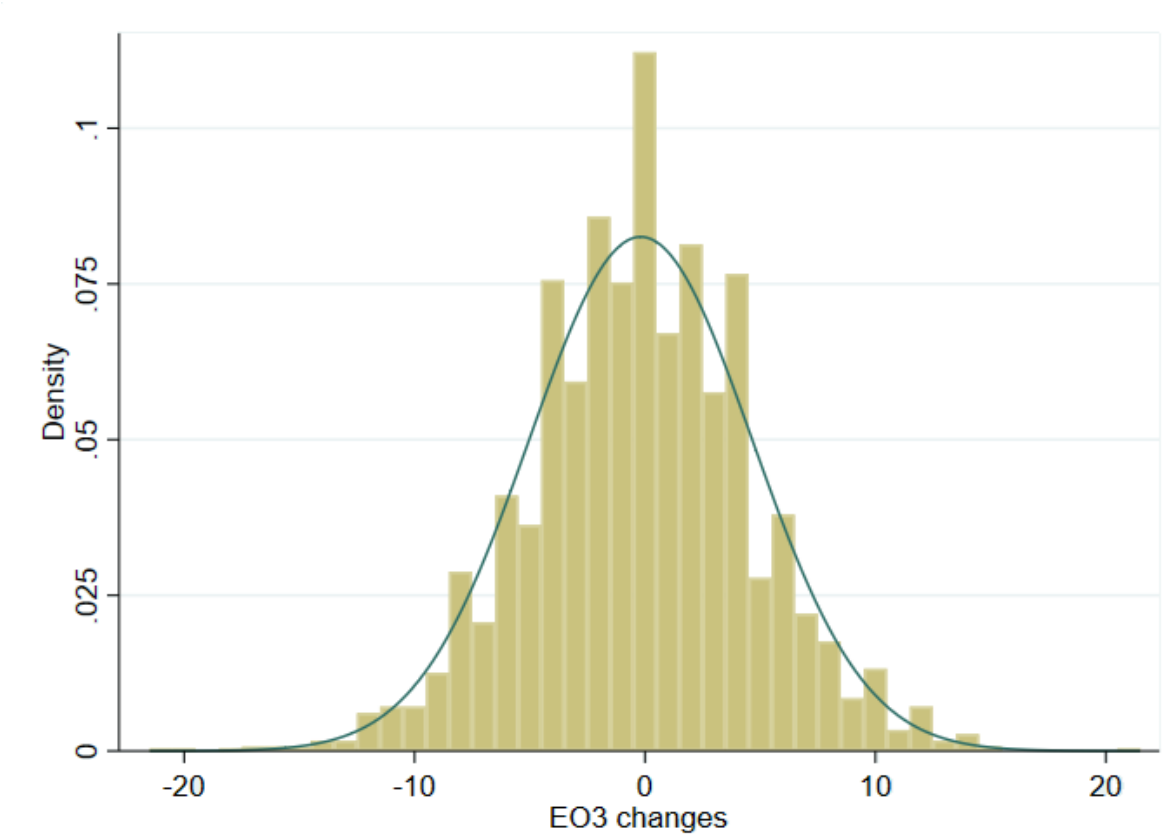
	Second Measurement				
First Measurement	Innovativeness	Proactiveness	Risk-taking	Competitive aggressiveness	EO3
1. Innovativeness	**0.53*****	0.33***	0.36***	0.18***	0.54***
2. Proactiveness	0.29***	**0.37*****	0.23***	0.21***	0.39***
3. Risk-taking	0.30***	0.25***	**0.48*****	0.20***	0.46***
4. Competitive aggr.	0.15***	0.18***	0.22***	**0.48*****	0.24***
5. EO3	0.52***	0.43***	0.49***	0.27***	**0.63*****

Significance levels *** p < 0.001. ** p < 0.005. * p < 0.05

Change of unidimensional EO

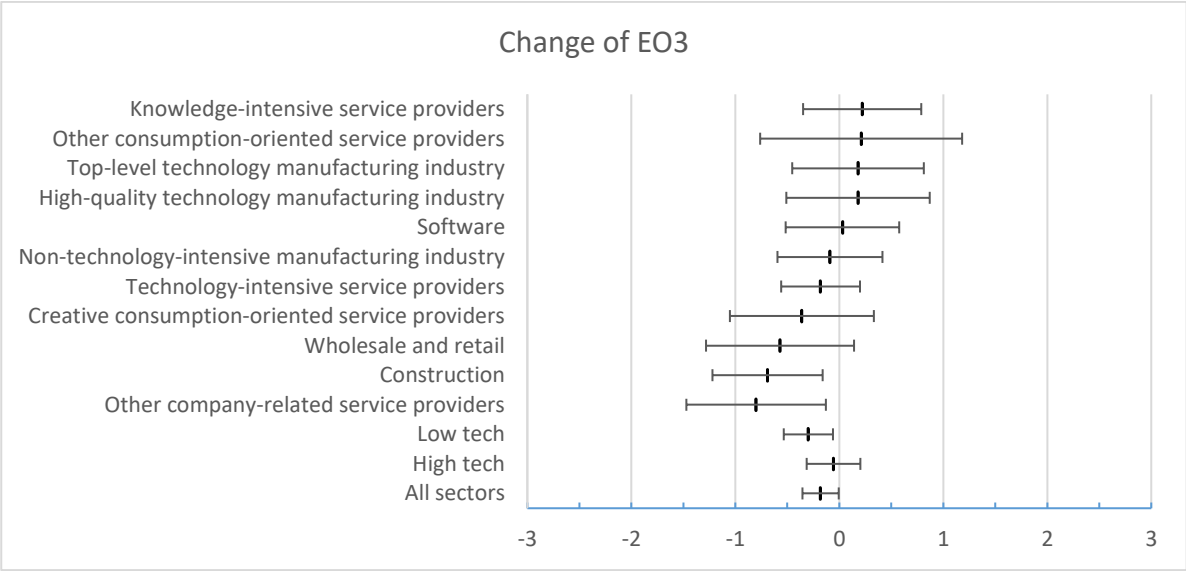
Figure 2 shows the distribution of the unidimensional EO3 measurement for the full sample. As a reference point, a normal distribution is included. While the distribution of changes generally follows a bell shape, an overrepresentation (compared to a normal distribution) of non-changers can be observed. The most frequent change is indeed a change of zero, but the majority of firms change their EO between both measurements.

Figure 2: EO3 changes in the whole sample



The average changes between the EO3 measurements for each sector are presented in Figure 3:

Figure 3: Average changes of EO3



The graph shows the average change within each of the sectors, as well as the average change in the whole sample and the categorizations into high or low tech regarding EO3 as a vertical

line, while the horizontal extensions show 95 per cent confidence intervals. The exact numbers can be found in appendix 2.A where a table containing all results is presented[4].

By looking at Figure 3 it can be observed that the average of the individual sectors follows a half S-shape where four sectors show a small gain, software firms keep their EO3 and the remaining sectors show increasing declines. The highest gain can be found in the knowledge-intensive service providers with a gain of 0.22 points. The highest decline is located at other company-related service providers with -0.80 points. All sectors combined lose an average of 0.18 points within both observations. To put this number into context, remember that by design the minimum EO3 a firm can achieve each year is located at six (each dimension between two and ten points) and the maximum at 30 points. In the case of EO3, high tech firms lose less EO than low tech firms and less than the full sample. In this study, we follow the suggestions of Benjamin et al. (2018) who argue that p-values of 0.05 show suggestive evidence and stronger thresholds of 0.005 and 0.001 show strong evidence to reduce the amount of type one errors regarding statistical significance. This also softens problems of alpha error inflation in multiple testing scenarios and provides an alternative to using methods like the Bonferroni correction which come with their own problems when the adjusted values are too strict (Gelman et al., 2012). As we only present an exploratory dive into the collected data, we believe these stricter levels are sufficient.

The average decline of all sectors of 0.18 EO points and for low tech firms is statistically different from zero [$Pr(T < t) = 0.0193$ and $Pr(T < t) = 0.0069$]. However, to identify potential industry and time effects, as well as their interaction, we conducted an analysis of variance (ANOVA). The results indicate that neither branch, time nor their interaction are leading to differences between the individual industries, year gaps or their interaction. The results are presented in Table 6:

[4] For curious researchers we also include the changes for a unidimensional EO measurement additionally containing competitive aggressiveness (EO4) in Appendix 2.A.

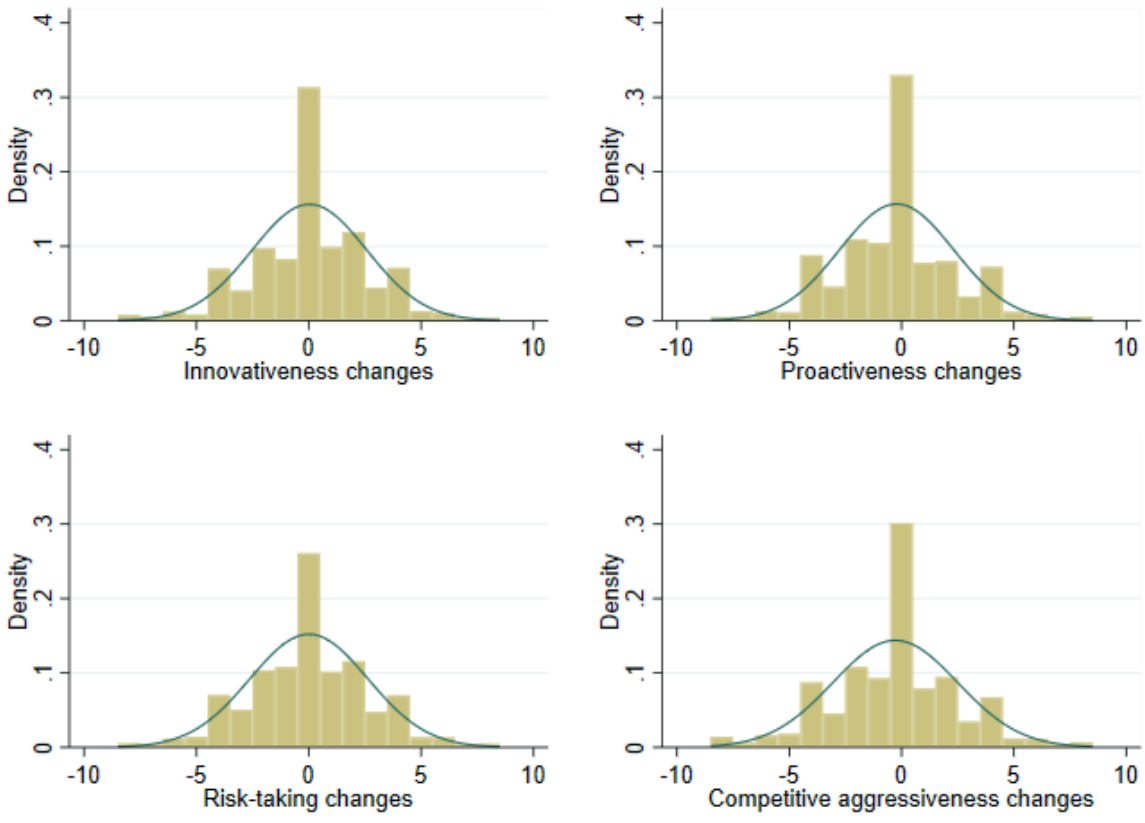
Table 6: ANOVA results of the unidimensional EO3 change

	Partial sum of squares	Degrees of freedom	Mean Square	F	Prob > F
Model	327.20186	30	10.906729	1.02	0.4298
Industry	91.321586	10	9.1321586	0.86	0.5729
Year gap	11.595036	2	5.7975179	0.54	0.5803
Industry#year gap	193.35701	18	10.742056	1.01	0.4458
Residual	31086.055	2,919	10.649556		
Total	31413.257	2,949	10.652173		

Temporal change of four EO dimensions

Like the unidimensional case, we start by presenting the distribution of individual dimensional changes within the whole sample in Figure 4:

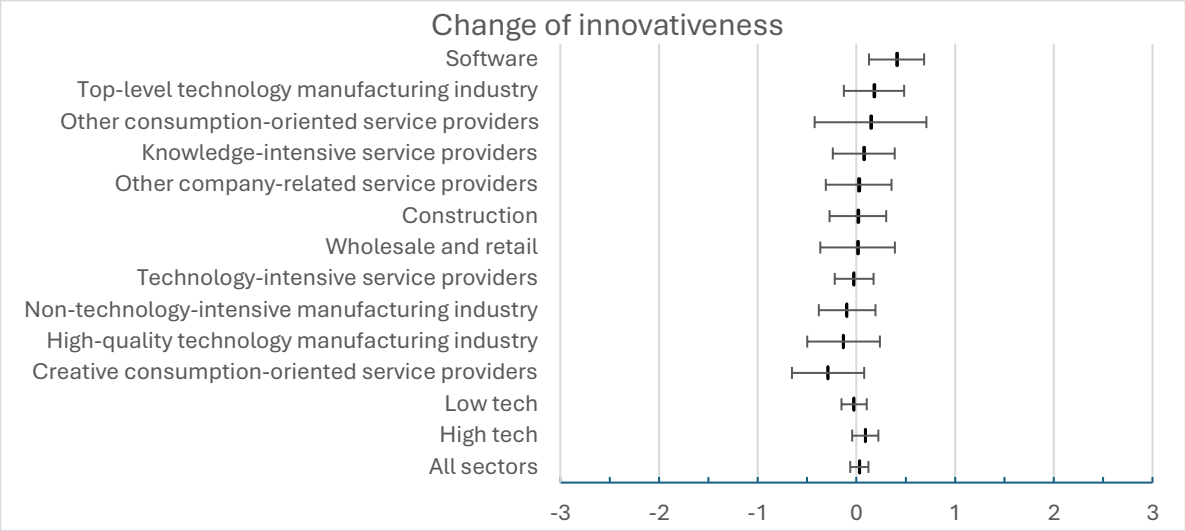
Figure 4: Distribution of the dimensional changes



The graphs contain a normal distribution as a reference point again. Unlike the unidimensional case, the distributions are less bell-shaped but compared to a normal distribution, the non-changers are again overrepresented and make up around 30 per cent of all firms in each dimension.

Innovativeness: Starting with innovativeness, the average changes are presented in Figure 5:

Figure 5: Average changes in innovativeness



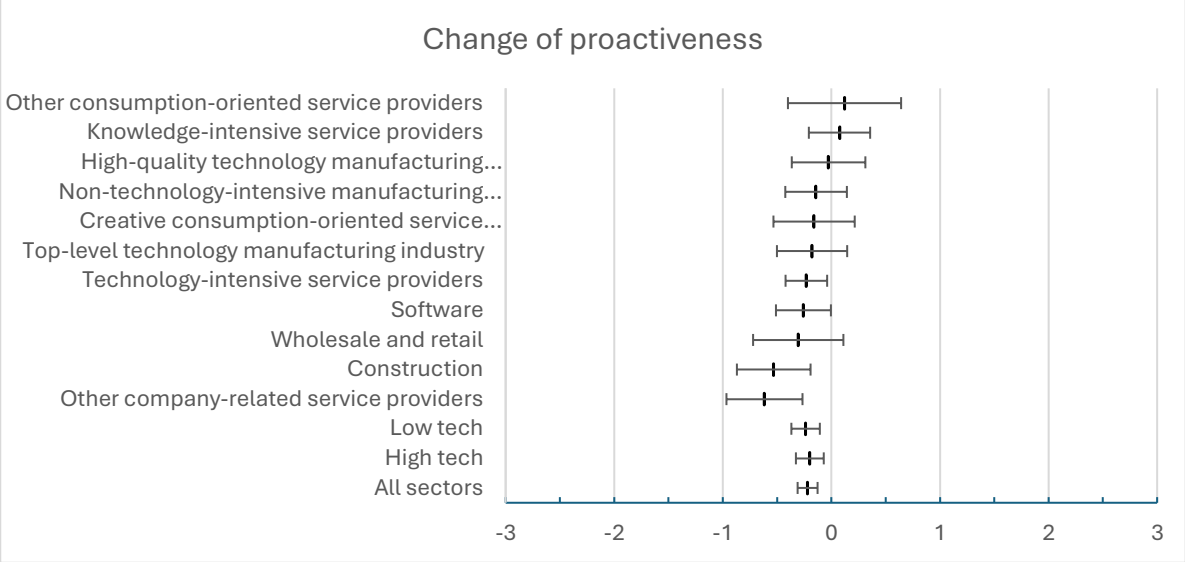
Out of eleven sectors, seven show an increase in innovativeness between both measurements. The average gain of innovativeness within all sectors is 0.03 points (see Appendix 2.B for all results). Software firms show the highest gain with 0.41 points while creative consumption-oriented service providers show a loss of 0.29 points. The graph already displays that the changes in many of the sectors seem to be very close to zero and testing for a significant verifies that the average change within all firms is indeed statistically not different from zero. Like in the unidimensional case, we conduct an ANOVA to identify potential industry and time effects. The results are presented in Table 7 and reveal that no industry, year gap or interaction between both can be identified within the innovativeness changes.

Table 7: ANOVA results of the innovativeness changes

	Partial sum of squares	Degrees of freedom	Mean Square	F	Prob > F
Model	82.885378	30	2.7628459	0.89	0.6444
Industry	33.330566	10	3.3330566	1.07	0.3824
Year gap	6.5179273	2	3.2589637	1.05	0.3517
Industry#year gap	43.073169	18	2.3929538	0.77	0.7406
Residual	9099.4709	2,919	3.1173247		
Total	9182.3562	2,949	3.1137186		

Proactiveness: The average changes in proactiveness are presented in Figure 6:

Figure 6: Average changes in proactiveness



Only two sectors show a slight gain (Appendix 2.C), while all other sectors lose on the proactiveness scale. Of the two gainers, other consumption-oriented service providers show a larger increase with an additional 0.12 points between both measurements. On the lower end, other company-related service providers lose 0.62 points on average. All sectors combined show a decrease of 0.22 points within the observations. The overall decrease of 0.22 within all sectors shows strong evidence for a statistical difference [$Pr(T < t) = 0.0000$]

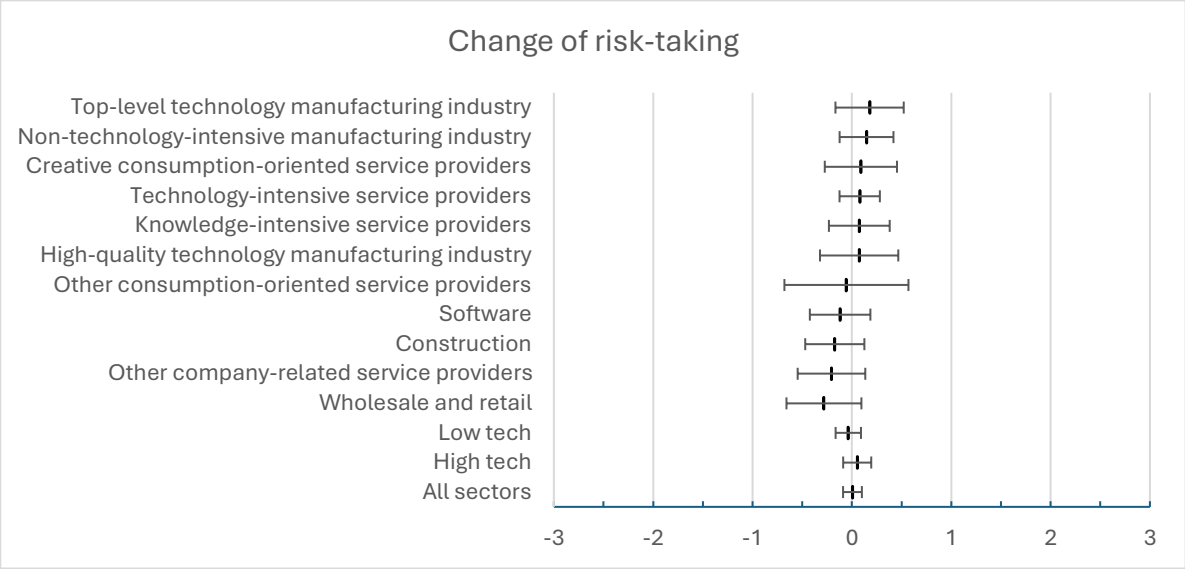
from zero. Table 8 contains the corresponding ANOVA results for proactiveness, which does not reveal any industry, time or effects of the interaction between both:

Table 8: ANOVA results of the proactiveness changes

	Partial sum of squares	Degrees of freedom	Mean Square	F	Prob > F
Model	105.05505	30	3.5018351	1.18	0.2291
Industry	36.761128	10	3.6761128	1.24	0.2600
Year gap	2.2827688	2	1.1413844	0.38	0.6806
Industry#year gap	59.834863	18	3.3241591	1.12	0.3238
Residual	8656.4183	2,919	2.9655424		
Total	8761.4733	2,949	2.9709981		

Risk-taking: Figure 7 shows the average changes in risk-taking:

Figure 7: Average changes in risk-taking



The changes regarding risk-taking appear to be even closer to zero as in the previous dimensions (Appendix 2.D). On average, all firms gain 0.01 points in risk-taking between both measurements, while only six sectors in total show a gain in risk-taking. The highest

gain is observable in the top-level technology manufacturing industry with a gain of 0.18. Retail firms lose 0.28 points between the observations.

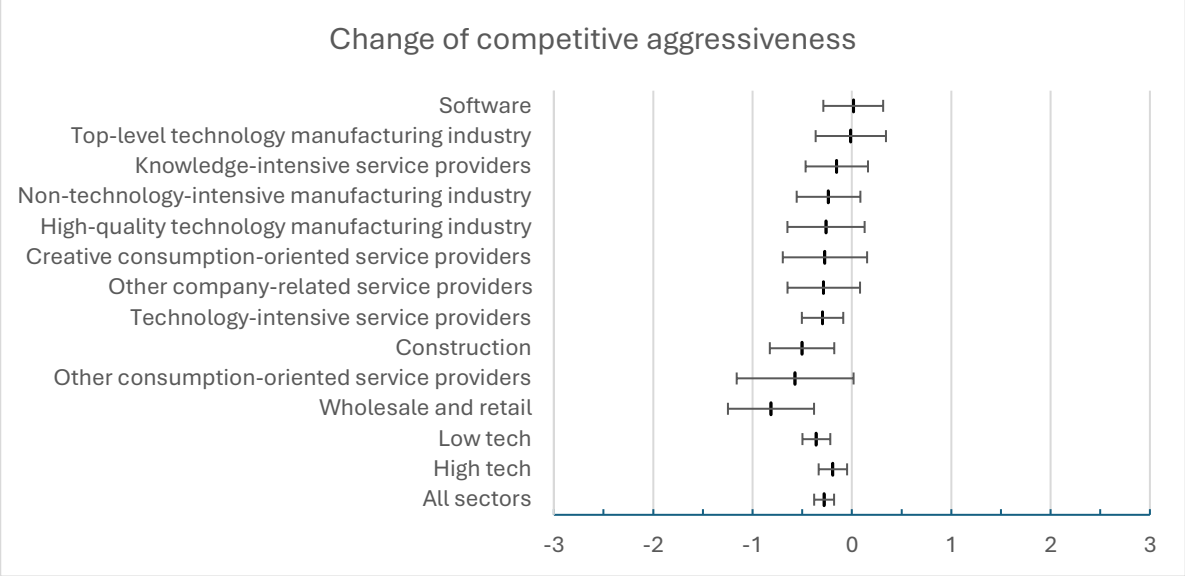
However, the test of the change within all firms for a difference from zero turns out insignificant. The results of the ANOVA regarding the risk-taking changes are presented in Table 9 and again, do not show any industry, time or interaction effects.

Table 9: ANOVA results of the risk-taking changes

	Partial sum of squares	Degrees of freedom	Mean Square	F	Prob > F
Model	128.21278	30	4.2737592	1.31	0.1185
Industry	22.705548	10	2.2705548	0.70	0.7274
Year gap	4.1816674	2	2.0908337	0.64	0.5260
Industry#year gap	58.783826	18	3.2657681	1.00	0.4517
Residual	9497.5357	2,919	3.253695		
Total	9625.7485	2,949	3.264072		

Competitive aggressiveness: Figure 8 shows the average changes in competitive aggressiveness:

Figure 8: Average changes in competitive aggressiveness



Only software firms show a very small gain of 0.01 points (Appendix 2.E). Retail firms show the highest decline of 0.81 points between both measurements, while the average decline of all firms is only 0.28 points.

When testing for statistical significance of the decline within all firms, low tech firms [both $Pr(T < t) = 0.0000$] and high tech firms [$Pr(T < t) = 0.0044$] reach a level of strong evidence for a difference from zero. Regarding industry, time and interaction effects, the ANOVA results are presented in Table 10:

Table 10: ANOVA results of the competitive aggressiveness changes

	Partial sum of squares	Degrees of freedom	Mean Square	F	Prob > F
Model	141.48994	30	4.7163312	1.30	0.1300
Industry	31.48519	10	3.148519	0.87	0.5654
Year gap	1.0298266	2	0.5149133	0.14	0.8681
Industry#year gap	40.178511	18	2.2321395	0.61	0.8922
Residual	10621.642	2,919			
Total		2,949			

Like the previous dimensions, neither branches, time nor interaction effects can be identified regarding the changes in competitive aggressiveness.

The last step after presenting the raw changes of all dimensions is to compare the effects in size. However, after calculating Cohen's d (Cohen, 1988), for all combinations within the dimensions, the changes do not differ substantially as for all estimations Cohen's d is below the minimum threshold of 0.2. The highest difference can be identified between innovativeness and competitive aggressiveness with a Cohen's d of just 0.115933. Thus, the changes are not only located close to zero, but they also do not differ between the dimensions.

Potential determinants of temporal changes in EO and its dimensions

Although the average changes are located close to zero, one can observe individual firms with very high and very low changes, but the origins of those changes remain unclear. As this study does not aim to explore the driver of changes in detail, we still want to present one interesting finding. 23.42 per cent of the firms in the sample do not have any employees, 17.83 have one

or fewer (due to part-time) employees or are a founding team of two and 13.80 per cent have two or fewer employees (solo founders with two employees or team founders with a maximum of one employee). Meaning, over 50 per cent of firms are composed of a single founder or a team and thus, have a maximum of two employees. Hence, EO should be relatively sensible to a change of the chief executive officer (CEO), if the CEO makes up for a large part of the whole company's manpower (Anderson, 2021). However, when analysing the changes of unidimensional EO3 and the single dimensions, this is not the case. An ordinary least square regression shows only suggestive evidence for one dimension where a CEO change exerts an influence: competitive aggressiveness ($p < 0.011$). All other dimensions and the unidimensional EO3 change are unaffected by a new CEO. We additionally calculated the highest and lowest 25 per cent of firms with their corresponding EO3 change and ran a logistic regression to calculate the odds ratio of a firm being in the 25 per cent highest changing firms. Again, a change of the CEO did not affect those odds. These analyses included industries, the change of employment, firm age, the year gaps between EO measurements and a dummy variable to control for team founders.

Additionally, we calculated all ANOVAs from the previous analyses with the addition of a CEO change. There, the competitive aggressiveness dimension is also unaffected by a CEO change, industry effects, time effects and interaction effects. One could argue here that the observed changes average out. But most of these results also hold when the models are applied to the absolute changes. For competitive aggressiveness, the corresponding ANOVA without a CEO change reveals a time effect ($F = 4.48$, $Prob > F = 0.0088$). The same holds if CEO changes are included ($F = 3.51$, $Prob > F = 0.0303$). With a CEO change, proactiveness also shows strong evidence for a difference between the year gaps ($F = 5.92$; $Prob > F = 0.0028$). Risk-taking shows weakly significant differences between the year gaps ($F = 4.20$, $Prob > F = 0.0153$).

The empirical relationship between EO and firm performance

As a last step, we illustrate one implication of the results regarding the identification of a causal relationship involving EO. Going back to the (on average) positive relation between EO and sales (Rauch et al., 2009) we can replicate this relation when conducting a simple ordinary least square regression with standard errors (clustered at the firm level; Abadie et al., 2022) within the sample but when regressing on changes, the effect turns insignificant. This means that an effect is present for a cross-sectional analysis but not when considering the panel structure of the data. This relates to the discussion regarding panel estimators. While it

can be argued that the unobserved heterogeneity between firms is time-invariant, a fixed-effects estimator would likely suffer from the incidental parameter problem where a fixed-effect estimator can be biased when the variation within the data is limited, or the amount of observation periods is too small compared to the number of observed individuals (Lancaster, 2000). Hence, the data would allow only for a random effects estimation although the fixed effect estimation would be appropriate. Regressing on changes does not solve this problem as the distribution of the changes which is located around zero, does not allow EO to explain the great variation of the dependent variable.

Table 11: EO - sales relation

(Change)Log of sales	OLS	OLS on Changes
EO3	0.04	
	(0.01)***	
Change of EO3		-0.00
		(0.00)
Firm age	0.08	-0.37
	(0.03)**	(0.02)***
Year gap-specific fixed effects	Yes	Yes
Industry-specific fixed effects	Yes	Yes
Observations	2,783	2,311

Significance levels *** p < 0.001. ** p < 0.005. * p < 0.05

2.5 Discussion and Conclusion

The previous results show that EO tends to be a stable firm trait for short to medium observation periods. The average changes of the unidimensional EO construct, as well as within the individual dimensions are close to zero. Yet, there are industries which show larger changes compared to others, but the analyses did not reveal any kind of systematic industry effects. Additionally, this study is the first one to use a direct EO measurement and thus, it is hard to compare the results with the previously mentioned studies related to EO change, especially the one of Keil et al. (2017) which is the only other study to our knowledge which shows EO over time. We cannot identify a systematic decline in EO like their results suggest, despite the average changes of all firms and most sectors are negative in our findings as well. This could be due to the limited observation period and the fact that the types of firms between the studies differ (large and established companies vs. startups). Additionally, our study relies on a validated EO measurement, not an indirect assessment. The results point to a more idiosyncratic direction of the EO changes. The first hint might already result from the bell

shape of the unidimensional EO changes, as well as the low intertemporal correlations between the individual dimensions.

Additionally, we analysed the type of firm where theoretically (Anderson et al., 2022) EO changes are expected to be more prominent: young firms. Against the theoretical expectation, their EO does not change much on average. Even analysing the theoretical arguments for an EO change, resulting in a change of the CEO, the results remain insensible to that new CEO taking over. This is also true for the firms with the highest and lowest observed differences between both measurements, the CEO change does not explain why these firms show the most prominent differences in their EO levels. Lastly, there are some time effects for specific analyses when taking the absolute of changes, but these time effects are not constantly present. All these aspects combined let the observed changes present themselves as idiosyncratic rather than following specific patterns. Hence, the distribution of changes is likely to be random, it is not random but driven by unknown factors or it is the result of measurement error. There is an additional argument why chance or measurement error could be prominent in this study. When regressing on levels, the sample shows the often-identified positive relation between the unidimensional EO and sales. This relation vanishes when regressing on changes and the EO change turns insignificant, meaning EO is turning into a part of a firm's quasi-fixed effects. Combined, the results of this study and their implications are a two-sided sword:

First, if measurement error is a particularly prominent problem in EO panel data, the promoted idea (Anderson et al., 2022) to analyse the changes of variables is increasing the associated problems of such errors (Wooldridge, 2010; Bertrand et al., 2004). The need for long observation periods with frequent measurements arises if the use of more sophisticated methods is the aim of the researcher. Still, this approach is time and resource-consuming, as well as suffering from its own problems like firms dropping out of the observation cohort early. Overcoming measurement error is especially challenging as one alternative solution, the use of instrumental variables (IVs) (Angrist and Krueger, 2001), is hard to achieve in the context of EO being such a fundamental construct. Identifying an IV regarding EO might be close to impossible as it first, needs to be exogenous and second, it needs to fulfil the exclusion restriction. This means that the IV only affects the dependent variable via EO and the dependent variable is not directly affected by the IV. On the other hand, one might accept the use of cross-sectional data as methods which rely on changes won't simply be able to identify such changes when EO tends to be stable on short to medium-observation periods.

Limitations

The main limitation of this study is the number of observations of EO variables with just two observations per firm and the limited time horizon between these measurements. Ironically, measurement error is still a problem, even if one of the conclusions is the potential presence of measurement error in EO studies. The limited time gaps between the measurements result from the varying research focus within the variable part of the panel. Even reintroducing EO questions now would not fix this issue as the startups present in this data would already be dropped out at this time. Hence, the stability of EO on a longer horizon remains an open research question.

Conclusion

This study provides answers to the question of whether EO is stable over time or whether it changes rapidly. The empirical results show that EO and its dimensions are relatively stable for most ventures in the short to medium term. The observed changes over time appear to be random and it cannot be ruled out that they are the result of measurement errors. The study is based on data from startups, and future studies should examine the extent to which the results also apply to established companies. It could at least be assumed that EO and its dimensions change less over time in established firms than in firms in the startup phase, but this assumption has to be proven. Furthermore, this study shows that the use of panel estimators can be problematic when EO is relatively stable as EO then represents a quasi-fixed effect.

Appendix

Appendix 2.A: Unidimensional EO3 and EO4 Changes

Sector	Variable N	Change of EO3				Change of EO4			
		Mean	Std	95% Confidence interval		**Mean**	Std	95% Confidence interval	
All sectors	2,950	**-0.18**	4.83	-0.36	-0.01	**-0.46**	5.85	-0.67	-0.25
High tech	1,384	**-0.06**	4.90	-0.31	0.20	**-0.25**	5.92	-0.56	0.07
Low tech	1,566	**-0.30**	4.77	-0.53	-0.06	**-0.66**	5.78	-0.94	-0.37
Other company-related service providers	219	**-0.80**	5.04	-1.47	-0.13	**-1.08**	5.92	-1.87	-0.29
Construction	273	**-0.69**	4.45	-1.22	-0.16	**-1.19**	5.35	-1.83	-0.55
Wholesale and retail	167	**-0.57**	4.66	-1.29	0.14	**-1.39**	5.84	-2.28	-0.50
Creative consumption-oriented service providers	188	**-0.36**	4.81	-1.05	0.34	**-0.63**	5.62	-1.44	0.18
Technology-intensive service providers	650	**-0.18**	4.92	-0.55	0.20	**-0.47**	5.96	-0.93	-0.01
Non-technology-intensive manufacturing industry	319	**-0.09**	4.58	-0.59	0.42	**-0.32**	5.58	-0.94	0.29
Software	295	**0.03**	4.76	-0.52	0.58	**0.04**	5.81	-0.62	0.71
High-quality technology manufacturing industry	192	**0.18**	5.05	-0.77	0.61	**-0.34**	5.73	-1.16	0.47
Top-level technology manufacturing industry	247	**0.18**	5.05	-0.45	0.81	**0.07**	6.11	-0.70	0.84
Other consumption-oriented service providers	91	**0.21**	4.66	-0.76	1.18	**-0.36**	5.77	-1.57	0.84
Knowledge-intensive service providers	309	**0.22**	5.08	-0.34	0.79	**0.07**	6.21	-0.62	0.77

Appendix 2.B: Innovativeness Changes

Sector	Observations	Mean	Std	95% Confidence Interval	
All sectors	2,950	0.03	2.55	-0.06	0.12
High tech	1,384	0.09	2.52	-0.04	0.22
Low tech	1,566	-0.02	2.58	-0.15	0.10
Creative consumption-oriented service providers	188	-0.29	2.54	-0.65	0.08
High-quality technology manufacturing industry	192	-0.13	2.59	-0.50	0.24
Non-technology-intensive manufacturing industry	319	-0.09	2.61	-0.38	0.19
Technology-intensive service providers	650	-0.02	2.56	-0.22	0.17
Wholesale and retail	167	0.01	2.47	-0.37	0.39
Construction	273	0.01	2.41	-0.27	0.30
Other company-related service providers	219	0.02	2.50	-0.31	0.36
Knowledge-intensive service providers	309	0.07	2.80	-0.24	0.39
Other consumption-oriented service providers	91	0.14	2.72	-0.42	0.71
Top-level technology manufacturing industry	247	0.18	2.43	-0.13	0.48
Software	295	0.41	2.44	0.13	0.69

Appendix 2.C: Proactiveness Changes

Sector	Observations	Mean	Std	95% Confidence Interval	
All sectors	2,950	-0.22	2.55	-0.31	-0.13
High tech	1,384	-0.20	2.43	-0.33	-0.07
Low tech	1,566	-0.24	2.64	-0.37	-0.11
Other company-related service providers	219	-0.62	2.63	-0.97	-0.27
Construction	273	-0.53	2.85	-0.87	-0.19
Wholesale and retail	167	-0.31	2.72	-0.72	0.11
Software	295	-0.26	2.21	-0.51	0.00
Technology-intensive service providers	650	-0.23	2.49	-0.42	-0.04
Top-level technology manufacturing industry	247	-0.18	2.58	-0.50	0.15
Creative consumption-oriented service providers	188	-0.16	2.60	-0.53	0.21
Non-technology-intensive manufacturing industry	319	-0.14	2.58	-0.42	0.14
High-quality technology manufacturing industry	192	-0.03	2.38	-0.36	0.31
Knowledge-intensive service providers	309	0.07	2.52	-0.21	0.36
Other consumption-oriented service providers	91	0.12	2.50	-0.40	0.64

Appendix 2.D: Risk-taking Changes

Sector	Observations	Mean	Std	95% Confidence Interval	
All sectors	2,950	0.01	2.63	-0.09	0.10
High tech	1,384	0.05	2.68	-0.09	0.19
Low tech	1,566	-0.04	2.58	-0.16	0.09
Wholesale and retail	167	-0.28	2.47	-0.66	0.10
Other company-related service providers	219	-0.21	2.56	-0.55	0.13
Construction	273	-0.17	2.50	-0.47	0.13
Software	295	-0.12	2.66	-0.42	0.19
Other consumption-oriented service providers	91	-0.05	3.00	-0.68	0.57
High-quality technology manufacturing industry	192	0.07	2.77	-0.32	0.47
Knowledge-intensive service providers	309	0.07	2.73	-0.23	0.38
Technology-intensive service providers	650	0.08	2.64	-0.12	0.28
Creative consumption-oriented service providers	188	0.09	2.53	-0.27	0.45
Non-technology-intensive manufacturing industry	319	0.15	2.46	-0.12	0.42
Top-level technology manufacturing industry	247	0.18	2.74	-0.17	0.52

Appendix 2.E: Competitive Aggressiveness Changes

Sector	Observations	Mean	Std	95% Confidence Interval	
All sectors	2,950	-0.28	2.78	-0.38	-0.18
High tech	1,384	-0.19	2.71	-0.33	-0.05
Low tech	1,566	-0.36	2.83	-0.50	-0.22
Wholesale and retail	167	-0.81	2.84	-1.25	-0.38
Other consumption-oriented service providers	91	-0.57	2.83	-1.16	0.02
Construction	273	-0.50	2.72	-0.83	-0.18
Technology-intensive service providers	650	-0.30	2.71	-0.50	-0.09
Other company-related service providers	219	-0.28	2.74	-0.65	0.08
Creative consumption-oriented service providers	188	-0.27	2.95	-0.70	0.15
High-quality technology manufacturing industry	192	-0.26	2.73	-0.65	0.13
Non-technology-intensive manufacturing industry	319	-0.24	2.91	-0.56	0.09
Knowledge-intensive service providers	309	-0.15	2.81	-0.47	0.16
Top-level technology manufacturing industry	247	-0.01	2.82	-0.46	0.24
Software	295	0.01	2.63	-0.29	0.31

Appendix 2.F: Autonomy Changes

Sector	Observations	Mean	Std	95% Confidence Interval	
All sectors	2,950	0.02	2.52	-0.07	0.11
High tech	1,384	0.14	2.41	0.01	0.27
Low tech	1,566	-0.08	2.61	-0.21	0.04
Construction	273	-0.34	2.84	-0.68	-0.01
Non-technology-intensive manufacturing industry	319	-0.16	2.56	-0.44	0.12
Creative consumption-oriented service providers	188	-0.06	2.15	-0.37	0.25
Knowledge-intensive service providers	309	-0.06	2.34	-0.32	0.20
Wholesale and retail	167	-0.02	2.78	-0.44	0.41
Other company-related service providers	219	-0.01	2.76	-0.38	0.35
Top-level technology manufacturing industry	247	0.04	2.66	-0.29	0.37
High-quality technology manufacturing industry	192	0.08	2.52	-0.28	0.44
Technology-intensive service providers	650	0.16	2.43	-0.03	0.35
Software	295	0.21	2.10	-0.03	0.45
Other consumption-oriented service providers	91	0.53	3.03	-0.10	1.16

3. Chapter three

Heterogeneity in the Imitation Behavior of Startups and the Dimensions of Entrepreneurial Orientation[5]

[5] Co-written with Prof. Dr. Werner Bönte, Prof. Dr. Diemo Urbig, Prof. Dr. Vivien Procher and Sandra Gottschalk. The paper on which this chapter is based is currently in the process of being submitted to a scientific journal.

3.1 Introduction

Entrepreneurial Orientation (EO), which reflects the fundamental strategic posture of organizations that can be considered entrepreneurial, is regarded as an important determinant of organizational performance (Covin and Slevin, 1989; Wiklund and Shepherd, 2003). In terms of innovation performance, since the beginning of research in this area, EO has been associated primarily with the *generation* of product innovations, but less so or not at all with the *imitation* of product innovations. For example, Miller (1983, p. 780) notes that theorists generally do not consider a firm to be entrepreneurial if it changes its technology or product line simply by directly imitating competitors. Consequently, empirical studies have mainly focused on the relationship between EO and the *generation* of product innovations, showing a positive empirical correlation between EO and the development of products that are new worldwide (Avlonitis and Salavou, 2007; Bucktowar et al., 2015; Madhoushi et al., 2011; Pérez-Luño et al., 2011; Zhou et al., 2005). In contrast, there is little empirical evidence on the relationship between EO and *imitation* of product innovations. Only the study by Pérez-Luño et al. (2011) provides some empirical evidence that product imitation is related to the EO dimension of proactiveness, i.e., a firm's tendency to proactively seek opportunities and take a forward-looking perspective.

The focus of previous EO research on the *generation* of product innovations is probably due to the fact that it is precisely these product innovations that are expected to have positive effects on firm performance. However, existing studies show that *imitation* of product innovations can also have positive impacts on firm performance: Imitation of product innovations can increase firm growth (Peng et al., 2021), reduce failure rates (Golder and Tellis, 1993) and lead to cost advantages (Sajeva, 2013). Imitating ventures can also be attractive from an investor's perspective. For example, Fu and Tietz (2019) show that investors prefer less novel, imitative ventures over novel ventures if the venture team has major capability advantages in exploitation (compared to exploration). According to Lieberman and Asaba (2006), one of the main motivations for firms to imitate is that they can catch up or keep pace with their competitors through imitation. However, Posen and Martignoni (2018) demonstrate that, under specific circumstances, imitation can lead to an enhancement in performance heterogeneity among firms rather than a reduction.

Given its importance for firm performance and the risks involved, the decision whether to imitate an existing product or to launch a new product globally is certainly an important strategic decision (Shinkle and McCann, 2014). However, firms also face another important

decision when imitating product innovations, namely the degree of novelty of the imitation. Imitators may either simply copy existing products, but they may also make additional improvements (Lee and Zhou, 2012; Grahovac and Miller, 2009; Shenkar 2010). Furthermore, new research emphasizes that there is not just one imitation strategy, but that firms may follow different imitation strategies and that it is important to consider the temporal and spatial dimensions of imitation (Posen et al., 2023). For example, a company may pick up the idea of imitating a product innovation from its immediate environment and launch a product that is new only to itself, or it may be the first company to introduce a product that is new to the region or even country in which the company is based. Consequently, not only the decision whether to launch a completely new product or to imitate a product innovation is of strategic importance, but also the decision on the degree of novelty of the imitated products. Therefore, it can be presumed that not only the *generation* of product innovations but also the *imitation* behavior of the companies is determined by their EO. So far, however, little is known about how the various forms of imitation behavior of companies are related to their EO.

To address the research gap regarding the link between EO and firms' imitative behavior, we introduce the concept of an innovation ladder that ranks firms according to the novelty of their products. Following Posen et al. (2023), we argue that firms may pursue different imitation strategies, which may differ in terms of difficulty. Our conceptualization of the innovation ladder captures three types of imitative behavior, which lie between the two extremes of innovation generation (global innovator, top rung) and a complete lack of product innovation (non-innovator, bottom rung). A firm that introduces a product innovation that is new only to the firm itself pursues the least innovative imitation strategy (firm-level imitator). The next level of imitation is achieved by firms that are the first to adopt a product innovation that is new in the firm's home region (regional-level imitator). The highest level of product imitation is achieved by firms that are the first to launch a new product in their home country (country-level imitator).

Furthermore, this study draws on the multidimensional conceptualization of EO most often associated with the work of Lumpkin and Dess (1996) and examines the relevance of four EO dimensions, namely innovativeness, proactiveness, competitive aggressiveness, and risk-taking, for firms' innovation and imitative behavior. More specifically, we focus on the link between these EO dimensions and four nested dichotomies, i.e.: (I) innovators vs. non-innovators, (II) global innovators vs. imitators, (III) non-firm level imitators (that launch

products that are not only new to the startup itself) vs. firm-level imitators (that introduce products that are only new to the firm itself) and (IV) country-level imitators vs. regional-level imitators.[6]

By linking our innovation ladder to the four EO dimensions, we can make several important contributions to the literature. First, we extend the knowledge of the relationship between EO and product innovation by emphasizing imitation behavior. While firms' imitative behavior has been examined in previous studies (Grahovac and Miller; 2009; Lee and Zhou, 2012; Lieberman and Asaba, 2006; Shenkar 2010), firms' imitative behavior has rarely been linked to EO dimensions. To our best knowledge, the study by Pérez-Luño et al. (2011) is the only study that examines the relationship between EO dimensions of risk-taking and proactiveness and product innovation adoption. However, in contrast to previous research, we show that EO dimensions are not only related to whether product innovations are generated or imitated but may also be relevant to the degree of novelty of imitated products. In particular, we argue that the EO of firms plays a role in whether firms only adopt product innovations that are new to the firm itself, or whether they are the first to imitate and adopt products that are new to the region or country in which the firm is located and thus add to the understanding of imitative heterogeneity (Posen et al., 2023). In case of a positive link between EO dimensions and the level of imitation, EO dimensions of firms would be important for the speed of diffusion of product innovations. In other words, the diffusion of product innovations would be faster in industries, regions or countries with a comparatively higher number of companies with a high level of EO. To our knowledge, the importance of EO for interregional and international diffusion of product innovations has not been addressed in the literature.

Second, we focus on the *independent* (unique) relationships between the degree of novelty level of product innovations and the dimensions of EO (Lomberg et al., 2017). In other words, we empirically examine whether the EO dimension of innovativeness is uniquely associated with the four nested dichotomies of the innovation ladder and whether the EO dimensions of proactiveness, risk-taking, and competitive aggressiveness are *uniquely* associated with these dichotomies, beyond their association with innovativeness. Our results suggest that the EO dimension of innovativeness is not equivalent to the generation of product innovations, as assumed by Pérez-Luño et al. (2011). Rather, our results show that this EO dimension is

[6] These decisions can thus form a hierarchy that makes the choice between different pairs of alternatives interdependent. Hence, the resulting empirical approach will also depend less on the so-called independence-of-irrelevant-alternatives assumption, which limits the use of different multinomial estimation methods (Cameron and Trivedi, 2005; Fox, 1997).

associated not only with the generation of innovations but also with *all* levels of imitation on our innovation ladder. Our results confirm the findings of Pérez-Luño et al. (2011) that the EO dimension of proactiveness is associated with both the generation and imitation of product innovations. However, going beyond their research, we show that proactiveness is associated with different degrees of novelty in imitated products and that the unique relationships remain even when controlling for the EO dimension of innovativeness. Furthermore, our empirical analyses show that it is important to distinguish between the two EO dimensions of proactiveness and competitive aggressiveness, as the latter is not relevant for the generation of product innovations but for the imitation of product innovations, especially those that are new to the firm. Our results point out that the EO dimension of risk-taking is not independently associated with the various dichotomies, but only through simultaneous changes in the other EO dimensions, particularly innovativeness.

Third, our empirical analysis is based on five survey waves of the IAB/ZEW Startup Panel, provided by the Centre for European Economic Research (ZEW). Our sample consists of 5,800 observations from 4,383 knowledge-intensive new ventures in Germany for which we have information on their EO and their position on the innovation ladder. Hence, we focus on startups, whereas previous empirical studies on the relationship between EO and product innovation are based on data from established companies (Avlonitis and Salavou, 2007; Bucktowar et al., 2015; Madhoushi et al., 2011; Pérez-Luño et al., 2011; Zhou et al., 2005). While there is a small but growing number of studies showing that EO is relevant in the early years of startups regarding financial outcomes and relative performance measurements (Donbesuur et al., 2020; Kollmann and Stöckmann, 2014; Lee et al., 2001; Messersmith and Wales, 2013; Wang et al., 2017), these studies do not examine the impact of EO on startups' imitation behavior. However, product imitation may be particularly important for startups. While it is well known that revolutionary breakthroughs often originate from small and young firms (Baumol, 2004), and empirical studies show that product novelty is an important indicator of overall startup performance and survival (Fontana and Nesta, 2009; Hsieh et al., 2018; Hyytinen et al., 2015), launching globally novel products also poses a particular challenge for resource-constrained startups. Therefore, less resource-intensive product imitation can be an alternative to launching a completely new product, especially for startups, as these very young ventures often have limited resources compared to established companies. However, launching an imitative product that is new in the startup's home country is certainly more challenging than launching a product that is new only in the startup's home

region or only for the startup itself. Entrepreneurs therefore face a strategic decision of how novel their imitation products should be. Indeed, the copying of business models has become the focus of some startup incubators, which Baumann et al. (2018) refer to as "clone factories". Baumann et al. explain this strategy using the example of the German incubator Rocket Internet, which pursues an imitation business model by recreating the business models of successful internet companies in the US and founding companies in other countries on this basis. We provide theoretical arguments and empirical evidence that the EO of startups is not only relevant for the development of world firsts but also plays a crucial role in the diffusion of product innovations. With our study, we are responding to the call for research into the importance of the imitating entrepreneur for market dynamics (Posen et al., 2023) and contributing to a better understanding of the factors that influence imitation by start-ups.

The chapter is structured as follows. First, we present the conceptual background of our study and derive testable hypotheses. We then describe our dataset before presenting some descriptive statistics and our estimation results. Finally, we discuss our results and the implications for further research.

3.2 Conceptual Background

Introduction of new products and the degree of novelty: the innovation ladder

While extant studies have predominantly associated EO with the generation of product innovations, we contend that EO is also a salient factor for the imitation behavior of firms. Strategic product imitation, in which firms deliberately reproduce the products of other firms, is an important source of dynamic capabilities and innovation, which in turn can lead to competitive advantage (Posen et al., 2023). Posen et al. distinguish between two models of imitation, namely the static and the dynamic model. Posen et al. state that the conventional view of imitation is static and assumes that imitation is a binary decision, and that imitation is quite easy and that weak firms in particular imitate. They contrast this with a dynamic model, which assumes that there are different imitation strategies, that imitation is difficult and that strong firms imitate. The static model seems more in line with previous research on the relationship between EO and innovation performance, which associates EO particularly with the generation of product innovations (Avlonitis and Salavou, 2007; Bucktowar et al., 2015; Madhoushi et al., 2011; Zhou et al., 2005), while EO is not associated with imitation (Miller, 1983). However, we follow the dynamic model proposed by Posen et al. (2023) and argue that there are different imitation strategies, and we suggest that different imitation strategies are uniquely associated with each of the EO dimensions.

When deciding on appropriate imitation strategies, firms need to answer questions such as: what, when, where and whom they want to imitate (Lieberman and Asaba, 2006; Posen et al, 2023). For example, firms must make strategic decisions about where to search for imitation targets. This is because imitation is also the result of a search process (see Mezias and Lant, 2002; Posen et al., 2018). Consequently, current research emphasizes the theoretical and practical relevance of studies that consider the temporal and spatial dimensions of imitation (see Posen et al., 2023).

To account for the existence of different imitation strategies and the temporal and spatial dimensions of imitation we refer to the Oslo Manual (OECD and Eurostat, 2018, p. 21) which defines a product innovation as a new or improved good or service that differs significantly from a company's previous goods or services and has been introduced to the market. According to the OSLO manual, product innovations include not only new products worldwide but also product imitations, which may differ in their degree of novelty. With this in mind, we introduce the concept of the innovation ladder and consider five different possible rungs that a start-up can climb on the innovation ladder. The generation of products is the top rung of the innovation ladder, i.e. startups that launch products that are new to the world are global innovators. In contrast, the lowest rung is occupied by non-innovators, i.e. startups that do not launch any new products on the market.

The three middle rungs represent different imitation behaviors reflecting the temporal and spatial dimensions of imitation. A startup that introduces a product innovation that is new only to the startup itself pursues the least innovative imitation strategy (firm-level imitator). The next level of imitation is achieved by startups that are the first to introduce a product innovation that is new in the startup's home region (regional-level imitator). Such startups deliberately seek out imitation targets in their own country but outside their own region. They copy products that already exist in other regions of their home country[7]. Startups achieve the highest level of product imitation by being the first to bring a new product to market in their home country (country-level imitator). This means that they actively seek out imitation targets in other countries and imitate them. For example, after eBay was founded in 1995 and became a remarkable success story, internet startups in other countries, such as Ricardo in Germany,

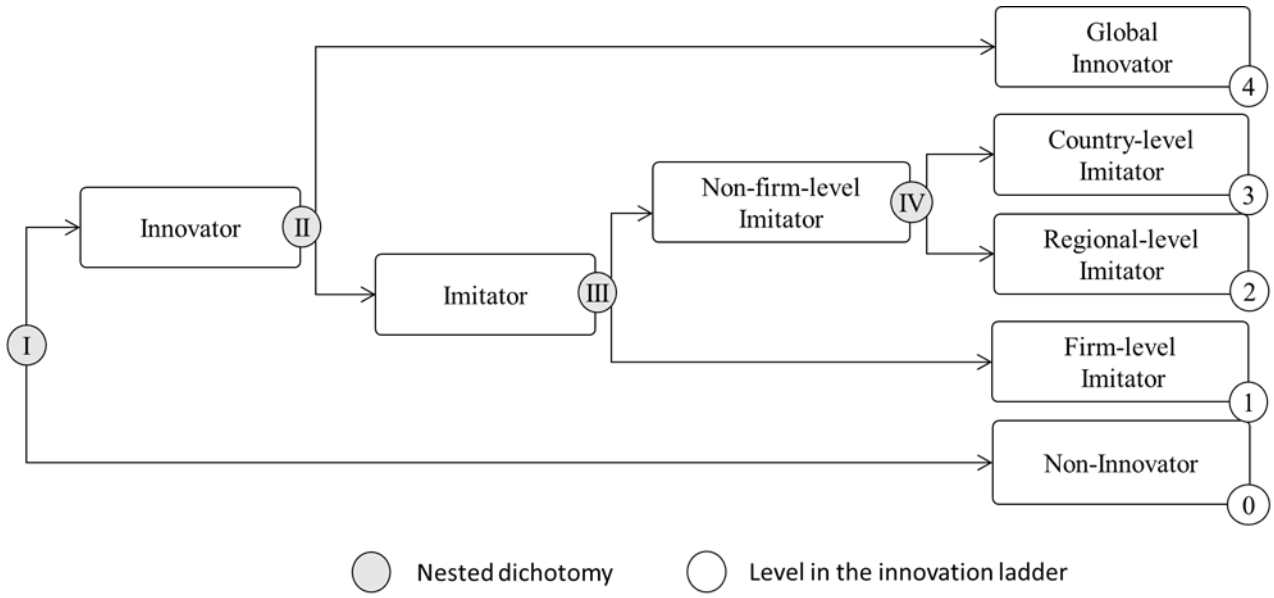
[7] The Oslo Manual only refers to the region in which an enterprise is located in very general terms, without specifying exactly what is meant by region. This is sufficient in our case since we are not analyzing the precise interregional imitation of product innovations. We simply want to distinguish between imitators at the regional level and imitators at the country level.

adopted the basic business idea and were the first to launch similar platforms in their countries.

Based on the five rungs of the innovation ladder, we compare four typical strategic choices for companies. These four dichotomies shown in Figure 9: (I) whether a startup is a non-innovator or an innovator, (II) whether a startup is an imitator or a global innovator, (III) whether a startup imitates product innovations that are new only to the firm (firm-level imitator) or copies product innovations from companies in other regions and countries (non-firm-level imitator), and (IV) whether a startup is a regional-level imitator or copies a product innovation that already exists in other countries (country level imitator). Previous research on the relationship between product innovation and EO has focused on the empirical analysis of dichotomies I and II (Avlonitis and Salavou, 2007; Bucktowar et al., 2015; Madhoushi et al., 2011; Pérez-Luño et al., 2011; Zhou et al., 2005). We extend previous research and empirically investigate the relevance of the EO dimensions for dichotomies III and IV. In doing so, we also implicitly examine the importance of the four EO dimensions innovativeness, proactiveness, competitive aggressiveness, and risk-taking for the interregional and international diffusion of product innovations.

Lumpkin and Dess (1996) introduced autonomy as the fifth dimension of EO. This dimension refers to the autonomy of people in organizations, which allows them to act independently and can foster the development of new ideas. However, this dimension is more relevant for established and larger organizations, not so much for very young companies, which usually have few or no employees. Therefore, we exclude the EO dimension of autonomy from our main analysis but include it in a robustness check (see Appendix 3.C).

Figure 9: Innovation ladder modelled and four nested dichotomies



Innovativeness

According to Lumpkin and Dess (1996), innovativeness is defined as the tendency of a company to seek novelty, which can lead to new products, services or technologies. This EO dimension is, of course, of crucial importance for product innovation. Considering this dimension to be independent of other dimensions such as risk-taking and proactiveness means that a venture tends to be innovative even if non-innovation and innovation are associated with the same risks and even if non-innovation can still include activities that are considered proactive. Kollmann and Stöckmann (2014) show that innovativeness is positively related to exploratory and exploitative innovation activities, with the effect being stronger for exploratory efforts. The more exploratory the efforts are, the more likely it is that new discoveries will be made. Hence, it can be conjectured that the EO dimension of innovativeness is positively related to the likelihood that a company will bring a product innovation to market (dichotomy I), as a behavioral consequence of a corresponding strategy (note that this is by no means deterministic. Various mechanisms may prevent a strategy from actually leading to the desired result, like changing legislation, sudden financial shortages or changes in customer preferences), which can be conjectured in the following hypothesis:

H1a: The EO dimension of innovativeness is uniquely and positively associated with dichotomy I, i.e. being an innovator rather than a non-innovator.

Building on the defining element of the innovativeness dimension, namely the "search for novelty", we assume that this search not only implies novelty for the innovating venture but is also related to the degree of novelty, i.e. whether it is new only for the innovating venture or for the world (Pérez-Luño et al., 2011). We expect innovativeness to be positively related to the likelihood of introducing a product innovation that is new to the world rather than introducing an imitated product (dichotomy II). This is consistent with empirical evidence from studies that have found a positive relationship between EO and radical innovation (Zhou et al., 2005; Bucktowar et al., 2015; Avlonitis and Salavou, 2007). In contrast to our study, these studies neither examine the individual effect of the EO dimension of innovativeness nor are radical innovations synonymous with globally new products. Although all radical innovations are also world-first, not all world-firsts are radical innovations. In this respect, our concept is somewhat broader than that of the other studies. Nevertheless, there is an overlap in content. Our considerations lead to the following hypothesis:

H1b: The EO dimension of innovativeness is uniquely and positively associated with dichotomy II, i.e. being a global innovator rather than an imitator.

Our study extends previous research by arguing that the EO dimension of innovativeness is also positively associated with the novelty of imitator products. Our innovation ladder concept allows us to distinguish between different degrees of novelty of imitative products, and we argue innovativeness is positively related to the probability of introducing imitative products that are new to the home region (dichotomy III) or new to the home country (dichotomy IV). With the definition of innovativeness and the results of Kollmann and Stöckmann (2014) in mind, we argue that imitating products, that already exist in other countries, also require a commitment to such innovation efforts, i.e., an active search and adoption. An innovation that is new only at the local or regional level requires less commitment to innovation efforts than an innovation that is imitated across countries (dichotomy IV). Consequently, we expect the extent of exploration to increase with the novelty of the imitated products, implying that the innovativeness dimension facilitates being a non-firm-level imitator compared to a firm-level imitator (dichotomy III). The same logic then applies to a country-level imitator rather than a regional-level imitator:

H1c: The EO dimension of innovativeness is uniquely and positively associated with dichotomy III, i.e. being a non-firm-level imitator rather than a firm-level imitator.

H1d: The EO dimension of innovativeness is uniquely and positively associated with dichotomy IV, i.e. being a country-level imitator rather than a regional-level imitator.)

Proactiveness

We argue that the EO dimension of proactiveness is uniquely related to the dichotomies of the innovation ladder independently of the EO dimension of innovativeness. Proactiveness is manifested in processes and activities that attempt to anticipate future needs and in the active search for opportunities (Lumpkin and Dess, 1996). Firms whose basic strategic orientation is to be proactive and to act first, in response to competitors, are more likely to introduce new products to the market than firms that are not proactive (Covin and Slevin, 1989). Hence, we assume that being proactive is related to innovation in general:

H2a: The EO dimension of proactiveness is uniquely and positively associated with dichotomy I, i.e. being an innovator rather than a non-innovator.

Product innovations that are new to the world are particularly likely to be associated with a higher level of proactiveness than imitative products because new products relate to future needs (Lumpkin and Dess 1996), create new resources through the exploration of opportunities (Wales et al., 2020), and thus, an innovation that is new to the world increases demand in existing markets or creates entirely new markets. New-to-the-world innovators are ahead of existing competition and exhibit proactive and future-oriented behavior (Venkatraman, 1989). Firms that strive to introduce new products and services, management techniques or operating technologies faster than their competitors are also more likely to introduce new products worldwide. These considerations lead to our next hypothesis:

H2b: The EO dimension of proactiveness is uniquely and positively associated with dichotomy II, i.e. being a global innovator rather than an imitator.

However, proactive firms can not only generate product innovations by using knowledge created internally by their own scientists or R&D staff, but they can also use knowledge developed by other firms to adopt product innovations (Pérez-Luño et al., 2011). We argue that the EO dimension of proactiveness is positively related to the likelihood of a startup introducing imitative products that are new to the home region (dichotomy III) or new to the home country (dichotomy IV). Of course, proactive behavior can also manifest itself on a

small scale by copying other firms in the same region. Local copying merely avoids competitive disadvantages but is unlikely to lead to an advantageous position. Product innovation by copying from further afield gives a startup a competitive advantage over local competitors who have not yet introduced the product. A proactive imitator can therefore manifest a relative advantage over competitors or maintain the distance from the market leader, especially if the time window to react is limited (Posen and Levinthal, 2012). Hence, if startups proactively seek opportunities and take a forward-looking perspective, they are more likely to launch a new product in the home region or even the home country rather than just imitating locally. These considerations lead to the following hypothesis:

H2c: The EO dimension of proactiveness is uniquely and positively associated with dichotomy III, i.e. being a non-firm-level imitator rather than a firm-level imitator.

Competitive aggressiveness

Following Lumpkin and Dess (1996, 2001), we distinguish between the EO dimensions of competitive aggressiveness and proactiveness and assume that each of these dimensions has a specific relation to product innovation. Hence, we argue that competitive aggressiveness is uniquely related to product innovation, especially product imitation, independent of the EO dimensions of innovativeness and proactiveness. Lumpkin and Dess (2001) suggest that proactiveness and competitive aggressiveness are different responses of firms to competition in markets. Proactiveness is a response to opportunities. Competitive aggressiveness, on the other hand, is a response to threats and thus, triggers different economic behavior. Proactive behavior refers to the exploitation of market opportunities and the initiation of actions to gain a leading position in the markets. Competitive aggressiveness, on the other hand, refers to a firm's response to trends and existing demands. In the context of technology and innovation, proactive behavior means that firms actively shape the environment, while reactive behavior means that firms adapt to the challenges posed by competitors.

Just observing the product innovations of competitors without acting manifests a competitive disadvantage. Thus, competitive aggressiveness will likely stimulate the imitation of existing innovations to catch up and overcome such competitive disadvantages. However, it could also encourage the development of a different approach to overtake the competitor and achieve a superior position. Regardless of which approach is chosen, this EO dimension tends to be positively related to the likelihood that a startup will introduce a product innovation that is at least new to the startup in order to defend its market position.

However, if the venture is already in a comfortable competitive position, targeting competition may not trigger additional opportunities for generating global innovations or any kind of imitation. Although the original definition of the dimension by Lumpkin and Dess (1996) includes the willingness to outperform competitors, a startup that has already closed gaps with competitors through imitation does not necessarily need further aggressive behavior. Launching new products is not necessary to defend a market position, and generating innovations is also resource-intensive. In an uncomfortable competitive position, advancement could be made by introducing a new product. Therefore, it is likely that competitive aggressiveness is positively related to the likelihood of being an innovator:

H3a: The EO dimension of competitive aggressiveness is uniquely and positively associated with dichotomy I, i.e. being an innovator rather than a non-innovator.

In our view, competitive aggressiveness can be associated with all types of imitation strategies, as it tends to be reactive. Depending on whether competitors are located in a startup's home region, in another region of the home country or in another country, a startup may defend its market position through imitation at the firm level, at the regional level or the country level. Therefore, it is not possible to say per se whether one of the imitation strategies in particular is associated with competitive aggressiveness. According to Ferrier (2001), the time to react in a competitive aggressive landscape depends on the complexity of the rival's actions. Hence, imitations which are only new to the firm are not only already widely spread, but they are also an indicator of low imitation barriers and as such require less time to copy. In contrast to proactiveness, we do not expect the EO dimension of competitive aggressiveness to be associated with the introduction of globally new products. While proactive startups might take the initiative and introduce global product innovations, it is more likely that competitively aggressive startups do not choose such a proactive strategy and only care about outperforming their competitors sufficiently or keeping an advantageous position (Ross and Sharapov, 2015). On the contrary, it could even be that these startups are less likely to introduce a new product globally due to the reactive nature of competitive aggressiveness. These theoretical considerations can be summarized in this hypothesis:

H3b: The EO dimension of competitive aggressiveness is uniquely and negatively associated with dichotomy II, i.e. being a global innovator rather than an imitator.

Risk-taking

Regarding the EO dimension of risk-taking, we believe that it is uniquely associated with the development and launch of new products worldwide, independent of the other three EO dimensions. Risk-taking reflects a tendency for firms to accept and engage in risky activities. Established measures of this EO dimension emphasize, for example, that risk-taking firms have a strong propensity for high-risk projects with very high returns, while risk-averse firms have a propensity for low-risk projects with normal rates of return (Miller, 1983, Covin and Slevin, 1989).

It is widely accepted that investing in unexplored technologies, launching new products in new markets or borrowing heavily is very risky (Lumpkin and Dess, 1996). Accordingly, it can be argued that startups that want to climb the top rung of the innovation ladder must engage in such risky activities so that risk-taking startups are more likely to be product innovation generators than imitators (dichotomy II). Empirically investigating the effects of the EO dimension of risk-taking on the introduction of new products, Pérez-Luño et al. (2011) found that risk-taking has a positive effect on product innovations that are new to the world.

We follow Pérez-Luño et al. (2011) and argue that the EO dimension of risk-taking has a positive effect on the probability of generating product innovations as world firsts but has no influence on the probability of adopting existing product innovations (imitation). While it could be argued that adopting product innovations from other countries could be time-consuming (e.g., search costs), costly (e.g., adapting the product to the needs of the startup's home markets), and risky (e.g., it is not certain that a product is successful in another country), the international imitation strategy is still significantly less risky than launching a product that is new to the world. Furthermore, not innovating is not risk-free either, as it carries the risk of falling behind the competition. This also aligns with the results of Lomberg et al. (2017), as we expect the other dimensions to be much more relevant for dichotomies I, III and IV and risk-taking only be associated with these dichotomies through the other dimensions, mainly proactiveness (e.g. taking risks to get and remain ahead of competition, Sharapov and Ross, 2023) and especially innovativeness. Against this background, we argue that the EO dimension of risk-taking is particularly relevant for dichotomy II but is not a determinant for dichotomies III and IV. Since there are also low-risk innovation strategies, risk-taking is unlikely to have a significant impact on firms' decisions to introduce new products in general (dichotomy I). Given our theoretical considerations and the findings of Pérez-Luño et al. (2011), we put forward our last hypothesis:

H4: The EO dimension of risk-taking is uniquely and positively associated with dichotomy II, i.e. being a global innovator rather than an imitator)

3.3 Materials and Methods

Sample and Data Collection

For our empirical analyses, we use four survey waves of the IAB/ZEW Startup Panel, provided by the Centre for European Economic Research (ZEW). Thus, there is a maximum of two separate EO measurements for each startup (see Chapters one and two). While much of previous empirical research on the impact of EO on firm performance is based on cross-sectional data (Miller, 2011), such research approaches are discouraged due to endogeneity problems (Anderson et al., 2022). Accordingly, we utilize our longitudinal panel data and evaluate the innovation ladder as a dependent variable with a one-year lag, i.e. the EO measurement of 2014 is paired with the product innovation measurement of 2015. Consequently, our sample consists of 5,800 observations from 4,383 firms from knowledge-intensive industries for which we have information on their EO, their position on the innovation ladder one year after the EO measurement took place and all necessary control variables available. Within these 4,383 firms, a group of 1,417 firms shows up twice as they answered all relevant questions for our analyses in their respective two waves of EO measurement.

Dependent variable: Innovation ladder's nested dichotomies

We measure a startup's position on the innovation ladder, i.e., the novelty of currently introduced products and services, using two survey items, that reflect items commonly included in innovation surveys and are based on the Oslo Manual interpretation of novelty (OECD and Eurostat, 2018). First, startups were asked whether they had introduced products or services in the market in the past year that were also new to their firm. If the startups answered "yes", they are further questioned on the geographical scope of the novelty. The possible answers were: no market novelty (1), a novelty in the regional market (2), a novelty in the German market (3) and a novelty in the global market (4). The exact wording of the questions can be found in Appendix 3.A. From this data, we construct the innovation ladder, as depicted in Figure 1, taking the following labels and values: On the lowest rung are non-innovators (0) that do not launch any new products or services. We distinguish between imitators at the firm level (1), regional-level imitators (2) and country-level imitators (3). On the highest rung are global innovators (4).

Entrepreneurial Orientation

Four dimensions of Entrepreneurial Orientation (EO) are operationalized based on the strategic posture scale developed by Covin and Slevin (1989) with extensions by Lumpkin and Dess (2001). We also adapted the items to make them suitable for very young firms, for example, it is not meaningful to ask two-year-old firms innovation results of the last three or five years, as proposed in the original EO measurement (Covin and Slevin, 1989). Since a significant proportion of startups are solo entrepreneurs, we followed the best practice of the IAB/ZEW Startup Panel and developed item versions for solo entrepreneurs and team startups (see Appendix 1.B).

We are confident that our adjusted measurements of EO dimensions are valid. First, previous research suggests that results regarding the relationship between EO and firm performance are generally relatively robust to variations in measurement instruments (Rauch et al., 2009). EO scales with a reduced number of items are not uncommon (Gupta and Gupta, 2015) and tend to represent valid EO scales (e.g., Zhao et al., 2011), including multidimensional measurement scales (e.g. Hansen et al., 2011). Second, we conducted an independent cross-validation of our adjusted and the original measures of the EO dimensions to further strengthen our confidence in our measures of the EO dimensions (see Chapter one).

Control variables

As in previous studies, we use employment as a measure of size (e.g., Real et al., 2014; Wiklund and Shepherd, 2011, Kollmann and Stöckmann, 2014) and include it logarithmically in the regressions. Firm age is measured by the difference between the founding year and the year of the corresponding survey wave. Furthermore, we include sector-specific fixed effects to account for unobserved sector-specific characteristics, such as the exposure of startups to sector-specific environmental hostility. We use the industry classification provided by the ZEW (see Appendix 1.A). Moreover, we control for time-fixed effects to account for year-specific general economic development.

3.4 Results

Descriptive statistics

First, we present descriptive statistics on the position of startups on the innovation ladder, which may vary from one observation year to another. Since some startups were surveyed twice and others only once (5,800 observations from 4,383 firms), we indicate the highest rung of the innovation ladder that a startup reached in one of the surveys. Of these 4,383

firms, 2,562 (58.45 per cent) report that they have not introduced any new products in the past year, 830 (18.94 per cent) report that they have introduced products that are new to the startup, 166 (3.79 per cent) have introduced products that are new to the region, 397 (9.06 per cent) startups have introduced products that are new to the country, and 428 (9.77 per cent) startups report that they have introduced new products that are new to the world[8]. Descriptive statistics and correlations for the relevant variables are shown in Table 12. Our four dichotomies tend to be positively correlated with the EO dimensions, with correlations being statistically significant at the 0.1 and 0.5 per cent level, especially for the EO dimension innovativeness, which prima facie shows that this EO dimension is not synonymous with being a global innovator but is also associated with imitative behavior.

[8] Note that the distribution by observation differs slightly, because some firms show up more than once. The shares at the observation level are as follows: No innovation 3,655 obs. (63.02 per cent), new to the firm 1,015 obs. (17.50 per cent), new to the region 181 obs. (3.12 per cent), new to the country 455 obs. (7.84 per cent) and new to the world 494 obs. (8.52 per cent). Whether at the firm-level or observation level, the percentage of firms that have introduced "new to the world" products is much lower than the 46 per cent reported in the study by Pérez-Luño et al. (2011). However, this could be due to the fact that the Pérez-Luño and colleagues ask about new product launches in the last five years and look at "firms from the industries that are most likely to exhibit innovative behaviors", whereas we only look at one year (after measuring EO) and our focus on knowledge-intensive industries is less restrictive in the sampling across industries. As our study focuses on startups (on average 1.5 years old), a five-year period makes little sense. A more comprehensive approach in terms of industries could help us to also observe a sufficient number of firms at lower and middle rungs of the innovation ladder.

Table 12: Descriptive statistics and correlations

	N	Mean	SD.	1	2	3	4	5	6
1. Innovativeness	5,800	5.08	2.66	1					
2. Proactiveness	5,800	7.87	2.22	0.35***	1				
3. Competitive aggressiveness	5,800	5.12	2.72	0.20***	0.23***	1			
4. Risk-taking	5,800	5.39	2.56	0.37***	0.27***	0.27***	1		
5. Employment (log)	5,800	1.36	0.63	0.09***	0.12***	0.15***	0.11***	1	
6. Firm Age	5,800	1.53	1.43	-0.07*	-0.06*	-0.07***	-0.07	0.18***	1
7. Dichotomy I	5,800	0.37	0.48	0.25***	0.19***	0.15***	0.17***	0.13***	-0.08***
8. Dichotomy II	2,145	0.23	0.42	0.32***	0.19***	0.08*	0.18***	0.11***	0.02
9. Dichotomy III	1,651	0.39	0.49	0.20***	0.22***	0.03	0.10***	0.03	-0.02
10. Dichotomy IV	636	0.72	0.45	0.20***	0.09*	0.04	0.14**	0.04	-0.02

Significance levels: *** p < 0.001, ** p < 0.005, * p < 0.05

Hypothesis tests

To test our hypotheses, we use a sequential multinomial logit model (Cameron and Trivedi, 2005), also known as the model of nested dichotomies (Fox, 1997). This estimation avoids the assumption of the independence of irrelevant alternatives (IIA) as assumed by traditional multinomial logit models (Fox, 1997). Violations of the IIA can be expected for innovation behavior because the odds of global innovation are not conditionally independent of the odds of innovating. To account for the various types of autocorrelation induced by the nature of panel data, we estimated cluster-robust standard errors (White, 1982, Rogers, 1993). As a robustness check, we instead included random effects (see Appendix 3.B), which explicitly model exchangeable autocorrelation (Cameron and Trivedi, 2005). The results remained robust. Estimating the standard error of the linear combination of coefficients from and test coefficients across different dichotomies, we employ seemingly unrelated estimation of standard errors (Weesie, 1999)[9]. To reduce Type I errors, we follow Benjamin et al. (2018) and change the default p-value threshold for statistical significance from 0.05 to 0.005 for claims of strong statistical evidence, and higher p-values up to 0.05 reflect suggestive evidence. Table 13 shows the results of our sequential multinomial logit model.

[9] We concede that this approach reduces efficiency somewhat as it unnecessarily allows for correlation between errors across equations. However, it provides a standard method implemented in Stata 16, that is used for the analyses and is, thus, less prone to errors associated with case-specific ad-hoc implementations.

Table 13: The innovation ladder and the unique effects of the four EO dimensions

	I Innovator vs. Non-innovator	II Global Innovator vs. Imitator	III Non-firm level imitator vs. Firm-level imitator	IV Country-level imitator vs. Regional-level imitator	χ^2-test
Innovativeness	0.13 (0.02)***	0.25 (0.03)***	0.13 (0.02)***	0.13 (0.04)**	*$\chi^2(4) = 233.20$* p = 0.000
Proactiveness	0.09 (0.02)***	0.16 (0.04)***	0.20 (0.03)***	0.04 (0.05)	*$\chi^2(4) = 90.35$* p = 0.000
Competitive aggressiveness	0.06 (0.01)***	0.00 (0.02)	-0.02 (0.02)	-0.01 (0.04)	*$\chi^2(4) = 26.48$* p = 0.0000
Risk-taking	0.04 (0.01)**	0.06 (0.03)*	0.02 (0.02)	0.06 (0.04)	*$\chi^2(4) = 16.07$* p = 0.0029
Log employment	0.26 (0.05)***	0.09 (0.09)	0.03 (0.09)	0.06 (0.15)	
Firm age	-0.08 (0.02)***	0.01 (0.05)	0.01 (0.04)	0.04 (0.07)	
Year fixed effects	Yes	Yes	Yes	Yes	
Industry fixed effects	Yes	Yes	Yes	Yes	
Observations	5,800	2,145	1,651	636	
Firms	4,383	1,821	1,447	593	
Total Log-Likelihood			-5847.3613		
Total Chi² (4x17)			1223.8381***		
Post-hoc coefficient comparisons					
	I	II	III	IV	
Proactiveness – Comp. Aggr.	0.04 (0.02)	0.16 (0.05)**	0.22 (0.04)***	0.04 (0.07)	

Notes: Sequential multinomial logistic regression analysis with cluster-robust standard errors reported in parentheses. Marginal effects reported for EO dimensions. In the last column, joint tests of the effects of EO dimensions for all dichotomies based on seemingly unrelated estimations of standard errors are reported. Significance levels: *** p < 0.001, ** p < 0.005, * p < 0.05

Innovativeness: The joint test across all dichotomies reveals that innovativeness is statistically significantly associated with product novelty ($\chi^2(4) = 233.20$, p = 0.000). For dichotomies I and II, there are relatively large effect sizes and strong empirical evidence. These findings support our Hypothesis 1a that a higher level of innovativeness makes it more likely that a startup is an innovator rather than a non-innovator (dichotomy I, $\beta = 0.13$, $p < 0.001$). In line with our theoretical considerations and previous research findings, we also find that innovativeness is relevant for transitioning from being an imitator to being a global

innovator. Hence, we can support our Hypothesis 1b related to dichotomy II ($\beta = 0.25$, $p < 0.001$).

Concerning firms' imitation behavior, we observe strong empirical evidence that the EO dimension of innovativeness increases the probability that a startup not only introduces product innovations that are new to the startup itself but also copies product innovations outside its home region or its home country (dichotomy III; $\beta = 0.13$, $p < 0.001$). Moreover, innovativeness is the only one of the four EO dimensions for which we find at least strong empirical evidence of relevance for dichotomy IV, i.e., the transition from a regional-level imitator to a country-level imitator ($\beta = 0.13$, $p = 0.004$). Hence, our estimations unambiguously support our Hypotheses 1c and 1d.

Proactiveness: The joint test for all dichotomies shows that proactiveness is statistically significantly associated with the degree of product novelty ($\chi^2(4) = 90.35$, $p = 0.000$). Looking at the dichotomies I to II, we observe strong statistical evidence for positive effects of proactiveness on the likelihood of introducing an innovation rather than not doing so and being an innovation generator rather than an imitator (Hypotheses 2a and 2b). Particularly for dichotomy II, the effect is comparatively large ($\beta = 0.16$, $p < 0.001$), suggesting that proactiveness is substantially associated with innovation generation.

In contrast, our results regarding the relevance of proactiveness for the imitation behavior of startups are less clear-cut. While the effect for dichotomy III is positive, relatively large, and statistically significant ($\beta = 0.20$, $p < 0.001$), the effect for dichotomy IV is small and not statistically significant ($\beta = 0.04$, $p = 0.487$). These findings clearly support our Hypothesis 2c on proactiveness decreasing the likelihood that startups to imitate only locally, but proactiveness does not seem to cause non-locally imitating startups to move from interregional to international imitation.

Competitive aggressiveness: The joint test across all dichotomies revels a statistically significant relation between competitive aggressiveness and product innovation ($\chi^2(4) = 26.48$, $p = 0.0000$). However, looking into the individual dichotomies, we see that this is driven solely by dichotomy I, where we find strong empirical evidence for a positive effect ($\beta = 0.06$, $p = 0.000$), implying that competitive aggressiveness pushes firms from non-innovation to the introduction of any product innovation, hence, supporting our Hypothesis H3a. While competitive aggressiveness does not significantly affect Dichotomies II, III and IV, it should be noted that these latter two effects are the only effects of the EO dimension

that are estimated to be negative. Interpreting the coefficients independent of their statistical significance would suggest that competitive aggressiveness might promote innovation via local imitation rather than global innovations or interregional innovation transfer. However, the lack of strong or even suggestive empirical evidence indicates that it should not be considered reliable empirical evidence, but this could be an interesting future avenue of research.

Our results concerning competitive aggressiveness and proactiveness also offer new insights concerning the relevance of the separation of proactiveness and competitive aggressiveness, as proposed by Lumpkin and Dess (2001). Based on our estimation, we calculate and test the differences between the estimated effects for these two dimensions (see bottom part of Table 13). The difference is significant for dichotomies II, III, and IV, but not for dichotomy I. Hence separating the two dimensions is worthwhile when it comes to explaining the emergence of new-to-the-world innovations or the international and interregional transfer of knowledge, i.e., the critical processes of innovation generation and diffusion, but less critical when it comes to whether ventures innovate at all.

Risk-taking: The joint test for all dichotomies reveals that risk-taking is weakly statistically significantly associated with the degree of product novelty ($\chi^2(4) = 16.07$, $p = 0.0029$) For dichotomy I (innovator vs. non-innovator), we observe an effect that is statistically significant at the 0.005 per cent level ($\beta = 0.04$, $p = 0.004$), hence risk-taking relates so innovation in general. For dichotomy II (global innovator vs. imitator), our results indicate suggestive empirical evidence ($\beta = 0.06$, $p = 0.024$). Hence, we see only *suggestive* empirical evidence for our Hypothesis 4 on risk-taking positively relating to a startup's likelihood to be an innovation generator rather than an imitator. Moreover, the effects of risk-taking, conditioned on innovativeness and proactiveness being constant are small compared to innovativeness and proactiveness, an observation we will discuss below.

Finally, and as expected from our theoretical considerations, risk does not play a role in discriminating different types of imitation behavior of startups (dichotomies III and IV).

Additional analysis: EO and imitative behavior

While dichotomy I distinguishes between innovators and non-innovators, the group of innovators comprises two quite distinct subgroups, namely global innovators and imitators. Consequently, the effects of the EO dimensions observed for dichotomy I could be solely caused by the top rung of the innovation ladder and erroneously attributed to imitative

behavior. To test the robustness of our results, we therefore exclude the highest rung (global innovator), so that the country-level imitator now represents the highest rung. The results of our additional analysis, presented in column 1 of Table 14, suggest that the effects of innovativeness, proactiveness and competitive aggressiveness found for dichotomy I are not solely driven by introducing new-to-the-world innovations and reconfirm that these three EO dimensions increase the likelihood of introducing imitative products.

To explore whether getting even lower on the innovation ladder changes the conclusions, we stepwise excluded the higher rungs one by one (see remaining columns in Table 14). The estimated effects of the EO dimension innovativeness and proactiveness are now smaller. The effects of innovativeness and proactiveness remain strongly significant for the first dichotomy but only show suggestive evidence for the new dichotomy II and turn insignificant for dichotomy III in the case of proactiveness. In contrast, the estimated effect of competitive aggressiveness remains unchanged and shows strong empirical evidence at the 0.1 per cent level for all dichotomies. These robustness checks confirm that the EO dimensions of innovativeness and proactiveness are particularly relevant for a higher degree of novelty of imitation products, while the transition from non-innovator to innovator at the firm level is inherently linked only to competitive aggressiveness.

Table 14: Imitation and the unique effect of the four EO dimensions - excluding the upper rungs of the innovation ladder

	Imitator vs Non-innovator	Regional- and firm-level imitator vs Non-innovator	Firm-level imitator vs Non-innovator
Innovativeness	0.08	0.04	0.04
	(0.01)***	(0.02)*	(0.02)*
Proactiveness	0.07	0.04	0.02
	(0.02)***	(0.02)*	(0.02)
Competitive aggressiveness	0.06	0.06	0.07
	(0.01)***	(0.01)***	(0.01)***
Risk-taking	0.03	0.01	0.02
	(0.01)	(0.02)	(0.02)
Log employment	0.22	0.20	0.19
	(0.05)***	(0.06)**	(0.06)**
Firm age	-0.08	-0.09	-0.08
	(0.02)**	(0.03)**	(0.04)**
Year fixed effects	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes
Observations	5,306	4,851	4,670
Firms	4,083	3,797	3,697
Total Log-Likelihood		-8084.6541	
Total Chi^2 (3x17)		659.81189***	

Notes: Sequential multinomial logistic regression analysis with cluster-robust standard errors reported in parentheses. Marginal effects reported for EO dimensions. Joint tests of the effects of EO dimensions for all dichotomies based on seemingly unrelated estimations of standard errors are reported in the last column. Significance levels: *** $p < 0.001$, ** $p < 0.005$, * $p < 0.05$

Additional analysis: Unique versus shared effects of the dimensions of EO

In our previous analyses, we focused on the *independent* effects attributable to *unique* variations in each EO dimension, which are the effects under the assumption that the other dimensions do not change along with the focal dimension (ceteris paribus). However, if an innovative strategic posture was to be equated with an innovation outcome, creating a tautology as highlighted by Covin and Wales (2019) and Pérez-Luño et al. (2011), then the estimated effects of the remaining dimensions of EO would be artefacts that cannot be meaningfully interpreted in terms of innovation outcomes. Moreover, our focus on independent effects of the dimensions of EO can generally limit our understanding of the effects of entrepreneurial orientation (Lomberg et al., 2017). Lomberg and colleagues illustrate this for the risk-taking dimension, which could have a positive effect on performance if risk-taking is related to innovativeness, such that innovativeness increases as risk-taking

increases. Hence, risk-taking might display no independent (unique) effect but matter through its relationship with innovativeness.

To explore the extent to which our results are affected by including or excluding the innovation dimension, we conducted additional analyses in which we excluded the innovativeness dimension (see Table 15). The joint tests reveal that risk-taking is statistically significantly associated with the degree of product novelty across all dichotomies ($\chi^2 = 67.44$, $p = 0.0000$). For dichotomy II in particular and to a lesser extent for dichotomy I, the effect estimates increase substantially and are now statistically significant even at the 0.1 per cent level ($p < 0.001$). In contrast, the effect estimates for Dichotomies III and IV remain small and only statistically weakly significant. Thus, our results confirm the findings of Lomberg et al. (2017) that risk-taking has a significant effect on firm performance due to its association with innovativeness. However, the effects associated with "risky innovativeness" appear to be relevant only for the top rung of the innovation ladder but not for the lower rungs, which is consistent with the assumption that the risk associated with product innovation is highest for new-to-the-world product innovation. Even more important to our analysis, the exclusion of innovativeness does not qualitatively change any of the results for proactiveness or competitive aggressiveness.

Table 15: The innovation ladder and the effects of the four EO dimensions - shared effects of each dimension with innovativeness

	I Innovator vs. Non-innovator	II Global innovator vs. Imitator	III Non-firm level imitator vs. Firm-level imitator	IV Country-level imitator vs. Regional-level imitator	χ^2-test
Proactiveness	0.13	0.23	0.22	0.07	*$\chi^2(4) = 159.55$*
	(0.01)***	(0.04)***	(0.03)***	(0.05)	p = 0.0000
Competitive aggressiveness	0.06	0.01	-0.02	-0.00	*$\chi^2(4) = 31.76$* p = 0.0000
	(0.01)***	(0.02)	(0.02)	(0.03)	
Risk-taking	0.07	0.12	0.05	0.10	*$\chi^2(4) = 67.44$*
	(0.01)***	(0.02)***	(0.02)*	(0.04)*	p = 0.0000
Log employment	0.26	0.13	0.06	0.07	
	(0.05)***	(0.09)	(0.08)	(0.14)	
Firm age	-0.09	-0.02	-0.00	0.02	
	(0.02)***	(0.04)	(0.04)	(0.08)	
Year fixed effects	Yes	Yes	Yes	Yes	
Industry fixed effects	Yes	Yes	Yes	Yes	
Observations	5,800	2,145	1,651	636	
Firms	4,383	1,821	1,447	593	
Total Log-Likelihood	-5975.169				
Total Chi² (4x16)	968.22279***				

Notes: Sequential multinomial logistic regression analysis with cluster-robust standard errors reported in parentheses. Marginal effects reported for EO dimensions. Joint tests of the effects of EO dimensions for all dichotomies based on seemingly unrelated estimations of standard errors are reported in the last column. Significance levels: *** p < 0.001, ** p < 0.005, * p < 0.05

To explore the total rather than independent effects of the dimensions of EO, we included each dimension separately so that the coefficients reflect the total effect of a dimension, which includes effects that only show up when other dimensions change simultaneously (see Table 16). As expected, the estimated effects and p-values for all four EO dimensions tend to increase compared to the results reported in Tables 13 and 15. However, we do not observe qualitatively different patterns for the total effects compared to the independent effects for proactiveness. The competitive aggressiveness dimension now shows a higher effect in dichotomy II with an increased level of significance (0.5 per cent) but still no effects in the latter dichotomies. This is in line with our previous results that suggest only shared effects to be present for competitive aggressiveness in dichotomy II. However, after excluding innovativeness, proactiveness and competitive aggressiveness, the effects of risk-taking even increase and reach statistically strong significance at the 0.1 per cent level for dichotomy III and 0.5 per cent in dichotomy IV, indicating strong empirical evidence. Again, we observe that risk-taking has a positive effect on the novelty level of product innovation due to its

alignment with changes in other dimensions, including proactiveness and possibly competitive aggressiveness. While higher risk-taking is necessary to achieve a higher position on the innovation ladder, risk-taking alone, e.g. gambling, cannot achieve this (Lomberg et al., 2017).

Table 16: The innovation ladder and the effects of the four EO dimensions - total effects of each dimension

	I Innovator vs. Non-innovator	II Global innovator vs. Imitator	III Non-firm level imitator vs. Firm-level imitator	IV Country-level imitator vs. Regional-level imitator
Innovativeness	0.17 (0.01)***	0.30 (0.02)***	0.16 (0.02)***	0.15 (0.04)***
Total Log-Likelihood	-5941.23679			
Total Chi² (4x14)	1,036.10***			
Proactiveness	0.17 (0.01)***	0.26 (0.03)***	0.23 (0.03)***	0.08 (0.05)
Total Log-Likelihood	-6039.77123			
Total Chi² (4x14)	839.02***			
Competitive aggressiveness	0.10 (0.01)***	0.06 (0.02)**	0.02 (0.02)	0.02 (0.03)
Total Log-Likelihood	-6142.85133			
Total Chi² (4x14)	632.87***			
Risk-taking	0.11 (0.01)***	0.15 (0.02)***	0.07 (0.02)***	0.10 (0.04)**
Total Log-Likelihood	-6107.13373			
Total Chi² (4x14)	704.29***			

Notes*:* Sequential multinomial logistic regression analysis including only one dimension of EO; hence each row presents one model for each of the four nested dichotomies. Standard errors are reported in parentheses. Each model includes all control variables and industry and time-fixed effects, but for brevity, coefficients are omitted from the table. Significance levels: *** p < 0.001, ** p < 0.005, * p < 0.05

3.5 Discussion and Conclusion

Using data from German knowledge-based startups, this study provides empirical evidence that the EO dimensions of innovativeness, proactiveness, and competitive aggressiveness are each independently associated with the degree of novelty of product innovations, while the effect of the EO dimension risk-taking mostly works via simultaneous changes in these former dimensions. More specifically, the likelihood of introducing products that are globally novel is positively related to innovativeness and proactiveness, and furthermore, these two EO dimensions are also associated with the likelihood of introducing imitation products from other regions or in the case of innovativeness additionally other countries. Competitive aggressiveness is the only EO dimension that is significantly related to the transition from

non-innovator to local firm-level imitator without relating to global innovation or imitation from other regions or countries. Consequently, our results extend the research on the relationship between EO and innovation by showing that the three EO dimensions of innovativeness, proactiveness, and competitive aggressiveness provide an explanation for variation in the novelty of imitative products.

The importance of EO dimensions for firms' imitation behavior

Our study contributes to research on firms' imitation behavior (e.g., Lee and Zhou, 2012; Grahovac and Miller, 2009; Shenkar, 2010; Peng et al., 2021; Posen et al., 2023) by showing how imitation is related to firms' basic strategic postures, i.e., the EO dimensions. Lieberman and Asaba (2006) state that according to information-based theories, firms follow others who are better informed, and according to rivalry-based theories (i.e. Delios et al., 2008; Semadini and Andrson, 2010; Milstein et al., 2022), firms imitate others to maintain competitive parity. The corresponding strategic posture could best be described by the EO dimension of competitive aggressiveness, that is, the responsiveness in the form of outperforming its rivals in the market causing the introduction of products that are new in the home region or even in the home country. However, it can also be more reactive when a firm introduces a product that is new only to the firm itself in order to respond to the introduction of new products by competitors. Our results show that competitive aggressiveness promotes all stages of imitation on our innovation ladder but is also the only EO dimension that is particularly associated with the likelihood of being a local imitator rather than global innovating or imitating from geographically distant places. In contrast, the EO dimensions of innovativeness and proactiveness are particularly relevant for the transition to higher levels of imitation. The diverging effects of proactiveness and competitive aggressiveness in the context of imitation outcomes, which illustrate distinct roles, validates Lumpkin and Dess's (1996, 2001) conceptualization of EO, which separates proactiveness and competitive aggressiveness. Our results tend to support the dynamic model of imitation proposed by Posen et al. (2023), according to which there are different imitation strategies, imitation is difficult, and entrepreneurial firms imitate.

Our findings also contribute to research on the diffusion of innovations (e.g. Rogers, 2003), as diffusion of product innovations is closely linked to imitation (Giachetti and Lanzolla, 2016). It is a stylized fact that the diffusion of new technologies over time follows an S-curve, and heterogeneity in firm characteristics provides an explanation for this pattern. According to the probit model, these S-curves occur because different firms with different goals and

capabilities are likely to want to adopt new technologies at different times (Geroski, 2000). Accordingly, firms of different types introduce new products and services gradually. Our results suggest that the heterogeneity of firms with respect to their EO dimensions may provide a further explanation for this imitation behavior and the diffusion of new products over time and across geographic areas. For example, if we assume that the EO dimensions of innovativeness and proactiveness are normally distributed in the firm population and that firms with very high innovativeness and proactiveness are the first to introduce products or services that are new to the region or country in which the firm is located, and firms with lower innovativeness and proactiveness introduce these products and services later, we obtain an S-shaped diffusion curve. Previous research has neglected the relationship between the diffusion of product innovations and EO dimensions, presumably because EO has been associated mainly with world firsts but not with imitation and diffusion of product innovations. However, our results suggest that the three EO dimensions of innovativeness, proactiveness and competitive aggressiveness are firm characteristics that are relevant to the diffusion of product ideas. Proactive startups look outside their region for ideas for their (imitative) product innovations, and startups that are highly innovative even go beyond their own country to find ideas for product innovations. To our knowledge, the role of EO for geographic product diffusion processes has not yet been considered in EO research, and, therefore, our initial findings could stimulate further research on these links between EO and innovation diffusion.

The importance of EO dimensions for being a global innovator

Our results suggest that the two EO dimensions of proactiveness and innovativeness are critical to being a global innovator. Since our empirical analysis focuses on the unique effects of the EO dimensions, this means that proactive firms in particular are more likely to reach the highest rung of the innovation ladder, regardless of the degree of innovative strategic posture. Thus, the generation of product innovation is not exclusively linked to the EO dimension of innovativeness (Pérez-Luño et al., 2011) but also requires a proactive strategic orientation. In contrast, our results provide at best suggestive empirical evidence of a unique relationship between the EO dimension of risk-taking and the likelihood of being a global innovator. The positive link between risk-taking and innovation generation reported by Pérez-Luño et al. (2011) is not confirmed by our results when controlling for an innovative strategic posture. However, like Lomberg et al. (2017), we find that the estimated effects of risk-taking are much stronger when not controlling for the EO dimension innovativeness and the other

two EO dimensions in the empirical analysis. This means that a strong propensity for risk-taking is not per se conducive to the introduction of products that are new to the world. Firms that score high on the EO dimension of risk-taking may also engage in risky actions that are not related to innovation or imitation strategies. We therefore conclude that the EO dimension of risk-taking only has a positive impact on the likelihood of being a global innovator if it is accompanied by a more innovative strategic stance.

The problem of a potential tautology

Covin and Wales (2019) point out that empirical studies examining the relationship between EO and radical product innovation need to take into account that evidence of radical product innovation can be seen as an indication of EO rather than a consequence of EO. To avoid the risk of examining tautological relationships, it is therefore important to make a clear distinction between the innovation behavior of firms and their fundamental strategic orientation. Our empirical analysis of the relationship between a startup's position on the innovation ladder and the four EO dimensions makes a clear distinction between a startup's strategic orientation and its innovation behavior, i.e., we do not examine a tautological relationship. A tautology would mean, for example, that the EO dimension innovativeness is synonymous with being a global innovator (launching products that are new worldwide). But then this EO dimension cannot simultaneously explain imitation behavior and the degree of novelty of the imitated products (introducing products that are new to the firm, region or country). However, this is exactly what our results suggest, as we find that both the likelihood of being a global innovator and the likelihood of being an imitator are related to the EO dimension of innovativeness. Moreover, consistent with the findings of Pérez-Luño et al. (2011), we find that the likelihood of being a global innovator is also uniquely related to proactiveness, although unlike them, we control for an innovation-oriented strategic posture. When focusing on startups' imitation behavior, we find that competitive aggressiveness also plays a role that goes beyond the effects of innovativeness and proactiveness. Again, the EO dimension of innovativeness does not fully explain a firms' innovation behavior. That is, even when controlling for innovative posture the remaining dimensions of EO have independent effects on innovation outcomes, an observation that could provide a more accurate understanding of how the dimensions of EO affect venture performance. Our empirical results show that innovativeness as a dimension of an entrepreneurial strategic posture is much more general and refers to various innovation behaviors, such as imitating new products, and not only to the introduction of products that are new to the world. Hence, although we reject the

claim that there is a fundamental tautology problem in empirical studies on the relationship between innovation behaviors or outcomes and the EO dimension of innovativeness, we nevertheless reiterate Covin and Wales' (2019) recommendation to be very careful and explicitly discuss the tautology problem when measuring EO and when analysing the relationship between EO and innovation outcomes.

Limitations

Although we believe that our study contributes to a better understanding of the links between firms' imitation behavior and the dimensions of EO, our study is not without limitations. As with previous empirical studies on the relationship between product innovation and EO, we cannot rule out endogeneity issues and therefore cannot claim to have identified causal effects. This would require a true natural experiment or the existence of a valid instrumental variable. However, since EO reflects the fundamental strategic posture of a venture, it may be difficult if not impossible to obtain valid instrumental variables, which satisfy the exclusion restriction. In contrast to most empirical studies on EO, which are based on cross-sectional data and are prone to endogeneity problems (Anderson et al., 2022), our study is based on data from the IAB/ZEW Startup Panel, which allows us to address some problems that previous empirical studies often face. First, our study reduces potential endogeneity problems as the measure of a startup's position on the innovation ladder comes from the survey wave conducted one year after the measurement of the EO dimensions. Second, Anderson et al. (2022) recommend including performance outcomes with a shorter lag to a change in EO, such as the introduction of new products. We follow this recommendation by using the degree of product novelty as a dependent variable. Note that our dependent variable is year-specific, so a start-up's position on the innovation ladder can change from year to year. Hence, EO creates new value by increasing the number of product innovations a venture firm has over time and positively affects the degree of novelty of product innovations (Wales et al. 2023). Third, by focusing on startups, we also address another specific endogeneity issue. Studies that examine the relationship between EO and performance measures based on data from established firms typically suffer from survival bias, as only surviving firms are examined (Wiklund and Shepherd, 2011). In this respect, it is advantageous to focus on new firms, as the selection bias is likely to be less pronounced for younger firms than for older ones.

Finally, our data includes a subsample of startups, which were not only surveyed twice regarding their EO but also reported product innovations in both survey waves and reported

all other considered variables. A natural next step would be to use panel estimators to control for unobserved firm-specific fixed effects. Of course, we have considered such panel regressions, but unfortunately, this approach does not work in our case for two reasons: First, with a maximum of two observations per firm, we face the "incidental parameters problem", which means that the maximum likelihood estimator in nonlinear panel data models with fixed effects tends to be biased and inconsistent (Lancaster, 2000). Second, from a theoretical perspective, EO dimensions reflect a firm's underlying strategic posture, which is likely to vary little in the short run, i.e. is relatively stable (Covin and Lumpkin, 2011; Covin and Wales, 2012). In this regard, our data from startups rather than established firms might be an advantage as Anderson et al. (2022) expect younger firms to change their EO more frequently. However, our data suggest that the variation in EO dimensions between startups is much larger than the variation within startups over time. For most startups with two EO measurements, we observe very little or no change in the measurements of their EO dimensions. That is, although our analyses of the startup data with a lagged dependent variable go beyond simple cross-sectional analyses and address some endogeneity issues, we cannot exploit sufficiently long panel data to address the problem of unobserved firm-level heterogeneity.

Conclusion

The relevance of a firm's fundamental strategic posture in terms of entrepreneurial orientation (EO) for its imitation behavior and thus its importance for the diffusion of product innovations has been largely overlooked in previous research. Our study fills this research gap and demonstrates the importance of EO dimensions for firms' imitation behavior. Our results show that heterogeneity in the imitation behavior of firms is related to three EO dimensions, namely innovativeness, proactiveness, and competitive aggressiveness. Each of these EO dimensions is uniquely related to a firm's position on the innovation ladder. Our study opens several avenues for future research, not least for exploring the importance of EO dimensions for interregional and international product diffusion.

Appendix

Appendix 3.A: Measurement of the Innovation Ladder

Label	English items	German items
IL1	Did you introduce any PRODUCTS or SERVICES on the market in [year] which were new for YOUR firm or which were significantly improved? 1: Yes 2: No Internal 9: Doesn't know / question not answered	Haben Sie im [Jahr] PRODUKTE oder DIENSTLEISTUNGEN in den Markt eingeführt, die für IHR Unternehmen neu oder gegenüber früher merklich verbessert worden waren? 1: Ja 2: Nein Intern 9: Weiß nicht / Antwort verweigert
IL2	Are there any products or services among those introduced in [year] which you have introduced on the global, German or regional market as the first supplier? 1: no, no market novelty 2: yes, market novelty in my region 3: yes, market novelty on the German market 4: yes, market novelty on the global market Internal 9: Doesn't know / question not answered	Gibt es unter den [Jahr] neu eingeführten Produkten oder Dienstleistungen solche, die Ihr Unternehmen weltweit, deutschlandweit oder in Ihrer Region als erster Anbieter im Markt eingeführt hat? 1: nein, keine Marktneuheit 2: ja, Marktneuheit in meiner Region 3: ja, Marktneuheit in Deutschland 4: ja, Marktneuheit auf dem Weltmarkt Intern 9: Weiß nicht / Antwort verweigert

Appendix 3.B: Nested Dichotomies with Random Effects

The relationship between a startup's position EO and geographic degrees of newness

	I Innovator vs. Non-innovator	II Global Innovator vs. Imitator	III Non-firm level imitator vs. Firm-level imitator	IV Country-level imitator vs. Regional-level imitator
Innovativeness	0.16 (0.02)***	0.38 (0.05)***	0.15 (0.03)***	0.46 (0.14)**
Proactiveness	0.11 (0.02)***	0.22 (0.06)***	0.22 (0.04)***	0.10 (0.18)
Competitive aggressiveness	0.07 (0.01)***	0.00 (0.04)	-0.03 (0.02)	-0.00 (0.11)
Risk-taking	0.05 (0.02)**	0.10 (0.04)*	0.03 (0.03)	0.21 (0.13)
Log employment	0.33 (0.06)***	0.19 (0.15)	0.04 (0.10)	0.22 (0.49)
Firm age	-0.10 (0.03)***	0.02 (0.08)	0.01 (0.05)	0.25 (0.24)
Year-specific fixed effects	Yes	Yes	Yes	Yes
Industry-specific fixed effects	Yes	Yes	Yes	Yes
Observations	5,800	2,145	1,651	636
Firms	4,383	1,821	1,447	593
Total Log-Likelihood	-5780.7579			
Total Chi^2 (4x17)	557.40661***			

Notes: Random-effect logistic regression analysis. Significance levels: *** $p < 0.001$, ** $p < 0.005$, * $p < 0.05$

Appendix 3.C: Including Autonomy

	I Innovator vs. Non-innovator	II Global Innovator vs. Imitator	III Non-firm level imitator vs. Firm-level imitator	IV Country-level imitator vs. Regional-level imitator	χ^2-test
Innovativeness	0.13	0.25	0.13	0.12	*$\chi^2(4) = 229.59$*
	(0.01)***	(0.03)***	(0.02)***	(0.04)**	p = 0.0000
Proactiveness	0.09	0.16	0.20	0.03	*$\chi^2(4) = 88.09$*
	(0.02)***	(0.04)***	(0.03)***	(0.05)	p = 0.0000
Competitive aggressiveness	0.06	0.00	-0.03	-0.01	*$\chi^2(4) = 26.31$*
	(0.01)***	(0.02)	(0.02)	(0.04)	p = 0.0000
Risk-taking	0.04	0.06	0.02	0.06	*$\chi^2(4) = 15.93$*
	(0.01)**	(0.03)*	(0.02)	(0.04)	p = 0.0031
Autonomy	-0.04	0.00	0.03	-0.03	*$\chi^2(4) = 11.84$*
	(0.01)**	(0.03)	(0.03)	(0.04)	p = 0.0186
Log employment	0.25	0.08	0.03	0.05	
	(0.05)***	(0.09)	(0.09)	(0.15)	
Firm age	-0.08	0.01	0.01	0.04	
	(0.02)**	(0.05)	(0.04)	(0.07)	
Year fixed effects	Yes	Yes	Yes	Yes	
Industry fixed effects	Yes	Yes	Yes	Yes	
Observations	5,766	2,133	1,641	634	
Firms	4,359	1,811	1,438	591	
Total Log-Likelihood			-5810.9259		
Total Chi² (4x18)			1226.6148***		

Notes: Sequential multinomial logistic regression analysis with cluster-robust standard errors reported in parentheses. Marginal effects reported for EO dimensions. Joint tests of the effects of EO dimensions for all dichotomies based on seemingly unrelated estimations of standard errors are reported in the last column. Significance levels: *** p < 0.001, ** p < 0.005, * p < 0.05

4 Chapter four

Entrepreneurial Orientation shaping Sustainability: Insights from German large Enterprises[10]

[10] Co-written with Markus Thomanek who handled the data access.

4.1 Introduction

From a strategic perspective, companies are facing new challenges due to the increasing importance of climate change and environmental pollution. How companies deal with these new challenges could also depend on their fundamental strategic orientation. For example, do they take a proactive or a wait-and-see approach (Clarke and Liesch, 2017)? Are they innovative or do they stick to tried and tested business models? However, these ecological challenges imply external costs humanity has to bear (Tol, 2002; 2018; Kolstadt and Moore, 2020). Firms play a crucial role in the ecological context of human development as firms decide about factors like output quantities, production processes and the introduction and adoption of novel technologies. These decisions have ecological implications. Thus, firms' actions have direct and indirect impacts considering the environmental state of our planet (Lin et al., 2021, Zeitouni and Easter, 2018, Wang et al., 2018). Overcoming these challenges is crucial to achieve a path which leads to a (environmental) sustainable economy. At the same time, the interest in sustainable investments is rising (Eyraud et al, 2013; Chitimiea et al., 2021) and thus, firms seeking new capital or a listing in sustainability-oriented capital funds can scare off potential investors by their involvement in controversial practices. Key to understanding the behavior of firms is their strategic posture which influences the individual decisions a firm makes and, therefore, influences the ecological and social impact each firm has on its environment.

In this study, we argue that the strategic posture expressed by a firm's different Entrepreneurial Orientation (EO) dimensions, influences the firm's sustainability and involvement in controversial behavior. EO and its relation to firm performance (Covin and Slevin, 1989; Wiklund and Shepherd, 2003, 2005; Gupta and Gupta, 2015) are well established, while the influence on sustainability and controversies is not as clear. The existing studies tend to find evidence for a positive relationship between EO and sustainability (e.g. Hooi et al. 2016; DiVito and Bohnsack, 2017; Marshall et al. 2015) and apply a mixture of uni- and multidimensional approaches, while no existing study includes the established five-dimension multidimensional approach of Lumpkin and Dess (1996) to research the link between EO and sustainability, especially as we argue that the dimensions can have opposing effects on our dependent variables and no previous study contained the dimensions of competitive aggressiveness and autonomy. Additionally, data regarding sustainability indicators is still not widely published as attempts to do so just started recently.

But achieving sustainability comes with its own challenges. Firms can only pretend to seek a higher level of sustainability, resulting in their actions being labelled as greenwashing (for a review see Yang et al., 2020), harming their reputation and reducing the attractiveness for potential investors seeking sustainability-oriented investments. While those specific controversies are directly related to sustainability efforts, firms always face the risk of finding themselves involved in a controversy caused by their daily operations which are based on a firm's strategic posture. For example, a new product could cause harm to the environment, the search for a market opportunity or fierce competition could lead to illicit actions, large risks could materialize, or employees' individual decisions could act detrimental to their firm's interests.

In this study, we examine the relationship between five individual EO dimensions and two measurements related to sustainable behavior: an indicator reflecting sustainability and a second one related to the number of controversies. To gain insights into the relationship between EO and sustainability and controversies, we focus on large companies as they have large impacts on sustainability issues in absolute terms (Azar et al., 2021), but at the same time can be relatively more efficient than small companies (Cole et al., 2013). In general, researchers can ask firms about their EO ex-post and do so in the mentioned literature, but these studies focus on small and medium enterprises (SMEs), while Marshall et al. (2015) include some large firms in their sample. The general access to sustainability data is better. For large firms, some databases already exist which contain a limited number of sustainability measurements. This is especially true for publicly traded firms as they are of a higher interest to investors compared to SMEs which are not present in any stock listing.

Typically, collecting measurements of firms' EO is complicated at best, due to the small number of responses and difficulties in having the firms' board or top management answer respective questionnaires (Mellahi and Harris, 2016; Cycyota and Harrison, 2006) as they are the appropriate addresses to capture a firm's strategic posture. Therefore, we employ an indirect approach to measure EO using computer-aided text analysis (CATA) (Short et al., 2010; McKenny et al., 2018b) and increase the sample size. By accessing publicly available letters to shareholders (LTS), published in the firms' annual financial reports, we infer the dimensions of EO through the use of words in these LTS. This approach was first introduced in the context of EO by Short et al. (2010) and advocated by Wales (2016), who acknowledges the new research opportunities an alternative measuring approach could open. We follow the approach of Short et al. (2010) and McKenny et al. (2018b) by analysing the LTS of large

German firms listed in the stock indices DAX, SDAX and MDAX. A CATA analysis, measuring EO expressed by the LTS is performed by adapting the dictionaries by Short et al. (2010) for German letters. These EO measures are then linked to our sustainability measurements. First, a score of sustainability regarding environment, workforce, and governance indicators; second, a score representing the number of a firm's controversies.

Our results contribute to the research on EO and sustainability in two ways. First, we show that EO, like in the studies by Hooi et al. (2016), DiVito and Bohnsack (2017) and Marshall et al. (2015), is positively linked to sustainability. However, this positive relation is only driven by one out of five EO dimensions, namely competitive aggressiveness and not by EO as a combination of all dimensions. Furthermore, we find that in more innovative firms a higher number of controversies occur. These findings also have very practical implications for firms pursuing sustainability goals. Second, our study further explores the use of CATA as an alternative measurement of EO. By applying CATA as an EO measurement on German LTS, we point out obstacles and potential shortcomings. We further highlight how the data must be interpreted carefully and demonstrate it on the EO dimension of autonomy. While using CATA to capture autonomy technically works, we found that the data we collected did not represent the idea of autonomy dimension within the LTS and thus limits the reliability for certain areas of application.

4.2 Conceptual Background

This study argues that a firm's strategic posture, reflected by the EO of a firm, influences decisions regarding the firm's sustainability and that each dimension has unique effects on the sustainability indicators used. Sustainability has its origins in forestry, where the amount of wood cut should never be higher than the amount of wood regrowing (Wiersum, 1995). In socio-economic research, many attempts to define sustainability exist. They range from statically defined pillars like "social"; "economic" and "environmental" (Gibson, 2001) to intertemporal considerations of present welfare and future needs (Kuhlman and Farrington, 2010). Other approaches try to capture what (un)sustainable practices are (Pope et al., 2004). Yet, with many definitions available, measuring sustainability is challenging as the understanding differs. Especially as the economic implications of sustainable production are broad. Not only are governments implementing more and more regulations regarding ecological and social issues, but customer awareness regarding sustainability has also increased over the past decades (Galbreth and Ghosh, 2013; Buerke et al., 2017; Garcia et al., 2019; Giacomarra et al., 2021). Therefore, sustainable practices can have a direct impact on

companies' revenues while a breach of expected or legally required conduct can cause a related controversy and harm a firm's reputation. Combining the definition of each EO dimension with the theoretical assessments of sustainability and controversies, we derive two sets of hypotheses.

Starting with Innovativeness, it can be argued that engaging in novelty-seeking activities can lead to beneficial outcomes when a new technology or product serves its designated purpose. At the same time, there are arguments for negative impacts, when a novelty results in unwanted consequences (Edgell and Vogl, 2013). However, by acknowledging sustainability issues rising in their importance by customers (Galbreth and Ghosh, 2013; Buerke et al., 2017; Garcia et al., 2019; Giacomarra et al., 2021), we expect that innovations are intended beneficial or at least not harmful in sustainability contexts. Consequently, our first hypothesis derives as:

H1a: Innovativeness is positively related to sustainability.

The considerations regarding the number of controversies are contrary as unintended and unforeseen effects of innovative efforts can always arise. Yet there is nothing like a positive controversy established and thus, controversies are per se negatively associated. Firms engaging in novelty-seeking activities consequently always face the risk of running into unwanted side effects[11] and finding themselves involved in some kind of scandal. Therefore, we hypothesize that:

H2a: Innovativeness increases the number of controversies.

For proactiveness, we expect a positive influence as well. If sustainability is regarded as a value by customers and firms, which goes beyond legal regulations (Gupta and Benson, 2012), companies can differ in their sustainability level and proactively seek to achieve higher outcomes. Hence, being ahead of the competition leads to a competitive advantage and thus, we expect that:

H1b: Proactiveness is positively related to sustainability.

[11] For example, the Thalidomide scandal in the 1960s where the side effects of the new sleeping aid drug Thalidomide (marketed as Contergan®) caused birth defects on newborn children.

At the same time, the seeking of a competitive advantage may lead firms or employees to act in an opposing way. Decision processes can be circumvented, rules and best practices bent (Baucus et al., 2008) and result in unintended consequences. Therefore, we expect that:

H2b: Proactiveness increases the number of controversies.

While risks are typically understood financially, accepting risks in sustainability contexts can have the same implications for firms. For example, pollution of the environment or avoiding safety standards can be beneficial in the short run by reducing costs (Pagell et al., 2020; Jayachandran, 2022). However, if illegal practices are uncovered financial consequences are even greater than they would have been by following laws or standards as the former status quo has to be restored and additional fines are imposed. Consequently, accepting risks in sustainability-related topics should lead to a negative impact on sustainability outcomes and increase the number of related controversies:

H1c: Risk-taking is negatively related to sustainability.

H2c: Risk-taking increases the number of controversies.

Similar to proactiveness, viewing sustainability as a value by firms and customers leads to the possibility that the current positioning of a firm is challenged by others. Hence, defending the current position by imposing aggressive market behavior should consequently lead to higher sustainability outcomes:

H1d: Competitive aggressiveness is positively related to sustainability.

Although aggressive behavior does not need to result in any kind of controversy, it is easy to imagine that the balance between too much and not enough can be hard to maintain as firms have to follow legal bindings and customer expectations (Creyer, 1997; Ferell et al., 2019). Accordingly, we expect competitive aggressiveness to increase the number of controversies:

H2d: Competitive aggressiveness increases the number of controversies.

As autonomy refers to employees' abilities to decide about actions their company should take, a higher degree of freedom increases the share of the employees' beliefs and values within those actions taken. Hence, employees can make decisions which are compatible with their own beliefs and increase their satisfaction (Bijaang et al.; 2018). Again, by referring to the general rise in the level of sustainability awareness, we hypothesize that:

H1e: Autonomy is positively related to sustainability.

By additionally considering the reputational risk the individual employee faces when making an unethical or detrimental decision (Helm, 2011), we expect a higher degree of autonomy to reduce the number of controversies:

H2e: Autonomy decreases the number of controversies.

4.3 Materials and Methods

Sample and Data collection

Our analysis is focused on German stock corporations which are publicly traded and included in the DAX, MDAX and SDAX indices. The DAX contains the largest 40, the MDAX the next 50 and the SDAX the following 70 biggest publicly traded companies, measured by market capitalization. Together the three indices form the "C-DAX". We targeted stock companies as they are required to publish an annual business report, which many firms use to address their shareholders with an optional letter to the shareholder (LTS). We decided not to include other stock corporations as the gathering of information would be extensively time-consuming as the publishing requirements can differ for firms, which are not listed in the indices above. Other legal forms of companies like the "Gesellschaft mit beschränkter Haftung (GmbH)" which is the German equivalent to the Anglo-American limited company are also subject to the obligation to publish annually, but this obligation only includes financial statements.

The first step in our analysis was accessing the annual reports for the years 2016 to 2022 for each firm in the C-Dax. By nature, some firms moved into the C-Dax or dropped out of it, so we collected different numbers of annual reports per firm. We used a Python program to access the reports automatically and double-checked if missing ones were unavailable or could just not be accessed by our program. Next, the annual reports were screened for LTS. In some firms, the shareholders are addressed by the "Aufsichtsrat", the supervisory board of the firm. As EO is a strategic posture, it is represented and executed by the people who have executive power in a stock corporation, in Germany this is the management board. This power split is a special characteristic in German stock companies, as the corresponding board of directors in Anglo-American firms contains execution and supervision in one panel. We subsequently removed all LTS which are not issued by the CEO or the management board. Some annual reports contain an interview with the CEO or management board instead of an LTS, where topics like past and future developments of the firm are addressed. We decided to keep these as they address the same topics and auditorium as LTS. The last restriction that we

made was to remove all English LTS from our files as they would result in a zero count for EO as we used a German translation of the original word lists to identify EO by Short et al. (2010). We present and discuss these so-called dictionaries below in the variables section. The LTS were then analysed with the help of computer-aided text analysis software, the *CAT scanner*[12]. Each EO dimension is measured by the count of words appearing in the corresponding dictionary. However, the CAT scanner only counts exact matches between the dictionary and LTS. Word endings created by different modes such as tense or case in German therefore had to be recognizable for the CAT scanner. To achieve that, we used a technique called lemmatizing (Balakrishnan and Ethel, 2014) where words are converted to the root word. We lemmatized the LTS as well as the corresponding dictionaries.

To access data regarding sustainability and core business data, we used data provided by the London Stock Exchange Group (LSEG), formerly known as Refinitv or Refinitiv Eikon[13]. LSEG provides a huge variety of data regarding stock trade companies from around the world, including financial statements, employment, firm sectors and sustainability data. The database is used in different fields of research including accessing their sustainability data (i.e. Khaled et al., 2021; Di Simone et al., 2022, Reber et al., 2022; Delgado-Ceballos et al., 2023) and therefore is established as a reliable source for company data. The EO measurements were then matched with the corresponding data retrieved from LSEG for the years 2016 to 2022. Our final sample consists of 612 observations by 132 different firms for which we have EO measurements as well as sustainability data available.

Main variables

Entrepreneurial Orientation:

As we follow the multidimensional approach by Lumpkin and Dess (1996), EO is measured by the individual score in each dimension: proactiveness, innovativeness, risk-taking, competitive aggressiveness and autonomy. For each dimension, the CAT scanner screened the LTS for words listed in the different dictionaries. Each word can be counted multiple times if it has multiple appearances inside the LTS. The score for each dimension is then calculated as the sum of all appearances of the words inside the dictionary. To reduce potential endogeneity problems (Anderson et al., 2022), we lag each EO measurement by one year,

[12] The program is available under https://www.catscanner.net/

[13] Refinitiv was sold to LSEG by the media company Thomson Reuters in 2021, therefore references might refer to the data source as Thomson Reuters, Refinitiv or Refinitiv Eikon.

meaning that the EO, measured in the LTS in year t is combined with financial and sustainability data from year t+1. To identify the EO dimensions, we based our dictionaries on the ones developed by Short et al. (2010). The dictionaries were translated into German. We checked the translated words to make sure they fit into an economic and entrepreneurial context, for some words, the German translation resulted in duplicates for which we tried to identify synonyms. However, for some original items, there was no further additional (meaningful) synonym available. In those cases, the German dictionary is shorter than the original one. The German and original dictionaries are presented in Table 17:

Table 17: Original and translated dictionaries

Dimension	German dictionary	Original English dictionary by Short et al. (2010)
Proactiveness	analysieren, antizipieren, aussichtsreich, erforschen, ermitteln, erkunden, erwarten, forschen, forschend, hinterfragen, nach einer Gelegenheit suchen, nachforschen, nachschauen, proaktiv, prüfen, Prüfung, sich vorstellen, Studie, suchen, untersuchen, Untersuchung, vorausblicken, voraussagen, vorausschauend, voraussehen, vorhersagen, vorhersehen	Anticipate, envision, expect, exploration, exploratory, explore, forecast, foreglimpse, foreknow, foresee, foretell, forward-looking, inquire, inquiry, investigate, investigation, look-into, opportunity-seeking, proactive, probe,prospect, research, scrutinization, scrutiny, search, study, survey
	∑ 27 entries	∑ 27 entries
Innovativeness	ändern, ausdenken, aushecken, begabt, bilden, Dinge sehen, einfallsreich, Einfallsreichtum, einzigartig, entdecken, Entdecker, Entdeckung, erfinden, Erfinder, Erfindergeist, erfinderisch, Erfindung, erfunden, erschaffen, erstellen, erträumen, Experte, formulieren, Freidenker, Genie, Gestalter, Gewandtheit, herbeizaubern, Ideenreichtum, Improvisation, improvisieren, Initiative, Initiator, Innovation, innovieren, ins Auge fassen, Inspiration, inspiriert, klug, Klugheit, konzipieren, Kreativität, Marke, Meisterleistung, Metamorphose, Neoterik, neoterisieren, neu, neu gestalten, neuartig, neufassen, Neufassung, Neuheit, Original, Originalität, originell, Patent, pfiffige Idee, Phantasie, radikal, Rahmen, revolutionieren, Schöpfer, schöpferisch, Schöpfung, sich vorstellen, Traum, Treffer, Umbruch, umgestalten, Ursprung, Verwandeln, visionär, visualisieren, Vordenker, vorstellen, Weitblick, zusammenbrauen, zusammenmischen	Ad-lib, adroit, adroitness, bright-idea, change, clever, cleverness, conceive, concoct, concoction, concoctive, conjure-up, create, creation, creative, creativity, creator, discover, discoverer, discovery, dream, dream-up, envisage, envision, expert, form, formulation, frame, framer, freethinker, genesis, genius, gifted, hit-upon, imagination, imaginative, imagine, improvise, ingenious, ingenuity, initiative, initiator, innovate, innovation, inspiration, inspired, invent, invented, invention, inventive, inventiveness, inventor, make-up, mastermind, master-stroke, metamorphose, metamorphosis, neoteric, neoterism, neoterize, new, new-wrinkle, innovation, novel, novelty, original, originality, originate, origination, originative, originator, patent, radical, recast, recasting, resourceful, resourcefulness, restyle, restyling, revolutionize, see-things, think-up,

		trademark, vision, visionary, visualize
	∑ 80 entries	∑ 87 entries
Risk-taking	abenteuerlich, abenteuerlustig, bedenklich, beherzt, couragiert, Einsatz, eintauchen, furchtlos, Gefahr, gefährlich, gewagt, Glücksspiel, heikel, kühn, Kühnheit, mutig, Risiko, risikoreich, riskant, rücksichtslos, tapfer, tollkühn, übermütig, unerschrocken, unsicher, Unsicherheit, unternehmungslustig, unüberlegt, unvorsichtig, verwegen, wagemutig, wagen, waghalsig, Wagnis, Wette, wetten, Zufall	Adventuresome, adventurous, audacious, bet, bold, bold-spirited, brash, brave, chance, chancy, courageous, danger, dangerous, dare, daredevil, daring, dauntless, dicey, enterprising, fearless, gamble, gutsy, headlong, incautious, intrepid, plunge, precarious, rash, reckless, risk, risky, stake, temerity, uncertain, venture, venturesome, wager
	∑ 37 entries	∑ 37 entries
Competitive aggressiveness	aggressiv, angreifen, antagonistisch, Anwärter, aufstrebend, ausnutzen, ehrgeizig, Einsteiger, erbittert, Feind, feindselig, Gefecht, Gegenspieler, Gegner, gegnerisch, Herausforderer, herausfordern, intensiv, intensiviert, Kampf, kampfbereit, kämpfen, Kämpfer, kämpferisch, Kandidat, kapitalisieren, Konflikt, konkurrieren, konkurrierend, Kontrahent, Leistung, messen, Mitbewerber, Positionskampf, rangeln, ringen, Rivale, rivalisieren, rivalisierend, sparren, streben, streiten, Tauziehen, umkämpfen, umstritten, Verdrängungswettbewerb, verschärft, verteidigen, Wettbewerb, wetteifern, wetteifernd, Wettkampf, wettstreitend, Widersacher, widersprechen	Achievement, aggressive, ambitious, antagonist, antagonistic, aspirant, battle, battler, capitalize, challenge, challenger, combat, combative, compete, competer, competing, competition, competitive, competitor, competitory, conflicting, contend, contender, contentious, contest, contestant, cutthroat, defend, dog-eat-dog, enemy, engage, entrant, exploit, fierce, fight, fighter, foe, intense, intensified, intensive, jockey-for-position, joust, jouster, lock-horns, opponent, oppose, opposing, opposition, play-against, ready-to-fight, rival, spar, strive, striving, struggle, tussle, vying, wrestle
	∑ 55 entries	∑ 58 entries
Autonomy	autark, autonome, Autonomie, Deregulierung, eigenständig, eigenverantwortlich, Emanzipation, Ermächtigung, frei, Freidenker, Freiheit, Freiraum, gesondert, getrennt, In Freiheit, Kontrollabbau, Lizenz, losgelöst, Privileg, Selbermachen, selbstbestimmt, Selbstbestimmung, selbstgesteuert, Selbstlenkung,, selbstreguliert, souverän, Souveränität, unabhängig, Unabhängigkeit, unbeherrscht, ungebunden, ungehindert, ungeregelt, ungezwungen, unverbunden	At-liberty, authority, authorization, autonomic, autonomous, autonomy, decontrol, deregulation, distinct, do-it-yourself, emancipation, free, freedom, freethinking, independence, independent, liberty, license, on-one's-own, prerogative, self-directed, self-directing, self-direction, self-rule, self-ruling, separate, sovereign, sovereignty, unaffiliated, unattached, unconfined, unconnected, unfettered, unforced, ungoverned, unregulated
	∑ 36 entries	∑ 36 entries

Sustainability data:

This paper does not aim to add a new definition or approach to the discussion, we focus on existing attempts to measure sustainability, as we believe our sustainability data contains essential parts of theoretical considerations. For example, firms trying to reduce water usage, and carbon emissions or having a policy regarding waste disposal are considered more sustainable in contrast to firms who do not implement such practices. We are aware that firms can easily overstate their commitment but acknowledging problems regarding sustainability issues is already more than ignoring them. Data provided by LSEG regarding sustainability is available in aggregated scores and individual measurements considered relevant to determine sustainability data. The main score is the ESG-Score (Environmental, Social, Governance). The ESG score includes self-reported assessments of company policy. A second score, measuring the number of controversies, is available as well. LSEG additionally provides more tangible measurements like the amount of CO_2 emissions, but the availability is yet limited as not all companies report this data continuously or just started recently to do so. LSEG operates several analyst centres and collects data itself as well as combining it with data which is self-reported by companies.

ESG Score: The ESG Score (*ESG*) is a combined score of 10 individual categories (Refinitiv, 2022) from 3 superordinate groups: environmental (emissions, environmental innovation, and resource use), social (human rights, product responsibility, workforce and community) and governance (management, shareholders and CSR strategy). The sub-scores are weighted for different industries and result in a score from 0 to 100, where a higher number of points is considered a higher sustainability level.

Controversies: The controversy score (*Contro*) results in a number between 0 to 100 per cent whereas firms with no recent controversies score at 100 per cent. Controversies are counted in 23 (Refinitiv, 2022) different topics regarding company issues in the categories of community, management, human rights, product responsibility, resource use, shareholders and workforce. A controversy is included if it is covered by the media. LSEG accounts for firm size in a matter that for larger firms the likelihood of any controversy to be covered in the media is larger than for small firms, meaning that the negative effect per controversy is larger for small firms. The controversies of previous years additionally influence the current score, but the effect is diminishing over time. LSEG operates several analyst centres that seek coverage of controversies in the media and collects this data itself.

Control variables

As Anderson et al. (2022) point out, analyses regarding EO as an explanatory variable should contain firm size and environmental hostility as a control variable. We used the logarithm of revenue as a proxy for firm size; alternatively, the number of employees is often regarded as an appropriate measurement (e.g., Real et al., 2014; Wiklund and Shepherd, 2011; Kollmann and Stöckmann, 2014). Industry-specific effects like hostility and sector-specific fixed effects are captured by including the firm's industry based on "The Refinitiv Business Classification". We additionally control for time-fixed effects by the year as our observation period could otherwise be biased by developments like the COVID-19 pandemic. To account for different lengths of the LTS, where it might be easier to score high in the EO dimensions by just publishing longer letters, we included the number of words (Total words) in the LTS as a control variable. The problem of different lengths of the LTS was already mentioned by Short et al. (2010).

4.4 Results

Descriptive statistics

The descriptive statistics are presented in Table 18: innovativeness is the most pronounced dimension with an average of 12.03 words per LTS, followed by competitive aggressiveness with only 4.83 words. The other three dimensions range from 1.75 words (autonomy), 1.83 words (proactiveness) to 1.94 words (risk-taking). We see low to medium but significant correlations between the dimensions. The average sustainability score in our sample is 61.83, while the controversy score ranges high at 86.70 points. This indicates that many firms have no reported controversies. In our sample, there are 459 entries with no reported controversies. The correlations between the two variables with the EO dimensions are low but show significance at the considered level of five per cent or lower. The correlations for the controversy score are negative. However, proactiveness does not correlate significantly with ESG or the controversy score. The number of words is significantly correlated to all EO dimensions, indicating that the caution Short et al. (2010) raised is justified.

Table 18: Descriptive statistics and correlations

	Mean	S.D.	1	2	3	4	5	6	7	8	9
1. Innovativeness	12.03	7.90	1								
2. Proactiveness	1.83	3.88	0.16***	1							
3. Risk-taking	1.94	2.28	0.21***	0.29***	1						
4. Competitive Aggressiveness	4.83	3.61	0.44***	0.29***	0.27***	1					
5. Autonomy	1.75	1.89	0.30***	0.33***	0.21***	0.30***	1				
6. ESG	61.83	18.64	0.18***	0.06	0.10*	0.20***	0.03	1			
7. Contro	86.70	27.56	-0.18***	0.04	-0.22***	-0.10*	-0.18***	-0.45***	1		
8. Log of sales	21.91	1.84	0.18***	-0.02	0.13***	0.17***	0.11**	0.68***	-0.56***	1	
9. Total words	1043.58	462.83	0.65***	0.40***	0.36***	0.62***	0.43***	0.20***	-0.16***	0.20***	1

Note: $n = 612$; *** $p < 0.001$, ** $p < 0.005$, * $p < 0.05$

Hypothesis tests

We test our hypotheses by employing three models. First, we use an ordinary least squares regression (OLS). This is followed by two more sophisticated approaches, a fractional response probit model (FRAC) first and a random effects panel regression second (REPR). We conducted a Hausman test to check for potential fixed effects in our model, which turned out to be insignificant. Hence justifying the use of a random effect model here. To account for potential autocorrelation, we calculated cluster-robust standard errors (White, 1982; Rogers, 1993), which in combination with a random effects model also account for exchangeable autocorrelation (Cameron and Trivedi, 2005). The standard errors are given in brackets within the result tables. Our independent variables ESG and Contro are distributed from zero to one hundred. This fits the data for a fractional response model, after a transformation into a zero-to-one interval by dividing the reported values by one hundred. A fractional response model softens the assumption of a beta regression that values cannot be exactly one or zero, as we observe such values. One major disadvantage of this transformation is the interpretation of the coefficient size. Still, effect directions can be identified. For this study, we use the P-value thresholds suggested by Benjamin et al. (2018). A p-value of up to 0.05 results in suggestive statistical significance, while values below 0.005 are called strong evidence.

ESG:

Innovativeness

Table 19 shows the results regarding our three models and the effect of EO on reported sustainability performance. While two analyses result in positive coefficients (0.03 for FRAC and 0.02 for REPR), the OLS estimate is negative with -0.02. However, we cannot identify any suggestive ($p < 0.05$) or strong evidence ($p < 0.005$) for a relation of a firm's innovative efforts on sustainability performance, meaning the results do not provide empirical evidence for our hypothesis H1as we cannot reject the null hypothesis.

Table 19: The relation between a start-up's position EO and ESG

Variable / Model	OLS	Fracreg	Random effects panel regression
Innovativeness	-0.02	0.03	0.02
	(0.10)	(0.28)	(0.06)
Proactiveness	0.10	0.22	0.05
	(0.13)	(0.37)	(0.09)
Risk-taking	-0.51	-1.33	-0.16
	(0.27)	(0.76)	(0.14)
Competitive aggressiveness	0.47	1.32	0.27
	(0.20)*	(0.54)*	(0.13)*
Autonomy	-0.40	-0.94	-0.04
	(0.32)**	(0.85)*	(0.18)
Log of sales	7.58	21.16	6.68
	(0.69)***	(1.93)***	(0.87)***
Year-specific fixed effects	Yes	Yes	Yes
Industry-specific fixed effects	Yes	Yes	Yes
Total Words	Yes	Yes	Yes
(Pseudo)R^2	0.7406	0.0857	0.7259
Observations		612	
Firms		132	

Note: Robust standard errors (clustered at the firm level) *** $p < 0.001$, ** $p < 0.005$, *$p < 0.05$

Proactiveness

The OLS shows a positive (0.10) impact of proactiveness on ESG performance. The same is true for the FRAC model, where the coefficient is 0.22. The REPR model shows a small positive coefficient (0.05). All coefficients are insignificant. Consequently, we don't see our prediction of H1b empirically substantiated that those proactive traits of a firm's strategic posture lead to sustainable behavior.

Risk-taking

Risk-taking is negatively related to sustainability performance. All models show negative coefficients (-0.51 for OLS, -1.33 for FRAC, -0.16 for REPR). No model shows suggestive or strong evidence ($p < 0.05$) that the relation is statistically significant. Therefore, there is no empirical evidence that risk is negatively related to sustainability performance.

Competitive aggressiveness

Challenging competitors has, according to our analysis, a positive impact on sustainability performance. While the OLS and REPR models show coefficients of 0.47 and 0.27, they also result in suggestive evidence ($p < 0.05$) for this relation. The FRAC coefficient is positive too (1.32) and significant at a suggestive evidence level. Hence considering the significance level, we tend to carefully approve hypothesis H1d that competitive aggressiveness has a positive effect on sustainability but at the same time see the need for further studies to verify our findings.

Autonomy

The relation between ESG and autonomy is negative in all our models (-0.40 for OLS, -0.94 for FRAC and -0.04 for REPR). The OLS estimator shows strong empirical evidence ($p < 0.005$), while the FRAC estimate is significant on a suggestive ($p < 0.05$) level. Considering the suggestions of Anderson et al. (2022) to base the identification of causal relationships on panel data, we don't see empirical evidence for our hypothesis H1e that autonomy has a positive effect on ESG as our most robust model results in a small and insignificant estimate.

Controversies:

Innovativeness

The results regarding controversies are presented in Table 20. Innovative efforts of a firm lead to more controversies according to our data, as a lower controversy score represents firms with more controversies. The OLS model results in a coefficient of -0.21. The FRAC and REPR point in the same direction with coefficients of -0.89 and -0.34. The OLS and REPR coefficients are significant at a five per cent level ($p < 0.05$), meaning that we find suggestive evidence, for our theory that innovativeness leads to more controversies. Therefore, we see our hypothesis H2a is weakly supported in our data.

Proactiveness

In contrast to innovativeness, all estimated coefficients for proactiveness are positive (0.40 for OLS, 3.40 for FRAC and 0.34 for REPR). However, all of those are insignificant and therefore deliver no evidence for a relation between proactiveness and the number of controversies in a firm. Therefore, we don't find support for our hypothesis H2b that proactiveness leads to more controversies.

Risk-taking

The estimates for the effect of risk-taking on controversies are negative in all three models.

In the OLS model, the coefficient is -0.94, while for FRAC it is -4.02 and for the REPR model -0.61. All coefficients remain insignificant. Therefore, we cannot conclude that the data supports our hypothesis H2c that more risk-taking is related to more controversies.

Competitive aggressiveness

The OLS model results in a coefficient of 0.12, the FRAC model identifies a positive relation as well (1.02), the same is true for the REPR model, where the estimated coefficient is 0.02. However, neither of the three coefficients is significantly related to the number of controversies. Hence, the results don't provide empirical support for our hypothesis H2d in that competitive aggressiveness increases the number of controversies.

Autonomy

Autonomy and controversies are negatively related in all our models (-2.20 for OLS, -9.62 for FRAC and -1.57 for REPR). The OLS estimator shows strong empirical evidence ($p < 0.005$), while the FRAC and REPR estimates are significant on a level that results in suggestive evidence. ($p < 0.05$) level. Therefore, we don't find empirical evidence in the data for our hypothesis H2e that autonomy reduces the number of controversies, the data supports the exact opposite.

Table 20: The relation between a start-up's position EO and controversies

Variable / Model	OLS	Fracreg	Random effects panel regression
Innovativeness	-0.21	-0.89	-0.34
	(0.18)	(1.04)	(0.17)*
Proactiveness	0.40	3.40	0.34
	(0.30)	(1.69)*	(0.18)
Risk-taking	-0.94	-4.02	-0.61
	(0.54)	(2.30)	(0.44)
Competitive aggressiveness	0.12	1.02	0.02
	(0.33)	(2.15)	(0.33)
Autonomy	-2.20	-9.62	-1.57
	(0.76)**	(4.20)*	(0.62)*
Log of sales	-6.45	-61.13	-6.50
	(1.06)***	(7.60)***	(1.11)***
Year-specific fixed effects	Yes	Yes	Yes
Industry-specific fixed effects	Yes	Yes	Yes
Total Words	Yes	Yes	Yes
(Pseudo)R^2	0.6032	0.4612	0.5999
Observations		612	
Firms		132	

Note: Robust standard errors (clustered at the firm level) *** $p < 0.001$, ** $p < 0.005$, *$p < 0.05$

Robustness checks and additional analyses

Due to our study design allowing each EO dimension score to reach theoretically unlimited numbers, we wanted to make sure that our analysis does not suffer from any outliers. For that, we winsorized (Kennedy et al., 1992) the values from each EO dimension and replaced the highest five per cent of values with the corresponding value of the 95 per cent quantile. Table 21 shows the winsorized estimates for the influence of EO dimensions on ESG. We don't observe major changes, however, the estimated coefficients of proactiveness in the REPR model now show suggestive evidence, meaning that further investigation of the relation between proactiveness and ESG could lead to more clarifying results.

Table 21: The relation between a start-up's position EO and ESG (winsorized 95%)

Variable / Model	OLS	Fracreg	Random effects panel regression
Innovativeness	0.01	0.13	0.03
	(0.11)	(0.29)	(0.07)
Proactiveness	0.91	2.54	0.49
	(0.50)	(1.31)	(0.24)*
Risk-taking	-0.52	-1.33	-0.17
	(0.39)	(1.07)	(0.20)
Competitive aggressiveness	0.49	1.35	0.25
	(0.23)*	(0.61)*	(0.12)*
Autonomy	-0.49	-1.18	-0.07
	(0.36)	(0.96)	(0.21)
Log of sales	7.59	21.24	6.71
	(0.70)***	(1.96)***	(0.72)***
Year-specific fixed effects	Yes	Yes	Yes
Industry-specific fixed effects	Yes	Yes	Yes
Total Words	Yes	Yes	Yes
(Pseudo)R^2	0.7428	0.0860	0.7281
Observations		612	
Firms		132	

Note: Robust standard errors (clustered at the firm level) *** p < 0.001, ** p < 0.005, *p < 0.05, + p = 0.05

The effects of most EO dimensions regarding their effect on the number of controversies do not change very much as shown in Table 22. Only the effects of innovativeness in the OLS and FRAC model turn insignificant, while the REPR estimate still shows suggestive evidence. Considering our REPR model as the most robust one, we find a weak statistical link for both sustainability measurements: ESG is positively related to competitive aggressiveness and innovativeness leading to a higher number of controversies.

Table 22: The relation between a start-up's position EO and controversies (wins. 95%)

Variable / Model	OLS	Fracreg	Random effects panel regression
Innovativeness	-0.33	-2.00	-0.45
	(0.20)	(1.28)	(0.17)*
Proactiveness	-0.31	-1.85	0.10
	(0.64)	(5.16)	(0.65)
Risk-taking	-1.00	-4.26	-0.57
	(0.63)	(3.27)	(0.52)
Competitive aggressiveness	0.15	1.29	0.02
	(0.35)	(2.33)	(0.31)
Autonomy	-2.27	-9.36	-1.54
	(0.86)**	(4.86)	(0.55)
Log of sales	-6.49	-60.35	-6.43
	(1.08)***	(7.59)***	(0.89)***
Year-specific fixed effects	Yes	Yes	Yes
Industry-specific fixed effects	Yes	Yes	Yes
Total Words	Yes	Yes	Yes
(Pseudo)R^2	0.6016	0.4603	0.5981
Observations		612	
Firms		132	

Note: Robust standard errors (clustered at the firm level) *** p < 0.001, ** p < 0.005, *p < 0.05

4.5 Discussion and Conclusion

Our study shows that EO can be linked to sustainability measurement and thus, contributes to the previous literature (Hooi et al. 2016; DiVito and Bohnsack, 2017; Marshall et al. 2015) which tends to show a positive relation. However, in contrast to previous research we include all five dimensions of the original Lumpkin and Dess (1996) approach and our results show that first, not all EO dimensions are linked to our sustainability outcomes and second, that our ESG variable is only positively influenced by competitive aggressiveness. We additionally find a negative impact of innovativeness which increases the number of controversies. Thus, our study has some practical implications. Firms seeking to improve their sustainability should focus on areas where their actions have a significant effect. In this case defending their current market by responding to competitors who have already implemented successful and tried-out sustainability attempts, rather than being a first mover. Furthermore, firms who

engage in novelty-seeking activities should be aware that they are at a higher risk of incurring controversies. However, by implementing additional mechanisms to reduce detrimental behavior these additional risks might be mitigated (Orlitzky et al., 2003).

Second, our findings lead back to the ongoing debate about whether EO is a unidimensional or multidimensional construct (Wales, 2016). While we argue that EO is a multidimensional one, one could easily argue for the opposite. However, using a unidimensional approach might lead to a loss of insights which a multidimensional approach provides. For example, the conclusion that EO is positively associated with sustainability could be driven solely by one dimension outweighing the others (George, 2011), which have a negative or no effect. Thus, in a unidimensional approach which identifies a positive relation between EO and sustainability, despite any evidence one would indirectly positively associate all dimensions with sustainability. Lastly, we address the fact that we did not discuss our findings regarding autonomy, although we found significant negative effects here.

Limitations

When we checked the data for the EO variables, we looked for extremely high values in each dimension and for potential errors in the CATA analysis via lemmatizing the letters. For that, we counted in how many LTS each word appeared. While all of the dimensions showed words which rarely or never appear, autonomy was dominated by only six words (see Appendix 4.A), “unabhängig” (independent) with 133 LTS and “Verantwortung” (responsibility) with 194 LTS, with the other 4 words (“eigenständig”, “verantwortlich”, “autonom” and “frei”) appearing in 40 to 65 LTS. We then checked for the context in which the two most counted words appeared. “Verantwortung” was mostly used in the context of sustainability or the Covid-19 pandemic. “Unabhängig” had multiple contexts starting from independent auditors for financial statements, resource or market independence of specific countries or independence from the internal combustion engine in the case of automotive firms and their suppliers. The word is also used in the German translation for "regardless of". This gave us the first intuition that measuring the autonomy dimension via word count might be problematic. We additionally read a randomly selected sample of LTS to check if the overarching theme of the autonomy dimension, the degree of freedom of decisions by the employees, is present in the LTS at all. In our subjective opinion, it is not. This might be due to the addressees of the LTS being shareholders where this information is not considered relevant by most firms in Germany or cultural or regulatory differences between Anglo-

American and German annual reports. Hence, with the average autonomy count of 1.75 words, there is a high probability that these words are included in another context and that our autonomy measurement is simply measuring something else as our study uses a very simple text analysis method, CATA. While it is easy to implement, one of the biggest flaws of counting words is the lack of context as we have seen with our doubts regarding the autonomy dimension. With the broader availability of more sophisticated analysis tools like large language models, the context of each word can be part of the analysis in future studies. Furthermore, we used dictionaries which were designed for English EO measurements, yet it cannot be ruled out that other dimensions do not suffer from similar problems, regardless of our translation into German. This is something further research could clarify. Additionally, large language models can analyse the contexts of individual words, so that the idea of each EO dimension present in a letter to a shareholder or any other company-related text source may be captured more accurately. Hence, the creation of a validated EO assessment via text analysis by a sophisticated text analysis method could strengthen the acceptance and reliability of this approach to measure EO.

While generating our dictionaries we followed the guidelines of Short et al. (2010), still, we cannot deny the possibility that they still have room for improvement to measure EO in German firms. Yet, we validated our EO assessment by replicating a positive EO and sales relation, which is widely accepted in the EO literature (Covin and Slevin, 1989; Wiklund and Shepherd, 2003, 2005; Gupta and Gupta, 2015). Another issue is related to the source of our EO measurement, the LTS. As EO manifests in the top-level management, measuring EO has to be done by directly involving these managers or indirectly measuring data created by them. We cannot guarantee that each LTS is written by the CEO or management board, we can only assume that. Lastly, our sustainability measurement regarding the ESG variable depends on self-reported data by the companies and thus, there is an incentive to overstate their efforts. Since the European Union passed the “Corporate Sustainability Reporting Directive”, starting in 2024 large companies and later medium and small firms are obligated to measure less vague data like direct and indirect CO_2 emissions and thus, will enable a more reliable approach to measure sustainability behavior in future studies.

Conclusion

The results of our study show that EO is linked to sustainability. In contrast to previous literature, we identify only one positive effect within the EO dimensions. Competitive aggressiveness increases sustainability, but the other dimensions remain insignificant.

Additionally, we find that innovativeness increases the number of controversies, which implies a negative impact on our second sustainability measurement. Regarding the accessibility of EO data, CATA can be an alternative when questionnaires are not feasible or result in low response rates. However, data must be interpreted carefully as a word's appearance does not guarantee the context underlying the dictionary is met.

Appendix

Appendix 4.A: Letter Count for the Autonomy Dictionary

German words	Number of letters
Befugnis, Berechtigung, Eigenregie, Empowerment, ermächtigen, selbstverantwortlich, Souveränität	1
Autonomie, Limit, Selbstbestimmung, Selbständigkeit, Selbstständigkeit, ungebunden	2
Verantwortlichkeit	3
autark, selbstbestimmt, selbstverwaltet	4
eigenverantwortlich	7
Eigenständigkeit, selbstständig	10
Beschränkung	13
befähigen	14
Freiheit	16
verantworten	19
Unabhängigkeit	21
uneingeschränkt	22
Kontrolle	26
eigenständig	40
verantwortlich	43
autonom	55
frei	65
unabhängig	133
Verantwortung	194

5 Chapter five

Final Discussion and Conclusion

5.1 Summary

In this thesis, we answered research questions evolving around the fundamental construct of Entrepreneurial Orientation. The main research questions of this thesis are:

1. *Are the EO dimensions rather stable or unstable over time?*
2. *Is heterogeneity in firms' imitation behavior linked to EO dimensions?*
3. *How do the EO dimensions influence the sustainability of large stock-traded firms?*

In Chapter one we validated the scale which was used in the IAB/ZEW Startup Panel to measure EO. We show that the scale is shorter but reaches a high and similar level of fit compared to established scales. This means that researchers can rely on a dataset which is rich in observations and variables measured with an increased level of confidence.

Chapter two answers the first question. By calculating the changes between the EO measurements in the IAB/ZEW Startup Panel. The distribution of the unidimensional EO measurement's changes graphically looks bell-shaped around zero as the most frequent observation. The changes in the individual dimensions are dominated by non-changers too but do not follow a classic bell curve. When searching for systematic differences between industry sectors or time-driven effects, the analyses do not show any. Thus, the results point in an idiosyncratic direction of those changes. This holds when we focus on the least and most changing firms and even a change of the CEO does not systematically explain EO changes. Thus, on short to medium periods EO tends to be a stable firm trait and the changes that occur seem to be driven by randomness.

In Chapter three we investigated the second research question. The IAB/ZEW Startup Panel allows us to distinguish between true innovation generation and imitative innovations. The results show that not all EO dimensions are involved in the transition between no innovation to any innovation and imitative to the generation of innovations. Moreover, a tautological relation between EO and innovation (Covin and Wales, 2019; Pérez-Luño et al., 2011) can be rejected as innovativeness shows an effect on the generation and imitation of innovations. The other dimensions show unique effects on certain dichotomies as well. Proactiveness drives innovation generation, while competitive aggressiveness is mostly relevant for becoming an innovator or defending the own position by copying from other firms in the same region. Risk-taking is mostly associated with the transition of a non-innovating firm to any kind of innovation.

The last research question regarding a firm's sustainability and its EO is investigated in Chapter three, where we create a panel dataset using the letters to the shareholders to assess EO via computer-aided text analysis. In line with previous research (e.g. Hooi et al., 2016; DiVito and Bohnsack, 2017; Marshall et al., 2015) we find a positive relationship between EO and sustainability as well. However, this is only due to competitive aggressiveness as it increases the sustainability indicator which we used to assess sustainability. Additionally, we find evidence that innovativeness increases the number of controversies a firm is involved in, meaning, that depending on the understanding that controversies are part of sustainability, one can conclude that EO has positive and negative effects.

5.2 Practical Implications and Future Research Suggestions

The first implications develop around the initial results of our main studies regarding innovation and sustainability in Chapters three and four. Both showed that more EO resulted in more of either imitative innovation, innovation generation and sustainability. However, neither study concluded that all dimensions of EO resulted in increasing those target variables. The overall insight is, that it is always only a part of the EO dimensions, which is of relevance. In the case of innovativeness, we saw an increase in the number of controversies. This means firms trying to actively adapt to a higher level of EO can focus on the relevant part of EO, depending on their target variables. This is true for all kinds of goals a firm can have and goes beyond the variables we used in our thesis. However, this could contradict the results of Chapter two, where we investigate the stability of EO but first, we do not know if those firms actively tried to change their EO. On average the unidimensional EO construct keeps relatively stable, the individual dimensions even more. But still, a distribution of changes is visible. Second, the time horizon of the study is limited as we have a maximum of three years between the measurements. It could be possible that EO changes very gradually over a longer period or abruptly, as suggested in the study of Kreiser et al. (2020) after economic shocks. While we did not analyse changes of EO in Chapter four in detail, we still calculated them and they mirrored the results of Chapter two. The average EO change of the unidimensional Covin and Slevin scale is still very small (0.55), the same holds for the individual dimensions, ranging from just 0.05 in risk-taking to 0.38 in innovativeness. We also calculated Cohen's d to compare the changes in the dimensions in Chapters two and four. None reached the threshold of 0.2[14]. Like in Chapter two, the distributions contain a lot of firms that indeed

[14] The highest Cohen's d in absolute terms was 0.16 for the competitive aggressiveness changes, the lowest 0.02 for the risk-taking changes.

show changes in the EO dimensions. The empirical analysis of the determinants of EO dimensions or their changes is beyond the scope of this thesis. Our results in Chapter two suggest, that a CEO change cannot explain the changes in EO dimensions, leaving this research area open for further analyses.

The results regarding EO and innovation in Chapter three pointed out that depending on the type of innovation, different EO dimensions matter the most. This can be of interest to different actors. First the firm itself and second policymakers who can form the economic environment which can moderate the effects of EO dimensions (Prasannath et al., 2024). As we have seen with no surprise, innovativeness is linked to the creation of new-to-the-world innovations. Thus, creating an environment that fosters the seeking of novelty increases the likelihood that firms introduce such innovations. Companies do not have to remain inactive either. They can try to consciously steer their corporate culture (Hatch, 1993; Bendak et al., 2020) in such a way that the search for innovation becomes part of their entrepreneurial core. The same holds for proactiveness when firms tend to observe their competitors first, instead of being ahead. Trying to become a leader rather than a follower increases the chance of new-to-the-world innovations as well. Thus, achieving a corporate mindset that places the firm in that leading position is the way to go if a firm wants to generate innovations. Regarding imitative innovations we have similar implications as competitive aggressiveness is the main lever in the imitative dichotomies within the innovation ladder introduced in Chapter three. Actively catching up to competitors to close competitive disadvantages is the main driver of adaptation of existing innovations in the study. Thus, firms who find themselves in a space that has fallen back need to actively identify the advantages of their competitors and try to copy them. This will not put them at an advantage but at least help to defend their position within the competition.

For the last study of this thesis regarding EO and sustainability, we have two main implications. First, if firms engage in novelty-seeking activities, they are at a higher risk of finding themselves involved in controversies. This is of course a downside compared to the encouraging implications of Chapter three but not completely unexpected as EO has been found to negatively impact firm performance indicators as well (e.g. Kreiser et al., 2013; Hernández-Linares and López-Fernández, 2018). The nature of novelty includes the possibility that unknown side effects or unwanted consequences will be uncovered over time. Fortunately, firms can implement processes that reduce the risk of getting involved in controversial behavior (Orlitzky et al., 2003). Beneficial to the sustainability indicator is the

EO dimension of competitive aggressiveness. Firms who want to become more sustainable should identify successful attempts of other firms and try to imitate them. Still, we need firms to find new approaches and solutions to soften sustainability issues but there is no clear first-mover advantage implicated by proactiveness or the innovativeness dimension in the data. The implementation of external incentives by policy makers might increase the readiness of firms to become a proceeding company and consequently the number of successful new solutions which can then be copied by following firms.

Lastly, we address the possibilities regarding further EO research. In general, the literature consisted of many studies focusing on financial performance. Other performance measurements which are not directly linked to financial indicators like sustainability have not been researched that much, although in the case of sustainability issues, we saw an increase[15] in the overall interest by more regulation (e.g. the Corporate Sustainability Reporting Directive or the NFRD) and rising interest from investors (Chitimiea et al., 2021) and consumers (e.g. Garcia et al., 2019; Giacomarra et al., 2021). Besides investigating further of such overlooked topics or opening completely new areas, there is still room for research regarding the mediating and moderating roles of EO and other variables like economic policies (Prasannath et al., 2024). Additionally, EO as a fundamental construct could be of interest regarding recent market developments like the broader availability of artificial intelligence (AI) applications. Dubey et al. (2020) examine the adoption of such applications and find that EO is fostering the usage of AI tools. Thus, considering EO to research very recent economic developments is a promising way to further increase the knowledge around this central piece of entrepreneurship theory. However, there are direct open connections to this thesis, especially regarding Chapters two and three. The diffusion of innovations and knowledge across regions is one of those. First, there exists extensive literature regarding knowledge spillovers (e.g. Fritsch and Franke, 2004; Audretsch and Lehman, 2005; Kalapouti and Varsakelis; 2015) and Chapter three shows that EO is linked to imitation of existing products. Thus, it might be interesting to ask how EO affects knowledge spillovers between firms and regions. Second, the distribution of EO levels and changes differ across the industries as seen in Chapters one and two, although the changes don't differ systematically. Still, one could expect industries or countries with show a more prominent EO to adapt faster to new technologies than ones with lower EO, thus investigating the relation of EO and

[15] We acknowledge that this interest might be slowing down at the moment. For example, the European Union and the US government are currently defusing regulatory requirements (e.g. OMNIBUS directive).

knowledge transfer further. The same holds for the results of Chapter four where a direct effect on sustainability is only visible in the competitive aggressiveness dimension. EO could still interact with other drivers of sustainability or act in the context of sustainability-related frameworks like the resilience theory where innovation takes a key role (Olsson et al., 2014).

5.3 Limitations

We already addressed the chapter-specific limitations within each chapter, but the overarching limitation of this thesis is still to be named:

The main overarching limitation deals with the general problem of identifying causalities. Our analyses could potentially suffer from endogeneity problems like omitted variables bias or simultaneity bias (Sande and Gosh, 2018; Park et al., 2021). Although we address those problems by using a time lag on the relevant performance variables in Chapters three and four, there is no certainty about the absence of such biases. This is why this thesis is a move in the direction of causality and not a proof of any causal relationships.

5.4 Some Final Remarks

This thesis investigated some of the broad research possibilities regarding EO. By providing the validation to the IAB/ZEW Startup Panel, we hope to encourage future research to confidently use it. Additionally, we shed some light on not-investigated areas regarding the stability of EO, the effects on innovations, imitations and sustainability. In our opinion, EO is not a construct made by scientists only for scientists, it is a tangible construct with relatability to the real economic world. If we understand EO and its effects, we might be able to put it into use, for example by fostering EO traits that are especially linked to innovations or sustainable behavior.

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