Sustainability of Mittelstand Firms

A Multi-Perspective Investigation of Regional Development, Investment Behavior, and Firm Strategies

DISSERTATION

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Preface

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List of Abbreviations

AG	Aktiengesellschaft
BBSR	Federal Office for Building and Regional Planning
Benelux	Belgium, Luxemburg, the Netherlands;
BMWK	Bundesministerium für Wirtschaft und Klimaschutz
BRIC	Brazil, Russia, India, China
(C-) DAX	(Composite-) Deutscher Aktienindex
CESEE	Central, Eastern, and Southeastern Europe
Cf.	Confer
CO_2	Carbon dioxide
CSR	Corporate social responsibility
DACH	Austria, Germany, Switzerland
E.g.	Exempli gratia (for example)
EBT	Earnings before taxes
EBIT	Earnings before interest and taxes
EBITDA	Earnings before interest, taxes, depreciation, and amortization
EPO	European Patent Office
Et al.	Et alii (and others)
EU	European Union
GDP	Gross domestic product
H	Hypothesis
HCs	Hidden champions
I.e.	Id est (that is)
ICT	Communications, computer, and electronics
IfM	Institut für Mittelstandsforschung

Log.	Logarithmized
NACE	Nomenclature statistique des activités économiques dans la communauté européenne
NUTS	Nomenclature des unités territoriales statistiques
OLS	Ordinary least squares
PE	Private equity
R&D	Research and development
ROA	Return on assets
ROE	Return on equity
ROS	Return on sales
RQ	Research question
SD	Standard deviation
SE	Standard error
SME	Small and medium-sized enterprise
VC	Venture capital
VIF	Variance inflation factor

Zusammenfassung

Das Erstreben nachhaltiger Entwicklung durch die Bekämpfung des Klimawandels und die Gestaltung einer gerechteren Welt ist eines der wichtigsten Themen unserer Zeit und eine dringende Aufgabe für Unternehmen. Zahlreiche empirische Studien beschäftigen sich mit diesem Thema, wobei viele Fragen zur Nachhaltigkeit in mittelständischen Unternehmen noch offen sind. Gerade der deutsche Mittelstand hat eine hohe volkswirtschaftliche Bedeutung und trägt zur Wertschöpfung, Beschäftigung, und Innovationskraft des Landes bei. Nicht zuletzt aufgrund steigender gesetzlicher Anforderungen und Kundenerwartungen ist auch der Mittelstand gezwungen, sich mit Nachhaltigkeitsthemen wie dem Klimawandel auseinanderzusetzen. Die sich daraus ergebende Motivation und der Aufbau dieser Dissertation werden in Kapitel 1 präsentiert. Um zu einem besseren Verständnis des Themas Nachhaltigkeit im Mittelstandskontext beizutragen, werden in den einbezogenen Studien verschiedene Typen von Mittelstandsakteuren und die drei Dimensionen der Nachhaltigkeit – soziale, wirtschaftliche und ökologische Nachhaltigkeit – untersucht.

Im Rahmen dieser Dissertation wird zunächst die Gruppe der Hidden Champions betrachtet (Kapitel 2 und 3). Dabei handelt es sich um marktführende Unternehmen, die in Nischenmärkten agieren und sich unter anderem durch eine starke Exportorientierung auszeichnen. Die erste Studie (Kapitel 2) verwendet einen Datensatz von 1.645 in Deutschland ansässigen Hidden Champions und stellt zunächst die Verteilung dieser Unternehmen auf die 401 deutschen Landkreise und kreisfreien Städte dar. Darauf aufbauend wird ein Maß für die Hidden Champion Intensität als Anzahl der Hidden Champions pro 100.000 Einwohner pro Kreis berechnet, um deren Einfluss auf verschiedene Dimensionen der regionalen Entwicklung zu untersuchen. Eine dieser Dimensionen ist die regionale Beschäftigung, gemessen an der Arbeitslosen- und Auszubildendenquote. Hier lässt sich ein positiver Effekt der Hidden Champion Intensität auch auf benachbarte Kreise feststellen. Eine hohe Beschäftigung trägt zum sozialen Wohlbefinden in einer Region bei und die kontinuierliche Ausbildung junger Menschen sorgt dafür, dass dies auch nachhaltig so bleibt. Uneinheitliche Ergebnisse zeigen sich für die Dimensionen der regionalen Innovativität und der wirtschaftlichen Leistung. Die ökonomische Dimension der Nachhaltigkeit ist auch Gegenstand der folgenden Studie (Kapitel 3), in deren Rahmen die wirtschaftliche Leistung von Hidden Champions im Vergleich zu anderen Unternehmen untersucht wird. Die Datenbasis bildet ein zehnjähriger Panel-Datensatz

bestehend aus 4.677 deutschen Unternehmen des verarbeitenden Gewerbes, von denen 617 Hidden Champions sind. Die Auswertungen zeigen, dass Hidden Champions eine höhere Rentabilität in Bezug auf die Gesamtkapitalrendite, aber nicht in Bezug auf die Eigenkapitalrendite aufweisen. Darüber hinaus ist der Hidden Champion Performance Effekt insbesondere bei kleineren Unternehmen zu beobachten. Die Ergebnisse der beiden Studien tragen zu einem besseren Verständnis des Hidden Champion Phänomens bei und liefern für das Forschungsfeld dringend benötigte empirische Evidenz. Sie geben Aufschluss über die soziale und ökonomische Bedeutung der Unternehmen sowohl auf regionaler Ebene als auch im Vergleich mit anderen Mittelständlern.

Die beiden anschließenden Kapitel befassen sich mit der ökologischen Dimension der Nachhaltigkeit. Kapitel 4 betrachtet mit Venture Capital und Private Equity Unternehmen zwei Arten von Investoren, die auf Start-Ups und mittelständische Unternehmen fokussiert sind. Grundlage der Studie ist ein Datensatz mit 468 Beobachtungen, der auf zwei europäischen Befragungen von Venture Capital und Private Equity Investoren basiert. Untersucht werden die Motive und Strategien zur Berücksichtigung von Klimaaspekten in Investitionsentscheidungen. Ethische Verantwortung kann als das am häufigsten genannte Motiv und Screening als die am häufigsten verwendete Strategie unter den Befragten identifiziert werden. Darüber hinaus unterscheiden sich die beiden Investorengruppen in ihren Motiven und Strategien zur Berücksichtigung von Klimaaspekten. Private Equity Investoren reagieren auf externe Stakeholder und aufgrund von Portfolio-Performance-Überlegungen und sie verfolgen die Strategie des aktiven Eigentums. Dahingegen sind Venture Capital Investoren durch Produktdifferenzierung motiviert und tendieren zu Impact Investments. Durch die Fokussierung auf Venture Capital und Private Equity Investoren einerseits und ökologische Nachhaltigkeit andererseits leistet die Studie einen Beitrag zur Literatur über nachhaltige Investitionen.

Als weiteren Beitrag zur ökologischen Nachhaltigkeit werden in Kapitel 5 die Dekarbonisierungs-Strategien von Unternehmen in Familieneigentum und anderen mittelständischen Unternehmen des verarbeitenden Gewerbes in Deutschland untersucht. Dabei können die Unternehmen zwei Arten von Dekarbonisierungsstrategien verfolgen: Symbolische Dekarbonisierungs-Strategien, die sich auf die Kompensation von CO_2-Emissionen konzentrieren, und substanzielle Dekarbonisierungs-Strategien, die darauf abzielen, die CO_2-Emissionen eines Unternehmens zu reduzieren. Die Wahl dieser Strategien kann durch verschiedene Faktoren beeinflusst werden, wie beispielsweise durch Stakeholder

Druck. Anhand eines Datensatzes von 443 mittelständischen Unternehmen wird der Einfluss von internem und externem Stakeholder-Druck auf deren strategische Dekarbonisierungs-Entscheidungen untersucht. Es wird deutlich, dass der Druck der Stakeholder insgesamt zu einer Umsetzung von Dekarbonisierungs-Strategien führt. Während der Druck interner Stakeholder die Unternehmen zu substanziellen Dekarbonisierungs-Strategien drängt, führt externer Stakeholder Druck dazu, dass die Unternehmen symbolische gegenüber und substanziellen Dekarbonisierungs-Strategien stärker verfolgen. Darüber hinaus wird der Einfluss von Familieneigentum in diesem Zusammenhang betrachtet. Es zeigt sich, dass Familienunternehmen unter externem Stakeholder-Druck weniger zu symbolischen Dekarbonisierungs-Strategien neigen als Nicht-Familienunternehmen. Die Ergebnisse tragen zu einem besseren Verständnis der Beziehung zwischen Stakeholder-Druck und ökologischer Nachhaltigkeit sowie der Rolle von Familieneigentum in diesem Zusammenhang bei.

Kapitel 6 schließt mit einer Zusammenfassung der Ergebnisse der vier Studien, den sich daraus ergebenden Implikationen für Theorie und Praxis sowie zukünftigen Forschungsmöglichkeiten. Diese Dissertation trägt zu einem besseren Verständnis von Nachhaltigkeit im Mittelstandskontext bei. Anstatt Nachhaltigkeit als Ganzes zu begreifen, werden die drei Dimensionen der Nachhaltigkeit separat und im Zusammenhang mit verschiedenen Akteuren im Mittelstand betrachtet. Daraus resultieren einerseits Implikationen für die regionale Bedeutung und die wirtschaftliche Leistung von Hidden Champions, die ebenfalls zu einem besseren Verständnis des Phänomens beitragen. Andererseits ergeben sich Implikationen für die Umweltstrategien von Investoren und mittelständischen Unternehmen. Darüber hinaus werden Schlussfolgerungen für Eigentümer und Manager von mittelständischen Unternehmen, politische Entscheidungsträger und den Bildungssektor gezogen.

Executive Summary

Striving for sustainable development by combating climate change and creating a more social world is one of the most pressing issues of our time. Growing legal requirements and customer expectations require also Mittelstand firms to address sustainability issues such as climate change. This dissertation contributes to a better understanding of sustainability in the Mittelstand context by examining different Mittelstand actors and the three dimensions of sustainability - social, economic, and environmental sustainability - in four quantitative studies. The first two studies focus on the social relevance and economic performance of hidden champions, a niche market leading subgroup of Mittelstand firms. At the regional level, the impact of 1,645 hidden champions located in Germany on various dimensions of regional development is examined. A higher concentration of hidden champions has a positive effect on regional employment, median income, and patents. At the firm level, analyses of a panel dataset of 4,677 German manufacturing firms, including 617 hidden champions, show that the latter have a higher return on assets than other Mittelstand firms. The following two studies deal with environmental strategies and thus contribute to the exploration of the environmental dimension of sustainability. First, the consideration of climate aspects in investment decisions is compared using survey data from 468 European venture capital and private equity investors. While private equity firms respond to external stakeholders as well as portfolio performance and pursue an active ownership strategy, venture capital firms are motivated by product differentiation and make impact investments. Finally, based on survey data from 443 medium-sized manufacturing firms in Germany, 54% of which are family-owned, the impact of stakeholder pressures on their decarbonization strategies is analyzed. A distinction is made between symbolic (compensation of CO_2-emissions) and substantive decarbonization strategies (reduction of CO_2-emissions). Stakeholder pressures lead firms to pursue decarbonization strategies, with internal and external stakeholders varying in their influence on symbolic and substantial decarbonization strategies, and the relationship being influenced by family ownership.

Chapter 1

Introduction

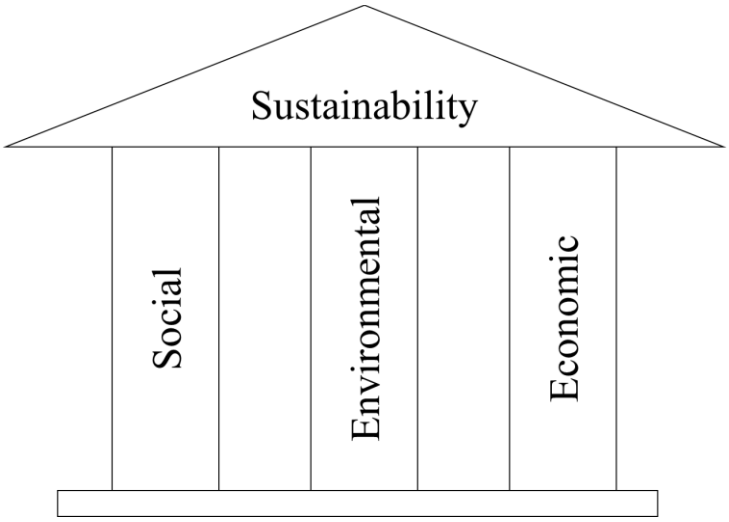
The following introductory chapter (Chapter 1) describes the motivation for this dissertation (Section 1.1) and presents the research questions to be investigated (Section 1.2). Finally, Section 1.3 provides an overview of the structure of this dissertation and describes the four included studies in more detail.

1.1 Motivation

"Creating a strong business and building a better world are not conflicting goals – they are both essential ingredients for long-term success" (William Clay Ford Jr., executive chairman Ford Motor Company). The pursuit of sustainable development by combating climate change and creating a more social world is one of the most pressing issues of our time and an urgent task for firms. While integrating social and environmental sustainability into business is challenging, it does not necessarily impede the goal of economic success. On the contrary, these goals can be intertwined and enable the long-term survival of firms, the environment, and society. Since Hart and Ahuja (1996) have asked the question "Does it pay to be green?" nearly three decades ago, many empirical studies have analyzed the relationship between sustainability and financial performance. Recent meta-analytic investigations go a step further by examining the circumstances under which environmental performance (e.g., Busch & Lewandowski 2018; Dixon-Fowler et al. 2013) and corporate social responsibility (CSR) performance (e.g., Velte 2022) affect financial performance. Thereby, the majority of studies focuses on large firms, while less is known about sustainability in Mittelstand firms.

In particular, the German Mittelstand, which includes many niche market leaders – the Hidden Champions (HCs) – is of considerable macro-economic importance. Mittelstand firms contribute to the value creation of the German economy, employment and training, innovation, and export activities (e.g., Berlemann & Jahn 2016; BMWK 2022; Pahnke & Welter 2019). In 2020, 99.3 percent of German firms belonged to the Mittelstand, accounting for 33.7 percent of revenues and 54.4 percent of employees (IfM Bonn 2022a). Sustainability related topics, such as CSR (e.g., Block & Moritz 2015; Icks et al. 2015) and climate change (Federal Statistical Office (Destatis) 2019) represent pressing but under-researched issues for Mittelstand firms. This dissertation follows the three-dimensional approach to sustainability, which is commonly presented as the three pillars of social, economic, and environmental sustainability, as shown in *Figure 1.1* (Purvis et al. 2019). Each of the three dimensions of sustainability discussed below offers its own research gaps, some of which will be addressed in this dissertation.

Figure 1.1 Three pillars of sustainability



Source: Purvis et al. (2019).

Social sustainability aims to develop social capital and justice, acts as a bridge to change behavior to achieve environmental goals and preserves socio-cultural traditions during times of change (Vallance et al. 2011). At the corporate level, social sustainability encompasses business practices that benefit stakeholders. In a narrow sense, these include for example employees; in a broader sense, it covers a firm's impact on the local community. A study of German small and medium-sized enterprises (SMEs) has shown that socially responsible management practices towards employees, customers, and society positively influence performance (Hammann et al. 2009). Moreover, previous literature suggests that family firms behave in a more socially responsible manner than non-family firms (e.g., Dyer & Whetten 2006), but the connection between family firm ethics and performance is largely unexplored (Ramos-Hidalgo et al. 2021). Also, little is known about the social influence of HCs which are often regionally connected and represent important employers as well as trainers (Lang et al. 2019; Lehmann et al. 2019; Pahnke & Welter 2019; Voudouris et al. 2000).

Economic sustainability encompasses practices that support a firm's long-term economic performance, without compromising the other sustainability dimensions. Broadly defined, it also includes a firm's impact on the economic environment in which it is embedded (Crane & Matten 2010). Certain organizations are centered on social or environmental sustainability, such as non-profit organizations (e.g., Drucker 1990). The majority of organizations, however, requires economic success to ensure their long-term existence. Thus, the economic pillar must be secured to ensure the firm's survival, so that it can address the other sustainability dimensions. While the German Mittelstand is known for its stable economic performance

(Berlemann et al. 2022), little insight exists for its specific subgroup of HCs (Benz et al. 2020; Langenscheidt & Venohr 2014; Simon 2012; Venohr & Meyer 2007).

Environmental sustainability refers to the conservation of natural resources and the protection of the environment and its ecosystems. Climate change and the 1.5° target to reduce global warming is one of the biggest environmental challenges of our time. Firms need to develop strategies to become more environmentally friendly, and it is only a matter of time before climate regulations such as the EU-Taxonomy will trickle down from large firms to smaller ones. Furthermore, financial investors are increasingly considering environmental criteria in their investment decisions, and related research is growing (e.g., De Angelis et al. 2022; Talan & Sharma 2019). It is important to learn more about the climate strategies of Mittelstand firms and the associated influencing factors. Prior research has identified various drivers of environmental strategies, such as organizational capabilities (e.g., Dzhengiz & Niesten 2020), stakeholder pressures (e.g., Seroka-Stolka & Fijorek 2020), and green innovation (e.g., Bhatia 2021). As firms, investors, and regulators work on their contributions to address environmental challenges, new opportunities are emerging, such as the concept of a circular economy (e.g., Morseletto 2020).

This dissertation contributes to a better understanding of sustainability in the Mittelstand context. To this end, the included studies examine different types of Mittelstand actors and the three dimensions of sustainability. Specifically, two datasets are used to examine social and economic aspects of HCs at the regional level and in comparison to other Mittelstand firms. In addition, recent survey data on the environmental strategies of entrepreneurial finance investors and (family-owned) Mittelstand firms is evaluated, to analyze the motives and strategies for climate-conscious investments and the firms' decarbonization strategies.

1.2 Research Questions

This dissertation addresses several research questions which are presented in the following paragraphs. They are grouped according to the type of Mittelstand actor (HCs, entrepreneurial finance investors, (family-owned) Mittelstand firms) to which they relate. The terms Mittelstand, SMEs, and family firms are often mixed or used interchangeably (Pahnke et al. 2023). From a quantitative perspective, Mittelstand firms can be defined according to firm size, including SMEs (IfM Bonn 2016) and midcaps (Röhl 2018). The qualitative perspective emphasizes the identity of ownership and management (IfM Bonn 2021), whereas most

Mittelstand firms are family firms. This dissertation takes a broad approach to the definition of the Mittelstand, in order to take a look at different actors involved in the Mittelstand context. These include specific subgroups of Mittelstand firms, such as HCs and family firms, as well as entrepreneurial finance investors.

1.2.1 Hidden Champions (Chapters 2 and 3)

As leading niche market players, HCs are a subgroup of the German Mittelstand. Although the HC phenomenon has received much interest in practice, academic research on the topic is rather scarce (e.g., Audretsch et al. 2018, 2020; Lehmann et al. 2019). While previous research addressed several characteristics of HCs and their strategy, two areas in particular require further investigation.

First, the impact of HCs at the regional level remains largely unexplored. Indeed, regional studies examining related firm types such as family firms, found evidence of an impact on regional development (e.g., Block & Spiegel 2013; Stough et al. 2015). Although HCs are similar to family firms in some respects, they possess unique characteristics, such as the focus on niche markets and export activities. These characteristics may have an influence on the districts in which the HCs are located. Known as (niche) market leaders and major employers (e.g., Pahnke & Welter 2019), it is of particular interest whether HCs have a sustained impact on the social and economic dimensions of regional development.

Second, HC research lacks quantitative empirical evidence on the financial performance of HCs relative to other firm types. Although popular sciences (e.g., Langenscheidt & Venohr 2014; Simon 2012) suggest that HCs outperform other firms, an empirical quantification of these differences is lacking. Since HCs are regarded as a subgroup of the German Mittelstand, non-market-leading medium-sized firms represent a suitable comparison group. These evaluations provide useful insights into the economic sustainability of HCs and other Mittelstand firms. Accordingly, the following two research questions are addressed in Chapters 2 and 3:

RQ 2: *What impact does regional HC intensity have on regional development?*

RQ 3: *When and to what extent do HCs financially outperform other types of medium-sized firms?*

1.2.2 Entrepreneurial Finance Investors (Chapter 4)

To gain a broader perspective on the Mittelstand sector in the context of sustainability, we take a look at other actors involved. Entrepreneurial finance investors, more specifically private equity (PE) and venture capital (VC) firms, provide financing to both medium-sized firms and start-ups. As sustainable investing has become increasingly important in recent years (e.g., Talan & Sharma 2019), a separate consideration of environmental sustainability and climate issues seems essential in this regard (e.g., De Angelis et al. 2022). To better understand investor behavior, it is necessary to examine the motivations and strategies for incorporating environmental sustainability into investment decisions. Prior research has already provided initial insights into the motivations and strategies for environmental, social, and governance (ESG)-related considerations of institutional investors in particular (e.g., Amel-Zadeh & Serafeim 2018; Eccles et al. 2017). Focusing on PE and VC investors and climate considerations can extend previous findings and help policymakers design more effective interventions in the entrepreneurial finance market to promote sustainable investment behavior. Chapter 4 therefore aims to answer the following research questions:

RQ 4.1: *What are the motives for VC and PE firms to consider climate issues in their portfolio investments?*

RQ 4.2: *Which strategies do VC and PE firms employ to address climate issues?*

RQ 4.3: *How do the motives for climate considerations affect the strategies employed?*

1.2.3 (Family-Owned) Mittelstand Firms (Chapter 5)

We then take a look at family-owned and other medium-sized German manufacturing firms. Being a major contributor to Germany's carbon emissions (IfM Bonn 2022b), these firms are under considerable pressure to decarbonize. As it is only a matter of time before regulatory frameworks such as the EU-Taxonomy are extended to this sector of the economy, it is important to understand the factors that influence the environmental strategies of these firms. Previous research suggests that stakeholder pressures are particularly influential in pushing firms towards environmental strategies to address their CO_2-emissions (e.g., Böttcher & Müller 2015; Dhanda et al. 2022; Yunus et al. 2020). Efforts are under way to identify the influence of different stakeholder groups on corporate environmental strategies (Hyatt & Berente 2017; Seroka-Stolka & Fijorek 2020). So far, it is unknown how stakeholder pressures from both internal and external sources influence the decision between symbolic (CO_2-compensation) and

substantive (CO_2-reduction) decarbonization strategies. Moreover, family-owned firms have been found to be more efficient at leveraging CSR to improve financial performance (Berrone et al. 2010; Combs et al. 2023). Yet, the impact of family ownership on the relationship between stakeholder pressures and decarbonization strategies remains to be uncovered. Therefore, the following research questions are discussed in Chapter 5:

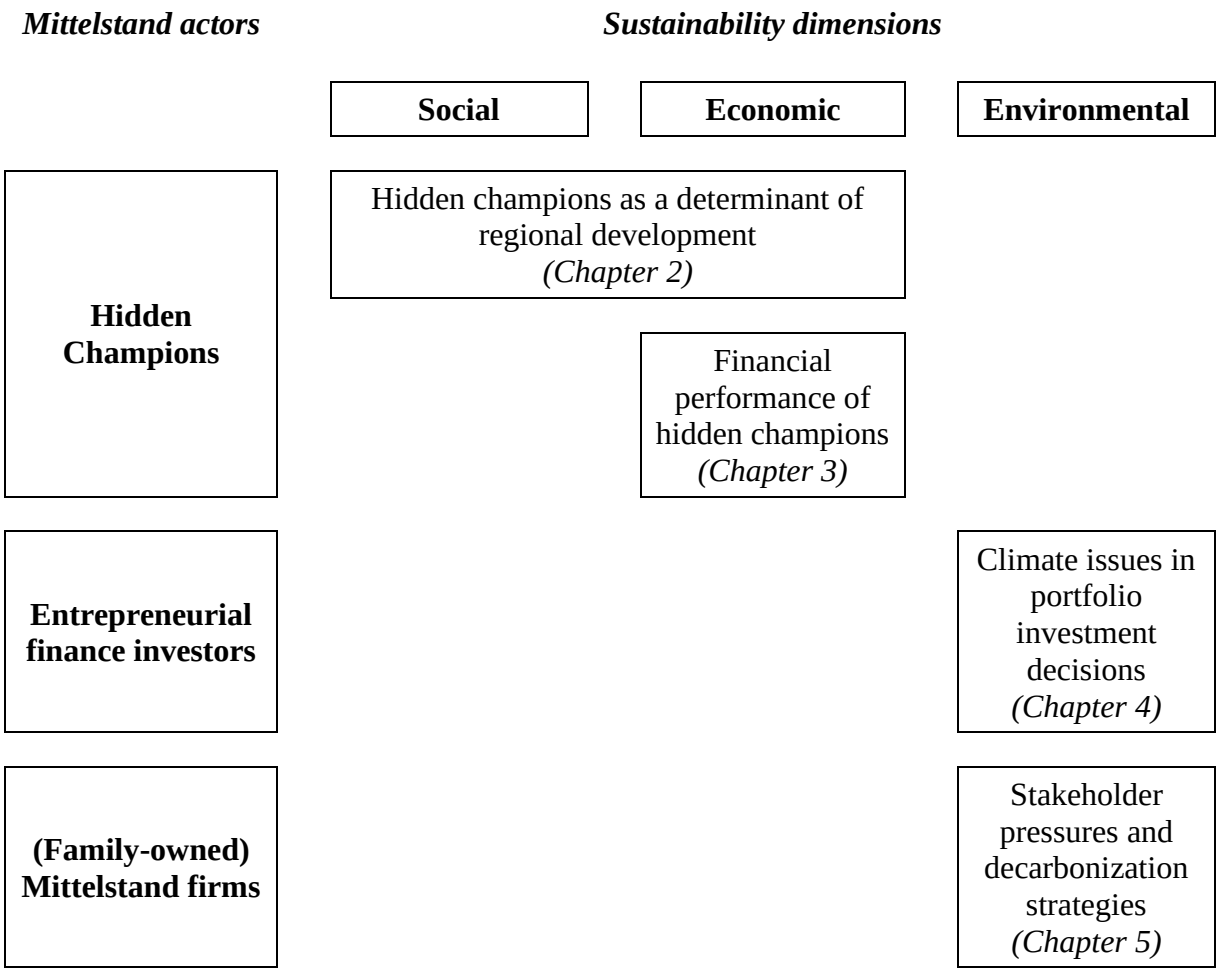
RQ 5.1: *How do stakeholder pressures influence the decarbonization strategies of Mittelstand firms?*

RQ 5.2: *Does family ownership have an effect on the relationship between the nature of stakeholder pressures and decarbonization strategies of Mittelstand firms?*

1.3 Structure of the Dissertation

Four quantitative empirical studies are included in this dissertation, which focus on different dimensions of sustainability and different types of actors involved in the Mittelstand sector. Beyond that, the studies cover the firm level as well as the regional level. The initial two studies (Chapters 2 and 3) both deal with HCs as a subgroup of Mittelstand firms. While Chapter 2 examines HCs as a determinant of regional development in terms of social and economic sustainability, Chapter 3 focuses on the economic dimension by analyzing the financial performance of HCs. Both subsequent studies explore environmental strategies. Thereby, Chapter 4 looks at entrepreneurial finance investors as another group of Mittelstand actors and analyzes why and how PE and VC investors include environmental sustainability considerations in their portfolio investment decisions. Last, Chapter 5 covers family-owned and other medium-sized manufacturing firms and examines how distinct types of stakeholder pressures affect their decarbonization strategies. *Figure 1.2* provides an overview of the structure of this dissertation. It consists of six chapters, which are summarized in the following paragraphs.

Figure 1.2 Structure of the dissertation



Source: Own illustration.

As a subgroup of the German Mittelstand, HCs are defined as market leaders in niche markets. Chapters 2 and 3 investigate these firms to add to a better understanding of the HC phenomenon. **Chapter 2** analyzes the impact of HCs as a determinant of regional development. Besides their contribution to the German economy and employment situation, previous research has identified the regional embeddedness of HCs (e.g., Audretsch et al. 2008). Building on this, we take a step further to the district level and examine the impact on HCs on selected dimensions of regional development. Using a dataset of 1,645 HCs located in 401 German districts, we illustrate the geographical distribution of HCs in Germany. Moreover, we analyze the effect of HC intensity, calculated as the number of HCs per 100,000 inhabitants per district, on seven measures of regional development. Findings show that HCs are not equally distributed across regions. We also find evidence for the importance of HCs for regional employment, training, as well as economic performance and uncover spillover effects to neighboring districts.

Further exploring the HC phenomenon, **Chapter 3** examines the profitability of HCs compared to other medium-sized firms in the German manufacturing sector. While previous research addresses the characteristics and strategies of HCs, little is known about their economic performance. Although anecdotal evidence suggests that HCs outperform other firms (e.g., Simon 2012), no study has quantified these differences in economic and statistical terms. Our study aims to fill this gap by examining the profitability of HCs compared to other medium-sized firms. Analyzing a panel dataset of 4,677 German manufacturing firms, of which 617 are HCs, we find a HC performance effect with regard to return on assets (ROA) that declines with firm size. The study contributes to a better understanding of HCs and how they remain successful and financially sustainable in the long run.

With a focus on entrepreneurial finance investors, **Chapter 4** addresses another type of Mittelstand actors, namely PE and VC firms. ESG criteria are increasingly considered in investment decisions (e.g., Abhayawansa & Mooneeapen 2022), and previous research has already provided initial insights into the motivations and strategies for ESG-related considerations (e.g., Amel-Zadeh & Serafeim 2018; Eccles et al. 2017). However, we lack research on entrepreneurial finance investors, on the one hand, and environmental sustainability, i.e., climate investments, on the other hand. By focusing on the investor type and the environmental dimension of sustainability, we seek to address both research gaps. Using survey data from a European sample of 468 investors, our study analyzes the motives and strategies for incorporating climate considerations into portfolio investment decisions of PEs and VCs. Results indicate that both investor types consider climate criteria but for different motives and following different strategies. While PE firms respond to external stakeholders and portfolio performance and pursue an active ownership strategy, VC firms are motivated by product differentiation and engage in impact investing.

Further contributing to the environmental dimension of sustainability, **Chapter 5** examines the decarbonization strategies of family-owned and other medium-sized German manufacturing firms. As major contributors to Germany's economic growth and carbon emissions (Federal Statistical Office (Destatis) 2022; IfM Bonn 2022b), these firms are under considerable pressure to decarbonize. Firms have been found to use two types of strategies to address environmental challenges (e.g., Damert et al. 2017): Symbolic decarbonization strategies, which focus on compensating CO_2-emissions, and substantive decarbonization strategies, which aim to reduce a firm's CO_2-emissions. Building on previous research (e.g., Hyatt & Berente 2017; Lopes de Sousa Jabbour et al. 2020; Seroka-Stolka & Fijorek 2020), we examine the influence of internal

and external stakeholder pressures, as well as the impact of family ownership, on the strategic decarbonization choices of 443 Mittelstand firms. We find that overall stakeholder pressures lead to a pursuit of decarbonization strategies, while internal and external stakeholders vary in their influence on symbolic versus substantive decarbonization strategies. Moreover, under external pressures, family-owned firms tend to be less inclined towards symbolic decarbonization strategies than non-family firms.

Finally, **Chapter 6** concludes with a summary of the main findings of the four studies presented in the previous chapters. In addition, implications for theory and practice as well as limitations and future research avenues arising from this dissertation are discussed.

Chapter 2

Hidden Champions as a Determinant of Regional Development: An Analysis of German Districts

HCs are defined as market leaders in niche markets. They represent the success of the German Mittelstand like no other group of firms. However, little is known on how HCs contribute to regional development. Given their export strength, regional embeddedness, and strong vertical integration we expect HCs to have a profound effect on regional development. Using a German dataset of 1,645 HCs located in 401 German districts, we analyze the effect of HCs on a variety of regional development dimensions. Our results show that HCs are not equally distributed across regions and influence regional development. Regions with a higher number of HCs show strong regional economic performance in terms of median income. Moreover, HC intensity affects regional unemployment and trainee rates as well as regional innovation in terms of patents. Surprisingly, we did not find an effect of regional HC intensity on regional research and development (R&D) levels and gross domestic product (GDP). We can further conclude that the effect of HCs is not limited to the particular region in which they are located but that sizable spillover effects exist. Besides its contribution to the regional development literature, our study adds to a better understanding of the HC-phenomenon. Implications for regional policymakers are discussed.[1]

[1] This chapter is based on Benz et al. (2021). The values in this chapter slightly differ from those in Benz et al. (2021) due to an update of the Hidden Champions dataset.

2.1 Introduction

Defined as (world) market leaders in a niche market, HCs are a successful subgroup of the German *Mittelstand*. Discovered as a phenomenon in the 1990s by Hermann Simon, the concept of the HC is now widespread. Though HCs partly overlap with the German Mittelstand, comprising many family businesses, the hidden (world) market leaders clearly stand out as they possess distinct characteristics. Their formula for success includes, among other things, the combination of a niche market focus and intense internationalization as well as superior technological capabilities and a specialized workforce (e.g., Audretsch et al. 2018; Rammer & Spielkamp 2015, 2019; Simon 2012).

HCs and the German Mittelstand in general make considerable contributions to the performance of the German economy and its status as a dominant export nation. In a country comparison study, Audretsch et al. (2020) identify Germany as the nation with the largest number of world market leaders per capita, which might be one reason for the success of the German economy. In addition to their importance at the national level, the impact of HCs on the regional economy is undeniable. Indeed, regional studies have examined related firm types such as family firms or members of the German Mittelstand in general and have found evidence of an impact on different regional development dimensions (e.g., Stough et al. 2015). For instance, previous studies analyzed the impact of these firm types on regional innovativeness (Berlemann & Jahn 2016; Block & Spiegel 2013), regional economic growth (Memili et al. 2015) and regional resources such as human resources (Basco 2015).

Although the three groups partly overlap, considerable differences exist, which are crucial for a separate analysis of HCs at the regional level. HCs are, for example, defined by market leadership in a niche market (Simon 2012) and not by firm ownership as family firms. An analysis of the regional impact of HCs provides the opportunity to gain deeper insights into the HC phenomenon, which is especially interesting from a policy perspective at the regional level. HCs make considerable contributions to the performance of the German economy (e.g., Lehmann et al. 2019) and they represent major employers (e.g., Pahnke & Welter 2019). Also, HCs are regionally connected and not only located in agglomerated but also peripheral areas (e.g., Audretsch et al. 2008; Lang et al. 2019). Due to the different characteristics of HCs, it is important to learn about their influence at the district level and uncover how they affect regional development dimensions such as performance or employment. Accordingly, HCs can attract the attention of policymakers and thus receive more support for the further development of the

regions in which they are located. These considerations lead to the following research question: *What impact does regional HC intensity have on regional development?*

To answer this research question, we combine a dataset covering 1,645 German HCs with a dataset covering the 401 German districts. The former serves as the basis for our independent variable *HC intensity*. The latter consists of data on regional development dimensions and regional-level control variables. After combining both datasets, the final dataset with 401 observations emerges, representing the 401 German districts. Conducting linear regression analyses, we examine the influence of HC intensity on a wide range of regional development dimensions, i.e., regional economic performance, employment, and innovation, to obtain comprehensive insights into how regional HC intensity affects regional development.

The findings show that HC intensity significantly influences each of the regional development dimensions examined in our study. We find only partial support for the anticipated effects on the dimensions of regional economic performance and regional innovation, showing that HC intensity significantly affects these two dimensions only to a limited extent. In terms of regional employment, we find a significant influence of HC intensity on both variables capturing this regional development dimension, fully supporting the expected relationships. These results have to be considered in light of potential reverse causality which is a common limitation of geographic studies that are unable to use historical data. In our case, we lack past information on the HC dataset.

Consequently, our study contributes to the small and emerging stream of HC literature, which has been rather scant so far, with few scientifically published academic studies (e.g., Audretsch et al. 2018, 2020; Johann et al. 2022; Lehmann et al. 2019). Our findings contribute to a better understanding of HC functionality by looking at how these firms affect several regional development dimensions. Hence, we uncover the impact of HCs on economic performance, employment, and innovation at the regional level, highlighting the key role of this group of firms in the districts in which they are located. By examining HCs on a regional level, we also contribute to the literature on determinants of regional development (e.g., Block & Spiegel 2013; Fritsch & Müller 2008; Vonnahme & Lang 2019), showing that HCs are an influential group of actors in the regional economy. Subsequently, these findings also have practical implications, especially for policymakers at the regional level.

This article is structured as follows: Section 2.2 provides deeper insights into the phenomenon of HCs, followed by an overview of the literature on the determinants and dimensions of

regional development. Section 2.3 contains the derivation of hypotheses on the impact of HC intensity on selected regional development dimensions. The data and methodology of the study are explained in Section 2.4, further introducing the variables included in our examinations. Section 2.5 presents the descriptive and multivariate analyses conducted, as well as a series of robustness checks and post hoc analyses. Finally, we discuss our findings in Section 2.6, reveal the implications and limitations of the study, and highlight arising avenues for future research.

2.2 Literature Review

2.2.1 The Hidden Champions Phenomenon

HCs represent a particularly successful subgroup of medium-sized firms. Simon first discovered the HC phenomenon in the 1990s. The following conceptual understandings of HCs therefore originate from Simon (1996, 2012, 2013), who defines HCs according to three criteria. *First*, HCs are among the top three market-leading firms in the global market or are number one in their domestic continent. *Second*, HCs earn revenues below five billion euros, and *third*, they are relatively unknown to the public. While market share and revenue are quantitative and regularly utilized criteria for identifying HCs, academic studies typically do not operationalize the qualitative criterion of public awareness (e.g., Rammer & Spielkamp 2015, 2019). As the definition indicates, HCs primarily pursue the two synergistic goals of market leadership and growth. On the one hand, HCs strive for market leadership in quantitative terms in the form of market share, as well as in qualitative terms in the form of leadership over market participants by setting standards or being pioneers. On the other hand, HCs strive for continuous growth. Numerous examples of former HCs that became major international enterprises listed on the stock exchange (e.g., SAP and Fresenius Medical Care) demonstrate this. To achieve their goals, HCs follow a strategy that combines two paradigms that initially appear to be contradictory. HCs strictly focus on niche markets where they serve selected customers with high-quality products. Nevertheless, while their focus on a selected niche makes their market small, international expansion gives them the necessary size to operate profitably. Therefore, HCs sell specialized products on a global scale (e.g., Audretsch et al. 2018; Voudouris et al. 2000).

Consequently, the HC phenomenon relates to the strategy literature. According to Porter (1980), firms strive for competitive advantages through the pursuit of one of three generic competitive strategies: cost leadership, product differentiation, or focus. While the achievement of

competitive advantages through cost leadership refers to product standardization, mass-market service, and the reduction of fixed costs, product differentiation attempts to achieve a competitive advantage by offering high-quality products and exploiting customers' increased willingness to pay for such products. The focus strategy represents a variation on product differentiation, as it aims to offer high-quality products specifically tailored to the needs of selected customers in a defined market segment. Hence, firms pursuing a focus strategy operate in niche markets (e.g., Audretsch et al. 2018; Toften & Hammervoll 2009, 2010a, 2010b). In general, a niche market is a narrowly defined market that typically consists of only one customer or a comparatively small group of customers with similar needs (Dalgic & Leeuw 1994). Accordingly, a niche market strategy describes a firm's concentration on certain customer needs, product segments, or geographically or demographically defined markets (Teplensky et al. 1993; Toften & Hammervoll 2010a, 2010b). Firms following a niche market strategy position themselves in small, profitable, and homogeneous market segments that are not occupied by competitors (Dalgic & Leeuw 1994).

Reviewing prior research, Toften and Hammervoll (2009, 2010b) identify seven interrelated characteristics of firms operating in niche markets. These characteristics contribute to the successful implementation of a niche market strategy and thus correspond to the HC strategy. *First*, niche firms think and act small (Hamermesh et al. 1978) as they offer, for example, comparatively small production volumes, concentrate only on selected customers, and deliberately choose markets in which few competitors operate (Hezar et al. 2006). Although HCs operate in narrowly defined markets and produce small volumes for their national customers, their production volumes grow due to their international expansion. *Second*, niche firms consciously select markets based on their own strengths and competencies (Hamermesh et al. 1978), entering into only those niches where they are able to contribute valuable products due to specific skills and in-depth knowledge. Consistent with this strategy, HCs are specialists within their industries. To maintain a market-leading position, they manufacture technologically advanced products and position themselves as quality leaders. Consequently, HCs require profound expertise, which they have acquired mainly due to their qualified workforce and extensive innovation activities (e.g., Lehmann et al. 2019; Rammer & Spielkamp 2015, 2019; Schenkenhofer 2022). *Third*, niche firms stand out by applying specialization and differentiation, typically with reference to products and customers (e.g., Audretsch et al. 2018, 2020; Dalgic & Leeuw 1994; Kotler 1997). In line with this, HCs focus on the individual demands of a limited customer base for whom they provide a correspondingly defined product

segment. Moreover, they not only manufacture quality products but also offer a deep range of services within narrowly defined markets. To provide depth in value creation, HCs typically have their own production facilities and innovation labs (Rammer & Spielkamp 2015, 2019). *Fourth*, they are subsequently able to cover several stages of their customers' value chain, directly aligning their specialized competencies and resources with their customers' needs. Hence, HCs tailor their products precisely to customer-specific demands and set a strong focus on customer needs (Dalgic & Leeuw 1994). *Fifth*, niche firms attach great importance to their reputation and use word-of-mouth references to expand (Dalgic & Leeuw 1994). Since HCs typically operate in business-to-business markets, they are little known to end-product consumers. Because HCs avoid extensive marketing activities, a strong reputation functions as a prerequisite for successful business relations. Apart from this, HCs practice a strong value system based on conservative principles such as trust and loyalty, guiding both their internal and external relationships. *Sixth*, HCs consequently build strong long-term relationships with relevant stakeholders (Dalgic & Leeuw 1994; Voudouris et al. 2000). In addition to close relationships with employees, HCs maintain tight customer relations (e.g., Audretsch et al. 2018). Customer proximity forms their greatest strength and is, due to international expansion, actively practiced across national borders. Because complex, customized products require regular customer contact, HCs enter foreign markets at an early stage, rely on direct sales, and establish their own subsidiaries abroad. Furthermore, HCs carry out innovation activities in close consultation with their customers, and even top management maintains regular contact with customers (e.g., Rammer & Spielkamp 2015, 2019). *Seventh*, niche firms charge a price premium, as they are able to offer superior customer value (e.g., Dalgic & Leeuw 1994; Kotler 1997). Since HCs provide highly specialized products with state-of-the-art technology, they do not compete on the price of their products. Therefore, prices are typically above the market average, which in combination with their international expansion significantly contributes to niche market profitability. Analyzing a sample of 4,677 German manufacturing firms over a period of ten years, Johann et al. (2022) for example show that HCs have a significantly higher profitability with regard to ROA than non-HCs.

2.2.2 Determinants and Dimensions of Regional Development

Regional development represents a multifaceted construct that links both different determinants and different dimensions at the regional level, as the processes and resources available to a region determine its development along several dimensions (Stimson et al. 2006). With regard

to the determinants of regional development, prior research has investigated, among other things, whether the presence of certain firm types affects regional development. For example, scholars have examined the role of family businesses (e.g., Basco 2015; Block & Spiegel 2013; Stough et al. 2015). Starting with the specific characteristics of family businesses, Basco (2015) systematically links the family business and regional development literatures to analyze whether family businesses affect the factors, processes, and proximity dimensions of regional development. Similarly, Stough et al. (2015) investigate whether and how family businesses contribute to regional economic growth and development. Moreover, Block and Spiegel (2013) study the impact of family firm density on regional innovation output. Furthermore, scholars have analyzed the influence of new business formation on regional development (e.g., Fritsch 2008; Stuetzer et al. 2014). For example, Fritsch and Müller (2004) examine the relationship between new business formation and regional development over time, identifying time lags as well as both positive and negative effects of new business formation on regional employment changes. As a follow-up, Fritsch and Schroeter (2011) investigate the effect of start-up activity on employment growth at the regional level, finding an inverse U-shaped relationship. However, while prior research has frequently examined the impact of specific types of firms, such as family businesses or start-ups, on regional development, research analyzing HCs as a determinant of regional development is rather scarce. Lang et al. (2019) as well as Vonnahme and Lang (2019) examine the role of HCs in small towns and peripheral regions. Analyzing five economic indicators, Lang et al. (2019) show that small towns with HCs, in peripheral as well as non-peripheral regions, are in a better economic situation than small towns without HCs. Also, qualitative research on HCs as a determinant of regional development exists in form of case studies (e.g., Kirchner 2019). Taking a quantitative approach, Vonnahme and Lang (2019) examine innovation activities based on a survey of 129 HCs. Since no homogeneous picture for the innovation behavior of HCs can be drawn, a cluster analysis divides the firms into groups that differ, for instance, with regard to the geographic focus of innovation activities. As the extent to which HCs contribute to progress and prosperity at the regional level remains mainly unclear, this study aims to empirically investigate the effect of HCs on several dimensions of regional development.

Concerning the dimensions of regional development, prior research has offered a diverse set of thematic priorities, including economic (e.g., Porter 2003), institutional (e.g., Rodriguez-Pose 2013) and social (e.g., Iyer et al. 2005) dimensions. Focusing on the economic dimensions of regional development, scholars have investigated regional innovativeness (e.g., Broekel &

Brenner 2011). In this context, Fritsch and Slavtchev (2011) emphasize the role of regional innovation systems, empirically analyzing factors that account for differences in the efficiency of regional innovation systems. Moreover, various studies have investigated the innovation output of regions as measured by the number of successful patent applications (e.g., Berlemann & Jahn 2016; Block & Spiegel 2013). In addition to analyzing dimensions related to knowledge creation at the regional level, others have considered employment-related dimensions (e.g., Fritsch & Müller 2008). Relating start-up rates to regional employment changes over time, Fritsch and Müller (2008), for example, find significant differences across regions in Germany; the effects of new business formation on regional employment changes are higher in agglomerations and regions with a high level of labor productivity than in rural areas and regions with a low level of labor productivity. For this study, we select three different dimensions of regional development in order to offer a broad picture on how HCs influence regional development.

2.3 Hypotheses

Since prior research has not sufficiently addressed the role of HCs as a determinant of regional development, the present study empirically investigates the effect of HCs on the following three dimensions of regional development: (1) regional economic performance, (2) regional employment, and (3) regional innovation. These three dimensions of regional development and the referring variables only partially capture the role of HCs as a determinant of regional development. In the following sections, we present each dimension and address their operationalization and the corresponding hypotheses. *Figure 2.1* provides an overview of the seven hypotheses and the expected influence of HC intensity on these regional development dimensions. In our study, we focus on the HCs' headquarters[2]. Even though HCs organize their work on average with ten different locations (Vonnahme & Lang 2019), prior research shows that the headquarters of multinational and multibusiness firms play a significant role in an entrepreneurial as well as administrative sense (e.g., Ambos & Mahnke 2010; Chandler 1991; Landau & Bock 2013). Therefore, we would like to put an emphasis on the HCs' headquarters and their impact on regional development.

[2] If the global headquarter is located outside of Germany, we include the national German headquarter of the HC.

2.3.1 Regional Economic Performance

The economic performance of a nation is closely linked to that of its individual regions, which can vary considerably. Therefore, many of the essential determinants of economic performance reside within individual regions rather than nations (e.g., Porter 2003; Kitson et al. 2004). One of the most commonly used measures of economic performance is GDP. It represents the total value of all goods, including products and services, generated in one year within the national borders of an economy. When transformed into GDP per capita for a defined area, conclusions about the development and performance of a region are possible. GDP is primarily generated by the production of goods. Although HCs operate in niche markets with small production volumes, operating on an international scale offers the potential to expand their production volumes. Since they manufacture on their own, HCs possess large production facilities, often located in rural areas. By producing large quantities locally (e.g., Lehmann et al. 2019), HCs significantly contribute to the GDP of their native regions. Consequently, we expect districts with a high intensity of HC headquarters to exhibit a higher GDP per capita.

H1a: Regional HC intensity is positively associated with regional GDP.

In addition to GDP, which captures the productive strength of a region, income levels are a fundamental measure of economic performance, as they reflect the standard of living of the regional workforce (Porter 2003). As previously mentioned, HCs generate huge profits by selling specialized goods on a global scale. Since HCs are deeply rooted in their home region, a large portion of their profits flows into the firm and its employees. Moreover, HCs are stable employers who view their workforce as an important factor in their success (e.g., Lehmann et al. 2019; Voudouris et al. 2000). Hence, monetary incentives play an important role in keeping employees over the long term. Profitably operating within global niche markets, HCs typically possess sufficient economic strength to offer monetary incentives and pay adequate salaries. Consequently, we expect districts with a high intensity of HC headquarters to have a higher median income.

H1b: Regional HC intensity is positively associated with regional labor income.

In addition to GDP and labor income, business taxes represent another appropriate indicator of regional economic performance, adding a tax perspective to the presented measures. Business taxes are levied on the earnings generated by a domestic business. Thus, the amount of business tax to be paid directly depends on the amount of profits made. Therefore, business taxes are the most important source of revenue for a district's municipalities. For the same reasons as those

already presented for hypotheses 1a and 1b, HCs significantly contribute to the business tax revenue of the municipality in which they are located (Lang et al. 2019; Röhl 2008). Because HCs successfully operate within global niche markets, they achieve comparatively high profits, thus leading to high business tax payments. Also, since HCs act independently and concentrate most of their activities and employees in their selected locations (e.g., local production facilities), business tax payments flow almost entirely into their native municipalities (e.g., Becker & Fuest 2010). As a result, municipalities that are home to HCs have higher business tax revenues. Wealthy municipalities in turn form the basis for the financial strength and economic prosperity of entire districts. Consequently, we expect districts with a high intensity of HC headquarters to have higher business tax revenues.

H1c: Regional HC intensity is positively associated with regional business tax revenues.

2.3.2 Regional Employment

In addition to performance indicators, human resource-related figures reflect regional development. Regional employment refers to the proportion of working-age people employed within a given region. Due to regional differences in population density, the unemployment rate serves as an accepted indicator of employment levels, making regions more comparable. Because HCs serve global niche markets, they need to handle relatively large production quantities. Nonetheless, HCs avoid outsourcing or strategic alliances and rely on maximum independence as well as control in production (Simon 2013). Consequently, they require a large workforce. Their strong growth further fuels the continuous demand for qualified employees. As a result, HCs try to manage the recruitment and long-term retention of employees by offering attractive jobs and familial corporate cultures (e.g., Lehmann et al. 2019; Voudouris et al. 2000). Accordingly, HCs make larger investments in human resource management practices (Rammer & Spielkamp 2019), acting as reliable long-term employers within mostly rural regions (Lang et al. 2019; Lehmann et al. 2019; Pahnke & Welter 2019). HCs permanently attract new employees and thus significantly contribute to regional employment. As a result, we expect districts with a high intensity of HC headquarters to exhibit lower unemployment rates.

H 2a: Regional HC intensity is negatively associated with the regional unemployment rate.

The manufacture of advanced products also requires specific expertise and technical knowledge (e.g., Lehmann et al. 2019; Rammer & Spielkamp 2015, 2019). Hence, HCs need specially trained workers and invest not only in the training and development of employees but also in the education of the trainees themselves. In particular, the dual apprentice system in Germany,

which specifically combines theoretical and practical teaching content, is an important pillar of the HC employment strategy (Audretsch et al. 2020; Jahn 2018; Lehmann et al. 2019; Schenkenhofer & Wilhelm 2020). It systematically ensures the technical competence of the workforce that is necessary to provide high-quality products. Jahn (2018) also verifies a significantly positive relationship between the relative importance of medium-sized firms and apprenticeship training at the regional level. Consequently, we expect districts with a high intensity of HC headquarters to have higher numbers of trainees.

H2b: Regional HC intensity is positively associated with the regional trainee rate.

2.3.3 Regional Innovation

The relevance of regional innovation as well as its possible determinants have received great attention in recent research (e.g., Block et al. 2021; Fritsch & Slavtchev 2011; Makkonen & van der Have 2013). For example, Broekel and Brenner (2011) examine how twelve selected regional factors, including the number of R&D employees, the presence of universities and technical colleges, and public research institutions, among others, affect the innovativeness of a region. Similar to various other studies (e.g., Block & Spiegel 2013; Fritsch & Slavtchev 2011; Fritsch & Wyrwich 2021; Thomi & Werner 2001), they relate these factors to the concept of regional innovation systems. A regional innovation system describes the components and processes of innovation on a regional level, forming an institutional setting within a region in which firms and other organizations interact and learn from each other (Cooke 2001; Cooke et al. 1998). This system provides targeted support for innovation activities at the regional level by creating an innovation-friendly climate that stimulates research cooperation, knowledge creation, and spillovers. Ultimately, this leads to increased regional innovation activities, both with regard to innovation input, for example, in terms of R&D expenditures, and innovation output, for example, indicated by the number of patent applications and new product developments. R&D expenditures and granted patents only represent a fraction of local innovation activities and allow limited statements on the innovation dynamics of a region as they focus almost exclusively on technological innovation (Block et al. 2021); however, they are established indicators in this context (e.g., Fritsch & Slavtchev 2011).

Niche firms play a particularly important role within regional innovation systems, as they require substantial expertise and profound knowledge to provide customers with specialized products (e.g., Dalgic & Leeuw 1994). Thus, to meet individual requirements and offer technological enhancements, HCs maintain large innovation capacities (e.g., Rammer &

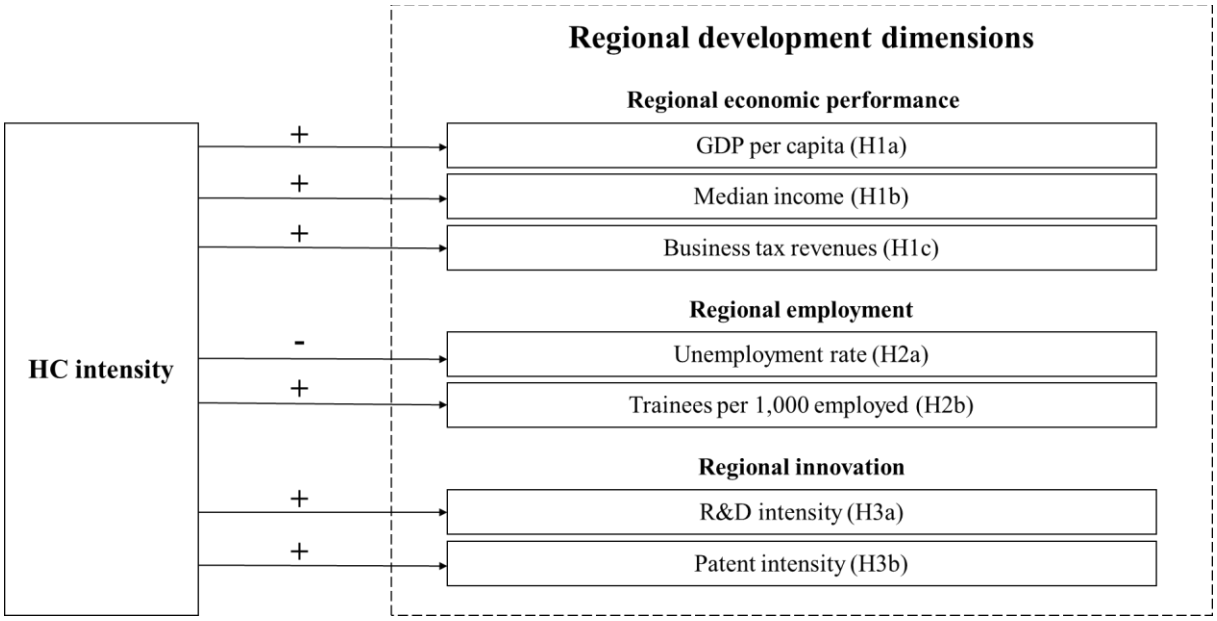
Spielkamp 2015, 2019). With regard to innovation input, HCs are associated with high levels of R&D investments (e.g., Audretsch et al. 2018; Schlepphorst et al. 2016; Zucchella & Palamara 2006). In a survey of 129 German HCs, Vonnahme and Lang (2019) find that more than 80 percent conduct in-house R&D. In addition to their own R&D activities, HCs often maintain regional relationships with universities and research institutions for innovation development, thus fostering the creation and exchange of knowledge (Rammer & Spielkamp 2015). Also, the majority of HCs assigns R&D contracts to third parties (Vonnahme & Lang 2019). Further, Fritsch and Slavtchev (2011) show that knowledge spillovers enhance private sector innovation activity, positively influencing regional innovation system efficiency. Therefore, by continuously investing in innovation (e.g., Rammer & Spielkamp 2015, 2019), HCs contribute to technological progress and substantially promote regional innovation. Consequently, we expect districts with a high intensity of HC headquarters to exhibit higher R&D expenditures.

H3a: Regional HC intensity is positively associated with regional R&D intensity.

Furthermore, the innovation activities of HCs are also visible with regard to innovation output. As HCs claim to be quality and technology leaders within global niches, they actively shape their markets by setting standards and taking on a pioneering role in the introduction of market novelties. Typically, HCs conquer their niche markets with radical innovations and subsequently defend their market-leading position through incremental improvements (e.g., Audretsch et al. 2020; Rammer & Spielkamp 2015, 2019; Voudouris et al. 2000). The innovation rate of HCs considerably exceeds the average rate for the German economy (Vonnahme & Lang 2019). As a result, the protection of intellectual property plays an important role, particularly with regard to product innovations. In addition to lead-time advantages, HCs heavily rely on patents as an effective protection mechanism. Typically, HCs possess significantly more patents than large firms do (e.g., Rammer & Spielkamp 2019). Thus, their leading role in knowledge creation and innovation development results in higher innovation output at the regional level, which is partly reflected by patent indicators. Consequently, we expect districts with a high intensity of HC headquarters to have a higher number of granted patents.

H3b: Regional HC intensity is positively associated with regional patent intensity.

Figure 2.1 Influence of HC intensity on regional development dimensions



Source: Own illustration.

2.4 Data and Method

2.4.1 Data Sources and Sample

The sample in our study consists of 401 observations, representing the 401 German districts. These refer to the NUTS 3-level (Nomenclature des unités territoriales statistiques), the official classification of the European Union for regional statistics, including all German districts and independent cities (European Union 2018). Data at the district level stem from various sources: (1) the INKAR online database of the Federal Office for Building and Regional Planning (BBSR), (2) the European Patent Office (EPO), (3) the Regional Database of the Statistical Offices of the Federal Republic of Germany and the Federal States, (4) the Donors' Association for Science Statistics, and (5) the Communal Education Database of the Statistical Offices of the Federal Republic of Germany and the Federal States. *Section 2.4.2* provides more details on the data source for each variable. The independent variable HC intensity is an exception, as we first collect data for this variable at the firm level via the Bureau van Dijk database Orbis and the Electronic Federal Gazette (Bundesanzeiger) and then convert it into a district-level variable. Additionally, we accessed data on the C-DAX stocks from the webpage of the Deutsche Börse AG, and VC investment data stem from the business-matching platform Spotfolio.

2.4.2 Variables

In the following, we describe the variables included in our analyses in detail. Additionally, *Table A2.1* provides a summary of the variables, including variable names, short descriptions of the variables, the data sources, and variable categories.

Dependent Variables

Seven dependent variables are included in our study, referring to the three regional development dimensions identified in S*ection 2.3*. Regional economic performance is captured by *GDP per capita* in euros per district in 2016; *median income*, measured as the monthly salaries of full-time employees subject to social insurance contributions in euros per district in 2017; and *business tax revenues* in euros per inhabitant per district in 2017. Data for all three variables are retrieved from the INKAR online database.

The *unemployment rate* is the first indicator for the second dimension, regional employment. It is measured as the share of unemployed individuals in the civilian labor force in percent per district in 2017. A further indicator for this dimension is the variable *trainees per 1,000 employees* as the number of trainees per 1,000 employees subject to social insurance contributions per district in 2017. Data for both variables are obtained from INKAR.

Regional innovation activity is the third dimension which is partly covered by two established indicators (e.g., Fritsch & Slavtchev 2011). A measure for the innovation input is *R&D intensity*. The initial data for this variable stem from the Donors' Association for Science Statistics, providing total corporate internal R&D expenditures, including personnel expenses in thousands of euros, for 377 districts in 2015. For privacy reasons, the values for the remaining 24 districts are included in the total of another district. Therefore, we divide this total value by the number of districts it comprises and use the result to replace the missing data for this variable in the dataset, thus keeping overall R&D expenditures constant. Finally, we calculate R&D expenditures per 100,000 inhabitants, giving the total corporate internal R&D expenditures in thousands of euros per 100,000 inhabitants per district in 2015. Another variable belonging to this dimension and referring to the innovation output is *patent intensity*, which is the number of patents granted per 100,000 inhabitants per district between 2011 and 2015. The total number of patens per district between 2011 and 2015 for 402 districts is taken from the EPO. Since November 2016, only 401 districts have existed due to Osterode and Göttingen being combined into a single district, Göttingen; hence, we utilize the mean value of the patents from the two former districts as the value for the combined district. Additionally, we obtain the number of

inhabitants in each district from INKAR, which we then divide by 100,000. Finally, the total number of patents is divided by this value to obtain the number of patents granted per 100,000 inhabitants per district.

Independent Variable

The starting point for our independent variable is the construction of a sample consisting of 1,645 German HCs. A list-based search was conducted in order to identify the HCs. As a foundation, the HC lists of WirtschaftsWoche (2020) Langenscheidt and Venohr (2014) and Simon (2012) were combined. In addition, we checked other firm lists such as the list of German family enterprises by Seibold et al. (2019) and the lists of innovative (Mittelstand) firms published in Yogeshwar (2019) and Frankfurter Allgemeine Zeitung (2019) for potential HCs. Information on market leadership was additionally selected from the firm websites of the respective firms. Furthermore, we set Google alerts for the terms *Weltmarktführer* and *Hidden Champion* in order to identify additional HCs for our sample.

The 1,645 firms identified fulfill five criteria. *First*, they are among the top three market leaders worldwide or are number one on a continent. *Second*, their revenues for 2019, 2018, or 2017 must lie between ten million and five billion euros. Depending on availability, the revenue data are taken from the Bureau van Dijk database Orbis or the electronic Federal Gazette. *Third*, all firms must be older than ten years and employ more than 50 people. Information on founding years and employee numbers stems from Orbis or the firm websites. *Fourth*, all firms must be located in Germany. *Fifth*, subsidiaries of foreign firms are only included if they operate independently of the mother firm. As the typical HC criterion *unknown to the public* is difficult to measure, we do not include it in our study.

After constructing our sample of 1,645 German HCs, we obtain data on the NUTS 3 level of these firms via Orbis and the firm websites. Thus, we are able to calculate the total number of HCs for each of the 401 German districts. Additionally, we divide the number of inhabitants in each district by 100,000. Finally, the total number of HCs is divided by this value to create our independent variable *HC intensity*: the number of HCs per 100,000 inhabitants per district.

Control Variables

We include several control variables in our study. First, *population density*, calculated as the number of inhabitants per km² per county 2017, indicates the rurality of a district. To gain information about the population, we utilized the *population average age* in years per district

in 2017. Both variables are obtained from INKAR. To analyze the business structure of the districts, we utilize *firm intensity* as the number of firms per 100,000 inhabitants per district in 2017, sourced from the Regional Database of the Statistical Offices of the Federal Republic of Germany and the Federal States. Furthermore, we calculate *university intensity* as the number of public and private universities per 100,000 inhabitants per district in 2018. Data on the total number of universities at the district level originate from the Communal Education Database of the Statistical Offices of the Federal Republic of Germany and the Federal States. Moreover, we calculate *C-DAX intensity* as the number of firms listed in the C-DAX per 100,000 inhabitants per district. Therefore, we accessed a list of the 414 C-DAX stocks from the Deutsche Börse AG on 17 June 2020 and eliminated 16 stocks to avoid double counting, as the associated firms were listed with more than one stock, and eliminated another seven stocks because the corresponding firms have not been active since 2016. The remaining 391 stocks and respective firms serve as the basis for our control variable. In addition, we access the number of newly established businesses per 1,000 inhabitants in 2017 from INKAR and replace the missing values for the districts of Bremen and Bremerhaven with the mean from the 399 available districts. We then multiply the numbers by 100 to achieve the number of newly established businesses per 100,000 inhabitants per district in 2017 as our variable *new business formation intensity*.

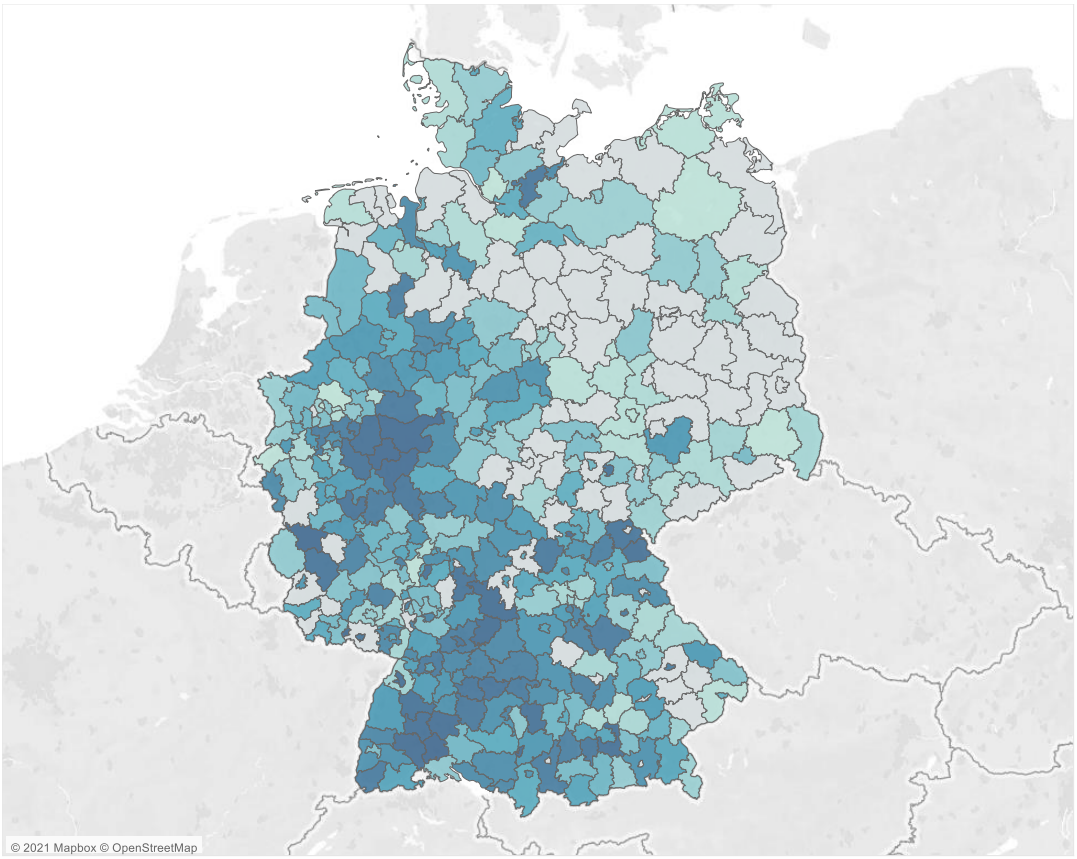
2.5 Results

2.5.1 Descriptive Results

In advance of the multivariate analysis, we present a series of descriptive results, starting with an illustration of where the HCs are located in Germany. *Figure 2.2* presents a map of Germany including the district boundaries and the distribution of the number of HCs per 100,000 inhabitants per district. The color of the district indicates the HC intensity; gray districts possess an HC intensity of zero, and darkly colored districts indicate an increasing HC intensity. Tuttlingen possesses the highest HC intensity, with 12.13 HC per 100,000 inhabitants, followed by the districts of Olpe (HC intensity = 10.39), Vulkaneifel (HC intensity = 9.90), Memmingen city (HC intensity = 9.12), and Zweibrücken city (HC intensity = 8.77). Utilizing the absolute number of HCs per district, we calculate a coefficient of concentration, stating that approximately 50 percent of the HCs are located in 54 of the 401 districts and that the six districts with the highest number of HCs account for more than 10 percent of the total number of HCs (1,645). Additionally, *Figure A2.1* presents a map of the distribution of the absolute

number of HCs per district, again with darkly colored districts indicating an increasing number of HCs. Ranking the districts according to their absolute number of HCs, the city of Hamburg has the highest number of HCs (35), followed by the city of Munich (33), the city of Berlin (30), Märkischer Kreis (28), and Esslingen (27). Several cartographic representations of HCs in Germany already exist. In order to verify our sample and the distribution of HCs, we compared our map to the representations of Langenscheidt and Venohr (2014), Simon (2012), and Ermann et al. (2011) which is based on the dataset of the Weissman Institute for Family Business. Our map shows a high visual similarity to the reference maps. Thus, it can be assumed that our sample and the distribution of HCs in Germany are in line with previous research. In addition, we calculated the number of world market leaders per district based on the WirtschaftsWoche (2020) sample and correlated it with the number of HCs per district of our sample. We find a correlation of 0.67, indicating a considerable overlap between the geographical distributions of the two samples.

Figure 2.2 Regional distribution of HC intensity in Germany



Explanation: Distribution of the number of HCs per 100,000 inhabitants per district; darker colors represent an increasing HC intensity; grey colored districts possess a HC intensity of zero.
Source: Own illustration, created via Tableau.

Table 2.1 presents the descriptive statistics of and correlations among the variables included in the regression model. We detect a greater correlation between median income and GDP per capita (0.72) as well as between median income and population average age (-0.70), neither of which are problematic for the regression analysis. Regarding multicollinearity, the variance inflation factors (VIFs) of the independent and control variables are relatively low and thus unobjectionable. The independent variable HC intensity has a mean of 1.98, which indicates that a district possesses on average two HCs per 100,000 inhabitants, with a minimum of zero and a maximum of 12.13 HCs per 100,000 inhabitants per district. In terms of economic performance, the average district had a GDP per capita of approximately 36 thousand euros in 2016 and a median income of approximately three thousand euros in 2017. Concerning regional employment, the districts possessed a mean unemployment rate of 5.36 percent and 43 trainees per 1,000 employees in 2017. The mean R&D intensity of 65,432.23 thousand euros per 100,000 inhabitants in 2015 and the mean patent intensity of 69.11 granted patents between 2011 and 2015 provide an overview of the regional innovation activities. Regarding regional exports, the average district possessed an export intensity of 1,060,115 thousand euros per 100,000 inhabitants in 2017.

Table 2.1 Descriptive statistics

Variable	Mean	SD	Minimum	Maximum	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	VIF
(1) GDP per capita	35,684.85	15,891.95	15,920.9	178,706.3															
(2) Median income	3,064.95	451.10	2,183	4,635	0.72														
(3) Business tax revenues	553.45	285.38	180	2,330.1	0.74	0.66													
(4) Unemployment rate	5.36	2.41	1.5	14	-0.05	-0.19	-0.13												
(5) Trainees per 1,000 employed	43.49	8.74	23.98	75.91	-0.01	0.24	0.03	-0.36											
(6) R&D intensity	65,432.23	124,742.3	381.89	983,442.9	0.51	0.53	0.30	-0.08	-0.05										
(7) Patent intensity	69.11	110.85	0	1,304.21	0.49	0.57	0.45	-0.13	0.01	0.48									
(8) Export intensity	1,060,115	1,181,402	15,681.49	1.21e+07	0.47	0.50	0.39	-0.10	0.13	0.48	0.48								
(9) HC intensity	1.98	2.00	0	12.13	0.21	0.37	0.33	-0.28	0.33	0.07	0.27	0.20							1.17
(10) Population density	533.75	702.70	36.13	4,686.17	0.48	0.48	0.45	0.42	-0.12	0.23	0.38	0.15	0.02						1.53
(11) Population average age	44.54	1.97	39.81	50.21	-0.49	-0.70	-0.51	0.28	-0.36	-0.28	-0.36	-0.24	-0.28	-0.46					1.77
(12) Firm intensity	4,423.55	709.95	2,543.16	8,144.85	0.29	0.18	0.45	-0.35	0.09	-0.03	0.16	0.05	0.23	0.13	-0.23				1.47
(13) University intensity	0.14	0.34	0	2.14	0.30	0.13	0.18	0.12	-0.14	0.09	0.09	0.09	0.02	0.26	-0.24	0.14			1.13
(14) C-DAX intensity	0.33	0.68	0	4.87	0.40	0.38	0.41	-0.02	-0.09	0.17	0.39	0.13	0.21	0.31	-0.26	0.30	0.20		1.24
(15) New business formation intensity	614.69	150.45	207.48	1,481.94	0.31	0.49	0.43	-0.07	0.19	0.08	0.18	0.13	0.17	0.47	-0.57	0.49	0.12	0.27	2.07

Explanation: n = 401; SD = standard deviation, VIF = variance inflation factor.

2.5.2 Multivariate Results

Sample Assessment

Before testing our hypotheses, we assess the quality of our HC sample as relates to the market leadership criterion. Continental market leadership or being one of the top three firms worldwide is strongly connected with a high degree of internationalization, which can be measured by, i.e., the export performance of a firm (e.g., Sullivan 1994). Since HCs strive for market leadership in global niche markets, they are characterized by above-average export rates (Fryges 2006; Johann et al. 2022). Therefore, we test whether regional HC intensity is associated with regional export performance, captured by the variable *export intensity*. The Regional Database of the Statistical Offices of the Federal Republic of Germany and the Federal States offers data on the export revenues of firms in the manufacturing sector in 2017. Twenty-one missing observations are replaced with the mean of the 380 districts with available data. We report the final variable as export revenues in thousands of euros per 100,000 inhabitants per district in 2017. The linear regression analysis in the last column of *Table 2.2* indicates a positive effect of HC intensity on export intensity ($\beta = 89{,}074.73$, $p < 0.01$). The international orientation and export strength of HCs make a decisive contribution to the export performance of the region in which they are located. Hence, districts with higher HC intensity also have higher export intensity, supporting our selection of HCs.

Hypothesis Tests

We test our hypotheses and examine the influence of HC intensity on various regional development dimensions by conducting a linear regression analysis for each dependent variable (see *Table 2.2*). Thus, we expect the number of HCs per 100,000 inhabitants per district to influence the regional development dimensions. Starting with regional economic performance, we find only partial support for our first hypothesis. HC intensity does not affect a district's GDP per capita, whereas it positively influences median income ($\beta = 45.52$, $p < 0.01$) and business tax revenues ($\beta = 20.55$, $p < 0.01$). Hypothesis 2 on regional employment is fully supported. A large number of HCs per 100,000 inhabitants per district significantly decreases the unemployment rate ($\beta = -0.08$, $p < 0.05$) and increases the number of trainees per 1,000 employees ($\beta = 0.99$, $p < 0.01$). The regression analysis does not support hypothesis 3a, but it does confirm hypothesis 3b, supporting the argument that high HC intensity positively affects the number of patents granted per 100,000 inhabitants per district. We find statistically significant support ($\beta = 9.49$, $p < 0.01$), implying that HC intensity significantly influences only

the output of innovation, measured by patent intensity, not innovation input, i.e., R&D expenditures.

Table 2.2 Linear regression analyses

	Regional economic performance			***Regional employment***		***Regional innovation***		
Dependent variables	**GDP per capita (H1a)**	**Median income (H1b)**	**Business tax revenues (H1c)**	**Unemployment rate (H2a)**	**Trainees per 1,000 employed (H2b)**	**R&D intensity (H3a)**	**Patent intensity (H3b)**	**Export intensity**
	Coeff (SE)	Coeff (SE)	Coeff (SE)	Coeff (SE)	Coeff (SE)	Coeff (SE)	Coeff (SE)	Coeff (SE)
Independent variable								
HC intensity	470.63	45.52	20.55	-0.08	0.99	174.12	9.49	89,074.73
	(331.55)	(7.85)***	(5.61)***	(0.04)**	(0.19)***	(3,186.40)	(2.51)***	(28,591.96)***
Control variables								
Population density	6.86	0.12	0.11	0.00	-0.00	24.01	0.05	111.36
	(1.08)***	(0.03)***	(0.02)***	(0.00)***	(0.00)***	(10.39)**	(0.01)***	(100.35)
Population average age	-2,568.29	-114.04	-40.76	0.71	-2.03	-17,644.76	-13.67	-102,252.5
	(415.30)***	(9.83)***	(7.02)***	(0.05)***	(0.24)***	(3,991.31)***	(3.14)***	(38,535.37)***
Firm intensity	4.07	-0.05	0.12	-0.00	-0.00	-14.75	0.01	-68.96
	(1.05)***	(0.02)**	(0.02)***	(0.00)***	(0.00)	(10.08)	(0.01)	(97.34)
University intensity	4,916.57	-98.15	-21.04	0.98	-4.13	-3,149.90	-27.15	116,329.1
	(1,939.35)**	(45.91)**	(32.79)	(0.25)***	(1.14)***	(18,638.49)	(14.67)*	(179,951.1)
C-DAX intensity	4,267.26	109.73	66.86	-0.02	-2.16	22,136.36	41.00	86,096.45
	(1,013.63)***	(24.00)***	(17.14)***	(0.13)	(0.60)***	(9,741.63)**	(7.67)***	(94,053.62)
New business formation	-18.75	0.26	-0.12	0.00	0.01	-108.35	-0.17	-191.92
intensity	(5.87)***	(0.14)*	(0.10)	(0.00)***	(0.00)	(56.43)*	(0.04)***	(544.80)
Constant	136,882.8	8,047.93	1,791.01	-22.99	132.09	963,184.7	673.22	5,756,527
	(20,275.12)***	(480.01)***	(342.78)***	(2.59)***	(11.92)***	(194,857.5)***	(153.39)***	(1,881,313)***
R-squared	0.41	0.59	0.48	0.59	0.33	0.12	0.31	0.09
F	39.48***	81.32***	51.73***	79.32***	27.51***	7.64***	25.14***	5.23***

Explanation: n = 401 districts; two-sided tests: * = $p \leq 0.10$, ** = $p \leq 0.05$, *** = $p \leq 0.01$; Coeff = coefficients, H = hypothesis; SE = standard error.

2.5.3 Spatial Autocorrelation Regression

Spatial autocorrelation is a common source of bias in regional-level analyses. Hence, we run a spatial autocorrelation regression analysis for each of the dependent variables, including our independent variable HC intensity and the control variables involved in our main analyses (*see Section 2.5.2*). Therefore, we systematically consider which of the variables require the inclusion of a spatial lag. We suspect the dependent variables, the independent variable and the university- and firm-related control variables to be spatially autocorrelated. The regression model further includes the control variables population density and population average age, which we do not suspect to be spatially autocorrelated. In addition to including the spatial lags of the variables to assess the strength of spatial interactions, we further include spatial error terms to correct for the spatial autocorrelative biases (Anselin 2001). As the coefficients of the spatial autocorrelation regression analyses are a combination of direct and indirect effects, we perform an impact test that estimates the mean of the direct, indirect, and total influences of the independent and control variables on the reduced-form mean of the dependent variables. *Table 2.3* presents the results of the impact test following the spatial autocorrelation regression analyses, including the direct, indirect, and total effects of HC intensity on the dependent variables. The direct effects report the change in the dependent variable within the same district. Accordingly, the indirect effects describe the spillover effects, i.e., the changes in the dependent variable in neighboring districts. The total effect on a given dependent variable is the sum of the direct and indirect effects.

After controlling for spatial autocorrelation, we retest the effect of HC intensity on our dependent variables, starting with the regional economic performance dimension. While HC intensity does not affect a district's GDP per capita, it positively influences the business tax revenue ($\beta = 20.90$, $p < 0.01$) of the same district. For median income, we find a significantly positive direct ($\beta = 22.64$, $p < 0.01$), indirect ($\beta = 39.19$, $p < 0.01$), and total ($\beta = 61.83$, $p < 0.01$) effect of HC intensity. For the second dimension, regional employment, we detect a significantly negative indirect ($\beta = -0.17$, $p < 0.05$) and total ($\beta = -0.17$, $p < 0.05$) influence of the independent variable on the unemployment rate. Furthermore, HC intensity significantly affects the number of trainees per 1,000 employees directly ($\beta = 0.50$, $p < 0.01$) and in total ($\beta = 1.19$, $p < 0.1$). We find no significant effects for the regional innovation dimension. A comparison between the effects of HC intensity and C-DAX intensity on the dependent variables is discussed in *Section 2.6.1*.

Table 2.3 Impact test following the spatial autocorrelation regression analyses

	Regional economic performance			***Regional employment***		***Regional innovation***		***Sample test***
Dependent variables	**GDP per capita**	**Median income**	**Business tax revenues**	**Unemployment rate**	**Trainees per 1,000 employed**	**R&D intensity**	**Patent intensity**	**Export intensity**
	Coeff (SE)	Coeff (SE)	Coeff (SE)	Coeff (SE)	Coeff (SE)	Coeff (SE)	Coeff (SE)	Coeff (SE)
Direct effects								
HC intensity	401.25	22.64	20.90	-0.00	0.50	426.83	6.60	119,110.3
	(358.95)	(7.92)***	(6.12)***	(0.04)	(0.17)***	(139,383.4)	(62.26)	(2,433,441)
C-DAX intensity	4,868.00	101.26	67.59	0.09	-0.82	20,861.31	41.89	-131,488.1
	(1,009.70)***	(21.88)***	(17.32)***	(0.11)	(0.51)	(1,409,616)	(256.27)	(1.05e+07)
Indirect effects								
HC intensity	-206.78	39.19	-13.81	-0.17	0.68	508,127.7	31.20	92,342.05
	(764.70)	(13.87)***	(14.16)	(0.08)**	(0.57)	(2.65e+07)	(202.40)	(2,222,752)
C-DAX intensity	-795.98	61.27	-68.81	-0.07	0.94	-5,146,078	-130.94	-395,087.5
	(2,979.31)	(55.74)	(60.19)	(0.31)	(2.62)	(2.70e+08)	(972.12)	(9,397,393)
Total effects								
HC intensity	194.47	61.83	7.01	-0.17	1.19	508,554.6	37.80	211,452.4
	(771.71)	(14.04)***	(14.34)	(0.08)**	(0.63)*	(2.67e+07)	(263.56)	(241,467.8)
C-DAX intensity	4,072.01	162.53	-1.22	0.02	0.12	-5,125,217	-89.05	-526575.5
	(3,306.80)	(61.69)***	(65.78)	(0.34)	(2.92)	(2.70e+08)	(1,223.84)	(1,211,221)

Explanation: n = 401 districts; two-sided tests: * = $p \leq 0.10$, ** = $p \leq 0.05$, *** = $p \leq 0.01$; Coeff = coefficients; SE = standard error. Further control variables are included in the model, which are not shown in this table: Population density, population average age, firm intensity, university intensity, and new business formation intensity. Model includes spatial lags of the dependent variables, the independent variable, the control variables C-DAX intensity, firm intensity, university intensity, and new business formation intensity, and spatial autoregressive errors. Generalized spatial two-stage least-squares estimator is used in order to fit multiple spatial lags.

2.5.4 Robustness-Checks and Further Analyses

In addition to the analyses presented above, we perform several robustness checks. First, we exchange several variables with alternative measures to detect divergent effects in the regression analysis. We replace the dependent variable median income with *household income*, retrieved from INKAR as the monthly household income in euros in 2016 per inhabitant per district. Household income is an alternative measure for regional economic performance, showing how income is distributed across districts. We discover a similar impact of HC intensity on household income ($\beta = 26.87$, $p < 0.01$) compared to median income. The coefficient is lower because the values for household income lie below the median income values.

Furthermore, we choose alternative measures for the control variable university intensity. First, we exchange the control variable with *technical college intensity*. The variable contains the number of technical colleges per 100,000 inhabitants per district in 2018, with data obtained from the Communal Education Database of the Statistical Offices of the Federal Republic of Germany and the Federal States. The significant influence of university intensity on median income, trainees per 1,000 employees and patent intensity now lose significance, while we detect a positive effect of technical college intensity on business tax revenues ($\beta = 50.32$, $p < 0.01$). The significance of the various effects of HC intensity on the different dependent variables remains unaffected. In addition, we combine the two academic education variables and test the effect of using the number of universities and technical colleges as a control variable in the regression analysis. Compared to those of the initial variable, the effects of *university and technical college intensity* on median income, trainees per 1,000 employees and patent intensity become insignificant, and we uncover a positive effect on business tax revenues ($\beta = 34.21$, $p < 0.05$) and export intensity ($\beta = 129{,}132.4$, $p < 0.1$). Again, the significance of the effect of HC intensity on the dependent variables remains unaffected. Thus, the number of universities affects regional development dimensions more significantly than the number of technical colleges.

As a further robustness check, additional control variables are integrated into the regression analysis. We calculate the number of VC investments per 100,000 inhabitants per district between 2011 and 2015, namely, *VC investment intensity*, to capture the number of innovative new businesses. Data on VC investments come from Spotfolio, a business-matching platform with a focus on innovative German high-tech firms. Except for a significantly negative effect

on trainees per 1,000 employees ($\beta = -0.47$, $p < 0.01$), the additional control variable is found to have no effect. In addition, the dependent variable R&D intensity is used as a control variable for the dependent variable patent intensity in a supplementary regression analysis to examine the relationship between the two innovation variables. Slight scaling adjustments, i.e., recalculating the variable as the total corporate internal R&D expenditures in millions of euros, increase its applicability as a control variable. R&D intensity exerts a significantly positive influence on patent intensity ($\beta = 0.32$, $p < 0.01$). As expected, the innovation input of a district influences its innovation output.

As a final robustness check, we recalculate the independent variable HC intensity as the number of HCs per 100,000 employees per district. Data on the number of employees per district in 2017 stem from the Regional Database of the Statistical Offices of the Federal Republic of Germany and the Federal States. We find similar significant effects on the dependent variables in the regression analysis, except for the impact on export intensity, which loses significance. Unsurprisingly, effect sizes are smaller for HC intensity per 100,000 employees, as the number of employees per district is below the corresponding number of inhabitants. Additionally, we rerun the regression analyses using the *absolute number of HCs* per district as the independent variable. Significantly positive influences on median income, business tax revenue, and patent intensity persist.

A series of post hoc analyses, which do not focus on our hypotheses, completes the examinations of this study, starting with the test of *VC investment intensity* as an additional dependent variable in the regression analysis. HC intensity does not significantly influence VC investment intensity, i.e., the number of innovative business formations. Thus, this dependent variable is not further examined.

Additionally, we perform a seemingly unrelated regression with the variables included in the main analysis, assuming correlation in the error terms across the equations. The significant and insignificant effects of HC intensity on the dependent variables remain, and the effect sizes are nearly equal to those found in the results of the linear regression models.

As HCs are argued to be mainly active in the manufacturing sector (Rammer & Spielkamp 2015, 2019), we would like to analyze whether the effects of HC intensity on these regional dimensions are driven by the manufacturing firms in the sample. Therefore, the NACE[3] codes

[3] Abbreviation for ‘nomenclature statistique des activités économiques dans la communauté européenne‘, a statistical classification of economic activities in the European Union.

for the HCs are collected via Orbis; missing data are supplemented by a personal assessment of the industry after collecting information from the firm websites. We then divide the sample into two groups: firms mainly active in manufacturing, i.e., NACE codes ten to thirty-three, and firms in the remaining industries. HC intensity measured as the number of HCs per 100,000 inhabitants per district is then recalculated for the two groups, resulting in *manufacturing HC intensity* and *non-manufacturing HC intensity*. *Table 2.4* shows the results of the linear regression analyses. Starting with exports as a quality assessment of our HC sample selection, only manufacturing HC intensity exerts a significant influence on regional-level export intensity ($\beta = 120{,}456.3$, $p < 0.01$).

Concerning the four regional development dimensions, we detect divergent influences of the two HC intensities on several dependent variables. In terms of regional economic performance, the regional GDP is affected only by manufacturing HC intensity ($\beta = 615.16$, $p < 0.1$), as is the case for business tax revenues ($\beta = 20.25$, $p < 0.01$). Both manufacturing HC intensity ($\beta = 45.95$, $p < 0.01$) and non-manufacturing HC intensity ($\beta = 43.52$, $p < 0.1$) positively influence regional median income. The unemployment rate is only influenced by non-manufacturing HC intensity ($\beta = -0.19$, $p < 0.1$), while the trainees per 1,000 employees are affected only by the HC intensity of manufacturing firms ($\beta = 1.22$, $p < 0.01$), representing the differing influence of the different HCs on regional employment. As a measure of regional innovation output, patent intensity is affected by both manufacturing HC intensity ($\beta = 7.98$, $p < 0.01$) and non-manufacturing HC intensity ($\beta = 16.42$, $p < 0.01$). In terms of R&D intensity, we do not find significant effects for the two HC intensities. However, the differing results for exports and the dependent variables presented above show that HCs are a group of firms that are indeed heterogeneous.

Table 2.4 Linear regression analyses with HC intensity divided into manufacturing and non-manufacturing firms

	Regional economic performance			***Regional employment***		***Regional innovation***		
Dependent variables	**GDP per capita (H1a)**	**Median income (H1b)**	**Business tax revenues (H1c)**	**Unemployment rate (H2a)**	**Trainees per 1,000 employed (H2b)**	**R&D intensity (H3a)**	**Patent intensity (H3b)**	**Export intensity**
	Coeff (SE)	Coeff (SE)	Coeff (SE)	Coeff (SE)	Coeff (SE)	Coeff (SE)	Coeff (SE)	Coeff (SE)
Independent variables								
Manufacturing HC intensity	615.16 (367.79)*	45.95 (8.72)***	20.25 (6.22)***	-0.06 (0.05)	1.22 (0.21)***	-607.70 (3,537.21)	7.98 (2.78)***	120,456.3 (33,965.3)***
Non-manufacturing HC intensity	-193.03 (802.04)	43.52 (19.01)**	21.92 (13.57)	-0.19 (0.10)*	-0.08 (0.47)	3,764.94 (7,713.68)	16.42 (6.06)***	-55,021.46 (74,069.00)
Control variables								
Population density	7.01 (1.09)***	0.12 (0.03)***	0.11 (0.02)***	0.00 (0.00)***	-0.00 (0.00)***	23.24 (10.51)**	0.05 (0.01)***	142.18 (101.93)
Population average age	-2,623.40 (419.79)***	-114.21 (9.95)***	-40.65 (7.10)***	0.70 (0.05)***	-2.12 (0.25)***	-17,346.58 (4,037.41)***	-13.09 (3.17)***	-114,217.9 (38,768.37)***
Firm intensity	4.10 (1.05)***	-0.05 (0.02)**	0.12 (0.02)***	-0.00 (0.00)***	-0.00 (0.00)	-14.87 (10.09)	0.01 (0.01)	-63.97 (96.93)
University intensity	4,891.06 (1,939.99)**	-98.22 (45.98)**	-20.99 (32.83)	0.98 (0.25)***	-4.17 (1.13)***	-3,011.84 (18,657.98)	-26.89 (14.66)*	110,079.3 (179,159.2)
C-DAX intensity	4,338.25 (1,016.86)***	109.95 (24.10)***	66.71 (17.21)***	-0.00 (0.13)	-2.04 (0.59)***	21,752.23 (9,779.70)**	40.26 (7.69)***	101,511.3 (93,907.43)
New business formation intensity	-19.00 (5.88)***	0.26 (0.14)*	-0.12 (0.10)	0.00 (0.00)***	0.01 (0.00)	-107.02 (56.54)*	-0.16 (0.04)***	-245.30 (542.92)
Constant	139,488.2 (20,481.24)***	8,055.77 (485.39)***	1,785.64 (346.63)***	-22.58 (2.61)***	136.27 (11.96)***	949,088.2 (196,980.1)***	646.00 (154.80)***	6,322,208 (1,891,459)***
R-squared	0.41	0.59	0.48	0.59	0.34	0.12	0.31	0.10
F	34.63***	70.97***	45.16***	69.60***	25.16***	6.71***	22.23***	5.19***

Explanation: n = 401 districts; two-sided tests: * = $p \leq 0.10$, ** = $p \leq 0.05$, *** = $p \leq 0.01$; Coeff = coefficients, H = hypothesis; SE = standard error.

2.6 Discussion, Limitations and Outlook

2.6.1 Discussion

By analyzing regional HC intensity in the context of regional development, we reveal several significant effects on three regional development dimensions: regional economic performance, employment, and innovation. Regarding the first dimension of regional economic performance, we find that HC intensity exerts a significant influence on median income and business tax revenues. This shows that a portion of the value creation generated by HCs remains in their region and is passed on to the inhabitants of the region through salaries and to the governments of the districts in the form of business tax payments. A significant impact on GDP per capita cannot be confirmed. Hence, the production volume that HCs process locally seems to be smaller than expected. This aligns with the findings of Herstatt et al. (2017) that although HCs concentrate their production activities in their German headquarters, most firms pursue a cooperative production strategy and produce in BRIC countries, especially China and India. According to a study by Vonnahme and Lang (2019), 85 percent of the 129 HCs surveyed possess more than one location, while the mean value accounted for ten locations worldwide. This also implies that the production of HCs is not exclusively limited to the German headquarters. Furthermore, spatial autoregressive analyses reveal that there is no significant direct effect of HC intensity on GDP per capita but there is such an effect on both median income and business tax revenues. In addition, HC intensity has significant indirect and total effects on median income. Once again, although the insignificant effect of HC intensity on GDP per capita is somehow surprising given our initial argumentation for hypothesis 1a, it is in line with the results of our main analyses. Moreover, significant results for median income are reasonable, as inhabitants of neighboring districts move between districts to work at HC firms but receive their income in their home district. Business taxes, however, are paid in the district where the HC is located; i.e., HC intensity has only a direct effect on tax revenue.

For the second dimension, regional employment, we find support for the impact of regional HC intensity on both the regional unemployment rate and the number of trainees per 1,000 employees. Hence, HCs are essential employers and trainers in their districts. The previous literature stating that HCs invest highly into human capital strengthens this argument (e.g., Rammer & Spielkamp 2019). Furthermore, spatial autoregressive analyses show mixed effects of HC intensity on the regional unemployment rate. Although HC intensity does not influence the unemployment rate within the HCs' home districts, it has significant indirect and total

effects, emphasizing their enormous regional scope as major employers. Due to continuous growth and mostly independent business activities, HCs require a large workforce that they attract supra-regionally and retain over the long run, thus contributing to increased employment levels across districts. Consequently, this finding again underlines the fact that employees travel between districts to work at HC firms. Additionally, HC intensity has both a significant direct and total effect on trainees per 1,000 employees. Although HCs train their own specialists within their home districts, their strong emphasis on trainees also has a clear effect beyond their home districts. Thus, HCs play a meaningful role in employment and training (e.g., Lehmann et al. 2019) both within and across districts.

HC intensity significantly affects the third dimension of regional innovation only in terms of innovation output, i.e., regional patent intensity, but not in terms of innovation input, measured by regional R&D intensity. Although HCs are associated with high R&D expenditures (e.g., Audretsch et al. 2018; Schlepphorst et al. 2016; Simon 2012), no regional-level impact on R&D intensity is found. This result corresponds with the findings of Rammer and Spielkamp (2015, 2019), who argue that HCs do not spend more on R&D than other firms but rather use resources more efficiently, thus enabling higher levels of innovation. HCs seem to innovate in a more efficient way. Furthermore, spatial autoregressive analyses show no significant direct, indirect or total effects of HC intensity on regional innovation – for either innovation input or output – which conflicts with prior research (e.g., Audretsch & Feldmann 2004). With regard to innovation output as measured by patent intensity, these results might indicate a shift within the innovation strategy of HCs away from purely formal protection mechanisms such as patents towards more multifaceted intellectual property protection strategies (e.g., secrecy) and open innovation approaches. This assumption would be to some extent consistent with the findings of Rammer and Spielkamp (2019), who conclude that HCs apply a complex intellectual property management system that combines different protection mechanisms such as patents, secrecy, and complexity of design. Also, Vonnahme and Lang (2019) find that most HCs pursue internal R&D and innovation activities often take place at the HCs' headquarters. They also find that regional innovation cooperation is of limited relevance. In line with Simon (2012), Vonnahme and Lang (2019) further show that HCs often rely on non-R&D activities such as production or customer relations as sources of innovation. These activities are not covered by our two variables for regional innovation.

In addition to the effect of HC intensity on the dimensions of regional development, we further consider the effect of C-DAX firms on a regional level. Thus, we examine the results of an

impact test conducted following the spatial autocorrelation regression analyses, including a comparison of the direct, indirect, and total effects of HC intensity and C-DAX intensity on the dependent variables. The results should be interpreted with the understanding that overlaps between the two groups are possible, as HCs may also be listed in the C-DAX. The issue of firm size should also be considered because C-DAX firms tend to be larger. Furthermore, the relevance of HCs differs across different spatial categories, as a large HC in a small peripheral town might possess stronger direct impacts compared to a small HC in an urban agglomeration (Lang et al. 2019). Interestingly, neither HC intensity nor C-DAX intensity significantly affects regional export intensity within either home or neighboring districts. While C-DAX firms are not associated with high levels of export activity per se, this result is surprising for HCs in particular, as they strongly emphasize international expansion. However, regarding the first dimension of regional economic performance, we find a significant direct effect of C-DAX intensity on each of the three measures: GDP per capita, median income, and business tax revenues. Because we find no significant direct effect of HC intensity on GDP per capita, our results indicate that C-DAX firms contribute more to a district's productive strength than HCs. Moreover, although we find a significant total effect of C-DAX intensity on median income, C-DAX intensity generates no significant spillover effects for neighboring districts. Thus, although total effects for median income are significant for both C-DAX firms and HCs, only HCs generate a significant indirect effect on median income. Consequently, employees of C-DAX firms seem to be less distributed across district boundaries, travelling less between districts for work than HC employees. For the regional economic performance dimension, it is clear that both C-DAX firms and HCs have a significant impact on their home district, but only HCs generate significant spillover effects, as they positively affect the median income of neighboring districts. For the second dimension of regional employment, we find no significant effects of C-DAX intensity on the unemployment rate, while HC intensity has significant indirect and total effects on the unemployment rate. Consequently, C-DAX firms influence neither their home nor their neighboring districts' unemployment rate. Moreover, only HC intensity has a significant direct and total effect on the number of trainees per 1,000 employees. Therefore, HCs considerably contribute to the regional training of skilled workers. For the third dimension of regional innovation, similar to HC intensity, we find no significant effects of C-DAX intensity on either R&D intensity or patent intensity. Again, these results are debatable, particularly with regard to patent intensity. Firms listed on the C-DAX are typically larger, which is why we would have expected them to rely on patents for different reasons. According to Blind et al. (2006), strategic motives for patenting correlate positively with firm size. For

example, by signaling successful innovation development and knowledge creation, patents function as helpful assets in negotiations with business partners.

2.6.2 Implications

Several implications for theory and practice arise from our study. Concerning our theoretical contribution, we add to the small and emerging stream of HC literature, as we examine the HC phenomenon on a regional level. Previous research on HCs has mainly focused on the internationalization (e.g., Audretsch et al. 2018), R&D, and innovation (e.g., Rammer & Spielkamp 2015, 2019) strategies of HCs, as identified by Schenkenhofer (2022). A rather small strand of the literature analyzes HCs in a geographic context, examining, for instance, the worldwide distribution of HCs (e.g., Audretsch et al. 2020; Lehmann et al. 2019) or the role of HCs in small towns and peripheral regions (e.g., Lang et al. 2019; Vonnahme & Lang 2019). Our study examines German HCs at the district level. We not only show the geographic distribution of HCs across German districts but also analyze the impact that HC concentration has on the regional development of the districts in which they are located. In doing so, we review the characteristics HCs are typically associated with and examine whether these characteristics have a visible impact at the regional level. The results of this study indicate that several typical HC characteristics have an impact at the regional level. The economic success of these firms leads to an increase in the regional median income and business tax revenues when HC intensity grows. A decreasing unemployment rate and a growing number of trainees associated with a higher HC intensity speak for the role of these firms as major and popular regional employers. While the significant influence of HC intensity on regional patent intensity highlights the fact that HCs file many patents, no support for the statement that HCs invest highly in R&D (e.g., Rammer & Spielkamp 2019) could be found at the regional level. Thus, the firm-level characteristics of typical HCs are only partly detectable at the regional level.

Consequently, we also contribute to the literature on the determinants of regional development as a second theoretical contribution. Prior research has identified specific firm types as determinants of different dimensions of regional development. One such firm type is the start-up, as the relationship between new business formation and regional employment change is a prominent research topic (e.g., Fritsch 2008; Fritsch & Müller 2008). Furthermore, family firms are another firm type analyzed as a determinant of regional development (e.g., Basco 2015; Block & Spiegel 2013). Our study considers HCs as a determinant of regional development by examining the impact of regional HC intensity on regional-level variables. Moreover, we

include a variety of regional development dimensions, namely, regional economic performance, employment, and innovation, and a set of variables to measure each of these dimensions. Applying this approach offers a comprehensive overview of the impact of HCs on the regional development of German districts. Consequently, we add to the research on specific firm types as determinants of regional development, as we identify HCs as impactful determinants at the regional level. The results indicate that regional HC intensity significantly influences each of the three dimensions analyzed. We find a clear impact on regional employment, as a high HC intensity reduces the regional unemployment rate and increases the number of trainees. For regional economic performance and innovation, we uncover only a partial impact: a high HC intensity increases only regional median income, business tax revenues, and patent intensity but not regional GDP and R&D intensity. Hence, HCs serve as an influential group of firms partly determining several dimensions of regional development.

Additionally, our results have practical implications, especially for policymakers at the regional level. We identify HCs as an important group of firms at the regional level and highlight their importance for the districts in which they are located. Hence, HCs contribute to the economic success of, employment in, and innovative performance of a district. Policymakers should consider the importance of such firms and keep them from moving to other locations. In addition, HCs can also influence soft factors of regional development that are difficult to measure, such as the image of a *region of world market leaders*. For example, the town Wertheim located in Baden-Wuerttemberg recently applied for adding the title *town of world market leaders* to their town sign (WirtschaftsWoche 2021). The regional ties of HCs also lead to the promotion of culture and sports and thus to an increase in the well-being of the local population. At the same time, the HCs themselves benefit from being actively involved in the regional development, as they may regard their involvement as an opportunity to actively shape their business environment (Lang et al. 2019). Further practical implications arise for the educational sector. The study confirms that successful and innovative firms are also located in smaller cities or peripheral areas, which can offer attractive jobs to future employees (e.g., Fritsch & Wyrwich 2021). In this context, the dual tertiary education model is also relevant, as it allows students to combine an academic education with practical training in technological leading firms (Schenkenhofer & Wilhelm 2020).

2.6.3 Limitations and Future Research

Our study has several limitations. *First*, the criteria utilized to construct the sample of HCs deviate from the initial criteria defined by Hermann Simon (1996). While the market leadership criterion is similar, we adjust the size criterion of revenues below five billion euros by including a minimum revenue level of ten million euros. Moreover, we add two more size criteria: firm age above ten years and a minimum of 50 employees, to exclude start-ups and very small firms from our sample. Hence, the upper-bound size restriction is similar to the initial definition, but we additionally use a set of lower-bound size restrictions. As the third HC criterion of Simon (1996), low public awareness, is difficult to measure and subjective, we do not include it in our study. This shortcoming of HC research has already been pointed out by Schenkenhofer (2022) who sees the development of a measure of the hidden criterion as a major avenue for future HC research.

A *second* methodological limitation is the disparate timeframes of the variables used, ranging from 2011 (patent intensity) to 2020 (HC intensity). Although we utilize the actual data available to us, we were forced to examine the influence of HC intensity on dependent variables from different years. Hence, a potential change in the data to date cannot be excluded. Nevertheless, changes at the regional level occur very slowly and are only clearly visible in the data after a longer period of time. Therefore, we consider this limitation to be rather unproblematic since most of the variables originate within five years of each other.

The *third* limitation of the study is its focus on German districts. Accordingly, the implications of the study are only partially transferable to other countries. By applying the study design to other countries, future research could increase the explanatory power of our results. Hence, future research could investigate the impact of local HCs on the dimensions of regional development in the corresponding economy or compare different countries in an analysis. Indeed, previous studies have examined the national HCs of different countries in single-country studies (e.g., McKieman & Purg Eds. 2013) and recently, Audretsch et al. (2020) compare several countries in a single study. Another avenue for future research in this context would be to go beyond the headquarter level. Vonnahme and Lang (2019) find that HCs organize their work in average with ten different locations in different regional settings often on a global scale. Analyzing the interplay between these locations and the distribution of value creation, production and innovation activities would increase our knowledge about the influence of HCs on regional development for headquarter and subsidiary locations. For the variables employed in our study, we anticipate differing degrees of headquarter effects. While

we expect central as well as decentral effects for the three regional economic performance indicators, the staff composition of headquarters and subsidiaries can differ (e.g., Tarique et al. 2006). Concerning regional innovation activity, we assume that patent applications are centralized at the headquarters, while R&D activities also take place at subsidiaries (Vonnahme & Lang 2019).

Fourth, in addition to locational expansion, the unit of analysis in terms of the regional economic dimensions of the study could be extended. The focus of our study lies in the three regional development dimensions: regional economic performance, employment, and innovation. Thus, only a part of regional development is covered, and statements regarding the effect of HCs are only valid for these three dimensions. To expand the explanatory power of these findings, future studies should include additional regional development dimensions and corresponding variables. The relationship between HCs and regional entrepreneurial culture serves as a promising dimension for analysis, as entrepreneurship and connected topics are a prominent research field in regional studies. For instance, previous research has examined the interplay between regional entrepreneurship cultures, regional knowledge bases, and new business formation (Fritsch & Wyrwich 2018). Moreover, Stützer et al. (2014) find that entrepreneurial culture has an effect on individual perceptions of founding opportunities, which in turn predicts regional start-up intentions and activity. Additionally, the actual debate on entrepreneurial ecosystems summarized by Schäfer and Mayer (2019) could also serve as a regional development dimension in future research. Not only further dimensions of regional development could be analyzed but also additional variables to increase the understanding of the three regional development dimensions of our study. Especially, taking a multi-dimensional approach to the innovation dimension would be a promising avenue for future research. Besides the R&D expenditures and the number of granted patents, other variables such as new business formation in the high-tech sector (Richter 2020) or direct innovation counts (e.g., Acs et al. 2002; Makkonen & van der Have 2013) can be applied. Moreover, Block et al. (2021) point out the importance of *soft* types of innovation, introducing trademarks as an indicator for non-technological innovation at the regional level. Although several quantitative studies examine the R&D and innovation strategies of HCs (e.g., Herstatt et al. 2017; Rammer & Spielkamp 2015; Vonnahme & Lang 2019), qualitative and mixed-methods research could shed more light on how these strategies are shaped by regional characteristics and vice versa. Thereby, qualitative research designs could be used to better understand the role of HCs in regional innovation systems and knowledge networks (e.g., Cooke 2001; Fritsch & Slavtchev 2011) and

precisely address the question of how and why HCs deliver added value in the region and how they differ from other (family) firms in their degree of locality and regional embeddedness (Baù et al. 2021; Stough et al. 2015). Qualitative research approaches are of particular relevance in the field of economic geography because, unlike quantitative analyses, they reduce concerns about measurement, provide important contextual information, and help develop compelling substantive arguments (Barthelt & Li 2020). For example, Schoenberger (1991) refers to the corporate interview as a qualitative research method in economic geography and Rutten (2019) uses qualitative comparative analysis in order to investigate the relationship between openness values and regional innovation.

A *fifth* limitation of our study is the potential for reverse causality. We assume that HCs influence the regional development of their districts and thus, for example, ensure a higher GDP. In contrast, HCs could settle in districts that are already regionally successful and have, for example, a high GDP. However, the possibility of reverse causality has been mitigated, as the HCs in our sample have an average age of 92.51 years, and we have applied an age minimum of ten years to exclude start-ups. Hence, no firm in the sample recently settled in its district. Nevertheless, the potential problem of reverse causality cannot be completely excluded. To further reduce this issue, future research could examine historical data at the regional level and examine the past regional economic performance, employment and innovation of currently successful districts. Comparable analyses have already been performed in previous research. For instance, Fritsch and Müller (2008) investigate historical data on regional employment and the impact of new business formation over time. Another example is a recent study on the historic causes behind the spatial distribution of innovation activities in Germany (Fritsch & Wyrwich 2021).

Finally, future research is necessary to expand knowledge on the phenomenon of HCs, especially at the firm level. Although an increasing number of studies on this phenomenon exist to date (see Schenkenhofer 2022), the number of scientifically published academic studies in the field is rather limited (e.g., Audretsch et al. 2018, 2020; Johann et al. 2022; Lehmann et al. 2019). Hence, further research is needed to better understand the inner workings of the HC phenomenon at the firm level as well as the external impact of this specific group of firms. The examination of the subgroup of younger HCs could be of particular interest, as they might have different dynamics, especially in terms of spatial patterns and the structural disadvantage of more rural regions. In this context, the presence of HCs might also have more impact than in urban regions and be of greater relevance to regional development issues. Future research could

tie in with the previous work of Lang et al. (2019) to further examine these aspects. Due to their technological strength and extensive internationalization efforts, linking younger HCs with the born globals concept (e.g., Baum et al. 2011, 2015; Knight & Cavusgil 2004; Sui et al. 2012) could be a fruitful approach to future research. Similar to HCs, born global firms are associated with distinct organizational features, early internationalization, and superior performance (e.g., Knight & Cavusgil 2004). Although existing studies already offer further differentiations of early internationalizing firms, e.g., between born globals and born regionals (Baum et al. 2015; Lopez et al. 2009; Sui et al. 2012), insights on globally active, technology-oriented startups, their characteristics and dynamics could also be transferable to the HC phenomenon.

Chapter 3

Financial Performance of Hidden Champions: Evidence from German Manufacturing Firms

HCs are market leaders in niche markets and are an important part of the German Mittelstand. Although the hidden champion phenomenon has received considerable interest in practice, few academic studies on this issue exist. We especially lack evidence on the financial performance of HCs. Our study addresses this gap and investigates the profitability of HCs. In analyzing a panel dataset of 4,677 German manufacturing firms, of which 617 are HCs, we find that HCs have significantly higher profitability with regard to ROA but less so regarding return on equity (ROE). The hidden champion performance effect on ROA is valued at 1.7 percentage points. Furthermore, the HC performance effect decreases with firm size. Our study contributes to the literature on the effect of firm strategy on firm profitability and adds to a better understanding of the HC phenomenon.[4]

[4] This chapter is based on Johann et al. (2022).

3.1 Introduction

HCs are market leaders in niche markets and are an important part of the German Mittelstand. Such entities are associated with the success of the German Mittelstand and the German economy. HCs follow a strategy based on the combination of two paradigms: niche market focus and international expansion. HCs focus on narrowly defined (niche) markets and provide high-quality products. To increase sales and achieve scale economies, HCs expand internationally (e.g., Audretsch et al. 2020; Rammer & Spielkamp 2015). Although the HC phenomenon has received much interest in practice, academic research on the topic is scarce. Prior research has investigated the characteristics of HCs and their firm strategies. HCs have higher export ratios than other firms (Rammer & Spielkamp 2015) and often enter foreign markets through fully owned subsidiaries (Audretsch et al. 2018). HCs employ a highly skilled workforce, which they constantly educate and train (Lehmann et al. 2019; Voudouris et al. 2000). HCs are effective (incremental) innovators and often also technology leaders (Audretsch et al. 2020; Rammer & Spielkamp 2015; Voudouris et al. 2000). However, while we already have an understanding of the characteristics of HCs and of their strategies, we know little about their economic performance. In particular, we lack quantitative empirical evidence on the financial performance of HCs relative to other firms. Although anecdotal evidence from the media (e.g., BBC 2017; The Economist 2012) and popular sciences (e.g., Langenscheidt & Venohr 2014; Simon 2012; Venohr & Meyer 2007) suggests that HCs outperform other firms, no study has quantified these differences in economic and statistical terms. Our study aims to close this gap and investigates the profitability of HCs compared to other firms.

We use a panel dataset of 4,677 German Mittelstand manufacturing firms, of which 617 are HCs, for a period of ten years. Our results show that HCs have a significantly higher ROA but that this is not the case for ROE. The HC performance effect on ROA is valued at 1.7 percentage points. Furthermore, the HC performance effect decreases with firm size and disappears for firms with more than 900 employees.

Our study contributes to three strands of literature. First, this work contributes to a better understanding of the HC phenomenon (e.g., Audretsch et al. 2018; 2020; Benz et al. 2021; Lehmann et al. 2019) and shows that the HC strategy can indeed lead to stronger financial performance as measured by ROA. Second, as HCs are an important part of the German Mittelstand, our study also contributes to the broader literature on the (German) Mittelstand (e.g., Berghoff 2006; Block & Spiegel 2013), particularly its success factors (De Massis et al.

2018). We contribute to the literature on the strategies employed by successful Mittelstand firms (e.g., De Massis et al. 2018; Pahnke & Welter 2019). Third, our study contributes to the literature on the determinants of financial profitability, particularly the link between strategy and firm performance (e.g., Bowman & Helfat 2001; Dess & Davis 1984; Hansen & Wernerfelt 1989; Spanos et al. 2004; White 1986). Prior research on strategy typologies describes a focused niche market strategy (e.g., Porter 1980; Dalgic & Leeuw 1994; Teplensky et al. 1993) and recommends this approach as a good strategy for SMEs (e.g., De Massis et al. 2018; Franch Parella & Carmona Hernández 2018; Gomes-Casseres 1997; Lee et al. 1999; Muzyka et al. 1997) and family firms (e.g., Hennart et al. 2019; McCann et al. 2001). The results of our study contribute to this discussion by showing that such a strategy can indeed lead to financial outperformance and that the relative advantage of a HC strategy compared to other strategies decreases with firm size, making it a good strategy for SMEs. With this result, we also add to the literature on the role of firm size in the strategy-performance relationship (e.g., Lee 2009; Leitner & Güldenberg 2010; Serrasqueiro & Nunes 2008; Shinkle et al. 2013; Thornhill & White 2007; Wagner 1995).

3.2 Theoretical Background

3.2.1 The German Mittelstand and its Characteristics

The term Mittelstand is associated with the success of the German economy. Since World War II and the German *Wirtschaftswunder*, the Mittelstand has been considered the backbone of the German economy and the engine of its industrial and economic growth (e.g., Kayser & Wallau 2002; Muzyka et al. 1997). Applying a quantitative criterion, Mittelstand firms include both SMEs (IfM Bonn 2016) and midcaps (Röhl 2018). A qualitative criterion stresses the identity of ownership and management (IfM Bonn 2021), and the majority of Mittelstand firms are family firms. Many large family firms also consider themselves part of the Mittelstand, leading to the emergence of the term *Mittelstand by perception* or identity (Pahnke & Welter 2019).

Because most Mittelstand firms are family-controlled and managed, they share some characteristics with family firms, including long-term orientation, regional embeddedness, and flat hierarchies (e.g., Berghoff 2006; Block & Spiegel 2013). Mittelstand firms have benefitted from globalization. They have internationalized and sell a significant share of their products abroad (Franch Parella & Carmona Hernández 2018; Kraft et al. 2012). Despite limited resources, such firms often attach great importance to innovation (De Massis et al. 2018).

However, while their long-term orientation and employee commitment positively influence innovation, the risk aversion of later family generations and resource constraints can pose a challenge (Decker & Günther 2017; Werner et al. 2018). Prior research has found that resource constraints and liabilities of smallness can hinder the formation of dynamic capabilities needed for business model innovation (Heider et al. 2020).

As the term Mittelstand is difficult to operationalize, little research exists on the financial performance of Mittelstand firms. However, number of studies have investigated the financial performance of German family firms. We identified five relevant studies. Andres (2008) finds that firms with an active founding family are more profitable than other firms. This result is confirmed by Audretsch et al. (2013), adding consideration of family monitoring to the literature. The authors argue that business families take an active monitoring role in the firm, protecting family wealth and positively influencing firm performance. Family influence also helps achieve a better strategic fit, which is closely linked to firm performance (Lindow et al. 2010). Other studies have examined the post-succession performance of family firms and found that the involvement of the previous owner and his/her human capital significantly affects firm performance (Ahrens et al. 2018). Additionally, family membership of the new chief executive officer improves post-succession firm performance according to Ahrens et al. (2019). While the performance of family firms as an important part of the German Mittelstand has been analyzed, we lack large-scale quantitative investigations of the performance of HCs.

3.2.2 The HC Phenomenon

HCs are referred to as the spearheading actors of the German Mittelstand. Simon (2012) defines HCs using three criteria. Market leadership is the first criterion. HCs are among the top three market-leading firms in the world or rank first on their continent. Second, HCs earn revenues of less than five billion Euros. Third, HCs are characterized by low public visibility. While market leadership and the amount of revenues can be quantified, low public visibility is difficult to measure and typically not included in the operational definition of HCs (e.g., Rammer & Spielkamp 2015). HCs pursue the following two goals: market leadership and growth through internationalization. They achieve these goals through the use of a focused niche market strategy. HCs are focused on niche markets serving demanding customers with high-quality and premium-priced products. Selling their products internationally extends their market and increases their sales volume, enabling scale economies and profitable operations (e.g., Audretsch et al. 2018; Voudouris et al. 2000). The HC strategy resembles the focus strategy

described by Porter's (1980) three generic competitive strategies. A focus strategy involves offering high-quality products to selected customers in narrowly defined market segments (Dalgic & Leeuw 1994).

Toften and Hammervoll (2009) identify seven characteristics of niche market strategies, namely, market segmentation based on the firm's strengths, small thinking and acting, building long-term relationships, focusing on customer needs, appreciation of the firm's reputation, specialization and differentiation, and charging a price premium (Dalgic & Leeuw 1994; Hammermesh et al. 1978). With the exception of 'thinking and acting small,' these characteristics fit with the HC strategy. While HCs operate in narrowly defined niche markets, they do not 'think and act small' but, on the contrary, have the ambitious goal of being the international market leader in their segment.

In addition to strategy research, entrepreneurship research has also analyzed the HC phenomenon, although the number of peer-reviewed articles is still low. Of the 94 studies identified by Schenkenhofer (2022), only a few studies are published in reputable academic journals. Audretsch et al. (2020) compare niche and scalable entrepreneurship across countries and identify Germany as the country where niche entrepreneurship is most prevalent. The authors' findings further show that country context and entrepreneurship strategies interact with each other and that country-specific institutions can explain the high prevalence of niche entrepreneurship in Germany. Focusing on the district-level, Benz et al. (2021) examine the HCs' impact on various regional economic indicators in Germany. The results show that a high regional HC density has a positive effect on the regional economy, for example in terms of income level or unemployment rate. Regarding regional innovations, a positive effect on patent applications but no influence on R&D expenditures of the districts can be found. Germany's historical and traditional institutions of quality orientation and a strong engineering focus combined with a highly educated workforce provide good conditions for the Mittelstand and its HCs (Audretsch et al. 2018; Lehmann et al. 2019; Rammer & Spielkamp 2015). In particular, the dual apprenticeship system in Germany is often cited as a major advantage, as it combines the relevant theoretical and practical knowledge and skills needed for high-quality manufacturing. HCs are more likely than other firms to qualify their employees to develop specific skills and human capital (Voudouris et al. 2000). Prior research has also investigated the particularities of HCs with regard to internationalization. As HCs' products are of premium quality and require considerable explanation and service, HCs are more likely than other firms to enter foreign markets through a direct market entry strategy by means of foreign direct

investments and wholly owned subsidiaries. HCs aim to retain control and ownership over their internationalization and foreign market entry strategies (Audretsch et al. 2018). With regard to innovation, it is suggested that HCs are strong in incremental innovation, as they strive to continuously improve their processes, products, and services (Lehmann et al. 2019). Close interactions with demanding customers are suggested to be the main source of innovation for HCs (Voudouris et al. 2000).

Regarding the performance of HCs, Benz et al. (2020) compare DAX 30 firms to 99 HCs listed in the CDAX according to different financial metrics that refer to growth, profitability, liquidity, and stock market performance. The authors' results show that HCs achieve operating and stock market performance similar to that of DAX 30 firms but differ in terms of financial liquidity and capital structure. Rammer and Spielkamp (2015) show that HCs exceed their control group in terms of market share, sales growth, and return on sales (ROS). Nevertheless, most insights into the financial performance of HCs are based on anecdotal evidence. Little evidence from large-scale quantitative studies exists.

3.3 Data and Method

3.3.1 Sample of German Mittelstand Firms from the Manufacturing Sector

To compare the performance of HCs to that of other Mittelstand firms, we used the Orbis database to generate a sample of German manufacturing firms. The following criteria were applied: (1) the firm was active as of December 2020; (2) its primary NACE code was between 10 and 33; (3) its revenues were below five billion Euros[5] and its number of employees was between 50 and 2,999[6]; and (4) it was not a subsidiary, foreign firm, nonprofit firm or public organization. We in turn obtained a sample of 9,594 firms. For these firms, we collected data on financial performance for 2011 to 2020, yielding an unbalanced panel dataset of 4,677 firms (28,584 firm-years).

3.3.2 Identification and Operationalization of HCs

Among the 4,677 firms, we were able to identify 617 HCs (3,958 firm-years). To identify HCs, we use the criteria of Simon (2012). HCs should be among the top three market leaders in the world or number one in Europe. We manually collected information on this criterion from the

[5] The revenues should be below five billion Euros for at least one of the last five years (2016 to 2020).
[6] This was measured for 2018.

firms' websites or from other online and offline sources, such as press releases and Google alerts ("Weltmarktführer" and "Hidden Champion"). In addition, we checked publicly available lists such as those provided by WirtschaftsWoche (2020), Seibold et al. (2019), and Langenscheidt and Venohr (2014). We also checked lists of innovative (Mittelstand) firms published in Yogeshwar (2019) and Frankfurter Allgemeine Zeitung (2019). The share of HCs included in our sample of Mittelstand firms amounts to 13.19%, which is similar to the share of 14.8% reported by Schlepphorst et al. (2016) for a comparable sample.

3.3.3 Variables and Methods

Our dependent variable is financial performance measured by ROA and ROE. To calculate *ROA* [*ROE*], we divide a firm's earnings before tax [EBT] by assets [equity].[7] Our focal variable *HC* is a dummy variable. In line with prior research on (family) firm performance (Andres 2008; Miller et al. 2007; Villalonga & Amit 2006), we control for firm age, firm size (number of employees), capital (debt-to-equity ratio) and ownership structure. *Table A3.1* provides an overview of the main variables used in our study.

Our analysis proceeds in three steps. First, we conduct descriptive analyses (*Section 3.4.1*). In addition to running correlations, we compare the means and medians of selected variables of HCs and non-HCs. Second, we run multivariate regressions to investigate whether HCs show higher levels of profitability than non-HCs (*Section 3.4.2*). We run two separate clustered ordinary least squares (OLS) regressions for ROA and ROE for the ten-year period of 2011 to 2020. Third, we conduct several further analyses, subsample investigations and robustness checks, as detailed in *Section 3.4.3*.

3.4 Results

3.4.1 Descriptive Results

Correlations

Table 3.1 presents the correlations among the variables included in our multivariate analyses. Not surprisingly, there is a strong correlation between our two performance measures, ROA and ROE (0.64). Surprisingly, our focal variable HC shows only weak correlations with the performance variables. The correlation with ROA [ROE] is 0.04 [0.01]. The VIFs of our

[7] We also used other earnings measures such as EBIT and EBITDA. The corresponding results are available upon request.

independent and control variables are relatively low, ranging from 1.02 (liquidity ratio) to 3.17 (export dummy). The average VIF is 1.42. Hence, multicollinearity is unlikely to be a major concern.

Table 3.1 Correlations and variance inflation factors

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	VIF
(1) ROA (%)															
(2) ROE (%)	0.64														
(3) HC (dummy)	0.04	0.01													1.19
(4) Firm age (log.)	0.05	0.03	0.15												1.12
(5) Employees (log.)	-0.05	-0.02	0.30	0.17											1.29
(6) Patents per employee	-0.01	-0.00	0.10	0.05	0.02										1.05
(7) Patents (dummy)	-0.01	0.03	-0.22	-0.19	-0.27	-0.19									1.18
(8) Export intensity (%)	-0.01	0.00	0.17	0.07	0.24	0.06	-0.17								3.16
(9) Export (dummy)	0.03	0.01	-0.12	-0.08	-0.27	-0.02	0.14	-0.82							3.17
(10) Liquidity ratio	0.12	-0.02	-0.01	0.02	-0.05	0.05	-0.02	0.00	0.02						1.02
(11) Debt-to-equity ratio (%)	-0.18	0.09	-0.02	-0.06	0.04	-0.01	0.04	-0.02	0.00	-0.11					1.02
(12) Blockholder (dummy)	-0.02	0.01	-0.11	-0.19	-0.09	0.00	0.02	0.04	-0.03	0.01	0.03				1.08
(13) Stock market listing (dummy)	-0.06	-0.04	0.19	0.07	0.15	0.05	-0.07	-0.11	0.13	-0.03	-0.05	-0.17			1.13
(14) Industry diversification (dummy)	0.01	0.02	0.00	-0.03	0.03	0.00	-0.00	0.01	-0.02	0.02	0.02	0.05	-0.10		1.02
(15) ROA volatility (%)	0.01	0.02	-0.03	-0.17	-0.13	0.05	-0.03	-0.00	0.02	0.01	0.04	0.12	0.01	-0.02	1.06

Explanation: n = 28,584; VIF = variance inflation factor.

Comparison of HCs to non-HCs

Table 3.2 provides descriptive statistics for our main variables distinguishing between HCs and non-HCs. We report mean and median values, standard deviations and t tests for the equality of means and Wilcoxon rank-sum-tests for the equality of medians. In this way, we examine whether the HCs in our sample have the typical characteristics attributed to HCs, namely, above-average export ratios, pronounced innovation activities, and healthy capital structures.

For *export intensity*, we find significantly higher mean and median values for HCs than for non-HCs. The mean export intensity is 54.78% for HCs versus 42.16% for non-HCs. HCs also show significantly higher levels of patent output. On average, HCs have 0.44 *patents per employee* (non-HCs: 0.29). The absolute numbers are even more impressive. HCs possess on average 264 (median: 86) granted patents, whereas non-HCs have only a mean of 85 (median: 18). Overall, our findings are consistent with prior research showing a stronger export orientation and higher innovation output for HCs compared to non-HCs (Lehmann et al. 2019; Rammer & Spielkamp 2015; Voudouris et al. 2000).

We also find significantly lower *ROA volatility* (6.20% versus 6.73%, $p < 0.01$) and *debt-to-equity ratio* (117% versus 125%, $p < 0.01$) values for HCs than for non-HCs, which is in line with HCs having healthy capital structures and revenue streams (Benz et al. 2020). In addition, the HCs' *liquidity ratio* is slightly lower than that of the other firms (2.55 versus 2.68, $p < 0.10$).

Regarding financial performance, we find that HCs have a mean ROA of 9.31% (median 7.98%), whereas non-HCs have a mean of 8.00% (median: 6.80%). This difference is statistically significant at the 1% level. Moreover, HCs have a higher ROE (mean: 25.10%, median: 18.06%) than non-HCs (mean: 24.09%, median: 16.68%).

Significant differences between HCs and non-HCs also exist regarding firm age and firm size. HCs are on average larger (in terms of employees) and older than non-HCs. Differences are statistically significant at the 1% level. The mean *firm age* of HCs is 59.47 years (non-HCs: 39.99), and the mean number of *employees* is 598 (non-HCs: 300).

Table 3.2 Descriptive statistics

	HCs			Non-HCs			t-stat.	z-stat.
	Mean	**SD**	**Median**	**Mean**	**SD**	**Median**		
ROA (%)	9.31	11.88	7.98	8.00	12.45	6.80	-6.41***	-7.52***
ROE (%)	25.10	59.91	18.06	24.09	75.34	16.68	-0.95	-4.43***
Firm age	59.47	56.63	43	39.99	40.00	27	-20.82***	-26.43***
Employees	598.15	524.84	416	299.63	373.53	181	-34.41***	-50.11***
Patents[1]	264.19	618.93	86	85.37	300.96	18	-17.14***	-41.40***
Patents per employees[1]	0.44	0.94	0.20	0.29	0.92	0.08	-9.13***	-26.14***
Export intensity (%)[2]	54.78	22.42	57.02	42.16	24.45	41.17	-22.38***	-21.41***
Liquidity ratio	2.55	4.00	1.57	2.68	5.03	1.29	1.87*	-11.68***
Debt-to-equity ratio (%)	116.92	138.98	68.30	124.53	155.85	68.66	3.14***	-1.75*
ROA volatility (%)	6.20	4.88	4.85	6.73	5.42	5.25	6.26***	6.22***
Number of firm-years	3,958			24,626			28,584	
Number of firms	617			4,060			4,677	

Explanation: Means, standard deviations (SD), medians and tests of differences in means and medians between HCs and non-HCs for selected variables. The sample comprises 28,584 firm-years from 4,677 firms. Asterisks denote statistical significance at the 0.01(***), 0.05(**), and 0.10(*)-level.

[1] As we only consider available patent data, we refer to 19,724 firm-years from 3,177 firms, thereof 3,714 firm-years from 577 HCs.

[2] As we only consider available export intensity data, we refer to 10,638 firm-years from 2,424 firms, thereof 2,020 firm-years from 414 HCs.

Industry Distribution

Table 3.3 shows the industry distribution of HCs and non-HCs. Across all industries, HCs have a share of 10.20%. Except for NACE 12 (tobacco products), HCs are present in all industries. However, HCs are not distributed equally across industries. The lowest share of HCs is found in NACE 18 (printing and reproduction of recorded media) (1.22%); the largest shares of HCs are found in NACE 28 (machinery and equipment; 22.12%), NACE 32 (other manufacturing; 20.74%), NACE 27 (electrical equipment; 19.34%), NACE 26 (computer, electronic and optical products; 17.85%), and NACE 13 (textiles; 17.28%).

Table 3.3 Industry distribution of HCs and non-HCs

NACE Code	Industry description	All Firms	HCs	Non-HCs	HCs in industry
10	Manufacture of food products	346	19	327	5.49%
11	Manufacture of beverages	72	5	67	6.94%
12	Manufacture of tobacco products	11	0	11	0%
13	Manufacture of textiles	81	14	67	17.28%
14	Manufacture of wearing apparel	45	3	42	6.67%
15	Manufacture of leather and related products	24	2	22	8.33%
16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	78	10	68	12.82%
17	Manufacture of paper and paper products	124	9	115	7.26%
18	Printing and reproduction of recorded media	82	1	81	1.22%
19	Manufacture of coke and refined petroleum products	20	2	18	10%
20	Manufacture of chemicals and chemical products	319	31	288	9.72%
21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	122	11	111	9.02%
22	Manufacture of rubber and plastic products	346	34	312	9.83%
23	Manufacture of other non-metallic mineral products	183	15	168	8.20%
24	Manufacture of basic metals	208	23	185	11.06%
25	Manufacture of fabricated metal products, except machinery and equipment	585	62	523	10.60%
26	Manufacture of computer, electronic and optical products	409	73	336	17.85%
27	Manufacture of electrical equipment	274	53	221	19.34%
28	Manufacture of machinery and equipment n.e.c.	886	196	690	22.12%
29	Manufacture of motor vehicles, trailers and semi-trailers	154	13	141	8.44%
30	Manufacture of other transport equipment	62	4	58	6.45%
31	Manufacture of furniture	44	3	41	6.82%
32	Other manufacturing	135	28	107	20.74%
33	Repair and installation of machinery and equipment	67	6	61	8.96%
Total		4,677	617	4,060	13.19%

Explanation: Number and percent of firms by primary two-digit NACE code. HCs are defined according to the criteria described in the text. The sample comprises 4,677 firm observations.

3.4.2 Multivariate Results

Our multivariate regressions investigate the performance effect of HCs using ROA and ROE as dependent variables. We run clustered OLS regressions for an unbalanced panel dataset spanning ten years. With regard to ROA, we find an economically and statistically significant effect. Being an HC has a positive relationship with ROA ($\beta = 1.73$, $p < 0.01$). With regard to ROE, we do not find a statistically significant HC performance effect ($\beta = 2.56$, $p > 0.10$).

Our control variables show significant industry effects. Interestingly, industries with a high HC share (*Section 3.4.1*) show a significantly higher profitability. For example, NACE 26 (computer, electronic and optical products) and NACE 27 (electrical equipment) have a significant positive relationship with ROA (NACE 26: $\beta = 2.78$, $p < 0.01$; NACE 27: $\beta = 2.12$, $p < 0.01$) and ROE (NACE 26: $\beta = 9.14$, $p < 0.05$; NACE 27: $\beta = 8.24$, $p < 0.10$). The same is true for NACE 28 (machinery and equipment), which shows a positive relationship with ROA ($\beta = 1.31$, $p < 0.05$). To conclude, the HC performance effect observed in practice may at least be partially attributed to industry effects. Innovation as measured by a firm's patents per employee shows a negative relationship with ROA ($\beta = -0.33$, $p < 0.10$) but no relationship with ROE. *Table 3.4* summarizes the results of the main analyses. An extended version showing the detailed industry effects can be found in *Table A3.2* of the appendix.

We next calculate the interaction effects between HC status and firm size (as measured by the number of employees). Our empirical model is a clustered OLS regression using ROA as the dependent variable. In calculating and plotting margins with 95% confidence intervals, we find support for the statistically significant HC performance effect with regard to ROA. The effect, however, decreases with firm size and loses its statistical significance for firms with 900 employees or more. *Figure 3.1* shows the interaction effects graphically.

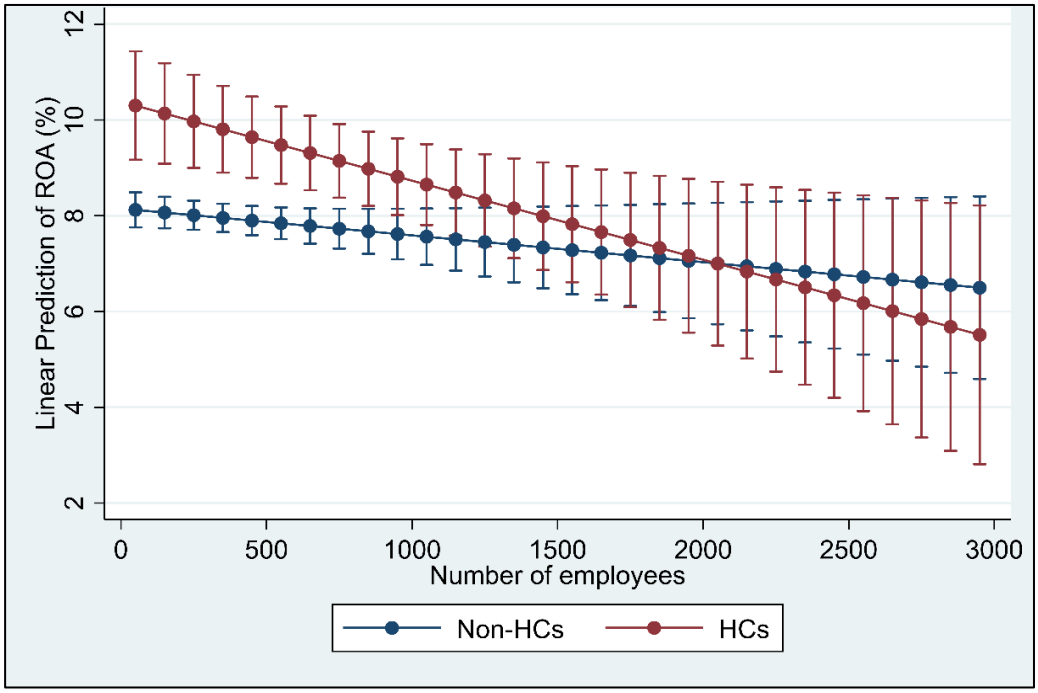
With regard to ROE, we neither find a statistically significant HC performance effect nor evidence for an interaction effect with firm size. *Figure 3.2* shows the interactions analysis for ROE.

Table 3.4 Clustered OLS regressions for our main sample

Dependent variables	**ROA (%)**	**ROE (%)**
Independent variable		
HC (dummy)	1.73***	2.56
	(0.45)	(2.41)
Control variables		
Firm age (log.)	0.71***	4.33***
	(0.17)	(0.99)
Employees (log.)	-0.46***	-1.08
	(0.18)	(1.02)
Patents per employee	-0.33*	-0.39
	(0.17)	(1.25)
Patents (dummy)	0.67*	6.60***
	(0.36)	(2.19)
Export intensity (%)	0.01	0.09
	(0.01)	(0.06)
Export (dummy)	1.34***	5.51*
	(0.46)	(2.89)
Liquidity ratio	0.21***	-0.24***
	(0.03)	(0.09)
Debt-to-equity ratio (%)	-0.01***	0.04***
	(0.00)	(0.01)
Stock market listing (dummy)	-6.50***	-19.03***
	(0.95)	(3.16)
Blockholder (dummy)	-0.57	0.38
	(0.36)	(1.76)
Industry diversification (dummy)	0.02	1.59
	(0.29)	(1.69)
ROA volatility (%)	0.03	0.21
	(0.04)	(0.24)
Constant	9.80***	7.21
	(1.48)	(8.52)
Observations	28,584	28,584
R-squared	0.07	0.02

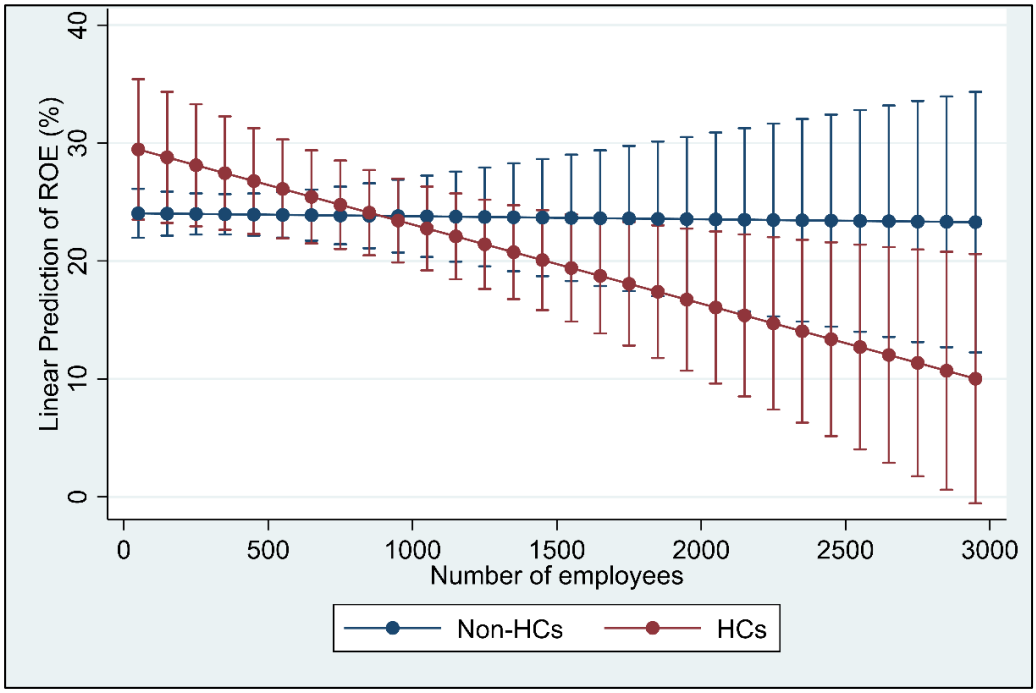
Explanation: Results of separate clustered OLS regressions of ROA and ROE on HC and further firm characteristics. All regressions include dummy variables for each year of the sample period, for German federal states and for two-digit NACE codes. The sample comprises 28,584 firm-year observations from 4,677 firms. The model shows coefficients with robust standard errors in parentheses. Asterisks denote statistical significance at the 0.01(***), 0.05(**), and 0.10(*)-level.

Figure 3.1 Predictive margins of HC with 95% confidence intervals for ROA



Explanation: Marginsplot based on a clustered OLS regression of ROA on HC and further firm characteristics, including the interaction effect between HC and a firm's number of employees. The sample comprises 28,584 firm-year observations from 4,677 firms.
Source: Own illustration, created via STATA.

Figure 3.2 Predictive margins of HC with 95% confidence intervals for ROE



Explanation: Marginsplot based on a clustered OLS regression of ROE on HC and further firm characteristics, including the interaction effect between HC and a firm's number of employees. The sample comprises 28,584 firm-year observations from 4,677 firms.
Source: Own illustration, created via STATA.

3.4.3 Further Analyses and Robustness Checks

In addition to our main analyses, we conduct several further analyses and robustness checks. As a first additional analysis, we perform the above described clustered OLS regressions for four subsamples based on firm size, age or revenue. *Table A3.3* of the appendix provides an overview of the main sample and the subsamples. We also perform a seemingly unrelated and median regression as well as a clustered OLS regression using *ROS* as the dependent variable. Finally, we test for the robustness of the results by winsorizing our dependent variables ROA and ROE.

Subsample Regressions

The first subsample consists of firms with a maximum of 499 employees, often referred to as medium-sized enterprises (IfM Bonn 2016). Our subsample regression using a sample of firms with between 50 and 499 employees shows an economically and statistically significant effect of HCs on both ROA ($\beta = 2.33$, $p < 0.01$) and ROE ($\beta = 5.78$, $p < 0.10$). The second subsample includes firms with a minimum of 500 employees and a maximum of 2,999 employees, thus including midcaps but excluding medium-sized enterprises (IfM Bonn 2016; Röhl 2018). The second subsample regression does not show a significant performance effect of HCs. In line with our analysis of interaction effects in the main analyses (*Section 3.4.2*), it seems that the HC performance effect exists for medium-sized Mittelstand firms but not for large Mittelstand firms. The third subsample is based on our main sample but excludes firms operating for less than ten years to exclude startups. Our third subsample regression confirms our main results. Significances and effect sizes resemble those of the main analyses. While we find a significant effect of HCs on ROA ($\beta = 1.80$, $p < 0.01$), we do not find one for ROE. *Table A3.4*, *A3.5*, and *A3.6* of the appendix show the results of the analyses.

We also perform a subsample regression for firms with revenues of less than three billion Euros. The HC criteria have slightly changed over time with regard to the upper threshold of revenues. Simon (2012) raised the threshold from three billion Euros to five billion Euros in 2012 to account for changing market conditions and firm growth. In analyzing 24,817 firm-years from 4,630 firms (616 HCs), we can confirm the results of our main analyses (*Section 3.4.2*). While HC has an economically and statistically significant effect on ROA ($\beta = 1.68$, $p < 0.01$), it is insignificant with regard to ROE ($\beta = 2.57$, $p > 0.10$).

Seemingly Unrelated and Median Regressions

As noted above, there is a strong correlation between our two dependent variables ROA and ROE (r=0.64), which may lead to a correlation in the error terms across the two regressions. When using a seemingly unrelated regression, accounting for such a correlation of error terms yields a positive significant relationship between HC and ROA ($\beta = 1.73$, $p < 0.01$) and a positive effect on ROE ($\beta = 2.56$, $p < 0.10$). *Table A3.7* of the appendix provides the results.

Additionally, we perform median regressions for ROA and ROE to account for the skewness of the dependent variables. This time, we find positive significant effects of HC on both ROA ($\beta = 0.83$, $p < 0.01$) and ROE ($\beta = 1.75$, $p < 0.01$). It seems that the insignificant relationship between HC and ROE found in the main analyses is at least partly due to the skewness of the dependent variable.

Using Alternative Dependent Variables

As another analysis, we perform a clustered OLS regression using ROS as a performance measure. ROS is calculated as EBT divided by the operating revenue of the firm. Using an unbalanced panel dataset of 24,778 firm-years for 4,630 firms (616 HCs), we find an economically and statistically significant performance effect of HCs ($\beta = 1.03$, $p < 0.01$). This result is in line with Rammer and Spielkamp (2015). *Table A3.8* of the appendix shows the regression results obtained when using ROS as the dependent variable.

Finally, we also performed regressions with winsorized dependent variables. To take into account outlier effects (Yale & Forsythe 1976), we transform the top (bottom) 1% and 5% of ROA and ROE, respectively; 1% (5%) of the lowest values are recoded to the value of the 1^{st} (5^{th}) percentile, while 1% (5%) of the highest values are recoded to the value of the 99^{th} (95^{th}) percentile. The results are as follows: Winsorizing at the 1% level yields a significant relationship between HC and ROA of $\beta = 1.65$ ($p < 0.01$). The relationship between HC and ROE is $\beta = 3.37$ ($p < 0.10$). Winsorizing at the 5% level yields similar results. *Table A3.9* of the appendix displays detailed results.

3.4.4 Limitations

Our study has some limitations. First, our sample is limited to Germany and to the manufacturing sector. The German manufacturing sector is a strong, export-oriented industry dominated by Mittelstand firms (Bernard & Wagner 1997). Our findings may not generalize to HCs and Mittelstand firms operating in industries that are less export-oriented, more business-

to-consumer focused or more service dominated. A second limitation concerns the large number of missing values affecting our profitability measures, which could lead to sample selection bias. Third, as our sample firms are mostly privately owned, we do not have information on the firms' market values and market-based performance measures. Finally, as our focal variable HC is constant over time, we cannot run fixed-effects regressions, which limits the interpretation of our findings, as we cannot claim causal effects.

3.5 Discussion and Implications

3.5.1 Summary of Main Results

The results of our empirical analyses support some of the earlier evidence on HCs (Audretsch et al. 2018; Rammer & Spielkamp 2015; Voudouris et al. 2000). For example, our results show that HCs have higher export ratios and higher patent output levels than other Mittelstand firms. Moreover, they are older, have less performance risk and have higher equity ratios. Regarding performance, our regressions show that HCs have a higher ROA but not a higher ROE. The HC performance effect on ROA is 1.7 percentage points and is therefore not only of statistical but also of practical significance. We also find that the HC performance effect is very heterogeneous and varies greatly. In particular, an interaction exists, and the effect seems to decrease with firm size. What do these results mean for theory and practice?

3.5.2 Implications for Theory and Future Research

Our study contributes to prior research on the determinants of financial profitability and particularly work on the link between strategy and performance (e.g., Bowman & Helfat 2001; Dess & Davis 1984; Hansen & Wernerfelt 1989; Spanos et al. 2004; White 1986). The question of which strategy leads to competitive advantage has been an integral part of the strategic management literature since such research began (e.g., Campbell-Hunt 2000; Spanos et al. 2004). As a result, research has identified different strategic orientations of firms and examined their effects on performance. For example, the typologies developed by Porter (1980) and Miles and Snow (1978) are among the most prominent strategic frameworks to date (Campbell-Hunt 2000; Ramos-Rodriguez & Ruiz-Navarro 2004). Both authors define strategic archetypes that firms follow to gain a competitive advantage. While Porter (1980) distinguishes between three generic strategies (cost leadership, differentiation, and focus), Miles and Snow (1978) divide firms into defenders, prospectors, and analyzers according to their strategic orientation.

Empirical evidence suggests that a firm's strategy indeed influences its performance (e.g., Bowman & Helfat 2001; Leitner & Güldenberg 2010; Spanos et al. 2004). For SMEs (De Massis et al. 2018; Franch Parella & Carmona Hernández 2018; Gomes-Casseres 1997; Lee et al. 1999; Muzyka et al. 1997) and family firms (e.g., Hennart et al. 2019; McCann et al. 2001), prior research has identified a focused niche market strategy as particularly suitable and profitable. Taking into account SMEs' resource constraints, Lee et al. (1999), for example, show that a niche market strategy allows SMEs to successfully compete with larger firms. Moreover, Hennart et al. (2019) find the adoption of a global niche business model to be a fruitful path for family-managed SMEs to overcome internationalization limitations and increase foreign sales. Our results confirm that a niche market strategy can lead to superior financial performance and that such a strategy fits well with the characteristics of small- and medium-sized firms. In this way, our study also contributes to research on the relationship between firm size and firm performance (e.g., Lee et al. 2009; Leitner & Güldenberg 2010; Serrasqueiro & Nunes 2008; Shinkle et al. 2013; Thornhill & White 2007; Wagner 1995), suggesting a niche strategy as an important moderator variable.

In addition to contributing to the broader strategy literature, our study contributes to a better understanding of the HC phenomenon. This is the first study to analyze the performance of HCs in a large-scale quantitative study. By evaluating the accounting performance of HCs in terms of ROA and ROE, we extend research on the characteristics of HCs (e.g., Audretsch et al. 2018, 2020; Benz et al. 2021; Lehmann et al. 2019) and Mittelstand firms (Berghoff 2006; Berlemann & Jahn 2016; Pahnke & Welter 2019). We answer the question of whether and to what extent HCs outperform other Mittelstand firms. While we can generally confirm outperformance (at least with regard to ROA), we also find substantial performance heterogeneity *within* the group of HCs. This result parallels findings from research on the performance of family firms. Miller et al. (2007) and Andres (2008) show that family firm performance depends very much on the definition of family firm and on the type of family firm considered. Some researchers even go so far as to completely reject the idea of comparing the performance of family and nonfamily firms and suggest focusing only on performance differences *among* family firms instead.

Our study can be seen as a starting point for research on the performance of HCs and their determining factors. More research is needed to better understand why and under which conditions HCs outperform other firms. When does a focused niche market strategy create economic value and when does it not? What internal and external factors interact with the HC strategy leading to (out-)performance? Potential external factors include country- and regional-

level institutions (Audretsch et al. 2020; Lehmann et al. 2019; Pahnke & Welter 2019), competitive factors (Porter 1980), and technological and industry environments (Spanos et al. 2004). Potential internal factors include a firm's resources and capabilities, such as its absorptive capacity, ambidexterity, and dynamic capabilities. Such a resource-based perspective of the HC strategy is missing thus far in the literature on HCs. Such a perspective would also extend the strategic fit literature (Bingham et al. 2011; Geiger et al. 2006; Lindow et al. 2010; Zajac et al. 2000). A final direction would be to investigate the relationship between firm ownership and HC strategy. For example, are family owners, due to their long-term focus, the ideal owners to pursue a HC strategy (Le Breton-Miller & Miller 2006; Lumpkin et al. 2010)?

3.5.3 Implications for Practice

The results of our study have practical implications for firm managers and owners in showing that a HC strategy can lead to superior firm performance, particularly for firms with fewer than 900 employees. Focusing on niche markets with a strong international and export orientation seems to be a profitable strategy. Our results should be interpreted with caution, however. Notable performance differences exist *within* the group of HCs, and by far, not all HCs are successful. It is also difficult for other Mittelstand firms to imitate an HC strategy. Hence, it is questionable whether HCs can truly serve as a role model for other firms. More research is needed to better understand when and under which conditions an HC strategy leads to superior performance and should be employed.

Chapter 4

Climate Issues in Portfolio Investment Decisions: A Comparison of Private Equity and Venture Capital

PE and VC firms increasingly consider climate issues in their portfolio investment decisions. However, what are their underlying motives and which exact climate consideration strategies do they employ? Based on data from two recent surveys, four motives emerge: ethical motives, responding to external stakeholders, product differentiation, and portfolio performance. Responding to external stakeholders and portfolio performance matter more to PE firms, while product differentiation is more significant for VC firms. No difference is found with respect to ethical considerations. Regarding climate consideration strategies, screening strategies (positive and negative) are most popular. Differences between VC and PE firms exist, and the motives to consider climate issues have an impact on the climate consideration strategies employed. The implications for policymakers and the entrepreneurial finance industry are discussed.

4.1 Introduction

In recent years, sustainable finance and sustainable investment strategies have gained importance in entrepreneurial finance. ESG criteria are increasingly considered in investment decisions, and entrepreneurial finance research has investigated sustainable investments (e.g., Abhayawansa & Mooneeapen 2022; Chatzitheodorou et al. 2019; Talan & Sharma 2019). Impact investors seem to be willing to sacrifice returns in exchange for nonpecuniary benefits (Barber et al. 2021) and research shows that investors value sustainability and ESG news as predictors of fund performance (Hartzmark & Sussman 2019), particularly when the information contained is financially material, positive, and unexpected (Serafeim & Yoon 2022). It has been shown that environmental sustainability and climate issues play considerable roles in this regard (e.g., De Angelis et al. 2022). Moreover, it has become increasingly important for investors to understand climate metrics and what they mean for their investments (Cheema-Fox et al. 2021).

Thus far, however, we lack a good understanding of the underlying motivations and climate consideration strategies employed, particularly for entrepreneurial finance investors such as PE and VC firms. Filling this gap is important because without profound knowledge about investors' motives for considering climate issues, it is difficult for policymakers to design an effective climate policy framework.

Our study contributes to closing these gaps by addressing the following interrelated research questions: *What are the motives for VC and PE firms to consider climate*[8] *issues in their portfolio investments? Which strategies do VC and PE firms employ to address climate issues? How do the motives for climate considerations affect the strategies employed?* To answer these questions, we first identify the most important motives (strategies) for incorporating climate considerations in the investments of entrepreneurial finance investors. Subsequently, we compare VCs and PEs and investigate potential differences in their motives (strategies) for considering climate investment criteria. By this means, we address a call to appreciate the heterogeneity of investors in the context of sustainability (Abhayawansa & Mooneeapen 2022). Finally, we link the motives for climate considerations and the respective consideration strategies pursued and analyze how the motives impact the strategies employed.

[8] With the term *climate* issues/considerations/etc., we refer to climate and environmental issues/ considerations/etc.

The context of our study is the European entrepreneurial finance industry. In 2021, 138 billion € were invested in the entire European PE market[9], including 20 billion € of VC investments in 5,334 portfolio firms and nearly 29 billion € of mid-market[10] buyouts in 580 portfolio firms (Invest Europe 2022). Commonly, VC and PE investors provide capital and management expertise to portfolio firms that are private or become private as part of the exit transaction to leave the portfolio firm after increasing its equity value (e.g., Caselli & Negri 2018; Kaplan & Sensoy 2015). *VCs* typically invest in young portfolio firms that are in the pre-seed to the expansion stage and that often have innovative concepts and high growth potential but also substantial risk and low liquidity. *PEs* typically invest in more established portfolio firms in growth and expansion or buyout stages. These mid-market portfolio firms are characterized by a proven concept and lower growth rates. However, they also take fewer risks and have stable cash flows.

Using survey data from a European sample of 163 PEs and 305 VCs, our study analyzes the motives and strategies for incorporating climate considerations into entrepreneurial finance investment decisions. Combined, the two surveys are among the largest of a kind in Europe. As such, they constitute a unique source of information that offers insights beyond the archival information available in existing databases. Our results indicate that entrepreneurial finance investors rank ethical responsibility the highest among all motives for climate investment considerations. However, PE investors respond significantly to external stakeholders and portfolio performance considerations, while VCs are considerably motivated by product differentiation. Moreover, entrepreneurial finance investors favor screening strategies as a tool to implement climate considerations in their investment decisions. While active ownership as a climate consideration strategy is significantly more prevalent among PEs, the opposite is true for impact investing. Finally, we draw a connection between the motives for considering climate investment criteria and the consideration strategies applied.

Our study differs from previous sustainability studies (e.g., Alareeni & Hamdan 2020; Serafeim & Yoon 2022) in terms of investment type (private versus public equity) and data source (survey data versus. archival data). In this way, we contribute to a growing stream of academic research that has developed around sustainable and climate investments (e.g., Amel-Zadeh & Serafeim 2018; Zaccone & Pedrini 2020). At the same time, we show that PE and VC investors

[9] Total PE investments by European and non-European PEs into European portfolio firms.
[10] Mid-market investments refer to equity investments made by a single PE firm or fund in a portfolio firm with values ranging from 15 million € to 150 million € (Invest Europe 2022).

both apply climate consideration strategies but do so based on different motives. The latter insights can help policymakers design more effective interventions in the entrepreneurial finance market, which is subject to major uncertainties regarding sustainability. On the one hand, regulative initiatives should set frameworks also applicable for small and mid-market portfolio firms; on the other hand, public institutions need to play a leading role in setting standards and best market practices. Moreover, insights into how climate issues influence the selection criteria and investment strategies of VCs and PEs can benefit start-ups and potential mid-market portfolio firms and help them increase their chances of obtaining funding.

The remainder of the study is organized as follows. The next section briefly reviews the literature related to motivations and strategies for sustainable investments. Subsequently, we introduce the survey, the sample, and the variables. The empirical results are presented and discussed thereafter. Finally, we summarize the main findings of the study, derive implications for theory and practice, and discuss several limitations as well as avenues for future research.

4.2 Related Literature

Previous research has already gained some insights into the motivations of institutional investors for ESG deliberations. For example, Amel-Zadeh and Serafeim (2018) find that investors use ESG data mainly because they are financially material to investment performance. Large investors are also driven in their ESG considerations by growing client or stakeholder demand as well as the development of investment products. Increasing pressure from various stakeholder groups is also identified as a major driver of ESG integration into PE (Zaccone & Pedrini 2020). Comparing a sample of VCs and business angels, Botsari and Lang (2020) find that the financial relevance of ESG criteria is a stronger motive for VCs, while business angels are driven by social responsibility considerations and social impact. In addition, Crifo and Forget (2013) identify socially responsible investing as a risk-management tool for VCs and buyout funds. In a global survey of institutional investors, fostering a long-term investment mindset and cultivating better investment practices are identified as the main reasons to integrate ESG criteria into investment decision making (Eccles et al. 2017).

In addition to the motivations for ESG investments, previous research has also addressed ESG investment strategies. Studies on institutional investors are inconsistent about the most important ESG strategies but agree that especially large institutional investors use ESG information as a screening tool (Amel-Zadeh & Serafeim 2018; Eccles et al. 2017). Similarly,

VCs and business angels apply ESG information primarily as a portfolio screening tool (Botsari & Lang 2020). Cappucci (2018) argues that the most effective strategy for risk-adjusted and long-term success is the full integration of ESG information into the investment process, hence using ESG to reduce risk and create value at the same time. However, PE investors focus their strategies on reducing risk by controlling for a minimum of ESG aspects in the due-diligence phase of a deal and less on value creation (Zaccone & Pedrini 2020).

Despite these insights into the motivations (strategies) for ESG investments, there is a lack of research on the motivations (strategies) for climate investments. However, the environmental aspects of ESG have gained increasing attention by researchers (Daugaard 2020) as well as investors who value corporate climate responsibility even higher after the shock of the COVID-19 crisis and its consequences (Garel & Petit-Romec 2021). To address these gaps, our study focuses on the motivations and strategies of PE and VC firms to account for climate issues in their investments.

4.3 Data and Method

4.3.1 Survey Design

Our dataset is derived from two extensive pan-European surveys of PE and VC fund managers/general partners, namely, the *2021 Private Equity Mid-Market Survey* and the *2021 Venture Capital Survey*, conducted by the European Investment Fund (EIF). To the best of our knowledge, the two surveys combined represent the largest regular survey of general partners in Europe. The two surveys were conducted online, and anonymized responses were received in July and early August 2021.

While the PE and VC surveys targeted distinct groups of recipients, they shared a similar questionnaire design. Each survey participant answered a total of up to ninety-three questions in their respective questionnaire. These included single choice, multiple-choice, and ranking questions, as well as free-text inputs. For this study, we primarily draw on the survey questions focusing on climate considerations of fund managers' investment decisions. Additionally, the dataset includes rich information on the demographics of the PE and VC fund managers, as well as their respective firms. For more information on both surveys, please refer to Botsari et al. (2021a, b).

4.3.2 Sample Construction

The surveys originally targeted 3,528 PE and 5,222 VC fund managers representing 1,668 distinct PE and 2,579 distinct VC firms.[11] The list of PE and VC firms, as well as the details of the relevant contacts within each firm, were obtained from Pitchbook. Moreover, the VC sample was enriched by contacts provided by Invest Europe.

The headquarters of the PE and VC firms contacted were predominantly in the twenty-seven countries included in the European Union (EU).[12] The vast majority of the respondents held the position of chief executive officer or managing or general partner in their respective firms. Thus, the sample of senior decision makers increased the relevance of our results. The dataset contains completed responses[13] from 215 PE fund managers (representing 188 distinct PE firms) and 479 VC fund managers (from 379 VC firms) for response rates (at the fund manager level) of approximately 6% and 9%, respectively. These response rates are comparable to those of other email-distributed academic surveys addressed at entrepreneurial finance investors (e.g., Amel-Zadeh & Serafeim 2018; Block et al. 2019). To analyze the motives and strategies for incorporating climate considerations in investment decisions, we reduce the initial sample of 694 fund managers for two reasons. First, we drop the 186 fund managers who responded that they do not (11 PEs and 62 VCs) or do not yet (22 PEs and 91 VCs) consider climate criteria in their investments. Second, we drop the responses of 40 fund managers in firms active in both the PE and VC markets to clearly differentiate between the two investor types. Accordingly, our final sample includes 468 observations, comprising responses of 163 PE fund managers (from 148 PE firms) and 305 VC fund managers (from 253 VC firms).

4.3.3 Sample Description

Sample Demographics

Table 4.1 shows the selected sample demographics for the entire sample of 468 fund managers as well as for the separate groups of PEs and VCs. Considering the full sample, the average survey participant invests in early-stage portfolio firms (26%), manages between 200 and 499

[11] The reported figures reflect the final versions of the samples that were used for the respective survey invitations (i.e., after removing fund managers/firms that explicitly requested not to participate in the survey or fund managers whom we failed to reach via e-mail).

[12] Firms with headquarters outside of Europe were still included in the sample if they had an office in Europe and were active in the European PE/VC market.

[13] We only consider fully completed responses, i.e., responses from fund managers who completed the survey till the very last question.

million € in total assets (25%), has a headquarters in South Europe[14] (19%), and invests in portfolio firms active in communications, computer, and electronics (ICT) sectors. When considering the VC and PE investors separately, however, we can observe distinct differences.

[14] With southern Europe, we refer to Cyprus, Greece, Italy, Portugal, and Spain.

Table 4.1 Sample demographics

	Full sample	VC	PE	Difference
Key investment stage				
Pre-seed stage	8.76%	13.44%	0%	**
Seed stage	19.66%	30.16%	0%	**
Early stage	25.64%	39.35%	0%	**
Later/Growth stage	23.93%	17.05%	36.81%	**
Buyout stage	22.01%	0%	63.19%	**
Total assets under management in million €				
< 50	17.31%	23.28%	6.13%	**
50 - 99	16.67%	19.02%	12.27%	
100 - 199	22.01%	22.30%	21.47%	
200 - 499	25.00%	22.62%	29.45%	
500 - 999	9.18%	8.20%	11.04%	
≥ 1000	9.82%	4.58%	19.64%	**
Headquarters location [1]				
Benelux	14.32%	16.72%	9.82%	*
CESEE	11.75%	10.16%	14.72%	
DACH	16.45%	19.02%	11.66%	*
France	11.75%	10.49%	14.11%	
Nordics	10.69%	12.46%	7.36%	
Southern Europe	19.23%	14.75%	27.61%	**
UK & Ireland	13.46%	13.44%	13.50%	
Other	2.35%	2.96%	1.22%	
Key industries of investment [2]				
Biotech and health care	44.02%	46.89%	38.65%	
Business products	31.41%	23.93%	45.40%	**
Business services	46.79%	37.38%	64.42%	**
Chemicals and materials	15.17%	15.08%	15.34%	
Consumer goods	26.50%	14.43%	49.08%	**
Consumer services	30.34%	27.21%	36.20%	*
Energy and environment	31.41%	36.07%	22.70%	**
Financial and insurance services	25.00%	32.46%	11.04%	**
ICT (communications, computer, and electronics)	55.77%	60.98%	46.01%	**
No clear sector focus	14.10%	8.85%	23.93%	**
Observations	468	305	163	

Explanation: The difference column reports the results of a t test of the null hypothesis that the respective percentages for VCs and PEs are equal to each other. *Statistically significant at the 5% level. **Statistically significant at the 1% level.

[1] *Benelux:* Belgium, Luxemburg, the Netherlands; *CESEE:* Bulgaria, Croatia, Czechia Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Russia, Serbia, Slovenia, Slovakia, Turkey, Ukraine; *DACH:* Austria, Germany, Switzerland; *Nordics:* Denmark, Finland, Iceland, Norway, Sweden; *Southern Europe:* Cyprus, Greece, Italy, Portugal, Spain.

[2] Multiple-choice question.

Concerning the key investment stage, nearly 83% of VCs invest in (pre) seed and early-stage portfolio firms, while PEs invest only in later or growth (37%) and buyout (63%) stages. These results mirror the market practice whereby VCs tend to invest in younger portfolio firms, while PEs focus on more established portfolio firms (e.g., Fenn et al. 1997). Furthermore, the VCs in our sample are smaller than the PEs. On average, the VCs fall within the third asset-size class, ranging from 100 to 199 million € of total assets under management, while the average PE falls within the fourth asset-size class, managing between 200 and 499 million € of total assets. The percentages of VCs and PEs for the first and last size classes significantly vary from each other (both p values < 0.01). Moreover, the two groups of investors differ in terms of the headquarters location of their respective firms. In the VC sample, most firms have their headquarters in the DACH region[15] (19%) and Benelux countries[16] (17%)—both percentages are significantly higher compared to PEs (both p values < 0.05). In contrast, the PEs in our sample are mainly located in southern Europe (28%) and the CESEE countries[17] (15%). However, a significant difference from the comparison group only exists for the southern European percentage (p value < 0.01). Regarding the key industries of investment, 61% of the VCs invest in portfolio firms active in ICT sectors, followed by investments in the biotech and health care industry (47%) and business services (37%). The latter constitutes the most frequently selected industry by PE survey participants (64%), followed by consumer goods (49%) and ICT investments (46%). Significant differences between the two investor groups exist for most investment industries. VCs significantly invest in energy and the environment, financial and insurance services, and ICT (all p values < 0.01), whereas PEs predominantly invest in the business products and services, consumer goods (all p values < 0.01), and consumer services (p value < 0.05) industries or do not have a sector focus at all (p value < 0.01).

Table 4.2 comprises further variables included as controls in the regression analyses of this study. This table reports the mean values for each investor type as well as the results of the two-sample t tests to unveil additional differences between the two groups. Compared to VCs, PEs manage significantly larger total assets under management[18], are older (both p values < 0.01), have been incorporating climate considerations in their investments for a longer period (p value < 0.05) and are more likely to only invest in portfolio firms located in the EU (p value < 0.01).

[15] The DACH-region includes Austria, Germany, and Switzerland.
[16] The Benelux countries are Belgium, Luxemburg, and the Netherlands.
[17] The CESEE-countries include Bulgaria, Croatia, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Russia, Serbia, Slovenia, Slovakia, Turkey, and Ukraine.
[18] Instead of a t test, we performed a chi-squared-test for the variable *total assets (in million €)*, as it consists of unequal categories (chi-squared (5) = 48.34).

PEs also have a lower share of female partners in their respective firms, and the surveyed fund managers are older[19] and more experienced (all p values < 0.01).

Table 4.2 T tests of control variables

	VC		PE		Difference
	N	Mean	N	Mean	
Firm age (years)	300	11.26	158	14.14	-2.88**
Female partner percentage	293	0.15	160	0.08	0.06**
EU-only investments	305	0.63	163	0.88	-0.25**
Years of incorporating climate considerations (five or more)	292	0.24	161	0.33	-0.09*
Respondent gender (male)	301	0.84	161	0.90	-0.06
Respondent experience (years)	305	12.15	163	17.50	-5.35**
First-time team	299	0.31	163	0.25	0.06

Explanation: This table reports the mean values for both investor types, for the control variables included in the regression analyses of this study. The difference-column reports the results of a t test of the null hypothesis that the mean values for VCs and PEs are equal to each other. *Statistically significant at the 5% level. **Statistically significant at the 1% level.

Key Investment Selection Criteria

To gain a deeper understanding of the general investment behavior of the fund managers in our sample, we focused on survey participants' indications of their key investment selection criteria out of a predefined list of eighteen items. *Table 4.3* presents the related results for both the entire sample of 468 fund managers and the two subsamples of PEs and VCs. The management team of a potential portfolio firm is the most important investment selection criterion for all survey participants, selected by 90% of respondents. Additionally, important for the whole sample are exit potential (63%) followed by the scalability of the business (62%). ESG considerations ranks fifth, selected by 54% of respondents.

[19] Instead of a t test, we performed a chi-squared-test for the variable *respondent age*, as it consists of unequal categories (chi-squared (5) = 17.30).

Table 4.3 Key investment selection criteria

Investment selection criterion	Full sample	VC	PE	Difference
Total addressable market	39.32%	51.48%	16.56%	**
Scalability of the business	61.54%	64.92%	55.21%	*
Valuation and deal terms	52.99%	50.16%	58.28%	
Exit potential	63.46%	64.59%	61.35%	
Technology/product's value proposition	58.76%	76.07%	26.38%	**
Past performance/track record	27.14%	22.95%	34.97%	**
Management team	89.53%	92.46%	84.05%	**
Business model	48.29%	46.56%	51.53%	
Our ability to add value	45.94%	39.02%	58.90%	**
Profitability (potential) of business	35.68%	24.59%	56.44%	**
Revenue-generating capacity/potential	30.56%	29.51%	32.52%	
Cash-generating capacity/potential	26.50%	13.77%	50.31%	**
Industry	25.00%	20.98%	32.52%	**
Strategic fit in investment portfolio	35.47%	39.67%	27.61%	**
ESG considerations	54.27%	52.13%	58.28%	
Diversity & inclusion considerations	16.45%	20.98%	7.98%	**
Referral by other GPs/investors	10.26%	14.75%	1.84%	**
Other/s	15.17%	21.97%	2.45%	**
Observations	468	305	163	

Explanation: This table reports responses to the multiple-choice question "Considering your firm's overall activity in the PE mid-market [VC market], what are the most important investment selection criteria?" The difference-column reports the results of a test of the null hypothesis that the percentages of VCs and PEs are equal to each other. *Statistically significant at the 5% level. **Statistically significant at the 1% level.

A comparison of both subsamples shows that 92% of the VCs selected the management team as a key investment criterion, 76% considered the value proposition of the technology or product (both p values < 0.01), and 65% considered the scalability of the business (p value < 0.05). These percentages are significantly higher than those of PEs. In addition, VCs are considerably more interested in the strategic fit of the potential portfolio firm, rely on referrals by other investors, and consider diversity aspects and the entire addressable market (all p values < 0.01). Selected by 84% of PE investors, the management team of a potential portfolio firm is the most important investment selection criterion for PEs, followed by exit potential (61%) and PEs' ability to add value (59%). However, only the latter is significantly higher for PEs than for VCs (p value < 0.01). In addition, PEs place a high emphasis on past performance or track records, profitability, and cash-generating potential as well as industry when considering an investment (all p values < 0.01). The insights into the general investment selection criteria are helpful for interpreting the forthcoming findings related to the motives of VC and PE investors for implementing climate considerations in their investment decisions.

4.3.4 Model Specification and Measures

Given that the research focuses on the motives (why) and strategies (how) of entrepreneurial finance investors related to integrating climate considerations into their investments, we divide our analyses into two parts. Each section begins with a descriptive examination of the most important motives (strategies) for climate considerations in investments for the sample as a whole and separately for the two investor groups (*Sections 4.1.1* and *4.2.1*). Subsequently, multivariate analyses address potential differences in the motives (strategies) for PE and VC investors and the interplay between the motives and the strategies (*Sections 4.1.2* and *4.2.2*). Therein, we run four (ordered) logit regressions for the motives for incorporating climate considerations into the investments as well as six logit regressions for the climate consideration strategies applied by entrepreneurial finance investors. In the following sections, we describe in detail the variables included in the regression analyses. Additionally, *Table A4.1* of the appendix provides a summarized variable description.

Dependent and Independent Variables

We use two sets of dependent variables to address our research questions. The first part of the analysis focuses on the motives of entrepreneurial finance investors to consider climate issues in their investments and, therefore, uses the survey participants responses to the question "*What are your motives for incorporating climate considerations in your investments?*" and their ranked choices (out of a predefined list of eleven items) by order of importance.[20] We conduct a factor analysis to unveil the underlying interrelations and superordinate dimensions between the motives for implementing climate considerations in investments. To perform this analysis, we transfer the ordered motives for implementing climate considerations in investments into nine dichotomous variables that take the value of 1 if the respective motive is selected and 0 otherwise. Based on the four factors identified, we construct four dependent variables as the row means of the underlying dichotomous items of the factors. These are *external stakeholder motive, product differentiation motive, portfolio performance considerations* (all ordered), and *ethical responsibility* (dichotomous). *Section 4.1.1* describes in more detail the factor analysis and the resulting four dependent variables. Additionally, these motives serve as independent variables in the second part of the analyses to examine their impact on the climate consideration

[20] Due to few observations, two items are not considered any further in this paper: the COVID-19 pandemic highlighted the impact of nonfinancial considerations on business activities and other/s.

strategies pursued by investors. In the remainder of the study, we use the term *climate consideration motives* to refer to the four superordinate motives.

The second part of the analyses covers the strategies applied by entrepreneurial finance investors to incorporate climate considerations in their investments. Toward this purpose, the survey participants' responses to the question "*How do you incorporate climate considerations into your investments?*" and their choices[21] among six offered strategies, namely, negative screening, positive screening, integration into valuation, thematic investments, impact investing, and active ownership, are used. Consequently, we construct six dichotomous variables that take the value of 1 if the respective strategy is selected and 0 if not. Subsequently, we refer to them as *climate consideration strategies*. In the case of *negative (positive) screening*, investors exclude (seek to include) portfolio firms that fail to meet (perform well in terms of) the selected climate criteria. *Active ownership* refers to the support and value-adding services provided to portfolio firms to improve their climate performance. *Integration into valuation* means including explicit climate-change criteria into firm valuation models or multiples or financial forecasts. By undertaking *thematic investments*, investments in climate themes or assets (e.g., in clean energy or sustainable agriculture) take place along with other (non-climate) investments. Finally, a climate-focused *impact investing* strategy (e.g., launching a climate impact fund) seeks to generate a purposeful, positive, and measurable impact on the climate, alongside a financial return.

We construct a dichotomous variable named *PE/VC investor* that takes the value of 1 if the respondent is employed in a PE general partner/management firm and 0 if employed in a VC general partner/management firm. We include the *PE/VC investor* as an independent variable in all regression models to examine the impact of PE and VC investors.

Control Variables

To account for the differences between PEs and VCs (*Section 3.3.1*), we control for several variables. First, at the firm level, we include *total assets (in million €)* as an indicator of firm size and ranked on a six-item scale. The latter ranges from less than 50 million € to more than 1 billion €.[22] *Firm age (years)* specifies the number of years since the firm was established. We calculate *female partner percentage* as the number of female partners divided by the total number of partners in the firm. To gain insights into investment behavior and to distinguish

[21] More than one strategy could be selected.

[22] The six size classes to be chosen in the questionnaire are: less than 50 million €, 50–99 million €, 100–199 million €, 200–499 million €, 500–999 million €, and more than 1 billion €.

between firms investing only in the EU and firms with a broader geographical investment focus, we use the dichotomous variable *EU-only investments*. Moreover, we calculate the dichotomous variable *years incorporating climate considerations (five or more)* to identify firms experienced with climate considerations for five years or more from those with between zero and four years of experience. Last, on the firm level, we include a set of dichotomous variables addressing the *investment industries* and that indicate whether or not the firm invests in a particular industry.[23]

At the respondent level, we control for the *respondent gender (male),* which takes the value of 1 if the respondent is male and 0 if female. Second, we use *respondent age*, ranked on a six-item scale and ranging from 18–24 years to 65 years or older.[24] The *respondent experience (years)* indicates the respondent's total years of experience working as a fund manager. Finally, with the dichotomous variable *first-time team*, we control whether the most recent fund raised by the firm was the team's first-ever fund raised.

4.4 Results and Discussion

The subsequent sections follow the structure of our research questions. The starting point of each subsection is a descriptive analysis of the motives (strategies) of entrepreneurial finance investors to consider climate issues in their investments, followed by a multivariate analysis of how VC and PE fund managers differ in these motives (strategies). Finally, we conduct multivariate examinations of how the motives for climate considerations affect the investment strategies applied.

4.4.1 Motives for Implementing Climate Considerations in Investment Decisions

Descriptive Analyses

Ranking of motives for implementing climate considerations in investments. The survey participants indicated their motives for incorporating climate considerations into their investment decisions. *Table 4.4* shows the ranking of these motives for the combined sample of 468 VC and PE fund managers. Ethical responsibility was the most frequently stated motive

[23] The ten variables included in this set are *biotech and health care, business products, business services, chemicals and materials, consumer goods, consumer services, energy and environment, financial and insurance services, ICT (communications, computer, and electronics),* and *no clear sector focus*. These items are identical to the predefined response options of the survey question that asked to select the most important industries in which a respondent's firm invests.

[24] The six classes to be chosen in the questionnaire are: 18–24 years, 25–34 years, 34–44 years, 45–54 years, 55–64 years, and 65 years or older.

for nearly two-thirds of all survey participants, followed by the growing demand by limited partners (LPs) or stakeholders (56%) and the importance of climate issues to investment performance (46%). Lower in the ranking but still selected by approximately one-third of the survey participants are risk management and regulation[25]. Fund managers also ranked the selected motives by order of importance. More than one-quarter of investors considered ethical responsibility to be the most important motive. Incorporating climate considerations as part of the investment product or strategy was the central motive for 21% of the respondents, followed by the importance of such considerations to investment performance (15%).

Table 4.4 Motives for incorporating climate considerations in investments

Motive	**% of respondents selecting the motive (multiple selection)**	**% of respondents ranking the motive as most important**
Ethical responsibility	65.17%	25.85%
Growing demand from LPs/stakeholders	55.56%	9.19%
Importance for investment performance	46.37%	14.74%
Part of investment product/strategy	45.09%	20.73%
Relevant initiatives (e.g., Principles for Responsible Investment)	34.83%	6.62%
Reputational benefits	34.83%	3.63%
Innovation and portfolio differentiation	33.97%	5.98%
Risk management	32.48%	7.91%
Regulation	32.26%	4.06%

Explanation: This table reports responses to the question "What are your motives for incorporating climate considerations in your investments?" for the full sample of 468fund managers, showing the percentage of investors that selected each motive and the percentage of investors that ranked the respective motive as most important.

Factor analysis to identify superordinate climate consideration motives. To unveil the underlying interrelations and superordinate dimensions between the nine motives for implementing climate considerations in VC and PE investments, we conduct a factor analysis[26]. We apply a principal-component method and use the nine dichotomous variables. The results of the factor analysis presented in *Table 4.5* reveal three underlying factors. Factor one includes four motives: growing demand from LPs or stakeholders, reputational benefits, regulation, and relevant initiatives[27]. Hence, the first factor builds an outside perspective of the firm, as it encompasses pressure from external parties (LPs and policymakers) as well as its outward

[25] Regulation refers to, for example, the EU Sustainable Finance Disclosure Regulation or the EU Taxonomy.
[26] Following a significant Bartlett's test of sphericity and a Kaiser–Meyer–Olkin value of 0.58.
[27] E.g., the Principles for Responsible Investment.

representation (reputation and initiatives). We refer to this factor as the *external stakeholder motive*. The second factor, subsequently called the *product differentiation motive*, includes two motives, namely, incorporating climate considerations as part of the investment product or strategy as well as for innovation and portfolio differentiation. Thus, factor two entails an internal perspective encompassing the strategic orientation and investment portfolio design of the firm. Factor three also takes an internal perspective on the firm but with a focus on financial and risk parameters, namely, the importance of climate considerations for investment performance and risk management. We call this factor *portfolio performance considerations*. The ninth motive, *ethical responsibility* (i.e., making investment decisions based on ethical principles while also considering possible harmful consequences), cannot be included in any in the factors and, therefore, remains a separate variable for the following analyses.

Table 4.5 Principal-component factor analysis

	Variance	Difference	Proportion	Cumulative
Factor 1	162.73	0.39	0.18	0.18
Factor 2	123.59	0.13	0.14	0.32
Factor 3	111.02	.	0.12	0.44

Factor rotation matrix

	Factor 1	Factor 2	Factor 3
Factor 1	0.95	-0.31	-0.05
Factor 2	0.295	0.82	0.50
Factor 3	-0.12	-0.49	0.87

Rotated factor loadings (pattern matrix) and unique variances sorted

	Factor 1	Factor 2	Factor 3	Uniqueness
Growing demand from LPs/stakeholders	0.65	-0.11	-0.16	0.54
Reputational benefits	0.63	0.02	0.04	0.60
Regulation	0.58	0.01	-0.10	0.65
Relevant initiatives (e.g., Principles for Responsible Investment)	0.53	0.16	0.20	0.66
Part of investment product/strategy	0.02	0.75	-0.03	0.44
Innovation and portfolio differentiation	0.00	0.67	0.15	0.53
Ethical responsibility	0.33	-0.39	0.23	0.69
Importance for investment performance	-0.24	0.17	0.70	0.43
Risk management	0.17	-0.12	0.69	0.49

Explanation: 468 observations. Chi-squared (36) = 161.72. Prob>chi-squared = 0.00. Kaiser-Meyer-Olkin measure of sampling adequacy = 0.58.

Comparison of climate consideration motives between PE and VC investors. *Table 4.6* reports the mean values of the four motives identified in the factor analysis as well as the results of two-sample t tests between the two investor groups. Significantly higher means for the *external stakeholder motive* as well as for the *portfolio performance considerations* are observed for PEs (both p values < 0.01), while a higher mean for the *product differentiation motive* (p value < 0.05) is documented for VCs. For *ethical responsibility,* we detect no significant mean differences between the two investor groups. These preliminary findings are further examined in the following multivariate analyses.

Table 4.6 Two-sample T tests of climate consideration motives

Climate Consideration Motive	**VC**		**PE**		**Mean difference**
	N	**Mean**	**N**	**Mean**	
External stakeholder motive	305	0.35	163	0.48	-0.13**
Product differentiation motive	305	0.42	163	0.34	0.08*
Portfolio performance considerations	305	0.35	163	0.48	-0.13**
Ethical responsibility	305	0.64	163	0.67	-0.03

Explanation: This table reports the mean values for both investor types, for the four superordinate climate consideration motives. The mean difference-column reports the results of a t test of the null hypothesis that the mean values for VCs and PEs are equal to each other. *Statistically significant at the 5% level. **Statistically significant at the 1% level.

Multivariate Analyses

Table 4.7 shows a set of ordered logit and binomial logit regressions to examine the differences in climate consideration motives for PE and VC investors. The four superordinate motives are the dependent variables, while the dichotomous variable *PE/VC investor* serves as the independent variable. Compared to VCs, PE investors are significantly more likely to integrate climate criteria into their investments as a response to *external stakeholders* and due to *portfolio performance considerations* (both p values < 0.01). In contrast, *product differentiation* motivates VC investors in their climate considerations (p value < 0.05). Finally, the fourth dependent variable, *ethical responsibility,* does not reveal a significant difference between PE and VC investors. In the following sections, we discuss these findings and provide plausible explanations for the documented patterns of results.

Table 4.7 Ordered logit and binomial logit regression analyses for climate consideration motives

	Ordered logit regressions						*Binomial logit regressions*	
Dependent variables	**External stakeholder motive**		**Product differentiation motive**		**Portfolio performance considerations**		**Ethical responsibility**	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Independent variable								
PE/VC investor		0.80**		-0.60*		0.81**		0.01
		(0.25)		(0.26)		(0.26)		(0.30)
Control variables								
Total assets (in million €)	0.20**	0.16*	-0.09	-0.05	0.06	0.02	0.09	0.05
	(0.07)	(0.08)	(0.07)	(0.08)	(0.07)	(0.08)	(0.08)	(0.09)
Firm age (years)	0.01	0.01	-0.03*	-0.03*	-0.00	0.00	0.01	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
Female partner percentage	0.13	0.42	-0.06	-0.00	-0.83	-0.55	2.10**	2.42**
	(0.52)	(0.58)	(0.55)	(0.59)	(0.54)	(0.59)	(0.67)	(0.76)
EU-only investments	0.044	-0.08	-0.25	-0.07	-0.14	-0.20	-0.14	-0.18
	(0.20)	(0.22)	(0.21)	(0.22)	(0.21)	(0.22)	(0.25)	(0.26)
Years incorporating climate	-0.95**	-0.97**	0.34	0.28	0.31	0.23	0.04	0.04
considerations (five or more)	(0.21)	(0.22)	(0.22)	(0.22)	(0.21)	(0.22)	(0.24)	(0.26)
Respondent gender (male)	-0.30	-0.19	-0.35	-0.21	-0.13	-0.16	0.30	0.32
	(0.30)	(0.31)	(0.31)	(0.32)	(0.30)	(0.32)	(0.35)	(0.36)
Respondent age	-0.15	-0.17	0.11	0.11	-0.03	0.04	-0.12	-0.09
	(0.11)	(0.12)	(0.12)	(0.13)	(0.12)	(0.13)	(0.14)	(0.15)
Respondent experience (years)	0.03*	0.03*	-0.01	-0.01	0.00	-0.01	0.02	0.03
	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.02)
First-time team	0.16	0.20	-0.19	-0.22	0.18	0.06	0.26	0.30
	(0.22)	(0.24)	(0.24)	(0.25)	(0.24)	(0.25)	(0.27)	(0.29)
/cut1	-0.92	-0.81	-0.75	-0.62	-0.13	0.13		
	(0.57)	(0.59)	(0.60)	(0.63)	(0.59)	(0.62)		
/cut2	0.594	0.698	1.329*	1.511*	1.99**	2.37**		
	(0.56)	(0.59)	(0.60)	(0.63)	(0.60)	(0.63)		
/cut3	1.91**	2.01**						
	(0.57)	(0.60)						
/cut4	3.62**	3.74**						
	(0.60)	(0.63)						
Constant							-0.43	-0.50
							(0.68)	(0.71)
Observations	459	427	459	427	459	427	459	427
Pseudo R-squared	0.06	0.07	0.07	0.07	0.03	0.04	0.06	0.06

Explanation: Investment industries included as controls in all models. Standard errors in parentheses. *Statistically significant at the 5% level. **Statistically significant at the 1% level.

External stakeholder motive. PE investors are significantly more likely to integrate climate criteria into their investments as a response to external stakeholders. An explanation for this could be the different degrees of institutionalization between the two investor groups. VCs are to a substantial extent financed by government agencies and corporate investors—both contributed 18% each to the total VC fundraising volume in 2021 (Invest Europe 2022). Institutional investors are less involved in VC financing. Pension funds, for example, accounted for only 6% of the total amounts raised by VC funds in 2021. In contrast, pension funds represent by far the largest investor group in PE, accounting for 18% of the volume raised by growth funds and 27% of the volume raised by buyout funds in 2021 (Invest Europe 2022). Consequently, PEs might face increasing pressure from the larger participation of institutional investors in their investor base, given that pension funds, for instance, are themselves subject to a series of ESG risks, such as regulatory and climate risk (Sautner & Starks 2021).

External pressure might also come from the regulatory side at the portfolio firm level. In contrast to VC-backed start-ups and emerging portfolio firms, larger and more established portfolio firms (as PE-backed firms tend to be) are subject to greater regulatory scrutiny, also in terms of sustainability reporting (e.g., the Corporate Sustainability Reporting Directive), which is currently under review by the European Commission (2022). Corroborating this line of argumentation on size-related considerations, the results further show that the *external stakeholder motive* is even more relevant for larger PEs in terms of total assets under management (p value < 0.05). Furthermore, fund managers who have already been incorporating climate considerations in their investment decisions for at least five years are less driven by an *external stakeholder motive* (p value < 0.01). Respondents with more experience as a fund manager, however, are more driven by this motive (p value < 0.05).

Portfolio performance considerations. The nature of the underlying investment portfolios might play a role in explaining why PEs are to a greater extent motivated by portfolio performance considerations. As discussed earlier, PEs invest in more established portfolio firms that provide performance measures for their ongoing operations and enable risk assessments due to better data availability. In contrast, VCs typically invest in small and emerging portfolio firms for which performance and risk measures are more difficult to calculate and, therefore, less likely metrics of consideration by VCs (e.g., Fenn et al. 1997).

In addition to the impact of the investment stage, the size and number of VC and PE deals also involve different risk levels. A typical PE commits larger investment tickets in fewer portfolio

firms, while VCs invest smaller amounts in a larger number of portfolio firms.[28] Consequently, the positive performance of individual portfolio firms is of greater importance for PEs than for VCs who rely on a more diversified portfolio base. Moreover, the syndication of investments reduces the risk of the single investor because more parties share the investment risk. Such investment partnerships are more common in the VC market, whereas PEs are less involved in syndication. For instance, Tykvová (2018) identifies thirty-five research papers published since 2011 focusing on the topic of syndication, thirty of which (i.e., 86%) refer to the VC market. Additionally, the VCs in our sample are significantly more likely to consider a referral by other general partners or investors when making investment decisions (p value < 0.01; see also *Table 4.3*). This is another indication that cooperation plays a key role for VCs. Apart from the reduction in financial risks, VC investors syndicate due to network effects and knowledge sharing (De Vries & Block 2011).

Additionally, VC and PE portfolios differ in terms of the target industries and sizes of their portfolio firms and the related climate risks involved. PEs typically invest in mature portfolio firms in traditional sectors, such as manufacturing, where a potentially adverse environmental footprint arising from their operations is a relevant issue to consider. In the case of VCs, their portfolio firms tend to be smaller and are active in sectors where the potential climate impacts are lower. Hence, climate risks seem to be more important for PE-supported portfolio firms. Consequently, climate risk management is more relevant for and needs to be implemented in a more intricate way by PEs. In a recent study of institutional investors, Krueger et al. (2020) examine the importance of climate risks and identify risk management and engagement as the leading approaches for addressing climate risks.

Moreover, as shown earlier in the context of the key investment selection criteria (see also *Table 4.3*), PEs are significantly more likely to look at past performance or track record as well as the profitability (potential) of a potential portfolio firm (both p values < 0.01). Block et al. (2019) obtain similar findings in an experimental conjoint analysis of entrepreneurial finance investors by showing that growth and buyout funds place a higher emphasis on profitability as a key investment criterion than do VCs.

Product differentiation motive. The industry structure and the characteristics of the investment portfolios of VCs and PEs can provide valuable insights into why VC investors are motivated

[28] For the year 2021, Invest Europe (2022) states that PE buyouts in 580 mid-market portfolio firms with a total investment of nearly 29 billion € took place in Europe compared to VC investments in 5,334 portfolio firms for a total of 20 billion €.

by product differentiation. As mentioned earlier, VCs tend to invest in young portfolio firms from innovative sectors, whereas the portfolio firms of PEs do not typically operate in high technology sectors but in more traditional industries, such as retail and manufacturing (Fenn et al. 1997). Thus, PEs are more limited in the set of industries they target for investment. Our previous analyses on the key investment selection criteria support this argument, showing that PEs are significantly more likely to consider the industry of the potential portfolio firm (p value < 0.01; see also *Table 4.3*). In contrast, VCs focus more on the technology and the value proposition of a firm. This technological focus leads to a more diversified portfolio in terms of target industries for investment. Moreover, a large part of recent technologies and innovative business opportunities aims at solving climate issues. Hence, due to their technology focus, VCs are more likely to invest in innovative green portfolio firms and establish new markets (Crifo & Forget 2013). Potential portfolio firms truly developing green technologies, products, or services and positioning themselves in a green sector send strong signals to VC investors (Mrkajic et al. 2019). Furthermore, as mentioned earlier, the more diversified nature of VC portfolios stems from the fact that VCs invest smaller amounts in a larger number of portfolio firms (see also Invest Europe 2022).

In addition to the diversification of their investment portfolio, VCs might have additional motives to differentiate themselves from one another. PEs usually execute large investment deals, where they are the lead investor and often acquire 100% of the portfolio firm (Kaplan & Sensoy 2015). Since the success of a portfolio firm or deal can be linked to the majority shareholder, this might already be sufficient to differentiate PEs from their peers. However, as already mentioned, VCs tend to syndicate investments and typically take a minority stake in their portfolio firms (Kaplan & Sensoy 2015). Therefore, the success of a portfolio firm or deal is perceived as the result of a collective effort rather than being attributed to an individual VC investor. Because they have greater difficulty differentiating themselves based on their track record, VCs might seek other ways to stand out, e.g., by pursuing a climate-focused investment strategy. Moreover, fund managers in younger firms are significantly motivated by product differentiation regarding their climate considerations (p value < 0.05).

Ethical responsibility motive. The final dependent variable, *ethical responsibility*, does not differ between PE and VC investors' investment decisions in the context of climate considerations. Given that this was the motive selected by nearly two-thirds of the survey participants, we cannot exclude the possibility of a socially desirable response behavior in this respect. In Amel-Zadeh and Serafeim (2018), only 32% of institutional investors consider ESG

criteria to be out of ethical responsibility. The different underlying samples (institutional investors versus PE/VC investors), our focus on the climate aspect of sustainability or even a shift in the importance of ethical responsibility in the last few years might explain the difference. Interestingly, the findings reveal that *ethical responsibility* is significantly more likely to drive climate considerations in firms with higher female participation at the partner level (p value < 0.01). Being valued by PE and VC investors, ethical responsibility is not dependent on the investor type but appears to be driven by other factors. For instance, prior research shows that personal values such as altruism influence investment decisions (Brodback et al. 2019). Indeed, certain investors seem to be willing to sacrifice returns in exchange for nonpecuniary benefits of sustainable or responsible investments (Barber et al. 2021; Gutsche & Ziegler 2019). Discussions of the potential underlying drivers of ethical responsible behavior, such as personality traits and values, are beyond the scope of our research design and thus cannot be compared for PE and VC investors in this study.

4.4.2 Strategies for Implementing Climate Considerations in Investment Decisions

Descriptive Analyses

Ranking of climate consideration strategies. Moving on, we examine the most important climate consideration strategies of entrepreneurial finance investors. In a multiple-choice question, the survey participants indicated the specific strategies they pursued to incorporate climate considerations into their investment decisions. *Table 4.8* shows the ranking of these strategies for the combined sample of 468 PE and VC fund managers. Selected by 57% of all survey participants, *negative screening* is the most frequently mentioned way to incorporate climate considerations in investments. *Positive screening* (48%) and *active ownership* (37%) are next. *Thematic investments* (27%), *integration into valuation* (19%), and *impact investing* (16%) complete the ranking. Overall, entrepreneurial finance investors favor screening strategies as a tool to implement climate considerations in their investment decisions, particularly on an exclusionary basis during due diligence. Amel-Zadeh and Serafeim (2018) find that active ownership, followed by integration into valuation and negative screening, are the ESG strategies featured most prominently among institutional investors, while the results of Eccles et al. (2017) are more aligned with our ranking of climate consideration strategies.

Table 4.8 Strategies for implementing climate considerations in investments

Climate consideration strategy[1]	**Full sample**	**VC**	**PE**	**Difference**
Negative screening	56.84%	52.46%	65.03%	**
Positive screening	47.65%	51.48%	40.49%	*
Active ownership	36.54%	26.23%	55.83%	**
Thematic investments	27.14%	16.39%	22.70%	
Integration into valuation	18.59%	31.48%	19.02%	**
Impact investing	16.03%	20.98%	6.75%	**
Observations	468	305	163	

Explanation: This table reports responses to the multiple-choice question "How do you incorporate climate considerations in your investments?" The difference-column reports the results of a t test of the null hypothesis that the respective percentages for VCs and PEs are equal to each other. *Statistically significant at the 5% level. **Statistically significant at the 1% level.

[1] Definition of climate consideration strategies: Negative (positive) screening: investors exclude (seek to include) portfolio firms that fail to meet (perform well in terms of) selected climate criteria; active ownership: support of portfolio firms to improve their climate performance; thematic investments: investments into climate themes or assets, alongside other investments; integration into valuation: including explicit climate-change criteria into firm valuation models/multiples/financial forecasts; impact investing: seeks to generate a purposeful, positive and measurable impact on climate, alongside a financial return.

Comparison of climate consideration strategies between PE and VC investors. The table also shows how frequently a specific climate consideration strategy is selected by each type of investor and includes the results of two sample t tests to unveil significant differences in these percentages between the two investor groups. Most PE investors apply *negative screening* (65%), followed by *active ownership* (56%) and *positive screening* (40%). The former two strategies are significantly favored by PEs compared to VCs (p value < 0.01). In contrast, *negative* (52%) and *positive* (51%) screening are by far the most common strategies among VC investors, with *integration into valuation* ranking third (31%). Compared to PE investors, VCs are significantly more likely to choose *positive screening* (p value < 0.05), *integration into valuation*, and *impact investing* (both p values < 0.01) as climate consideration strategies. The remaining strategy of thematic investments does not reveal significant mean differences between the two investor groups. These preliminary findings are further examined in the following multivariate analyses.

Multivariate Analyses

The six climate consideration strategies operate as dependent variables in the ordered logit regressions presented in *Table 4.9*, while the dichotomous variable *PE/VC investor* serves as the independent variable. The results indicate that PEs are more likely to adopt an *active ownership* strategy (p value < 0.01) than are VCs. Furthermore, VCs are significantly more likely to perform *impact investing* than are PEs (p value < 0.01). For the remaining climate consideration strategies, we find no significant differences between PE and VC investors.

Table 4.9 Binomial logit regression analyses for climate consideration strategies

Dependent variables	**Negative screening**	**Positive screening**	**Active ownership**	**Integration into valuation**	**Thematic investments**	**Impact investing**
Independent variables						
PE/VC investor	-0.17	-0.21	0.88**	-0.05	0.05	-1.32**
	(0.30)	(0.30)	(0.31)	(0.38)	(0.35)	(0.48)
External stakeholder motive	1.63**	0.34	1.61**	0.11	-0.42	-0.65
	(0.42)	(0.40)	(0.43)	(0.50)	(0.47)	(0.60)
Product differentiation	-0.78*	0.68*	0.65*	0.54	1.17**	0.89*
motive	(0.31)	(0.31)	(0.32)	(0.38)	(0.36)	(0.44)
Portfolio performance	0.87**	0.50	0.81*	1.07**	0.62	0.078
considerations	(0.32)	(0.31)	(0.33)	(0.38)	(0.37)	(0.45)
Ethical responsibility	0.37	0.32	0.13	0.71*	0.00	-0.04
	(0.23)	(0.23)	(0.24)	(0.31)	(0.27)	(0.33)
Control variables						
Total assets (in million €)	0.09	-0.02	0.14	0.15	0.08	0.17
	(0.09)	(0.09)	(0.10)	(0.11)	(0.11)	(0.13)
Firm age (years)	-0.01	-0.02	0.01	0.02	-0.01	-0.06*
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)
Female partner percentage	-0.21	0.99	-0.24	0.39	-0.04	-0.02
	(0.68)	(0.67)	(0.74)	(0.82)	(0.79)	(0.89)
EU-only investments	0.49	-0.20	0.13	0.31	-0.15	-0.09
	(0.26)	(0.25)	(0.27)	(0.33)	(0.29)	(0.35)
Years incorporating climate	0.37	0.22	0.25	0.07	-0.19	0.82*
considerations (five or more)	(0.27)	(0.26)	(0.27)	(0.31)	(0.31)	(0.35)
Respondent gender (male)	0.19	0.44	-0.48	-0.48	0.04	-0.24
	(0.36)	(0.36)	(0.38)	(0.44)	(0.41)	(0.49)
Respondent age	-0.21	-0.23	-0.02	0.36	-0.07	-0.03
	(0.15)	(0.15)	(0.16)	(0.19)	(0.18)	(0.21)
Respondent experience	0.01	0.01	0.03*	-0.00	-0.01	0.05*
(years)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
First-time team	-0.18	-0.01	0.12	0.46	0.29	0.20
	(0.29)	(0.28)	(0.30)	(0.36)	(0.33)	(0.41)
Constant	-0.58	-0.67	-2.67**	-4.99**	-1.64	-1.97
	(0.75)	(0.73)	(0.80)	(1.02)	(0.86)	(1.04)
Observations	427	427	427	427	427	427

Explanation: Investment industries included as controls in all models. Standard errors in parentheses. *Statistically significant at the 5% level. **Statistically significant at the 1% level.

As discussed earlier, PEs are usually the lead investor and often acquire 100% of the portfolio firm, while VCs tend to syndicate their investments and therefore typically take a minority stake in their portfolio firms (Kaplan & Sensoy 2015). Accordingly, PEs have the necessary power and preconditions to actively instigate changes in their portfolio firms and implement processes that improve their climate performance. VCs, as minority shareholders, may lack the power to influence corporate behavior to this extent and are, therefore, less likely to pursue an *active ownership* strategy. PEs have not only the necessary power to actively initiate changes in their portfolio firms but also a greater need to do so. Since PEs commit larger investment tickets in fewer portfolio firms, and VCs invest smaller amounts in a larger number of portfolio firms (see also Invest Europe 2022), the positive performance of an individual portfolio firm is of greater importance for PEs than for VCs. Moreover, as mentioned earlier, PEs invest in traditional sectors such as manufacturing (Fenn et al. 1997), where environmental footprints are a relevant topic. These established portfolio firms need more assistance in enhancing the environmental footprint arising from their operations compared to VC-backed start-ups and emerging portfolio firms just starting their operations.

Impact investing, despite featuring last in the ranking of strategies, is still selected by more than 20% of VC survey participants. This strategy is significantly less relevant for PEs. Alongside a financial return, a climate-focused impact investing strategy aims at generating a purposeful, positive, measurable environmental footprint. As discussed earlier, when considering an investment, VCs tend to focus on the technology and value proposition of a portfolio firm's (see also *Table 4.3*). Solving climate issues may comprise many opportunities for recent technologies and innovative firms, including large potential for impact investments. Due to their technological focus, VCs are more likely to invest in innovative green firms and establish new markets (Crifo & Forget 2013). As impact investors, VCs select portfolio firms that already have a positive, *pre*-investment impact on the climate. In contrast, PEs improve the climate impact of their portfolio firms *post*-investment via active ownership.

Link between climate consideration motives and strategies. In this last section, we examine the influence of climate consideration motives on the climate consideration strategies pursued by entrepreneurial finance investors. The latest table also includes the four superordinate motives as independent variables in the binomial logit regression analyses using the climate consideration strategies as dependent variables.

Investors motivated to consider climate as a response to *external stakeholders* are significantly more likely to do so via *active ownership* (p value < 0.01) but not likely to do so via *impact*

investing. A climate impact fund seeks to generate a measurable, positive climate impact from portfolio firms as a direct result of the latter's investment activities. In other words, the impact is not simply the result of a positive externality but of an intentional, positive change triggered by the business model of a firm. Hence, while improving the climate performance of a portfolio firm via *active ownership* reflects investors' mindfulness of the externalities of their investments and their intention to mitigate the negative impact, it does not necessarily translate into proactively pursuing a positive impact, as per the *impact investing* definition. This is because *impact investing* typically goes far beyond the integration of ESG considerations in investing and can even be performed without necessarily considering the entire spectrum of ESG criteria (Botsari & Lang 2020). It is therefore not a strategy that investors pursue in response to external pressure to integrate climate considerations into the investment process.

When motivated to consider climate in investments due to *portfolio performance considerations*, investors are significantly more likely to choose *negative screening* (p value < 0.01), *active ownership* (p value < 0.05), and *integration into valuation* (p value < 0.01). The motive at hand and the valuation strategy are clearly connected. Investors motivated by *portfolio performance considerations* select portfolio firms based on performance and risk measures. Using such valuation models and financial forecasts for investment decisions, investors also tend to include climate change factors in valuation.

Climate considerations driven by *product differentiation* are significantly associated with *positive screening*, *active ownership* (both p values < 0.05), *thematic investments* (p value < 0.01), and *impact investing* (p value < 0.05). The opposite holds true for *negative screening* (p value < 0.05). Currently, an increasing number of start-ups address climate issues. In Germany, for example, 30% of start-ups in 2021 contributed to the ecological goals of the green economy (Fichter & Olteanu 2021). These young and innovative potential portfolio firms are worth considering for investors who intend to diversify their product portfolios. Motivated by this goal, investors undertake *thematic investments* or *pursue impact investing* to include in their investment portfolios firms addressing climate issues.

Finally, *ethical responsibility* is associated with explicitly integrating climate criteria into firm valuation models, multiples, or financial forecasts (p value < 0.05). Compared to other climate consideration strategies, such as *negative screening*, the integration of climate criteria into valuation is a more advanced way to incorporate climate aspects into investments. It is thus more likely to be adopted by investors intrinsically motivated by ethical considerations.

4.5 Implications and Outlook

4.5.1 Main Results and Theoretical Implications

This study examines the motives behind and strategies for incorporating climate considerations in investment decisions by different actors in entrepreneurial finance. Using a unique dataset of two European surveys, we compare the distinct motivations and strategies of PE and VC investors. *Table 4.10* provides a summary of the main results as well as a comparison of the VC and PE characteristics discussed to explain these results. Entrepreneurial finance investors rank ethical responsibility as the most important motive, followed by growing demand by LPs or stakeholders and importance for investment performance. Furthermore, our results suggest that PE and VC investors have distinct reasons for considering climate issues. Of the four superordinate motives identified in a factor analysis, PEs are driven by *external stakeholders* as well as *portfolio performance considerations*, while VCs are motivated by *product differentiation*. *Ethical responsibility* is an equally important motive for both investor groups. Explanatory approaches for the differing motives arise from the characteristics of the VCs and PEs, their portfolios, and the corresponding markets. Additionally, entrepreneurial finance investors favor screening strategies as a tool to implement climate considerations in their investment decisions. A comparison of both investor groups shows that PEs follow the climate consideration strategy of *active ownership*, while VCs prefer *impact investing*. Moreover, our findings imply that climate consideration motives influence the climate consideration strategies applied by investors.

Table 4.10 Summary and explanation of main results

Summary of main results			
	Multivariate comparison of VC/PE investors		***Ranking*** *(extract)*
	VC	**PE**	**Full sample**
Climate consideration motives	Product differentiation motive	External stakeholder motive Portfolio performance considerations	1. Ethical responsibility 2. Growing demand from LPs/stakeholders 3. Importance for investment performance
Climate consideration strategies	Impact investing	Active ownership	1. Negative screening 2. Positive screening 3. Active ownership

Explanation of VC/PE differences by investor characteristics		
VC	***Characteristics***	**PE**
Young (small) firms High growth-potential and substantial risk Innovative firms	*Portfolio firm characteristics*	Established (large) firms Stable cash-flow and small risk Firms from traditional sectors
(Pre-)Seed stage, early stage, later/growth stage	*Investment stage*	Later/Growth stage, buyout stage
Small sum in a high number of deals	*Investment size*	Large sum in a small number of deals
Minor (deal syndication typical)	*Equity-share in portfolio firms*	Major (usually lead investor in the deal)
Low	*Degree of institutionalization*	High

Our results entail diverse implications for research and practice. Due to the unique dataset of VC and PE fund managers, we differ from previous studies addressing ESG or climate topics in public equity or examining archival data (e.g., Alareeni & Hamdan 2020). Thus, we contribute to the literature on sustainable investments in entrepreneurial finance (e.g., Crifo & Forget 2013; De Angelis et al. 2022; Zaccone & Pedrini 2020). Analyzing the motives behind considering climate issues in investments enables a deeper understanding of actual investment behavior. Hence, a connection between what is done – the climate consideration strategies – and why it is done – the climate consideration motives – can be drawn. Moreover, instead of addressing ESG as a whole, as most studies to date do, we focus on the climate aspects that have attracted emerging attention from researchers (Daugaard 2020). Answering a call by Abhayawansa and Mooneeapen (2022), we appreciate the heterogeneity of investors in the context of sustainability by separately examining and comparing the climate consideration motives and strategies of VCs and PEs. Therefore, our findings and the concomitant implications are focused on two means: first on the climate part of sustainability and second on two subgroups of entrepreneurial finance investors.

4.5.2 Policy Implications

The entrepreneurial finance market is subject to major uncertainties regarding sustainability. Investors face a lack of reporting standards, inconsistent measures and tools, as well as the risk of greenwashing on the side of the portfolio firms. Regulatory initiatives, such as the EU Taxonomy, provide improvement but are not (sufficiently) applicable for VC and PE investment targets, i.e., start-ups and small or mid-market portfolio firms. Standards for ESG reporting and ESG performance measurement could facilitate the assessment and comparison of disclosed ESG information by portfolio firms (Botsari & Lang 2020) and likewise reduce uncertainties for investors. Therefore, especially in a transitional phase such as the current one, regulatory frameworks also applicable for smaller portfolio forms are needed, and public institutions in the entrepreneurial finance market need to play a leading role in setting and disseminating standards, best market practices and related expertise. Moreover, since investor types differ in their motives for considering the climate in their investments, they need to be treated differently by policymakers. In particular, PEs seem responsive to regulation, as one-third of all VC and PE investors in our sample state that they are driven by regulatory pressure. Moreover, the effect of climate regulations of other actors involved, such as pension funds or

other institutional investors, should be considered by policymakers because these institutional investors put particular pressure on PEs.

Furthermore, the motives and strategies for climate investments are relevant for firms seeking funding. Confirming previous findings (Mrkajic et al. 2019), innovative start-ups with a business model or product that addresses climate issues can attract increased attention by VCs, as this contributes to *portfolio differentiation* and fits the strategy of *impact investing*. In contrast, mid-market firms with moderate climate performance still have a chance to obtain funding as PEs work actively to improve the climate performance of portfolio firms as part of the *active ownership* strategy.

4.5.3 Limitations and Outlook

Avenues for future research emerge from the limitations of our study. We examine the motives behind and strategies for climate considerations for the group of VCs and PEs that already incorporate climate considerations into their investment decisions. Subsequent research could take a closer look at those investors who do not (yet) perform climate-considered investments and examine the reasons for this. This group accounts for 27% of our sample. Understanding the reasons that some VCs and PEs do not consider climate investment criteria might help policymakers set the right incentives to encourage a shift toward climate-friendly investment behavior. Beyond the PE and VC context, Amel-Zadeh and Serafeim (2018) identify a lack of comparability across firms and the absence of standards for ESG reporting as the major barriers for institutional investors to implement ESG considerations in their investment decisions. Similar considerations might apply for the PE and VC markets. As stated above, the entrepreneurial finance market needs effective interventions in terms of regulative initiative-setting frameworks also applicable for small or mid-market portfolio firms and public institutions establishing standards and best market practices.

Another limitation of the study is that our results are only valid for a certain part of the entrepreneurial finance market. Given the different dynamics and market conditions, studies of PEs investing in large firms would be of particular importance because stronger regulations also regarding climate aspects can be expected there (e.g., European Commission 2022). In addition, it would be interesting to extend the research approach to public investors, such as pension funds that also play a role in PE, to gain a deeper understanding of their underlying motivations for climate investments. Kraemer-Eis et al. (2021) state that public investor participation in PE and VC funds targeting green portfolio firms can have a positive signaling

effect in the PE market. The interaction of private and public investors regarding climate investments offers great potential for further research. Finally, the consequences of the different climate consideration strategies build another promising research strand.

Chapter 5

Stakeholder Pressures and Decarbonization Strategies in Mittelstand Firms

Decarbonization strategies are a firm's response to environmental concerns. This study differentiates between symbolic decarbonization strategies focused on compensating CO_2-emissions, and the substantive strategies and actions taken by a firm to reduce its harmful emissions. The influence of internal and external stakeholder pressures, and the effect of family ownership on the strategic decarbonization choices is examined. Data from 443 'Mittelstand' manufacturing firms reveals that overall stakeholder pressures lead firms to pursue decarbonization strategies. We find that internal stakeholders lead firms to pursue substantive decarbonization strategies. In contrast, external stakeholder pressures push a firm more strongly towards symbolic than substantive decarbonization strategies. Interestingly, even under external pressures, family-owned firms tend to be less drawn towards symbolic decarbonization strategies than their non-family counterparts. In addition to confirming the positive relationship between stakeholder pressures and the decarbonization strategies of a firm found in the literature, this study reveals that internal stakeholders are more influential in steering mid-sized German firms to take substantive actions to mitigate their carbon emissions. Implications for theory, practice, and policymakers are discussed.

5.1 Introduction

Business organizations around the world are facing legislative and stakeholder pressures to help combat environmental challenges. In Germany, the Mittelstand (mid-sized) manufacturing firms are major contributors to the economic growth, as well as carbon emissions, exceeding 198 million tons in 2020, which accounts for nearly 35% of the CO_2-emissions of all German economic sectors (Federal Statistical Office (Destatis), 2022; IfM Bonn 2022b). As the country transitions towards a CO_2-neutral economy, these firms are under significant pressure to decarbonize and reduce their emissions. Although regulatory frameworks like the EU-Taxonomy currently apply only to larger firms, it is only a matter of time when these regulations will expand to this sector of the economy, making it important to understand the factors influencing the environmental strategies of these firms.

Firms have been found to use two types of strategies to address environmental challenges - symbolic and/or substantive decarbonization strategies (e.g., Damert et al. 2017). *Symbolic strategies* are focused on compensating CO_2-emissions by purchasing CO_2-certificates, planting trees etc. That is, while a firm continues to generate harmful emissions through its operations or value chain, it counterbalances these negative effects outside of its organizational boundaries. *Substantive decarbonization strategies*, on the other hand, focus on reducing the CO_2-emissions of a firm through changes in its business model, operations, processes, resources used etc.

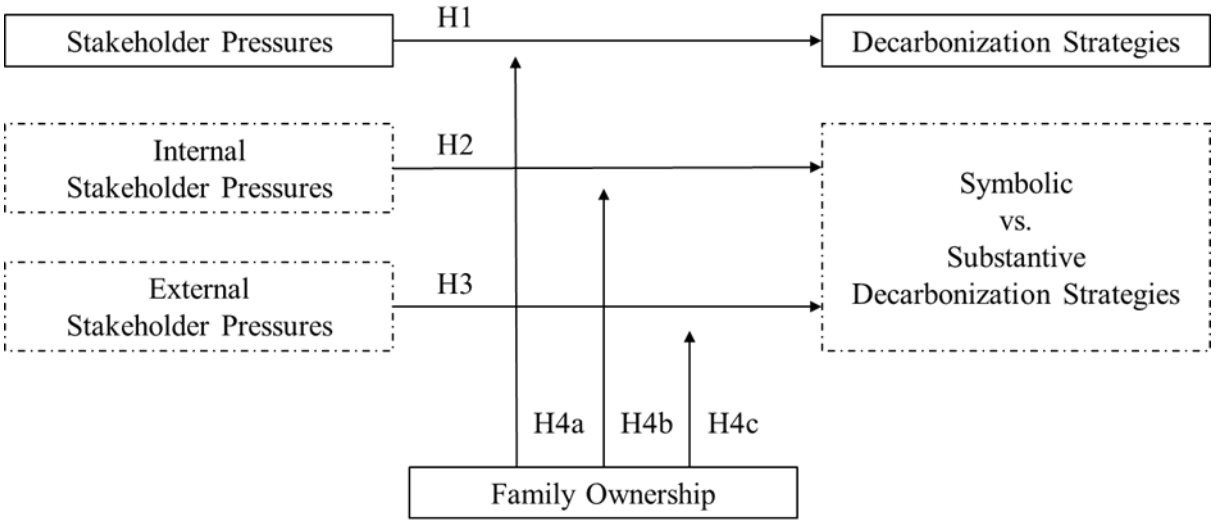
Various factors affect a firm's choice of decarbonization strategies. Research points to the influential role of stakeholder pressures to gain business leaders' attention towards the environmental performance of their firms (e.g., Buysse & Verbeke 2003; Vazquez-Brust et al. 2010). There is ample evidence that firms more attentive to stakeholder pressures tend to pursue environmental strategies to address their CO_2-emissions (e.g., Böttcher & Müller 2015; Brulhart et al. 2019; Dhanda et al. 2022; Henriques & Sadorsky 1999; Lopes de Sousa Jabbour et al. 2020; Seroka-Stolka & Fijorek 2020; Yunus et al. 2020). Efforts are under way to identify the impact of different stakeholder groups on environmental strategies of organizations (e.g., Seroka-Stolka & Fijorek 2020). For example, Hyatt and Berente (2017) found that internal [external] normative stakeholder pressures primarily drive substantive [symbolic] commitments to environmental practices. However, the relationship between internal and external stakeholder pressures on the choice between symbolic and substantive decarbonization strategies remains unclear, leading to our first research question: *How do stakeholder pressures influence the decarbonization strategies of Mittelstand firms?*

As family-owned firms have been found to be superior environmental performers by being more efficient at leveraging symbolic [substantive] CSR to enhance short-term [long-term] financial performance (Berrone et al. 2010; Combs et al. 2023), we explore our second question of whether *family ownership has an effect on the relationship between the nature of stakeholder pressures and decarbonization strategies of Mittelstand firms?*

To answer these questions, we develop and test a conceptual model (*Figure 5.1*) using literature on stakeholder pressures, symbolic and substantive management, and family firms. This model is tested using survey data collected from 443 German Mittelstand manufacturing firms. Consistent with previous research, stakeholder pressures lead Mittelstand firms to pursue decarbonization strategies. Moreover, internal stakeholders motivate firms to pursue substantive decarbonization strategies, whereas external stakeholders push more strongly towards symbolic than substantive ones. Family ownership weakens the effect of external stakeholder pressures on the pursuit of symbolic decarbonization strategies.

We bring specificity to our understanding of the relationship between stakeholder pressures and environmental sustainability by showing the varied effect of internal and external stakeholders on symbolic and substantive decarbonization strategies of mid-sized firms. The role of family ownership favoring substantive over symbolic decarbonization strategies in reaction to stakeholder pressures, reinforces the socioemotional wealth protection orientation of family firms (cf. Berrone et al. 2010; Block & Wagner 2014; Combs et al. 2023; Dou et al. 2019). Practical implications arise for the educational sector, for firm owners to value the role of internal stakeholders for substantive decarbonization, and for policymakers to incentivize substantive decarbonization.

Figure 5.1 Stakeholder pressures and decarbonization strategies



Source: Own illustration.

5.2 Theoretical Background

5.2.1 Stakeholder Pressures

A stakeholder is "any group or individual who can affect or is affected by the achievement of an organization's objectives" (Freeman 1984, p. 46). Although stakeholders differ with regard to their power, legitimacy, urgency, and proximity to a firm (Driscoll & Starik 2004; Mitchell et al. 1997), they are often distinguished either as primary and secondary, or internal and external stakeholders (Carroll & Näsi 1997). We follow the latter classification to understand the effect of internal and external stakeholders on a firm's environmental strategy to decarbonize (Böttcher & Müller 2015; Dhanda et al. 2022; Seroka-Stolka & Fijorek 2020; Yunus et al. 2020).

Internal Stakeholder Pressures

Internal stakeholder pressures come from actors within the firm. They include pressures from the owners of a firm and its shareholders as well as its management and employees who are all linked to the firm via ownership or employment. Ramanathan et al. (2014) found that internal stakeholders possess the greatest impact on the environmental performance of a firm, as compared to economic, regulative, and external stakeholder pressures. Firm owners and members of the top management team are particularly influential in a firm's environmental strategy, not only by dictating its values and norms, but also controlling resources (e.g., Hyatt

& Berente 2017). For example, environmentally conscious owners and employees tend to direct resources and effort to enhance the related performance of their firm (Buysse & Verbeke 2003; Cadez et al. 2019).

External Stakeholder Pressures

External stakeholder pressures comprise pressures from heterogenous stakeholders beyond a firm's boundaries. These stakeholders may also affect the firm's resources and strategy by their actions or interactions with the firm (e.g., Schmitz et al. 2019; Sharma & Henriques 2005). For example, regulators are an especially influential external stakeholder group when considering policies and guidelines related to climate change (e.g., Schmitz et al. 2019; Yunus et al. 2020). Moreover, climate-conscious consumers, investors, and suppliers exert their influence by supporting firms that align with their values and preferences related to climate change (Buysse & Verbeke 2003; Cadez et al. 2019; Sprengel & Busch 2011). Other external stakeholders like non-governmental organizations (NGOs) and the media exert indirect pressure on a firm by influencing the opinion of stakeholders who affect its resource flows (Cadez et al. 2019; Dhanda et al. 2022).

5.2.2 Decarbonization Strategies

Damert et al. (2017) noted that corporate strategies aimed to combat climate change have been described broadly using terms like climate change strategy (Kolk & Pinkse 2005; Okereke & Russel 2010), corporate carbon or CO_2 strategy (Lee 2012; Weinhofer & Hoffmann 2010), carbon management strategy (Busch & Schwarzkopf 2013; Yunus et al. 2020), climate change mitigation strategy (Cadez & Czerny 2016), and greenhouse gas reduction strategy (Cadez et al. 2019). Adding another layer of specificity, Wimbadi and Djalante (2020, p. 4) define decarbonization as "the process by which countries, individuals, or other entities aim to achieve zero fossil carbon existence [which] typically refers to a reduction of the CO_2-emission associated with electricity, industry, and transport" (IPCC 2018). Building on this literature, we differentiate between two forms of decarbonization strategies – symbolic and substantive.

Symbolic Decarbonization Strategies

Symbolic management refers to the manipulation or ceremonial adoption of organizational symbols or objects, in an attempt to enhance a firm's reputation through impression management (Johnson 1990; Hyatt & Berente 2017). The aim is to rationalize the activities of a firm to gain legitimacy with its key stakeholders (Pfeffer 1981). Being less resource intensive,

such actions are easier to implement and modify as they do not require changes in organizational strategy or operations (e.g., Durand et al. 2019; Mahon 2002).Previously, symbolic strategies have been analyzed in the context of CSR of organizations (e.g., Wickert et al. 2017; Zhong et al. 2022). Symbolic CSR includes low-cost CSR communication about activities without real societal benefits (Nardi 2022). Nevertheless, depending on the stakeholders they are directed to, symbolic CSR actions can positively affect a firm's financial performance (Schons & Steinmeier 2016).

This study extends the usage of the concept to examine the environmental dimension of sustainability. Symbolic actions build the appearance of a firm's environmental commitment with the goal of protecting its reputation, but not necessarily enhancing its environmental performance (e.g., Hyatt & Berente 2017; Rodrigue et al. 2013). The focus is on managing the impressions of key stakeholders regarding the environmental commitment of a firm without expending significant organizational resources or effort to change an organizational business model or activities causing negative impact (Truong et al. 2021). *Symbolic decarbonization strategies* like purchasing CO_2-certificates to compensate for the carbon emissions of a firm, focus on creating a positive impression of a firm's environmental strategy on its key stakeholders, rather than actually reducing the harmful impact of the CO_2-emissions of its operations.

Substantive Decarbonization Strategies

As substantive managerial strategies require fundamental changes in an organization, they often require significant and irreversible organizational resources (e.g., Durand et al. 2019, Pfeffer 1981). Strategies that assign a high priority to environmental criteria in a firm's decision making are referred to as substantive environmental strategies (Hyatt & Berente 2017). Such strategies rely on a deep commitment of organizational players and resource investments aimed towards improving the environmental performance of a firm (Sharma & Vredenburg 1998). Similar to the concept of symbolic strategies, prior literature examined firms' substantive CSR strategies (e.g., Nardi 2022; Schons & Steinmeier 2016; Wickert et al. 2017; Zhong et al. 2022). For instance, firms are more likely to engage in substantive CSR when stakeholders value and monitor the firms' socioenvironmental performance more closely and the respective resources are available (Durand et al. 2019; Perez-Batres et al. 2012).

As our study focuses on the specific environmental strategy of decarbonization, drawing from previous research, we define *substantive decarbonization strategies* as organizational actions

aimed to reduce its CO_2-emissions. Such actions may be internally or externally focused and include activities like generating or using green electricity or reducing CO_2-emissions of the value chain. Commitment of top organizational leaders is essential for such path-breaking resource intensive substantive decarbonization strategies aimed to reduce the negative environmental impact of firms' operations (Dahlmann et al. 2019).

5.3 Hypotheses

5.3.1 Stakeholder Pressures and Decarbonization Strategies

Long-term success of a firm relies on creating value for all key stakeholders (Freeman 1984), including those concerned about environmental sustainability. While the relative power, legitimacy, urgency, and proximity of different stakeholder groups may vary (Driscoll & Starik 2004; Mitchell et al. 1997), organizational survival necessitates understanding and addressing stakeholders perspectives. Indeed, prior literature shows an interrelation between stakeholder pressures and environmental strategies (e.g., Brulhart et al. 2019), with Murillo-Luna et al. (2010) arguing that firms respond to environmental demands from different stakeholder groups in a similar way. In the context of carbon emissions, stakeholder pressures have been found to determine the adoption of greenhouse gas reduction strategies (Cadez et al. 2019), and low-carbon operational practices (Böttcher & Müller 2015). Research evidence of a positive influence of stakeholder pressures on organizational actions and strategies leads to our first hypothesis related to decarbonization strategies.

H1: Stakeholder pressures lead Mittelstand firms to pursue decarbonization strategies.

5.3.2 Internal Stakeholder Pressures and Substantive Decarbonization Strategies

In this study, we differentiate between internal and external stakeholder pressures, and also between symbolic and substantive decarbonization strategies. Aimed to improve the environmental performance of a firm, substantive decarbonization strategies require major organizational resources and changes (e.g., Truong et al. 2021). Berrone et al. (2009) describe pollution prevention strategies, which are closely related to decarbonization strategies, as technologically, socially, and structurally complex and risky. Internal stakeholders internalize a firm's values and norms related to its key positions including its strategy of environmental protection (e.g., Hyatt & Berente 2017). High-proximity internal stakeholders like employees

and managers, who are characterized by a low physical distance and high involvement in a firm, are not only involved in the establishment and implementation of its sustainability strategies, they are also influenced by related actions in their day to day work (e.g., Alt et al. 2015; Darnall et al. 2009; Schons & Steinmeier 2016). Accordingly, internal stakeholders are able to recognize the substantive nature of the decarbonization strategies and the real sustainability efforts of a firm, which is more difficult to observe for external stakeholders (Perez-Batres & Doh 2014). Nevertheless, substantive and symbolic strategies are not mutually exclusive and internal stakeholders might want the firm to use symbolic strategies to communicate its environmental commitment (Hyatt & Berente 2017). Accordingly, we hypothesize that internal stakeholder pressures lead to both substantive and symbolic decarbonization strategies but are stronger for substantive decarbonization.

H2: Internal stakeholder pressures lead Mittelstand firms to pursue substantive decarbonization strategies more strongly than symbolic decarbonization strategies.

5.3.3 External Stakeholder Pressures and Symbolic Decarbonization Strategies

Symbolic actions build the impression of environmental commitment at low costs (e.g., Truong et al. 2021). Indeed, the purchase of CO_2-certificates signals a commitment for decarbonization, but it implies little costs and organizational changes for the firm, compared to, for example, adjusting the production process. Prior literature identifies symbolic sustainability actions and strategies as a response to external stakeholders in order to build the impression of sustainable commitment and to gain legitimacy (e.g., Berrone et al. 2009; Dahlmann et al. 2019; Shabana & Ravlin 2016; Truong et al. 2021). Pressures from low-proximity stakeholders with a high physical distance and low involvement in the firm have been found to encourage greenwashing, which is closely related to the adoption of symbolic environmental practices (Schons & Steinmeier 2016; Testa et al. 2018). As compared to internal stakeholders, externals like customers and industrial associations are low-proximity stakeholders facing higher information asymmetries making it difficult for them to clearly distinguish between symbolic and substantive actions of a firm (Schons & Steinmeier 2016). This may encourage some firms to engage in opportunistic behavior of adopting symbolic low-cost decarbonization strategies to appease distal stakeholders (Kulkarni 2000). Although more discerning external stakeholders may be able to distinguish between firms pursuing symbolic versus substantive decarbonization

strategies, overall, we expect external stakeholder pressures propel firms towards easier to pursue symbolic decarbonization strategies.

H3: External stakeholder pressures lead Mittelstand firms to pursue symbolic decarbonization strategies more strongly than substantive decarbonization strategies.

5.3.4 The Moderating Role of Family Ownership

Family-owned firms are differentiated from non-family firms by their penchant to make managerial decisions aimed to simultaneously pursue economic and non-economic goals of preserving socioemotional wealth of the owning family (Chrisman et al. 2012). Gómez-Mejía et al. (2007, p.106) defined socioemotional wealth as referring to the "non-financial aspects of the firm that meet the family's affective needs, such as identity, the ability to exercise family influence, and the perpetuation of the family dynasty". Accordingly, family firms with trans-generational continuity intentions are managed with a long-term orientation (e.g., Chua et al. 1999). Leaders of such enterprises pay particular attention to their reputation (e.g., Deephouse & Jaskiewicz 2013; Dyer & Whetten 2006; Zellweger et al. 2013), as the firm's identity is inextricably linked with that of the family (Block 2010).

As these characteristics affect the management of ethical and sustainability issues of family firms (e.g., Dou et al. 2019; Le Breton-Miller & Miller 2016; Vazquez 2018), they are likely to influence the decarbonization strategies adopted. Indeed, prior research shows that family ownership has distinct effects on the dimensions of CSR (Block & Wagner 2014) which also varies by the stakeholder type linked to the CSR dimension (Cruz et al. 2014). Eager to protect their socioemotional wealth resources, family firms better leverage symbolic [substantive] CSR to enhance short-term [long-term] financial performance (Combs et al. 2023). Family ownership not only affects the financial performance of firms (e.g., Garcés-Ayerbe et al. 2022) but also influences their environmental performance (e.g., Berrone et al. 2010; Terlaak et al. 2018). However, research on sustainability in family firm is still in its early stage (Clauß et al. 2022; Ferreira et. al. 2021) and especially underdeveloped is the environmental pillar of sustainability (Curado & Mota 2021).

Due to their aspiration to protect socioemotional wealth and family reputation, family firms differ from non-family firms in their stakeholder management approach (Neubaum et al. 2012; Sharma 2001). While caring more for their stakeholders (Cennamo et al. 2012), family firms tend to use an informal approach to managing relationships both with internal and external stakeholders (Campopiano & De Massis 2015; García-Sánchez et al. 2021; Gómez-Mejía et al.

2007). The different approach of family firms to stakeholder management has also been observed with regard to sustainability, highlighting employee satisfaction and informal communication with externals as key drivers for sustainability in family firms (e.g., Broccardo et al. 2019; Cruz et al. 2014).

Transferring these considerations to the decarbonization context, we argue that the stakeholder management approach caused by the urge to protect the socioemotional wealth, long-term orientation, and reputation of the firm will differ in family-owned firms. More precisely, we hypothesize that the effect of stakeholder pressures on pursuing decarbonization strategies will be stronger in family-owned firms as compared to non-family firms.

H4a: Family ownership strengthens the effect of stakeholder pressures on pursuing decarbonization strategies.

Internal stakeholders internalize the values and norms of a firm regarding environmental protection (e.g., Hyatt & Berente 2017) and are involved in establishing the referent strategies (e.g., Alt et al. 2015; Darnall et al. 2009). Thus, internal stakeholders are able to recognize the substantive nature of decarbonization strategies. As dominant internal stakeholders, family members face additional pressure to preserve the longevity of the enterprise and preserve the socioemotional wealth of the family (e.g., Chua et al. 1999; Gómez-Mejía et al. 2007; Le Breton-Miller & Miller 2006). Moreover, family firms have close relationships with their employees as they are often considered part of the organization (Broccardo et al. 2019). Family firm employees report high levels of job satisfaction (Block et al. 2015) and closer identification with the firm (Reck et al. 2022; Vallejo 2009). Consequently, we hypothesize that the effect of internal stakeholder pressures on pursuing substantive decarbonization strategies will be stronger in family-owned firms compared to non-family firms.

H4b: Family ownership strengthens the effect of internal stakeholder pressures on pursuing substantive decarbonization strategies.

In order to protect their socioemotional wealth and reputation, family firms are responsive to external stakeholders to avoid negative assessments (Berrone et al. 2010; Gómez-Mejía et al. 2011). Compared to their non-family counterparts, family firms often have cooperative relationships with local communities, customers, and suppliers (e.g., Broccardo et al. 2019; Campopiano & De Massis 2015) and they develop strong relationships with the legislators and even their competitors (Bendell 2022). Communication of family firm leaders with external stakeholders is more informal and personal (Campopiano & De Massis 2015). Although there

is some evidence to suggest that family firms are more likely to cover up and get away with symbolic actions (Combs et al. 2023; Du 2015), in the context of well-informed populace surrounding the German Mittelstand, we argue that the close relationships and informal communication with external stakeholders causes symbolic decarbonization strategies to become less effective. As information asymmetries between family firms and their external stakeholders diminish, the symbolic decarbonization strategies of impression management are more likely to be recognized and abhorred. In contrast, the external stakeholders of non-family firms rely on formal communication channels making it more challenging to overcome information asymmetry and recognize the symbolic nature of a strategy (Kulkarni 2000; Schons & Steinmeier 2016). Accordingly, we hypothesize that the effect of external stakeholder pressures on pursuing symbolic decarbonization strategies will be weaker in family-owned firms compared to non-family firms.

H4c: Family ownership weakens the effect of external stakeholder pressures on pursuing symbolic decarbonization strategies.

5.4 Data and Method

5.4.1 Sample and Data Collection

The Orbis database was used to generate a population of 10,765 knowledge-intensive, medium-sized, German manufacturing firms[29] that were at least ten years old as of September 2020 and employed between 50 and 2,999[30] individuals (IfM Bonn 2016; Röhl 2018). Subsidiaries of larger corporations, foreign and non-profit firms, and public institutions were excluded from this population.

A German empirical social research institute used computer assisted telephone interviews to collect questionnaire data between January and April 2022. The questionnaire included single-choice, multiple-choice, and ranking questions related to decarbonization and environmental sustainability. Firm-specific financial and ownership data were collected from Orbis to complement the survey data.

Of the 1,959 randomly generated firms from the population that were contacted, completed surveys were received from 444 firms, resulting in a response rate of 22.66%. This response

[29] The knowledge-intensive manufacturing industries included in our sample are NACE 20, 21, 26, 27, 28, 29, and 30 (Gehrke et al., 2010), which are completed by NACE 22, 23, 24, and 25.
[30] The number of employees was within the specified range for at least one of the years 2017, 2018, and 2019.

rate compares well with previous sustainability research (e.g., Böttcher & Müller 2015; Cadez & Czerny 2016; Chen 2008; Seroka-Stolka & Fijorek 2020). One observation was dropped, as the firm exceeded the employee number of 3,000 people and mean value imputation was used to replace missing values in the data, resulting in a final sample of 443 firms. The surveyed sample represents the population of 10,765 firms in terms of industry and locational distribution. However, the surveyed firms are significantly larger in terms of number of employees. The 443 firms of our final sample are between 12 and 208 years old, with an average firm age of 49 years. Moreover, they have between 50 and 2,722 employees, with an average employee number of 346. According to the employee numbers, the sample consists of 86% medium-sized firms (50 to 499 employees, IfM Bonn 2016) and 14% Mid Caps (500 to 2,999 employees, Röhl 2018). The surveyed firms are distributed across all 16 German federal states, whereas most firms are located in North Rhine-Westphalia (29.57%), Baden-Württemberg (16.03%), and Bavaria (13.77%). Concerning the industry distribution, all firms are active in the manufacturing sector, with machinery (NACE 28, 24.60%), fabricated metal products (NACE 25, 21.90%), and rubber and plastics (NACE 22, 12.64%) being the most frequent industries.

5.4.2 Measures

The dependent as well as independent variables and a set of control variables are based on survey data. Besides the variable descriptions below, an extract from the survey questionnaire can be found in *Figure A5.1* of the Appendix.

Dependent Variables

Respondents were asked to indicate the importance of three approaches to achieving their firms' CO_2-emission targets on a five-point scale ranging from 'unimportant' to 'very important'. These approaches were: (i) internal CO_2-reduction (e.g., reduction of process emissions or use of internally generated green electricity), (ii) external CO_2-reduction (reduction of value chain emissions), and (iii) CO_2-compensation (e.g., purchase of CO_2-certificates). All three dependent variables used in the analysis are derived from the survey data.

The first dependent variable – *decarbonization strategies* is calculated as the row mean of the three approaches and represents the overall importance of strategies to address CO_2-emissions. The second dependent variable – *symbolic decarbonization strategies* is based on the responses to the third approach of CO_2-compensation. Our third dependent variable –*substantive*

decarbonization strategies is calculated as the row mean of the two approaches of internal and external CO_2-reduction. Accordingly, it represents the importance of actions to reduce the CO_2-emissions of a firm and its value chain.

Independent Variables

Three of the four independent variables are derived from the survey data. Responses to the question 'Please indicate how much pressure the following stakeholders exert on your firm with regard to reducing CO_2-emissions' were measured on a 5-point scale from 'no pressure' to 'very high pressure'. Sixteen stakeholder categories of influencers of CO_2-emission strategies derived from the literature were provided to the respondents (Böttcher & Müller 2015; Seroka-Stolka & Fijorek 2020).

The first independent variable – *stakeholder pressures* was calculated as the row mean of the sixteen stakeholders, thereby representing the overall perceived stakeholder pressures with regard to reducing CO_2-emissions. Factor analysis, presented in *Table 5.1* was conducted to reveal potential interrelations between the stakeholders. The results of the analysis reveal two underlying factors, representing two superordinate stakeholder groups. Factor one includes the following twelve stakeholders: trade unions/works council, distributers/suppliers, trade, end consumer, consumer associations, competitors, banks/financial institutions, insurance companies, legislators, ecology associations, press/media, and the local population (Cronbach's alpha $\alpha = 0.89$). These stakeholders represent actors from outside of the firm exerting pressures to reduce its CO_2-emissions. Accordingly, the independent variable based on the first factor is labelled as *external stakeholder pressures*.

Factor two contains four stakeholders: owners/shareholders, top management, middle management, and employees (Cronbach's alpha $\alpha = 0.81$). As these stakeholders are internal to an organization, we label this factor as *internal stakeholder pressures*. The low inter-factor correlation of 0.19 supports the classification of stakeholders into external and internal, which is also a common classification in the literature (Carroll & Näsi 1997).

For the last independent variable, the ownership data was obtained from Orbis and supplemented by a manual search of corporate websites. Based on this data, the dichotomous variable family ownership (dummy) is calculated and equals one, if at least 51% of ownership shares are attributed to the founder and/or the family, zero otherwise. Accordingly, the sample contains 54% family-owned firms and 46% non-family firms (*Table 5.2*).

Table 5.1 Factor analysis: Perceived stakeholder pressures to reduce CO_2-emissions

	Variance	**Difference**	**Proportion**	**Cumulative**
Factor 1	4.32	1.61	0.62	0.62
Factor 2	2.71	.	0.39	1.01

443 observations. Chi^2 (120) = 2,899.38. Prob>Chi^2 = 0.00. Kaiser-Meyer-Olkin measure of sampling adequacy = 0.93.

Factor rotation matrix

	Factor 1	Factor 2
Factor 1	0.81	0.59
Factor 2	-0.59	0.81

Rotated factor loadings (pattern matrix) and unique variances sorted

	Factor 1	Factor 2	Uniqueness
Ecology associations	0.67	0.27	0.48
Local population	0.64	0.32	0.49
Insurance companies	0.63	0.20	0.56
Consumer associations	0.61	0.27	0.56
Press/media	0.59	0.31	0.55
Banks/financial institutions	0.59	0.28	0.57
Distributers/suppliers	0.57	0.14	0.66
Trade unions/works council	0.53	0.30	0.62
Trade	0.53	0.27	0.65
Competitors	0.53	0.39	0.57
End consumer	0.49	0.31	0.67
Legislators	0.49	0.27	0.69
Top management	0.18	0.76	0.39
Owners/shareholders	0.16	0.68	0.50
Middle management	0.32	0.66	0.46
Employees	0.45	0.51	0.54

Control Variables

Prior research indicates that firm characteristics affect the environmental sustainability efforts of firms (Balasubramanian et al. 2021). Consequently, we included several control variables in our study. For the first set of control variables, the underlying data are obtained from Orbis. First, firm age is frequently included in family firm research and studies on the environmental sustainability and performance relationship (e.g., Adomako et al. 2019; Chrisman et al. 2012; Shrivastava & Tamvada 2019). In this study, we use the variable *firm age (log.)* as an experience measure, calculated as the logarithmized number of years since the founding of the firm. Second, *firm size* has been identified as an influential contextual variable in studies on decarbonization strategies (Böttcher & Müller 2015; Lee 2012; Weinhofer & Hoffmann 2010)

and the relationship of stakeholder pressures and environmental strategies (Buysse & Verbeke 2003; Seroka-Stolka & Fijorek 2020; Yunus et al. 2020). In our study, firm size is indicated by the logarithmized number of employees in 2018 as the variable *employees 2018 (log.)*. Finally, *industry* is another widely used control variable in comparable research (e.g., Dhanda et al. 2022; Garcés-Ayerbe et al. 2012; Henriques & Sadorsky 1999; Hyatt & Berente 2017). We include a set of dichotomous variables labelled *NACE 20 to 30*, representing the manufacturing industry the firm is primarily active in.

Additional control variables are derived from our survey data, starting with a profitability measure (e.g., Damert et al. 2017; Flammer 2013). Responses to the question 'How do you rate the profitability of your firm compared to your competitors?' were measured on a five-point scale ranging from 'much worse' to 'much better'. Based on these, the dichotomous variable profitability was created, taking the value one if the firm assesses to have a higher profitability compared to its competitors (scale values four and five), zero otherwise (scale values one to three). Furthermore, we include a growth measure. Responses to the question 'What are your firm's growth ambitions for the next five years?' were measured on a five-point scale ranging from 'low growth ambitions' to 'high growth ambitions'. Building on these, we built the dichotomous variable growth ambitions, taking the value one if the firm has high growth ambitions (scale values four and five), zero otherwise (scale values one to three). Finally, we control if the firm has already set a target year for CO_2-neutrality (covering Scope 1 and 2 emissions) or not. For the question 'By which year does your firm plan to be CO_2-neutral in terms of its own CO_2 emissions (Scope 1 and 2)?', respondents had to select between nine options, ranging from 'We are already CO_2-neutral' to 'We have not yet set a specific target year'. Based on the responses, we constructed the dichotomous variable CO_2-neutrality target, taking the value one if the firm has a target year for CO_2-neutrality, zero otherwise.

5.4.3 Assessment of Sample Biases

Several measures to identify and reduce potential sample biases were applied. First, to control for *non-response bias*, we conducted several statistical tests to compare the characteristics of the 1,959 firms that were contacted for the survey and the 443 that responded. The respondents have significantly larger number of employees compared to the non-respondents, but the two groups did not differ in terms of industry and location.

The Ukraine war started on February 24, 2022, during the survey period. As the conflict influenced energy-related topics, we were concerned about the effect on the response behavior

of our survey participants over time. To address this concern, we divided the sample into two groups of early- and late respondents and compared the distribution of the three dependent variables. The early respondents include 187 firms surveyed between January 18 and February 23, before the war started, while the late respondents cover 256 firms surveyed between February 24 and April 14. As no differences in the dependent variables can be observed, we can rule out the *late response bias*.

We also applied measures to mitigate the risk of *common method bias* and related measurement biases (MacKenzie & Podsakoff 2012, Podsakoff et al. 2012). Addressing the ability to respond accurately, we formulated the survey questions in a simple and understandable way and provided explanatory texts, read out by the interviewers in case of further inquiry. Prior to the interviews, the social research professionals contacted the firms to identify the person responsible for sustainability in the referring firm, to obtain the optimal respondent fit and guarantee the respondent's experience with the topic of the survey. Addressing the participants' motivation to respond accurately, we incentivized the participation by offering an individual management summary for the firm and an invitation for a workshop on the survey results. Also, respondents were assured that their data is processed anonymously and for scientific reasons only. The questions were positioned in a way that participants would not notice a direct relationship between the constructs. Moreover, we tried to minimize common method bias by variating the measurement scales of the survey questions related to the dependent and independent variables. The correlations between the dependent variables on decarbonization strategies and the independent stakeholder pressures variables lie below 0.40 (see *Table 5.2*). Also, the moderator variable family ownership originates from another data source. Additionally, we applied marker variable technique and included two marker variables on the COVID-19 crisis and digital transformation in our survey[31]. As correlations between the marker variables and our dependent and independent variables lie below 0.20, possible biases are ruled out.

Finally, we address *social desirability bias*. The questionnaire does not contain individual level questions – however, if there is a high level of commitment to the firm, socially desirable response behavior might be transferred to the firm level. Based on established scales (Allen &

[31] The two marker variables refer to the impact of the COVID-19 crisis on the firm's revenues (measured on a five-point scale from 1 = 'high revenue decline' to 5 = 'high revenue increase') and the assessment of digital transformation as the greatest challenge of current times (measured on a five-point Likert-scale from 1 = 'strongly disagree' to 5 = 'strongly agree').

Meyer 1990; Mowday et al. 1979), we included a commitment measure in our survey[32]. A linear regression analysis using the commitment measure as dependent variable and the six decarbonization strategies and stakeholder pressures measures as independent variables. No significant effects were found, eliminating commitment and social desirability related concerns.

5.5 Results

Table 5.2 present the variable means and correlations, while the results of the linear OLS regressions are presented in *Table 5.3* for decarbonization strategies and *Table 5.4* for substantive and symbolic decarbonization strategies. Supporting Hypothesis 1, we find a positive effect of stakeholder pressures on the pursuit of decarbonization strategies ($\beta = 0.32$, $p < 0.01$).

Internal stakeholder pressures possess a positive effect on substantive ($\beta = 0.25$, $p < 0.01$) but no effect on symbolic decarbonization strategies. We test the equality of these two coefficients, showing that they significantly differ from each other ($p < 0.1$). Accordingly, Hypothesis 2, stating that internal stakeholder pressures lead Mittelstand firms to pursue substantive decarbonization strategies more strongly than symbolic decarbonization strategies, is supported. This procedure is repeated for the subsequent hypothesis. External stakeholder pressures possess a positive effect on substantive ($\beta = 0.11$, $p < 0.01$) and symbolic ($\beta = 0.25$, $p < 0.01$) decarbonization strategies. The test for equality of these two coefficients shows that they significantly differ from each other ($p < 0.05$), supporting Hypothesis 3, that external stakeholder pressures lead Mittelstand firms to pursue symbolic decarbonization strategies more strongly than substantive decarbonization strategies.

Model 2 (*Table 5.3*) includes the interaction of stakeholder pressures and family ownership. As the interaction effect is insignificant, Hypotheses 4a cannot be supported. Models 2 and 4 (*Table 5.4*) include the family ownership interaction with internal and external stakeholder pressures. Similarly, hypotheses 4b cannot be supported by the regression analyses. However, Hypothesis 4c is confirmed, supporting the argument that family ownership weakens the effect of external stakeholder pressures on pursuing symbolic decarbonization strategies ($\beta = -0.40$, $p < 0.01$). These interaction effects are graphically displayed in *Figure 5.2*, showing the predictive

[32] The three items included in the commitment scale are ‘I care deeply about the future of this firm‘, ‘I feel a strong sense of belonging to this firm‘, and ‘I feel proud when I can tell others that I belong to this firm‘ (measured on a five-point Likert-scale from 1 = ‘strongly disagree‘ to 5 = ‘strongly agree‘).

margins of family ownership with 95% confidence intervals for symbolic decarbonization strategies based on a linear OLS regression.

Table 5.2 Means and correlations

Variables	**Mean**	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**
Decarbonization strategies (1)	3.40											
Substantive decarbonization strategies (2)	3.80	0.85										
Symbolic decarbonization strategies (3)	2.57	0.76	0.32									
Stakeholder pressures (4)	2.36	0.38	0.37	0.25								
Internal stakeholder pressures (5)	$-7e^{-10}$	0.34	0.37	0.17	0.68							
External stakeholder pressures (6)	$-3e^{-10}$	0.26	0.21	0.22	0.85	0.19						
Family ownership *(*dummy*)* (7)	0.54	-0.07	-0.06	-0.05	-0.04	-0.08	-0.00					
Age (log.) (8)	3.70	0.07	0.03	0.10	0.03	0.04	0.02	0.27				
Employees 2018 (log.) (9)	5.22	0.10	0.09	0.08	0.24	0.21	0.17	-0.04	0.21			
Profitability *(dummy)* (10)	0.44	0.12	0.14	0.05	0.04	0.05	0.02	0.05	0.03	-0.02		
Growth ambitions *(dummy)* (11)	0.52	0.08	0.07	0.06	0.15	0.12	0.11	-0.05	-0.01	0.12	0.10	
CO_2-neutrality target *(dummy)* (12)	0.37	0.33	0.35	0.18	0.27	0.30	0.15	-0.04	0.03	0.14	0.01	0.09

Explanation: SD = Standard deviation. N = 443. The variables internal stakeholder pressures (5) and external stakeholder pressures (6) have been predicted by STATA as a result of our factor analysis. Therefore, they deviate from the original scale and the mean values should be interpreted with caution.

Table 5.3 Linear regression analyses for decarbonization strategies

Dependent variable	**Decarbonization strategies**	
	(1)	(2)
Independent variables		
Stakeholder pressures	0.32***	0.36***
	(0.05)	(0.07)
Family ownership *(*dummy*)*	-0.12*	0.06
	(0.07)	(0.23)
Family ownership *(*dummy*)* x Stakeholder pressures		-0.07
		(0.09)
Control variables		
Age (log.)	0.10*	0.10*
	(0.06)	(0.06)
Employees 2018 (log.)	-0.01	-0.00
	(0.04)	(0.04)
Profitability *(dummy)*	0.17**	0.17**
	(0.07)	(0.07)
Growth ambitions *(dummy)*	0.01	0.01
	(0.07)	(0.07)
CO_2-neutrality target *(dummy)*	0.41***	0.41***
	(0.07)	(0.07)
NACE 21 - Pharmaceuticals	-0.16	-0.15
	(0.25)	(0.25)
NACE 22 - Rubber and plastics	-0.04	-0.04
	(0.16)	(0.16)
NACE 23 - Non-metallic mineral products	-0.12	-0.12
	(0.18)	(0.18)
NACE 24 - Basic metals	-0.08	-0.07
	(0.20)	(0.20)
NACE 25 - Fabricated metal products	-0.20	-0.19
	(0.14)	(0.14)
NACE 26 - Computer, electronic & optical products	-0.37**	-0.36**
	(0.17)	(0.17)
NACE 27 - Electrical equipment	-0.28*	-0.28*
	(0.17)	(0.17)
NACE 28 - Machinery	-0.29**	-0.29**
	(0.14)	(0.14)
NACE 29 - Motor vehicles	-0.27	-0.27
	(0.23)	(0.23)
NACE 30 - Other transport equipment	-0.01	0.02
	(0.34)	(0.34)
Constant	2.31***	2.21***
	(0.29)	(0.32)
Observations	443	443
R-squared	0.24	0.24

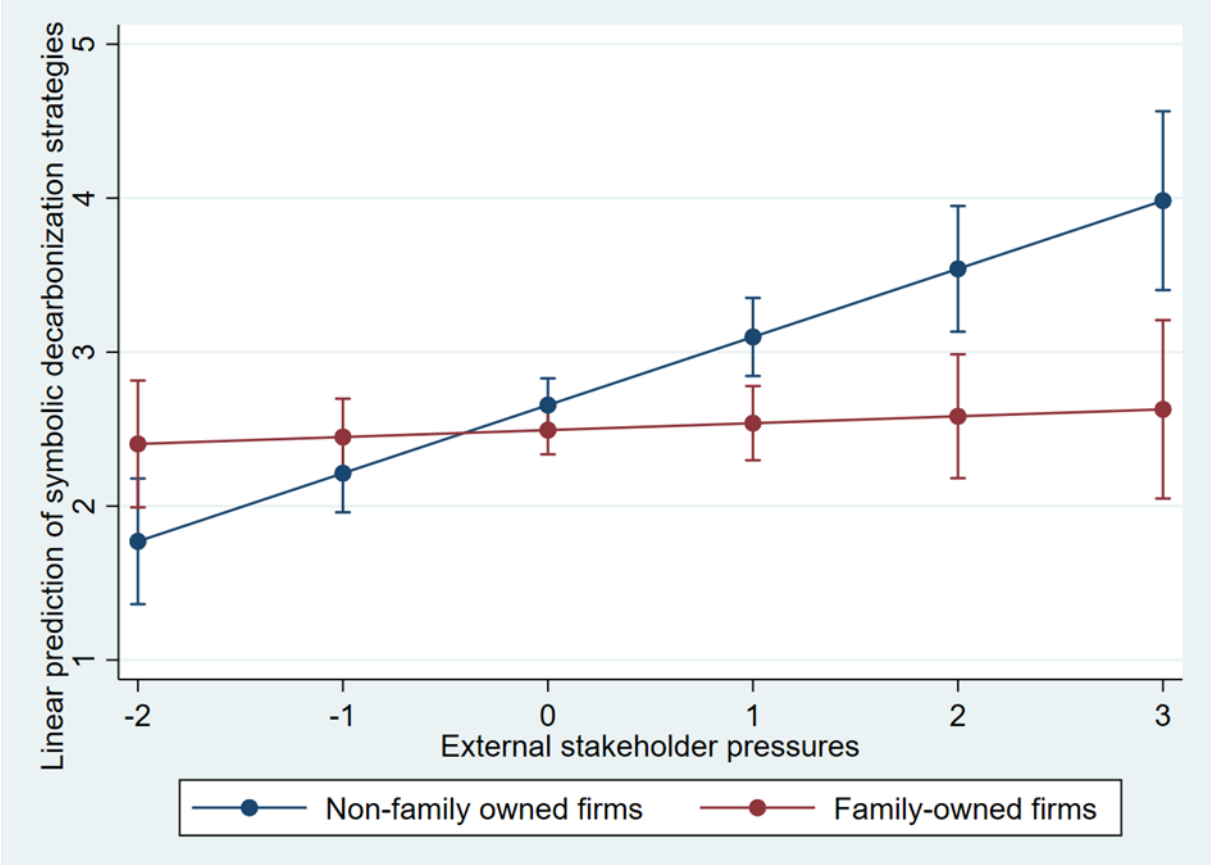
Explanation: Standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01. Variable NACE 20 - Chemicals dropped.

Table 5.4 Linear regression analyses for substantive and symbolic decarbonization strategies

Dependent variables	**Substantive decarbonization strategies**		**Symbolic decarbonization strategies**	
	(1)	(2)	(3)	(4)
Independent variables				
Internal stakeholder pressures	0.25*** (0.04)	0.19*** (0.07)	0.11 (0.08)	0.14 (0.11)
External stakeholder pressures	0.11*** (0.04)	0.11** (0.05)	0.25*** (0.07)	0.44*** (0.09)
Family ownership *(*dummy*)*	-0.08 (0.07)	-0.08 (0.07)	-0.18 (0.12)	-0.16 (0.12)
Family ownership *(*dummy*)* x Internal stakeholder pressures		0.10 (0.08)		-0.05 (0.14)
Family ownership *(*dummy*)* x External stakeholder pressures		-0.00 (0.08)		-0.40*** (0.13)
Control variables				
Age (log.)	0.04 (0.06)	0.05 (0.06)	0.24** (0.10)	0.21** (0.10)
Employees 2018 (log.)	-0.01 (0.04)	-0.02 (0.04)	0.00 (0.07)	0.02 (0.07)
Profitability *(dummy)*	0.20*** (0.07)	0.20*** (0.07)	0.09 (0.12)	0.08 (0.12)
Growth ambitions *(dummy)*	-0.01 (0.07)	0.00 (0.07)	0.04 (0.12)	0.07 (0.12)
CO_2-neutrality target *(dummy)*	0.41*** (0.07)	0.42*** (0.07)	0.32** (0.13)	0.35*** (0.13)
NACE 21 - Pharmaceuticals	-0.25 (0.25)	-0.26 (0.25)	-0.08 (0.45)	-0.02 (0.45)
NACE 22 - Rubber and plastics	0.14 (0.16)	0.14 (0.16)	-0.40 (0.28)	-0.41 (0.27)
NACE 23 - Non-metallic mineral products	-0.01 (0.18)	-0.01 (0.18)	-0.36 (0.32)	-0.32 (0.32)
NACE 24 - Basic metals	0.07 (0.20)	0.07 (0.20)	-0.46 (0.35)	-0.40 (0.35)
NACE 25 - Fabricated metal products	-0.04 (0.14)	-0.05 (0.14)	-0.48* (0.26)	-0.46* (0.25)
NACE 26 - Computer, electronic & optical products	-0.21 (0.17)	-0.23 (0.17)	-0.68** (0.31)	-0.69** (0.31)
NACE 27 - Electrical equipment	-0.14 (0.17)	-0.14 (0.17)	-0.55* (0.30)	-0.51* (0.30)
NACE 28 - Machinery	-0.11 (0.14)	-0.11 (0.14)	-0.66*** (0.25)	-0.66*** (0.25)
NACE 29 - Motor vehicles	-0.03 (0.23)	-0.04 (0.23)	-0.60 (0.40)	-0.58 (0.40)
NACE 30 - Other transport equipment	0.02 (0.34)	-0.00 (0.34)	-0.08 (0.60)	0.11 (0.59)
Constant	3.57*** (0.28)	3.59*** (0.28)	2.06*** (0.50)	2.01*** (0.50)
Observations	443	443	443	443
R-squared	0.25	0.25	0.11	0.13

Explanation: Standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01. Variable NACE 20 - Chemicals dropped.

Figure 5.2 Symbolic decarbonization strategies of family versus non-family firms



Explanation: Predictive margins of family ownership with 95% confidence intervals for symbolic decarbonization strategies.
Source: Own illustration, created via STATA.

5.6 Discussion, Implications, and Future Research Avenues

Our research reveals several implications for future research. First, while reinforcing previous literature regarding the positive influence of stakeholder pressures on environmental sustainability (e.g., Böttcher & Müller 2015; Damert et al. 2017; Dhanda et al. 2022; Yunus et al. 2020), our study adds a layer of specificity by confirming this relationship extends to the decarbonization strategies. We find that when German Mittelstand firm leaders perceive stakeholder pressures related to environmental degradation concerns, they respond by pursuing decarbonization strategies before they are legally required to implement such strategies. It will be interesting for future research to explore whether there is a difference between the first- versus late-movers in decarbonization strategies within the Mittelstand firms and if so, what causes such differences.

We are excited about our second finding and related theoretical implication as it opens a new arena for future research. Our study reveals that pressures from different types of stakeholders

– internals versus externals, have different effects on the decarbonization strategies of Mittelstand firms. While external stakeholder pressures influence symbolic decarbonization strategies more strongly than substantive ones, internal stakeholder pressures only possess an effect on substantive decarbonization. Accordingly, it is important for researchers to separately examine the influence of different stakeholder groups not only on environmental strategies like decarbonization (e.g., Hyatt & Berente 2017; Seroka-Stolka & Fijorek 2020), but perhaps also on other stakeholder impacts on corporate strategic orientation and behaviors.

Third, we contribute to literature on symbolic and substantive management (Pfeffer 1981). While prior research has applied these concepts to CSR or the social dimension of sustainability (e.g., Nardi 2022; Schons & Steinmeier 2016; Wickert et al. 2017; Zhong et al. 2022) and environmental strategies (e.g., Hyatt & Berente 2017; Rodrigue et al. 2013; Truong et al. 2021), we extend the concept to the environmental strategy of decarbonization, defining and examining symbolic and substantive decarbonization strategies. Doing so, we further focus and develop the concept of symbolic and substantive strategies for usage in future studies.

Furthermore, we contribute to research on family firms and stakeholders (e.g., Deferne et al. 2022). In addition to distinguishing between internal and external stakeholders, our study suggests that it is equally essential to distinguish symbolic from substantive decarbonization strategies. Curiously, by doing so, we find that family ownership does not affect the impact of internal stakeholder pressures on substantive decarbonization strategies, as evident by the non-support of Hypothesis 4b. We speculate that this result may have been caused by two opposite direction effects cancelling each other. On one hand, the socioemotional wealth presentation propensity of family firms may drive their carbon performance strategies (e.g., Dahlmann et al. 2019; Gómez-Mejía et al. 2007). On the other hand, family firms' tendency to avoid risky capital investments as compared to non-family firms (Anderson et al. 2012; Naldi et al. 2007), may slow down investments in substantive decarbonization strategies (e.g., Durand et al. 2019). Both effects might cancel each other out, so that the influence of internal stakeholder pressures on substantive decarbonization strategies is neither stronger nor weaker in family-owned firms. Future research to verify our interpretation of this finding will be useful.

Combs et al.'s (2023) research on S&P 500 firms reveals that in the short term family-owned firms are more likely to get away with symbolic CSR due to their reputation and strong stakeholder relationships. Du (2015) provides evidence that some Chinese family-owned firms use philanthropic giving to alleviate negative reputational impacts of their environmental misconduct. Despite this evidence that family-owned firms tend to engage in symbolic

behavior, we find that family ownership weakens the effect of external stakeholder pressures on symbolic decarbonization. Our finding confirms the argument that the close relationships and informal communication of family firms with certain external stakeholders (e.g., Bendell 2022; Broccardo et al. 2019; Campopiano & De Massis 2015) reduce information asymmetries and enable these stakeholders to recognize the symbolic nature of the decarbonization strategies. Accordingly, the external stakeholders of family-owned firms might tolerate symbolic actions in certain areas like CSR or corporate giving (Combs et al. 2023; Du 2015) but are less tolerant in the case of climate change related strategies like decarbonization. This opens an interesting avenue of research to uncover perceived urgency of different dimensions of sustainability for internal and external stakeholders.

Additional avenues for future research arise for the emerging research stream on decarbonization drivers. Being among the first to examine decarbonization strategies as a dependent variable in the Mittelstand context, we analyze the impact of stakeholder pressures. In addition, there might be other influential factors. Previously identified drivers of environmental strategies (e.g., González-Benito & González-Benito 2006; Sharma & Sharma 2011) might also affect a firm's decarbonization strategies. Zhao et al. (2022) currently examined the most relevant drivers of supply chain decarbonization in the plastics industry, confirming stakeholder pressures as a specifically influential factor, while pointing out additional drivers, such as regulations. Indeed, regulations can push towards climate actions by setting the referring policy guidelines (Okereke & Russel 2010; Schmitz et al. 2019; Yunus et al. 2020). Learning more about regulations as a driver of decarbonization in Mittelstand firms will be particularly relevant in the upcoming years, as regulatory frameworks like the EU-Taxonomy, that currently apply only to larger firms, will expand to smaller ones.

Another promising research avenue is to consider decarbonization strategies from a capability-based perspective. Dynamic capabilities, referred to as a "firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments" (Teece et al. 1997, p. 516), are crucial for sustainability (Buzzao & Rizzi 2021). Prior research highlights the role of dynamic capabilities for the innovation of green products (e.g., Dangelico et al. 2017), processes (e.g., Bhatia 2021), and business models (e.g., Inigo et al. 2017) as well as for a firm's environmental performance (Dzhengiz & Niesten 2020; Eikelenboom & de Jong 2019). So far, little is known about dynamic capabilities in the context of decarbonization strategies (cf. Lopes de Sousa Jabbour et al. 2020). Future research might examine how dynamic capabilities drive decarbonization and what types of capabilities matter most. Other

potential decarbonization drivers worth analyzing are reputational aspects (e.g., Martín-de Castro et al. 2020), chief executive officer characteristics such as sustainability orientation (e.g., Adomako et al. 2021), and market conditions like the level of competitiveness (e.g., Böttcher & Müller 2015) or internationalization (e.g., Denicolai et al. 2021). Examining the effect of stakeholder pressures, we shed light on one of many potential drivers of decarbonization strategies to explore.

5.6.1 Limitations

Lastly, our study entails several limitations. As our sample covers knowledge-intensive, medium-sized, German manufacturing firms, our results are limited to a certain firm size, country, and industry section and may not generalize to Mittelstand firms at large. Applying the research design to firms that lay beyond these size criteria, located in other countries, and active in other industries, could increase the explanatory power of our results. Besides, future extensions of reporting obligations regarding the CO_2-emissions of Mittelstand firms could offer new data sources for future research, that can complement survey data and reduce related biases. Furthermore, examining family ownership entails limitations, as it does not cover the heterogeneity of family firms. Additional layers about the family-firm interaction effect might involve the family generation and the culture and values of the family firm (Astrachan et al. 2020; Block 2010; Block & Wagner 2014; Chrisman et al. 2012; Le Breton-Miller & Miller 2016; Sharma et al. 1997).

5.6.2 Practical Implications

A few pragmatic suggestions for firm owners and policymakers emerge from our study. To begin with, as internal stakeholders matter more for substantive decarbonization, firm leaders should consider systematically engaging employees to generate ideas for substantive decarbonization. Related efforts are already underway in some firms like the Dutch paint manufacturer Royal van Wijhe Verf and German Mittlestand firms like the food manufacturer Rügenwalder Mühle, the shower system and faucet manufacturer Hansgrohe, and ORCA that offers software solutions for the construction industry. In these enterprises, employees systematically contribute ideas for the climate neutrality and sustainability of the firm. As research shows that firms with the capability of stakeholder integration tend to develop environmental strategies (Delgado-Ceballos et al. 2012), such firms with deeper employee

engagement are likely to progress with their decarbonization strategies more rapidly than others.

Policymakers eager to encourage firms to decarbonize could improve the conditions for more substantive versus symbolic decarbonization, e.g., by restricting CO_2-certificate trading or incentivizing substantive actions, such as implementing a CO_2-efficient production process. Moreover, incentivizing firms to educate their current and future employees and owners on sustainability strategies like decarbonization is likely to be useful. With advancements in online education, certificate programs on sustainability might be particularly useful for current employees as they can be pursued alongside full-time work commitments. This leads to a parallel implication for educators to integrate sustainability related insights into their current curriculum for management graduates.

Chapter 6

Conclusion

This closing chapter (Chapter 6) forms the conclusion of this dissertation. Section 6.1 summarizes the main findings of the four studies presented in the previous chapters. The implications for theory and practice are discussed in the subsequent Section 6.2. Finally, Section 6.3 concludes with a discussion of the limitations and avenues for future research that emerge from this dissertation.

6.1 Summary of the Main Findings

Table 6.1 provides an overview of the research questions addressed in the respective chapters of this dissertation. The main findings for each chapter are summarized in the following paragraphs.

Table 6.1 Research questions addressed in this dissertation

	Research question	Answered in
Hidden Champions		
RQ 2	What impact does regional HC intensity have on regional development?	Chapter 2
RQ 3	When and to what extent do HCs outperform other types of medium-sized firms in terms of financial performance?	Chapter 3
Entrepreneurial finance investors		
RQ 4.1	What are the motives for VC and PE firms to consider climate issues in their portfolio investments?	Chapter 4
RQ 4.2	Which strategies do VC and PE firms employ to address climate issues?	
RQ 4.3	How do the motives for climate considerations affect the strategies employed?	
(Family-owned) Mittelstand firms		
RQ 5.1	How do stakeholder pressures influence the decarbonization strategies of Mittelstand firms?	Chapter 5
RQ 5.2	Does family ownership have an effect on the relationship between the nature of stakeholder pressures and decarbonization strategies of Mittelstand firms?	

Chapter 2 addresses the research question of what impact regional HC intensity, measured as the number of HCs per 100,000 inhabitants per district, has on regional development using a dataset of 1,645 HCs located in 401 German districts (RQ 2). Starting from the geographical distribution, the calculation of a concentration coefficient shows that HCs are not equally distributed in Germany, as approximately 50 percent of the HCs are located in 54 of the 401 districts. We then test a set of hypotheses that include the effect of HC intensity on seven measures of regional development. We find strong evidence for a HC effect on the social dimension of regional development, as HC intensity affects the regional unemployment and trainee rates. Also, regions with a higher number of HCs show strong regional economic and

innovation performance in terms of median income and patents. Moreover, the positive impact of HCs on the social and economic dimensions of the regions in which they are located spills over to neighboring districts. However, two hypotheses cannot be confirmed as we find no impact of HC intensity on regional R&D levels and GDP. These results hold after several robustness checks. In addition, post hoc analyses show the heterogeneity of HCs, as the results are stronger for HC intensity based on manufacturing firms only.

Looking at HCs from a different angle, **Chapter 3** examines when and to what extent HCs outperform other types of medium-sized firms in terms of financial performance, using a ten-year unbalanced panel dataset of 4,677 German manufacturing firms, of which 617 are HCs. A descriptive comparison of HCs and non-HCs supports some of the previous evidence on HCs (e.g., Audretsch et al. 2018; Rammer & Spielkamp 2015), suggesting that HCs have higher export and equity ratios, higher patent output levels, contain less performance risk, and are older and larger in terms of employee number than other Mittelstand firms. Also, HCs are not distributed equally across industries. Running clustered OLS regressions, we then examine the performance effect of HCs on ROA and ROE. While being an HC has no effect on ROE, we find an economically and statistically significant HC performance effect on ROA of 1.7 percentage points. However, further subsample analyses show that the HC performance effect is heterogeneous and highly variable, especially as it declines with firm size. Moreover, in a post hoc analysis using ROS as an alternative performance measure, we support previous research and find an economically and statistically significant HC performance effect on ROS (Rammer & Spielkamp 2015). Summarizing the answer to RQ 3, especially small HCs outperform other types of medium-sized firms regarding financial performance in terms of ROA and ROS.

Moving on, **Chapter 4** looks at another type of Mittelstand actor, entrepreneurial finance investors, specifically PE and VC firms. The study compares the motives and strategies for incorporating climate considerations into portfolio investment decisions, using survey data from a European sample of 468 PE and VC firms. Starting with the motives of entrepreneurial finance investors to consider climate issues in their portfolio investments (RQ 4.1), findings indicate that ethical responsibility is the most important motive. Moreover, an analysis of the four superordinate motives identified in a factor analysis shows that PE and VC investors have different reasons for considering climate issues. While there is no difference for ethical responsibility, PEs are motivated by external stakeholders and portfolio performance considerations, whereas VCs are driven by product differentiation. Subsequent analyses of the

strategies for climate considerations (RQ 4.2) reveal that screening strategies are most frequently selected by the respondents. Significant differences between the investor groups can be observed as PEs pursue active ownership while VCs choose impact investing. Additionally, we observe an effect of the motives for climate considerations on the strategies employed (RQ 4.3). Explanatory approaches for the findings on the environmental sustainability considerations of entrepreneurial finance investors arise from the characteristics of the investor types and the respective markets.

Lastly, **Chapter 5** examines the influence of internal and external stakeholder pressures on the choice of symbolic (CO_2-compensation) and substantive (CO_2-reduction) decarbonization strategies of Mittelstand firms. The analyses are based on recent survey data from 443 medium-sized, German manufacturing firms, 54% of which are family-owned. With respect to RQ 5.1, preliminary analyses show that overall stakeholder pressures drive Mittelstand firms to pursue decarbonization strategies. Taking this a step further, a factor analysis was conducted to identify potential interrelationships among stakeholders. The results of the analysis reveal two underlying factors, representing two superordinate stakeholder groups: internal and external stakeholders. While internal stakeholder pressures lead firms to pursue substantive decarbonization strategies, external stakeholders push firms more towards symbolic rather than substantive decarbonization strategies. Further examining the impact of family ownership on this relationship (RQ 5.2), we find that under external pressures, family-owned firms tend to be less inclined towards symbolic decarbonization strategies than non-family firms. However, we cannot confirm a moderating effect of family ownership on the relationship between overall stakeholder pressures to pursue decarbonization strategies and internal stakeholder pressures to pursue substantive decarbonization strategies.

6.2 Implications for Theory and Practice

6.2.1 Implications for Theory

Contributions to a number of research areas are emerging from this dissertation. These are summarized in the subsequent paragraphs.

HC phenomenon (Chapters 2 and 3). The findings add to the small and emerging stream of HC literature (Schenkenhofer 2022). In the absence of a theoretical anchor, this literature represents phenomenon-based research (von Krogh 2012). Although the HC phenomenon has received much interest in practice, academic research on the topic, particularly in the field of

sustainability, is scarce. This dissertation makes several contributions to a better understanding of the HC phenomenon. Previous research examines the global distribution of HCs (e.g., Audretsch et al. 2020) or their role in peripheral regions (e.g., Vonnahme & Lang 2019). Chapter 2 extends the research on HCs in a geographic context by analyzing the impact of HC concentration on several regional development dimensions at the district level. Addressing social sustainability, decreasing unemployment and growing trainee rates point to the role of HCs as major regional employers. A high level of employment contributes to the social well-being of a region and the continuous training of young people ensures that this is sustained. Furthermore, their economic success leads to rising regional median incomes and business tax revenues. Further contributing to the economic sustainability of HCs, Chapter 3 evaluates the accounting performance of HCs in a so far unique large-scale quantitative study. The results indicate a ROA outperformance of HCs compared to other Mittelstand firms, as well as substantial performance heterogeneity within the group of HCs. The latter is in line with findings on the performance of family firms, stating that family firm performance depends on the definition and type of family firm (Andres 2008; Miller et al. 2007). The findings in Chapters 2 and 3 contribute not only to the characteristics of HCs. They also add to the research on specific firm types as determinants of regional development (e.g., Block & Spiegel 2013) by identifying HCs as influential determinants at the regional level. Moreover, they contribute to research on financial profitability, by confirming that a niche market strategy can lead to better financial performance for specific firm types (e.g., Hennart et al. 2019; Lee et al. 1999).

Sustainable investments (Chapter 4). Analyzing the motives and strategies for considering climate issues in the investment decisions of VCs and PEs contributes to the literature on sustainable investments in entrepreneurial finance (e.g., De Angelis et al. 2022; Zaccone & Pedrini 2020). It provides a deeper understanding of the investment behavior and draws a connection between what is done (strategies) and why it is done (motives). The study differs from previous work in the field of sustainable investments due to several reasons. First, we acknowledge the heterogeneity of investors in the context of sustainability (Abhayawansa & Mooneeapen 2022) by separately examining a unique dataset of VC and PE fund managers. Consequently, the results and implications are tailored to these two investor types. Second, we focus on climate issues rather than ESG as a whole. Daugaard (2020) identifies climate change as an emerging but underdeveloped topic in the field of ESG investing. By focusing on this aspect of sustainability, our study contributes to the emerging subarea of sustainable investments, which is still in its infancy.

Stakeholder pressures and environmental sustainability (Chapter 5). Several contributions are made to the literature on the relationship between stakeholder pressures and environmental sustainability. First, we strengthen previous literature on the positive influence of stakeholder pressures on environmental sustainability (e.g., Böttcher & Müller 2015; Dhanda et al. 2022; Yunus et al. 2020) and add specificity by confirming that this relationship extends to decarbonization strategies. Moreover, we highlight the importance of distinguishing between stakeholder groups, as pressures from internal and external stakeholders have different effects on the decarbonization strategies of Mittelstand firms (cf. Hyatt & Berente 2017). Also, the concept of symbolic and substantive management (Pfeffer 1981), which has previously been applied to CSR (e.g., Wickert et al. 2017; Zhong et al. 2022) and environmental strategies (e.g., Rodrigue et al. 2013; Truong et al. 2021), is extended to the environmental strategy of decarbonization. In doing so, we provide a definition of symbolic and substantive decarbonization strategies. Lastly, we specify the role of family ownership in the relationship between stakeholder pressures and environmental sustainability. We find that family ownership weakens the effect of external stakeholder pressures on symbolic decarbonization, confirming that information asymmetries diminish due to the close relationship and informal communication between family firms and certain external stakeholders (e.g., Bendell 2022; Broccardo et al. 2019; Campopiano & De Massis 2015), allowing these stakeholders to recognize the symbolic nature of the decarbonization strategies.

6.2.2 Implications for Practice

Several groups of practitioners are impacted by the results of this dissertation, as discussed in the following.

Owners and managers of Mittelstand firms. The findings of this dissertation have several implications for owners and managers of Mittelstand firms. First, Chapter 3 shows that the HC strategy, i.e., focusing on niche markets along with a strong export orientation, can lead to superior firm performance, especially for firms with less than 900 employees. Although it is difficult for other Mittelstand firms to imitate the HC strategy, their owners and managers can learn from it to become sustainably profitable. Furthermore, Chapter 4 has implications for Mittelstand firms and start-ups seeking funding. It supports the findings of Mrkajic et al. (2019) that start-ups with a business model or product that addresses climate issues attract increased attention from VCs, as this fits to portfolio differentiation and impact investing. Mittelstand firms with a moderate climate performance can still receive PE funding and improve it as part

of the PE active ownership strategy. Additional implications follow from Chapter 5. As internal stakeholders are more important for substantive decarbonization, firm leaders should consider systematically engaging employees to generate ideas for substantive decarbonization. Research shows that firms with stakeholder integration capabilities tend to develop environmental strategies (Delgado-Ceballos et al. 2012). Accordingly, firms with deeper employee engagement are likely to advance their decarbonization strategies faster than others.

Policymakers. At the regional level, Chapter 2 highlights the social and economic importance of HCs for the districts in which they are located as well as for neighboring districts. Besides, the regional ties of HCs can also strengthen the soft factors of regional development such as a region's culture and image. Similarly, these firms can benefit from actively shaping their business environment (Lang et al. 2019). Consequently, regional policymakers should consider the importance of HCs and discourage them from moving to other locations. Policymakers in the PE and VC market are addressed in Chapter 4. The market is subject to major uncertainties regarding sustainability, i.e., due to inconsistent measures and reporting standards, and therefore requires more effective interventions. On the one hand, regulatory initiatives should establish frameworks that also apply to start-ups and Mittelstand firms, and on the other hand, public institutions must play a leading role in setting standards and establishing best market practices. As VC and PE investors differ in their motives for considering the climate in their investments, policymakers should treat them accordingly. In course of the transitions towards a CO_2-neutral economy discussed in Chapter 5, regulatory frameworks like the EU-Taxonomy currently apply only to larger firms but the regulatory landscape is rapidly adapting. In this turn, policymakers seeking to encourage firms to decarbonize could improve the conditions for substantive rather than symbolic decarbonization, for example by restricting CO_2-certificate trading and incentivizing substantive behavior.

Educational sector. Further practical implications arise for the educational sector. Chapter 2 shows that successful and innovative firms are also located in smaller cities or peripheral areas (e.g., Fritsch & Wyrwich 2021). These firms can offer attractive jobs. For future employees, the dual tertiary education model is relevant, as it allows students to combine an academic education with practical training in technologically leading firms (Schenkenhofer & Wilhelm 2020). Apart from large cities, rural regions also offer attractive training and employment opportunities that future students and trainees should be informed about. Furthermore, Chapter 5 implies the importance for firms to educate current and future employees, managers, and owners on sustainability strategies such as decarbonization. With advances in online education,

certificate programs in sustainability might be particularly useful for current employees as they can be pursued alongside full-time work commitments. A parallel implication for educators is to integrate decarbonization strategies and other sustainability related insights into their current curricula for management graduates.

6.3 Limitations and Avenues for Future Research

This dissertation is not without limitations. First, the chapters examine the three dimensions of sustainability separately, i.e., none of the included studies addresses all three dimensions. Following the three-dimensional approach (Purvis et al. 2019), social sustainability is covered in Chapter 2, economic sustainability is part of Chapters 2 and 3, and environmental sustainability is covered in Chapters 4 and 5. Consequently, the findings apply only to certain sustainability dimensions and never to sustainability as a whole. However, it is important to understand each dimension before considering sustainability holistically. Future research can learn from the insights on the individual dimensions to analyze the sustainability concept and the interplay between the three dimensions. Additional limitations arise from the data. The samples included in Chapters 2, 3, and 5 are subject to several constraints, as all firms are located in Germany and meet certain size criteria. Moreover, Chapters 3 and 5 focus on firms operating in manufacturing industries. Accordingly, the results may not be generalized to the Mittelstand sector as a whole. In order to increase the explanatory power of the results, the research designs need to be extended to firms that exceed the size criteria, are located in other countries, and operate in other industries. Chapters 4 and 5 are based on survey data and might therefore be subject to specific limitations, in particular common method bias, as the referent dependent and independent variables are derived from the same data source. Future expansions of reporting requirements for CO_2-emissions and other environmental sustainability information for Mittelstand firms will provide new data sources that can complement survey data and reduce related biases.

Moreover, Chapters 2 and 3, which examine the HC phenomenon, entail several limitations. The HC phenomenon was first addressed in popular sciences by Simon (1990, 1996) and does not have a theoretical foundation. Therefore, phenomenon-based research is needed to generate scientific knowledge and research practices to systematically examine the various aspects of the phenomenon (von Krogh et al. 2012). Although phenomenon-based research aims to develop theoretical foundation, HC research is still at the point where new facets of the phenomenon are discovered, diverse research designs and existing theoretical lenses are applied

to improve understanding. Therefore, the lacking theoretical foundation of the two studies on HCs might be considered as a limitation of this dissertation. However, exploring new facets of the HC phenomenon has implications for practice and forms the foundation for future theory building on HCs. Another limitation of HC research is the applicability of the three criteria defined by Simon (1996). Since the criterion of low public awareness is difficult to measure and subjective, we do not include it in our studies and deviate from the HC definition. This limitation has already been highlighted by Schenkenhofer (2022), who sees the development of a measure for this criterion as a central approach for future HC research.

Further limitations arise from Chapter 4, in which we examine the motives and strategies of VC and PE firms to integrate climate considerations into their investment decisions. However, the study does not address those investors who do not yet perform climate-considered investments. Future research could build on comparable work (e.g., Amel-Zadeh & Serafeim 2018) to examine the reasons why PE and VC investors do not incorporate climate considerations into their investment decisions. Understanding these barriers could help policymakers set the right incentives to encourage PEs and VCs to shift towards climate-considered investments.

Lastly, there are additional limitations to Chapter 5. Examining family ownership as a moderator in the relationship between stakeholder pressures and decarbonization strategies does not cover the heterogeneity of family firms. Additional layers worth analyzing include the family generation or the culture and values of the family firm (e.g., Astrachan et al. 2020; Block 2010; Le Breton-Miller & Miller 2016). Besides, other avenues for future research emerge. We find that German Mittelstand firms pursue decarbonization strategies before they are legally required to do so, when they perceive stakeholder pressures related to environmental degradation concerns. It will be interesting for future research to investigate whether there is a difference between the early and late movers and if so, what causes such differences. In addition to stakeholder pressures, there might be other factors driving the decarbonization activities of Mittelstand firms. For example, regulations, as they encourage climate action by setting referential policy guidelines (Okereke & Russel 2010; Schmitz et al. 2019; Yunus et al. 2020). Learning more about regulations as a driver of decarbonization in Mittelstand firms will be particularly relevant in the coming years, as regulatory frameworks such as the EU-Taxonomy will be extended to smaller firms. Dynamic capabilities (Teece et al. 1997) are also crucial for sustainability (Buzzao & Rizzi 2021). So far, little is known about dynamic capabilities in the context of decarbonization strategies (cf. Lopes de Sousa Jabbour et al. 2020). Future research could explore how dynamic capabilities drive decarbonization and which capabilities are most

important. Other potential decarbonization drivers include reputational aspects (e.g., Martín-de Castro et al. 2020), chief executive officer characteristics (e.g., Adomako et al. 2021), and market conditions (e.g., Denicolai et al. 2021).

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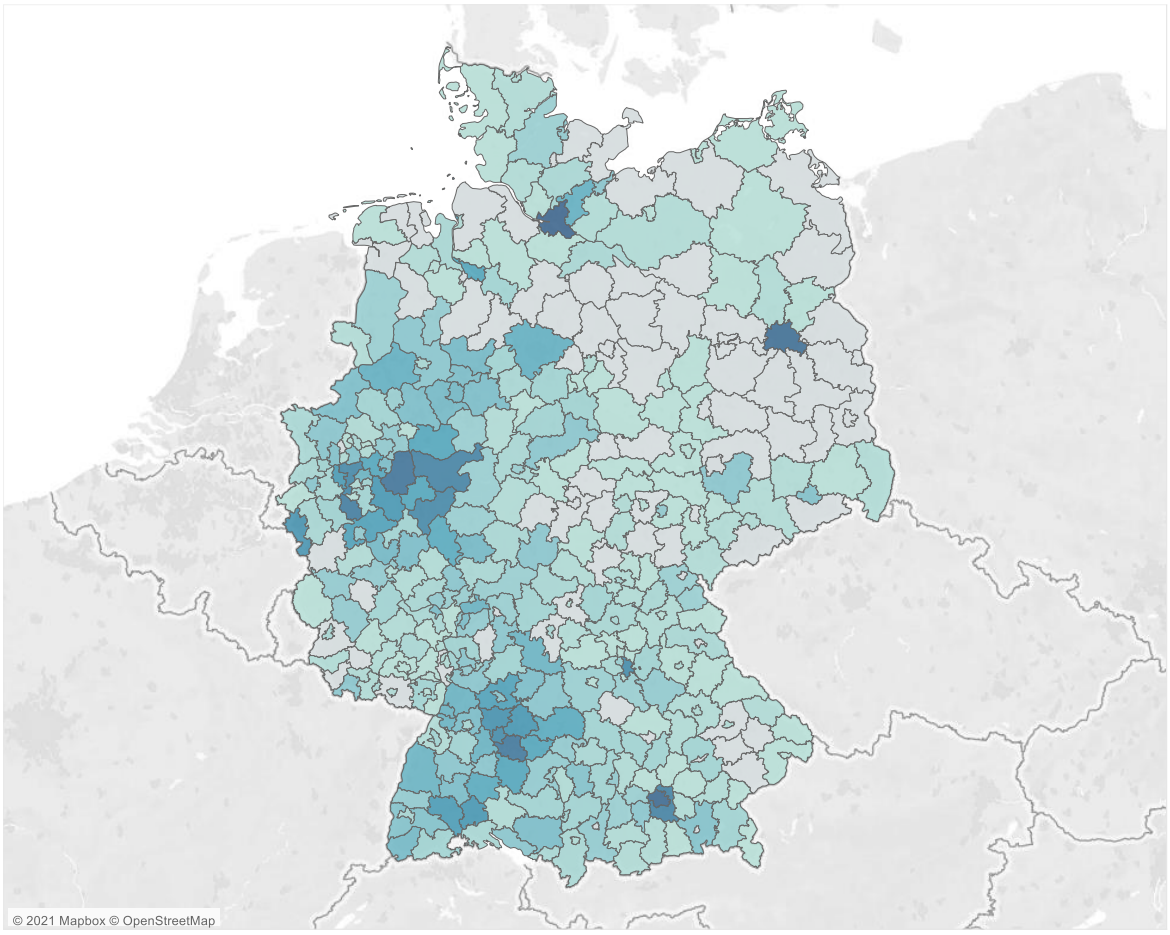
Appendix

Figure A2.1 Regional distribution of HCs in Germany



Explanation: Distribution of the absolute number of HCs per district; darker colors represent an increasing number of HCs; grey colored districts possess zero HCs.
Source: Own illustration, created via Tableau.

Figure A5.1 Extract from the survey questionnaire

Firms can take a variety of approaches to achieve their CO_2 emission targets. How important are the following approaches in your firm?

	Unimportant (1)	Rather unimportant (2)	Neutral (3)	Rather important (4)	Very important (5)
Internal CO_2-reduction (e.g., reduction of process emissions or use of internally generated green electricity)	○	○	○	○	○
External CO_2-reduction (reduction of value chain emissions)	○	○	○	○	○
CO_2-compensation (e.g., purchase of CO_2-certificates)	○	○	○	○	○

Please indicate how much pressure the following stakeholders exert on your firm with regard to reducing CO_2-emissions.

	No pressure (1)	Very low pressure (2)	Low pressure (3)	High pressure (4)	Very high pressure (5)
Employees	○	○	○	○	○
Top management	○	○	○	○	○
Middle management	○	○	○	○	○
Owners/shareholders	○	○	○	○	○
Trade unions/works council	○	○	○	○	○
Distributers/suppliers	○	○	○	○	○
Trade	○	○	○	○	○
End consumer	○	○	○	○	○
Consumer associations	○	○	○	○	○
Competitors	○	○	○	○	○
Banks/financial institutions	○	○	○	○	○
Insurance companies	○	○	○	○	○
Legislators	○	○	○	○	○
Ecology associations	○	○	○	○	○
Press/media	○	○	○	○	○
The local population	○	○	○	○	○

Figure A5.1 (continued)

How do you rate the profitability of your firm compared to your competitors?

Please rate on a scale from 1, Much worse, to 5, Much better. You can use the values in between to grade.

	1	2	3	4	5	
Much worse	○	○	○	○	○	Much better

What are your firm's growth ambitions for the next five years?

Please rate on a scale from 1, Low growth ambitions, to 5, High growth ambitions. You can use the values in between to grade.
On request: Declining sales/low sales growth can result, for example, from the sale of parts of the company or a declining market volume. High sales growth can result, for example, from expansion of the company in terms of new locations or product groups.

	1	2	3	4	5	
Low growth ambitions	○	○	○	○	○	High growth ambitions

By which year does your firm plan to be CO_2-neutral in terms of its own CO_2-emissions?

Please refer in your answer to those CO_2 emissions that are caused directly in the company (e.g., from combustion in own furnaces) as well as to those emissions that are caused indirectly in the generation of purchased energy (i.e., electricity, steam, heating and cooling).

- ○ We are already CO_2-neutral
- ○ Till 2025 or earlier
- ○ Between 2026 and 2030
- ○ Between 2031 and 2035
- ○ Between 2036 and 2040
- ○ Between 2041 and 2045
- ○ Between 2046 and 2050
- ○ After 2050
- ○ We have not yet set a specific target year

Table A2.1 Description of variables for chapter 2

Variable name	Definition	Data Source	Category
GDP per capita	In € per district in 2016	INKAR	Dependent
Median income	Monthly salaries of full-time employees subject to social insurance contributions in € per district in 2017	INKAR	Dependent
Unemployment rate	Share of unemployed in the civilian labor force in % per district in 2017	INKAR	Dependent
Business tax revenues	Business tax revenues in € per inhabitant per district in 2017	INKAR	Dependent
Trainees per 1,000 employed	Number of trainees per 1,000 employees subject to social insurance contributions per district in 2017	INKAR	Dependent
R&D intensity	Total corporate internal R&D expenditures in tsd € per 100,000 inhabitants per district in 2015	Donors' Association for Science Statistics	Dependent
Patent intensity	Number of granted patents per 100,000 inhabitants per district between 2011 and 2015	EPO	Dependent
Export intensity	Export turnover in tsd € per 100,000 inhabitants per district in 2017	Regional Database of the Statistical Offices of the Federal Republic of Germany and the Federal States	Dependent
HC intensity	Number of HCs per 100,000 inhabitants per district in 2020	Own research	Independent
Population density	Number of inhabitants per km² per county 2017	INKAR	Control
Population average age	In years per district in 2017	INKAR	Control
Firm intensity	Number of firms per 100,000 inhabitants per district in 2017	Regional Database of the Statistical Offices of the Federal Republic of Germany and the Federal States	Control
University intensity	Number of public and private universities per 100,000 inhabitants per district in 2018	Communal Education Database of the Statistical Offices of the Federal Republic of Germany and the Federal States	Control
C-DAX intensity	Number of firms listed in the C-DAX per 100,000 inhabitants per district in 2020	Deutsche Börse AG	Control
New business formation intensity	Number of newly established businesses per 100,000 inhabitants per district in 2017	INKAR	Control

Table A3.1 Description of variables for chapter 3

Variable name	Definition	Category
ROA (%)	Percentage ratio based on EBT divided by total assets of the firm.	Dependent
ROE (%)	Percentage ratio based on EBT divided by shareholder funds.	Dependent
HC (dummy)	Equals one if the firm is a market leader, zero if not. Data source: Own research.	Independent
Firm age (log.)	Number of years since the founding of the firm (logarithmized).	Control
Employees (log.)	Number of employees of the firm (logarithmized).	Control
Patents per employee	Number of patents granted per employee of the firm calculated based on the firm's number of granted publications 2020 and average number of employees between 2011 and 2020.	Control
Patents (dummy)	Equals zero if patent data is available, otherwise one. If patent data is not available, we perform a missing value imputation by replacing missings with zero (for multivariate analyses only).	Control
Export intensity (%)	Percentage ratio based on export revenue divided by operating revenue of the firm.	Control
Export (dummy)	Equals one if export intensity data is available, otherwise zero. If export intensity data is not available, we perform a missing value imputation by replacing missings with zero (for multivariate analyses only).	Control
Liquidity ratio	Ratio of the current assets minus stocks to current liabilities of the firm.	Control
Debt-to-equity ratio (%)	Percentage ratio based on debt divided by equity of the firm.	Control
Blockholder (dummy)	Equals one if the firm has a recorded shareholder with a direct ownership of over 50 percent (Bureau van Dijk independence indicator D), otherwise zero. Classification is based on the Bureau van Dijk independence indicator which characterizes the degree of independence of a firm with regard to its shareholders. If the Bureau van Dijk independence indicator is not available, we perform a missing value imputation by replacing missings with zero.	Control
Stock market listing (dummy)	Equals one if the firm is listed on the stock market, otherwise zero. Classification based on the firm's IPO date and delisting date (if available).	Control
Industry diversification (dummy)	Equals one if the firm is active in more than one industry, otherwise zero. Classification based on the firm's NACE primary code and NACE secondary code (if available).	Control
ROA volatility (%)	Standard deviation of the firm's ROA between 2011 and 2020 calculated based on the firm's ROA between 2011 and 2020.	Control
NACE (dummies)	Equals one if the firm operates within the respective industry (NACE primary code 10 to 33), otherwise zero.	Control
Federal state (dummies)	Equals one if the firm is located in the respective German federal state (*Bundesland*), otherwise zero.	Control
Year (dummies)	Equals one for the respective year (2011 to 2020), otherwise zero.	Control

Table A3.2 Clustered OLS regressions for the main sample with industry dummies

Dependent variables	**ROA (%)**	**ROE (%)**
Independent variable		
HC (dummy)	1.73*** (0.45)	2.56 (2.41)
Control variables		
Firm age (log.)	0.71*** (0.17)	4.33*** (0.99)
Employees (log.)	-0.46*** (0.18)	-1.08 (1.02)
Patents per employee	-0.33* (0.17)	-0.39 (1.25)
Patents (dummy)	0.67* (0.36)	6.60*** (2.19)
Export intensity (%)	0.01 (0.01)	0.09 (0.06)
Export (dummy)	1.34*** (0.46)	5.51* (2.89)
Liquidity ratio	0.21*** (0.03)	-0.24*** (0.09)
Debt-to-equity ratio (%)	-0.01*** (0.00)	0.04*** (0.01)
Stock market listing (dummy)	-6.50*** (0.95)	-19.03*** (3.16)
Blockholder (dummy)	-0.57 (0.36)	0.38 (1.76)
Industry diversification (dummy)	0.02 (0.29)	1.59 (1.69)
ROA volatility (%)	0.03 (0.04)	0.21 (0.24)
NACE 11(dummy)	0.31 (1.07)	-4.90 (4.36)
NACE 12(dummy)	6.87 (5.07)	57.43 (38.80)
NACE 13(dummy)	-0.82 (1.03)	-0.09 (7.75)
NACE 14(dummy)	-0.58 (1.68)	7.31 (12.28)
NACE 15(dummy)	0.66 (1.44)	-4.10 (5.07)
NACE 16(dummy)	-1.26 (1.12)	-7.87 (4.84)
NACE 17(dummy)	-0.45 (1.06)	-0.02 (6.82)
NACE 18(dummy)	0.06 (1.49)	0.28 (7.77)
NACE 19(dummy)	-1.03 (1.54)	-7.10 (5.20)
NACE 20(dummy)	2.16*** (0.68)	8.90** (4.21)
NACE 21(dummy)	0.63 (1.10)	4.88 (5.02)
NACE 22(dummy)	2.36*** (0.75)	4.46 (3.92)
NACE 23(dummy)	-0.03 (0.98)	-2.12 (4.57)
NACE 24(dummy)	-1.26* (0.73)	-6.15 (3.99)
NACE 25(dummy)	0.77 (0.60)	6.26* (3.74)
NACE 26(dummy)	2.78*** (0.75)	9.14** (3.96)
NACE 27(dummy)	2.12*** (0.79)	8.24* (4.69)
NACE 28(dummy)	1.31** (0.59)	3.18 (3.23)
NACE 29(dummy)	0.46 (0.91)	-4.67 (6.11)
NACE 30(dummy)	0.00 (1.55)	0.56 (8.96)
NACE 31(dummy)	0.91 (1.24)	4.01 (7.47)
NACE 32(dummy)	2.08** (1.04)	13.05 (8.06)
NACE 33(dummy)	1.35 (1.26)	2.97 (7.48)
Constant	9.80*** (1.48)	7.21 (8.52)
Observations	28,584	28,584
R-squared	0.07	0.02

Explanation: Results of separate clustered OLS regressions of ROA and ROE on HC and further firm characteristics. All regressions include dummy variables for each year of the sample period and German federal state. The sample comprises 28,584 firm-year observations from 4,677 firms. The model shows coefficients with robust standard errors in parentheses. Asterisks denote statistical significance at the 0.01(***), 0.05(**), and 0.10(*)-level.

Table A3.3 Overview of the main sample and subsamples

Sample	Criteria	All Firms	HCs	Non-HCs	HCs in Sample (%)
Main sample	50 to 2,999 employees	28,584 (4,677)	3,958 (617)	24,626 (4,060)	13.85 (13.19)
Subsample 1	50 to 499 employees	23,052 (3,781)	2,242 (353)	20,810 (3,428)	9.73 (9.34)
Subsample 2	500 to 2,999 employees	5,532 (896)	1,716 (264)	3,816 (632)	31.02 (29.46)
Subsample 3	50 to 2,999 employees and at least ten years old	27,498 (4,370)	3,840 (588)	23,658 (3,782)	13.96 (13.46)
Subsample 4	Revenue threshold of 3 billion Euros	24,817 (4,630)	3,773 (616)	21,044 (4,014)	15.20 (13.30)

Explanation: Overview of all samples analyzed in this study. The table refers to firm-year observations and shows the corresponding firms in parentheses. Criteria were applied for the year 2018 regarding employees and for 2020 regarding age.

Table A3.4 Clustered OLS regressions for subsample 1

Dependent variables	**ROA (%)**	**ROE (%)**
Independent variable		
HC (dummy)	2.33***	5.78*
	(0.60)	(3.34)
Control variables		
Firm age (log.)	0.68***	4.85***
	(0.20)	(1.21)
Employees (log.)	-0.55**	-1.95
	(0.27)	(1.61)
Patents per employee	-0.29	-0.38
	(0.19)	(1.38)
Patents (dummy)	0.73*	6.46***
	(0.39)	(2.34)
Export intensity (%)	0.01	0.12*
	(0.01)	(0.07)
Export (dummy)	1.07**	5.37*
	(0.53)	(3.14)
Liquidity ratio	0.24***	-0.23**
	(0.03)	(0.09)
Debt-to-equity ratio (%)	-0.01***	0.04***
	(0.00)	(0.01)
Stock market listing (dummy)	-9.93***	-26.48***
	(1.62)	(4.79)
Blockholder (dummy)	-0.63	0.43
	(0.43)	(1.98)
Industry diversification (dummy)	0.13	2.87
	(0.33)	(1.90)
ROA volatility (%)	0.02	0.18
	(0.05)	(0.26)
Constant	10.64***	9.64
	(1.90)	(10.79)
Observations	23,052	23,052
R-squared	0.08	0.02

Explanation: Results of separate clustered OLS regressions of ROA and ROE on HC and further firm characteristics. All regressions include dummy variables for each year of the sample period, for German federal states and for two-digit NACE codes. The sample comprises 23,052 firm-year observations from 3,781 firms. The model shows coefficients with robust standard errors in parentheses. Asterisks denote statistical significance at the 0.01(***), 0.05(**), and 0.10(*)-level.

Table A3.5 Clustered OLS regressions for subsample 2

Dependent variables	**ROA (%)**	**ROE (%)**
Independent variable		
HC (dummy)	0.67	-1.78
	(0.63)	(3.24)
Control variables		
Firm age (log.)	0.91***	2.71*
	(0.28)	(1.53)
Employees (log.)	-0.56	-0.91
	(0.46)	(2.55)
Patents per employee	-0.34	0.09
	(0.39)	(2.38)
Patents (dummy)	0.77	11.15*
	(0.91)	(6.50)
Export intensity (%)	0.02	0.01
	(0.02)	(0.12)
Export (dummy)	2.17**	4.70
	(0.90)	(6.72)
Liquidity ratio	0.09*	-0.17
	(0.05)	(0.26)
Debt-to-equity ratio (%)	-0.01***	0.04**
	(0.00)	(0.02)
Stock market listing (dummy)	-3.74***	-13.92***
	(1.05)	(4.76)
Blockholder (dummy)	-0.76	-0.78
	(0.57)	(3.67)
Industry diversification (dummy)	-0.56	-3.45
	(0.57)	(3.67)
ROA volatility (%)	0.12	0.44
	(0.10)	(0.60)
Constant	9.31***	12.01
	(3.40)	(21.72)
Observations	5,532	5,532
R-squared	0.11	0.07

Explanation: Results of separate clustered OLS regressions of ROA and ROE on HC and further firm characteristics. All regressions include dummy variables for each year of the sample period, for German federal states and for two-digit NACE codes. The sample comprises 5,532 firm-year observations from 896 firms. The model shows coefficients with robust standard errors in parentheses. Asterisks denote statistical significance at the 0.01(***), 0.05(**), and 0.10(*)-level.

Table A3.6 Clustered OLS regressions for subsample 3

Dependent variables	**ROA (%)**	**ROE (%)**
Independent variable		
HC (dummy)	1.80***	2.68
	(0.46)	(2.46)
Control variables		
Firm age (log.)	0.31	3.55***
	(0.19)	(1.08)
Employees (log.)	-0.44**	-1.08
	(0.18)	(1.04)
Patents per employee	-0.25	0.61
	(0.16)	(0.87)
Patents (dummy)	0.68*	6.47***
	(0.37)	(2.20)
Export intensity (%)	0.01	0.09
	(0.01)	(0.06)
Export (dummy)	1.46***	6.53**
	(0.48)	(2.97)
Liquidity ratio	0.22***	-0.24***
	(0.03)	(0.09)
Debt-to-equity ratio (%)	-0.01***	0.05***
	(0.00)	(0.01)
Stock market listing (dummy)	-6.50***	-19.46***
	(0.96)	(3.18)
Blockholder (dummy)	-0.68*	0.09
	(0.36)	(1.78)
Industry diversification (dummy)	0.07	1.40
	(0.30)	(1.72)
ROA volatility (%)	0.05	0.24
	(0.04)	(0.25)
Constant	10.95***	8.21
	(1.54)	(8.84)
Observations	27,498	27,498
R-squared	0.07	0.03

Explanation: Results of separate clustered OLS regressions of ROA and ROE on HC and further firm characteristics. All regressions include dummy variables for each year of the sample period, for German federal states and for two-digit NACE codes. The sample comprises 27,498 firm-year observations from 4,370 firms. The model shows coefficients with robust standard errors in parentheses. Asterisks denote statistical significance at the 0.01(***), 0.05(**), and 0.10(*)-level.

Table A3.7 Seemingly unrelated regression for our main sample

Dependent variables	**ROA (%)**	**ROE (%)**
Independent variable		
HC (dummy)	1.73***	2.56*
	(0.23)	(1.38)
Control variables		
Firm age (log.)	0.71***	4.33***
	(0.09)	(0.53)
Employees (log.)	-0.46***	-1.08*
	(0.09)	(0.55)
Patents per employee	-0.33***	-0.39
	(0.09)	(0.56)
Patents (dummy)	0.67***	6.60***
	(0.18)	(1.07)
Export intensity (%)	0.01**	0.09***
	(0.00)	(0.03)
Export (dummy)	1.34***	5.51***
	(0.26)	(1.60)
Liquidity ratio	0.21***	-0.24***
	(0.02)	(0.09)
Debt-to-equity ratio (%)	-0.01***	0.04***
	(0.00)	(0.00)
Stock market listing (dummy)	-6.50***	-19.03***
	(0.44)	(2.69)
Blockholder (dummy)	-0.57***	0.38
	(0.18)	(1.11)
Industry diversification (dummy)	0.02	1.59*
	(0.15)	(0.88)
ROA volatility (%)	0.03**	0.21**
	(0.01)	(0.08)
Constant	9.80***	7.21
	(0.79)	(4.81)
Observations	28,584	28,584
R-squared	0.07	0.02
Chi-square	2,253.81	700.94
Breusch-Pagan test of independence (Chi-square)	12,749.54***	

Explanation: Results of the seemingly unrelated regression of ROA and ROE on HC and further firm characteristics. Regression includes dummy variables for each year of the sample period, for German federal states and for two-digit NACE codes. The sample comprises 28,584 firm-year observations from 4,677 firms. The model shows coefficients with robust standard errors in parentheses. Asterisks denote statistical significance at the 0.01(***), 0.05(**), and 0.10(*)-level.

Table A3.8 Clustered OLS regression for ROS

Variables	**ROS (%)**
HC (dummy)	1.03***
	(0.35)
Firm age (log.)	0.48***
	(0.14)
Employees (log.)	-0.06
	(0.15)
Patents per employee	0.81**
	(0.34)
Patents (dummy)	0.14
	(0.30)
Export intensity (%)	0.02***
	(0.01)
Export (dummy)	1.20***
	(0.32)
Liquidity ratio	0.24***
	(0.03)
Debt-to-equity ratio (%)	-0.01***
	(0.00)
Stock market listing (dummy)	-3.38***
	(0.86)
Blockholder (dummy)	-0.17
	(0.25)
Industry diversification (dummy)	0.20
	(0.23)
ROA volatility (%)	-0.06*
	(0.03)
Constant	3.31***
	(1.12)
Observations	24,778
R-squared	0.08

Explanation: Results of clustered OLS regression of ROS on HC and further firm characteristics. Regression includes dummy variables for each year of the sample period, for German federal states and for two-digit NACE codes. The sample comprises 24,778 firm-year observations from 4,630 firms. The model shows coefficients with robust standard errors in parentheses. Asterisks denote statistical significance at the 0.01(***), 0.05(**), and 0.10(*)-level.

Table A3.9 Clustered OLS regressions for our main sample using winsorized data

Winsorization level	**ROA (%)**	**ROE (%)**
1%	1.65***	3.37*
	(0.42)	(2.02)
5%	1.36***	2.69**
	(0.34)	(1.16)

Explanation: Results of the clustered OLS regressions for our main sample analyzing the relationship between the independent variable HC and the winsorized dependent variables ROA and ROE. The sample comprises 28,584 firm-year observations from 4,677 firms. The model shows coefficients with robust standard errors in parentheses. Asterisks denote statistical significance at the 0.01(***), 0.05(**), and 0.10(*)-level.

Table A4.1 Description of variables for chapter 4

Variable name	Definition
External stakeholder motive	Row means of the four motives for climate considerations in investments, namely: growing demand from LPs/stakeholders, reputation benefits, regulation, and relevant initiatives; ranging from 0 if respondents select none of the four motives to 1 if they select all four motives.
Product differentiation motive	Row means of the two motives for climate considerations in investments, namely: as part of investment product/strategy, and for innovation and portfolio differentiation; ranging from 0 if respondents select none of the two motives to 1 if they select both motives.
Portfolio performance considerations	Row means of the two motives for climate considerations in investments, namely: the importance for investment performance, and for risk management; ranging from 0 if respondents select none of the two motives to 1 if they select both motives.
Ethical responsibility	Takes the value of 1 if ethical responsibility is stated as a motive for investing into climate, 0 otherwise.
Climate consideration strategies	Takes the value of 1 if the respondent pursues a particular climate strategy, 0 otherwise.
PE/VC investor	Takes the value of 1 if the respondent is employed in a PE firm and 0 if employed in a VC firm.
Total assets (in million €)	Ranked total assets under management on a six-item scale, from less than 50 million € to more than 1 billion €.
Firm age (years)	Number of years since the firm has been established.
Female partner percentage	Percentage of partners that are female out of all partners in the firm.
EU-only investments	Takes the value of 1 if the firm only invests in the EU, 0 otherwise.
Years of incorporating climate considerations (five or more)	Takes the value of 1 if the firm incorporates climate considerations in investments for five years or more, 0 otherwise.
Respondent gender (male)	Takes the value of 1 if the respondent is male, 0 if female.
Respondent age	Ranked age of the respondent, from 18 – 24 years to more than 65 years.
Respondent experience (years)	Respondent's total years of experience as a fund manager.
First-time team	Takes the value of 1 if the most recent fund raised has also been the team's first-ever fund raised, 0 otherwise.
Investment industries	Group of dichotomous variables taking the value of 1 if the respondent's firm invests into a particular industry, 0 otherwise.

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