Managing the digitalization of companies internationally:
The role of culture, tensions and business models

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When research for this dissertation began in 2020 at the height of the COVID-19 lockdowns, many suspected that the increasing digitalization efforts of companies and the trend towards de-globalization were only short-term phenomena in the context of the pandemic. Five years later, it is now clear that digital transformation with the growing potential of AI is one of the top priorities for companies, while de-globalization and the associated supply chain disruptions due to wars and protectionist policies are still dominating the global economic news.

I would therefore like to thank various parties for allowing me to shed light on these current topics as part of my doctorate at the Faculty of Engineering at the University of Duisburg-Essen. This dissertation would not have been possible without their support.

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Duisburg, August 2025 Christian Festing

Summary

Digitalization and related technologies are creating numerous opportunities and changes that companies must embrace in order to remain competitive. In this context, the successful digital transformation in companies from manufacturing industries requires suitable strategies to benefit from investments in digitalization. However, many companies have not yet succeeded in doing so, partly because they are approaching digitalization too narrowly. For internationally operating companies in particular, it is important to reconcile digitalization with a multinational environment. This dissertation therefore explores relevant contextual factors, mechanisms and outcomes of digitalization from a management perspective, going beyond operational approaches. To this end, three studies were conducted, which form the core of the dissertation.

First, Study 1 clarifies what holistic management of digitalization towards high digital maturity involves, identifying various components within digital activity, digital business, and operational and dynamic capabilities. In this context, the study examines the role of national culture as a contextual factor for digital maturity along Hofstede's six cultural dimensions. National culture was placed at the center of this analysis, as it shapes the decisions and behavior of employees and has hardly been addressed in the literature on digitalization. The results from a survey with 603 manufacturing companies show that high collectivism, uncertainty avoidance, long-term orientation and restraint support digital maturity, which implies that national culture has a significant influence on digitalization in companies apart from the dimensions of power distance and masculinity. On this basis, companies are recommended to heed national culture as a determinant of digitalization in their global strategies.

Study 2 deals with further contextual factors in the global environment of companies. It looks at how, among other things, geopolitical changes towards protectionism, the pressure to become more sustainable and the emergence of new growth markets lead to paradoxical tensions for companies' international operations. As a strategy for dealing with this, mechanisms of digital platforms and the resulting opportunities for increased international cooperation in ecosystems are explored and examined in a study of 286 internationally active automotive companies. The results from structural equation modeling confirm the suitability of platforms to mediate tensions across countries but also show potential for optimization in the context of unexploited platform effects such as data-based learning using artificial intelligence (AI).

Accordingly, Study 3 focuses specifically on the digital technology of AI. It shows, based on theory, how AI can overcome previous limitations in terms of learning, but also in terms of companies' scale and scope. On this basis, it further explores how AI can improve the business models of companies. A survey of 250 internationally active automotive companies confirms, among other things, some of the potential. However, it also reveals that the companies' business models have not yet benefited sufficiently from learning by means of AI, justifying the need for future research at this point.

Thus, the dissertation provides important insights into contextual factors on a global level, mechanisms, especially along digital business models and platform-based ecosystems, as well as desired outcomes of digitalization in companies. In particular, the management of internationally operating manufacturing companies can be given guidelines that allow them to sharpen their digital, global strategies on this basis, while new fields of action related to digitalization can be derived for research.

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List of abbreviations

AI	artificial intelligence
AVE	average variance extracted
BRIC	Brazil, Russia, India, China
CA	Cronbach's alpha
CASE	connected, autonomous, shared, electric
CEO	Chief Executive Officer
CR	composite reliability
cf.	confer (compare)
e.g.	exempli gratia (for example)
et al.	et alii (and others)
ERP	enterprise resource planning
FDI	foreign direct investment
GLOBE	global leadership and organizational behavior effectiveness
GoF	goodness-of-fit
H	hypothesis
IB	International Business
ICT	information and communication technology
IDV	individualism
IoT	Internet of Things
IT	information technology
IVR	indulgence vs. restraint
LLM	large language model
MAS	masculinity
MIST	Mexico, Indonesia, South Korea, Turkey
MNE	multinational enterprise
NFI	Normed Fit Index
OEM	original equipment manufacturer
OLS	ordinary least squares
OLI	ownership, location, internalization
PDI	power distance
PLS	partial least squares
PLS-SEM	partial least squares structural equation modeling
RQ	research question
SCM	supply chain management
SEM	structural equation modeling
SRMR	standardized root mean square residual
UAI	uncertainty avoidance
VIF	variance inflation factor
VRIN	valuable, rare, inimitable, non-substitutable

Chapter A: Introduction

1. Motivation

Digitalization is one of the most far-reaching phenomena in recent human history, having a huge impact on the everyday lives of most people, societies and companies (Barker et al., 2024). Digitalization is defined as "the increased generation, analysis and use of data" (Björkdahl & Holmén, 2019). The term is to be clearly distinguished from digitization, which describes the conversion of analogue into digital information and processes and thus provides a basis for digitalization (Gradillis & Thomas, 2025). However, digitalization is also associated with the rising integration of digital technologies in companies' activities and offerings (Björkdahl, 2020; Miller & Wang, 2024). These technologies have significantly changed how companies work and how they deliver their products and services to customers (Ancillai et al., 2023; Volberda et al., 2021), as can already be observed in numerous data-driven business models (Dabestani et al., 2025).

As a result, the market dynamics of many industries have sharply increased, while industry boundaries have blurred (Benner & Waldfogel, 2023; Knobbe & Proff, 2020). For example, three out of four trends in the automotive industry, known by the acronym "CASE" (connected, autonomous, shared and electric), are enabled by digitalization and describe the establishment of connectivity, autonomous driving and shared mobility using digital technologies alongside the transition to electromobility (Adner & Liebermann, 2021; Llopis-Albert et al., 2021). Differentiation in this industry is therefore now taking place via software, digital extensions and data-driven business models in and around cars and no longer just via the mechanical properties of the vehicles (Reischauer et al., 2024; Sterk et al., 2024). This is forcing traditional players in this industry to adapt and allowing IT companies (e.g., Baidu, Google) as well as new OEMs (e.g., BYD, Tesla) to capture substantial market shares (Hossain, 2024; MacDuffie, 2018).

The automotive industry serves at this point as just one of many examples illustrating the extensive impacts of digitalization. Digital technologies such as artificial intelligence (AI), Big Data analytics, augmented and virtual reality, blockchain, cloud technologies, the Internet of Things (IoT) and digital platforms open up potentials for companies across all industries (Ahi et al., 2022; Ciulli & Kolk, 2023), which can be a source of new competitive advantages (Kemp, 2024; Meier et al., 2025) and raised firm performance (Ribeiro-Navarrete et al., 2021; Tsou & Chen, 2023). Many potentials are associated with enhanced efficiency, innovation, growth and handling of crises (Chen et al., 2025; Lanzolla et al., 2020; Verhoef et al., 2021).

Accordingly, companies search for strategies to deal successfully with the various changes and opportunities that these technologies entail (Menz et al., 2021; Faraj & Leonardi, 2022), while digitalization has also become a subject of growing importance in the management literature (Calderon-Monge & Ribeiro-Soriano, 2024; Hanelt et al., 2021; Plekhanov et al., 2023). Research on managing digitalization is particularly relevant in the field of international business (Birkinshaw, 2022; Luo, 2022), as digital technologies are capable of bridging large distances (Autio et al., 2021) and simplifying transactions (Nagle et al., 2025). Digitalization therefore plays an important role in companies' internationalization strategies and the management of multinational enterprises (MNEs) (Bhandari et al., 2023; Drori et al., 2024), which usually steer numerous locations and subsidiaries globally with different cultural backgrounds (George & Schillebeeckx, 2022; Proff, 2018).

Forecasts predict that investments in the digital technology of generative AI will increase by 60% between 2024 and 2027 (BCG, 2025). Unfortunately, companies often struggle to fully exploit the potential offered by digitalization (Kallmuenzer et al., 2025). Despite large investments, the hoped-for competitive advantages from digital technologies fail to materialize or fall short of expectations for many companies (BCG, 2025; Kohtamäki et al., 2020). This phenomenon is referred to in the literature as the digitalization paradox (Ancillai et al., 2023; Gebauer et al., 2020), demonstrating that a successful digital transformation requires more than the mere integration of technologies (Cao et al., 2025; Vial, 2019). Rather, it must also be accompanied by an adaptation of strategies, business models, the organization and the resource base of a company in line with changes in the environment to achieve the desired success (Helfat et al., 2023; Konopik et al., 2022; Leso et al., 2024). This is because the digital "transformation is shaped by organizational and societal contexts" (Bodrožić & Adler, 2022). In addition to technological change, such contextual factors have also been strongly marked by climate change and geopolitical shifts in recent years (George & Schillebeeckx, 2022; Teece, 2025). These are reshaping the conditions for global supply and value chains and the offering of products and services outside of domestic markets, creating sometimes contradictory circumstances for companies (Heucher et al., 2024). Digital technologies, however, can be a way of dealing with these conditions and gaining an edge over competitors (Lanzolla, 2020).

Accordingly, suitable digital strategies must be found that are also aligned with companies' global strategies (Meyer et al. 2023). To this end, contextual factors that shape digitalization in companies must be taken into account and mechanisms of digital technologies must be used appropriately in order to ultimately optimize the output for companies (Hanelt et al., 2021).

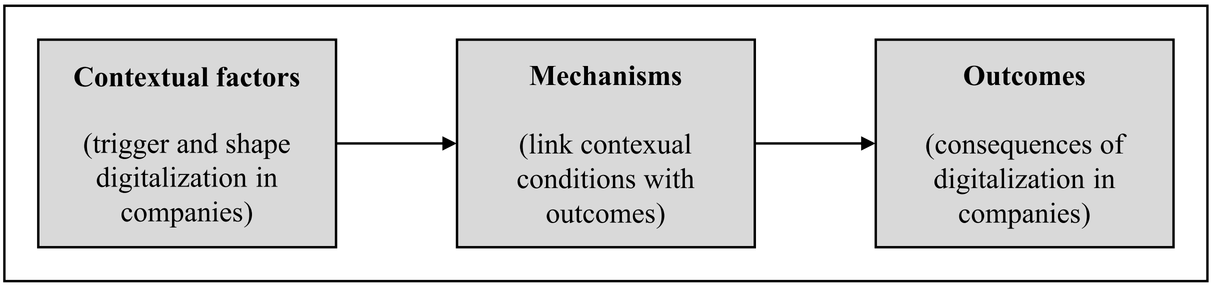

Figure A-1: Framework of digitalization in companies
(based on Hanelt et al., 2021)

This dissertation therefore contributes to further clarifying the current understanding of these contextual factors, mechanisms and outputs of digitalization (Figure A-1), thus providing an enriched framework for the management of digitalization in companies internationally. In the next section, this overarching research objective is specified through a concretization of problem statements and associated research questions.

2. Problem statement and research questions

The potential of digitalization is encouraging companies to drive forward their digital transformation (Barker et al., 2024; Verhoef et al., 2021). The progress of such a transformation is reflected in the degree of digital maturity in a company (Fleury et al., 2024; Kane et al., 2017), which encompasses several components in the overarching spheres of digital activity, digital business, operational and dynamic capabilities (Sommer & Proff, 2023). A strong digital maturity thus expresses that various mechanisms of digitalization in a company are exploited to a high degree. Indeed, digital maturity depends on a variety of facilitating and hindering contextual factors (Hanelt et al., 2021). Research has therefore increasingly sought to identify these drivers and barriers of digitalization (Yang et al., 2024), with culture repeatedly highlighted as a decisive determinant (Pedersen, 2022). Unfortunately, culture has so far been reduced almost exclusively to organizational culture in this regard (Butt et al., 2024; Cao et al., 2025; Plekhanov et al., 2023).

In international management, however, national culture also plays an important role as a further layer of culture (Chen & Lin, 2021; Leung et al., 2005) but has so far been insufficiently examined in terms of its influence on the digital maturity of companies. Accordingly, since national culture largely shapes the decisions and actions of employees (Vaara et al., 2021), understanding its role as a possible contextual factor from an international perspective is essential for the successful management of digitalization in companies with a globally distributed, diverse workforce (Reuber et al., 2021). This leads to the first research question (RQ) of this dissertation:

RQ 1: Which impact does national culture have on the digital maturity of companies?

As already illustrated, it is not only digitalization that is leading to changes in the environment, which companies must manage from an international perspective and take into account as part of their transformations. In recent years, "new realities for international business" have emerged (Ghauri et al., 2021). In particular, current geopolitical changes (Teece, 2025), reflected in terms like "de-coupling" (Witt et al., 2023), "de-globalization" (Petricevic & Teece, 2019; Witt, 2019) and "de-internationalization" (Kafouros et al., 2022; Pillich, 2025; Tang et al., 2021), are shifting the requirements for companies' international business as well as global supply and value chains (Kano et al., 2020). These changes have been triggered by the increasing focus on climate protection, by growing economic nationalism and protectionism resulting from Trump's policies or Brexit, for example, and by recent crises such as the COVID-19 pandemic or the war in Ukraine (Meyer & Li, 2022; Prud'homme et al., 2025; Zahoor et al., 2023). At the same time, by contrast, new growth markets are emerging for companies that are often far away from their home countries and motivate these companies to invest further in international activities (Ghauri et al., 2021), although the discussions on de-internationalization are pushing them to reduce their international footprints (Békés et al., 2021).

In their upcoming global strategies, companies must therefore deal with these contradictory contextual factors and the associated tensions by exploiting the potential of digitalization (Autio et al., 2021; Benito et al., 2022). In this context, the use of digital platforms is discussed in the literature in order to link the necessary stakeholders across national borders in a resource-saving, asset-light way (Cha, 2020; Furr et al., 2022). This has also fueled research on ecosystems as new interorganizational value architectures based on digital platforms in recent years (Jacobides et al., 2024). However, there is still a lack of studies on the extent to which mechanisms of digital platforms and related ecosystems can act as mediators to mitigate these tensions and ultimately increase the success of companies. This justifies the second research question of this dissertation:

RQ 2: Can digital platforms mitigate tensions in international operations and improve success?

Moreover, companies must ensure that they are able to meet the expectations of stakeholders in a highly dynamic environment. This is a challenge for companies, especially given the heterogeneous needs and requirements of globally distributed consumers, sub-industries and country markets (Mittal et al., 2021; Stallkamp et al., 2022). Companies therefore need to further evolve their business models and interact more closely with these stakeholders in order to offer suitable value propositions and optimize value creation and delivery as well as value capture (Snihur & Markman, 2023).

There is extensive literature on the potential of digital technologies in terms of improving business models (Ancillai et al., 2023; Caputo et al., 2021; Rachinger et al., 2019). AI technologies such as machine learning are described as particularly promising in this regard as they allow companies to overcome certain constraints (Huang & Rust, 2024; Iansiti & Lakhani, 2020; Kemp, 2024). However, there is a lack of necessary work to gain an understanding of the extent to which AI can be used to enhance business models (Hillebrand et al., 2025; Jorzik et al., 2024), including across borders. This question is particularly important to answer for the business models of internationally active and asset-intensive companies that do not only offer digital products (Buck et al., 2023). Thus, the last research question arises, which will be addressed in this dissertation:

RQ 3: What potential does AI provide for business models in asset-intensive, internationally operating companies?

The research questions are therefore not limited solely to digital technologies themselves but also move along the contextual factors, mechanisms and outputs relevant to them in companies, as outlined in Table A-1.

Table A-1: Overview of the research questions related to digitalization

	Contextual factors	**Mechanisms**	**Outcomes**
RQ 1	National culture	Digital activities Digital business Operational capabilities Dynamic capabilities	Digital maturity
RQ 2	“New realities for international business”	Digital platforms and ecosystems (as mediators of tensions)	Success
RQ 3		AI Digital business models • Value creation and delivery • Value proposition	Value capture

3. Structure of the dissertation

To address the research questions, this dissertation is built along a coherent structure. After the introduction in Chapter A, the necessary theoretical framework is explained in Chapter B, in particular by presenting the explanatory approaches and the economics of digitalization. Chapter C then continues with an overview of the methodology applied.

The individual research questions of this dissertation are specifically examined in three studies in sections D to F. These studies are presented in the context of three articles published in management journals or under review, as shown below. Each of the three articles contains a separate introduction, theoretical basis, methodology, results, implications and conclusion on the specific objectives addressed.

Chapter D: Study 1:

Festing, C., & Proff, H. (2025). Assessing the impact of national culture on digital maturity. *Digital Business, 5*(2), 100121.

Chapter E: Study 2:

Festing, C., & Proff, H. (2024). Mediating the paradoxes of (de-) internationalization through digital platforms. *International Journal of Business Science & Applied Management, 19*(2), 35–56.

Chapter F: Study 3:

Festing, C., & Proff, H. (2025). Uncovering the potential of artificial intelligence for business models. *Technology Analysis & Strategic Management*, under review for publication.

Chapter G summarizes the results of the three studies and draws implications for both research and management from the combined findings. Finally, this chapter closes the dissertation with the formulation of limitations and an outlook for the overarching research area of managing digitalization in an international context. Figure A-2 provides an overview of the course of the dissertation.

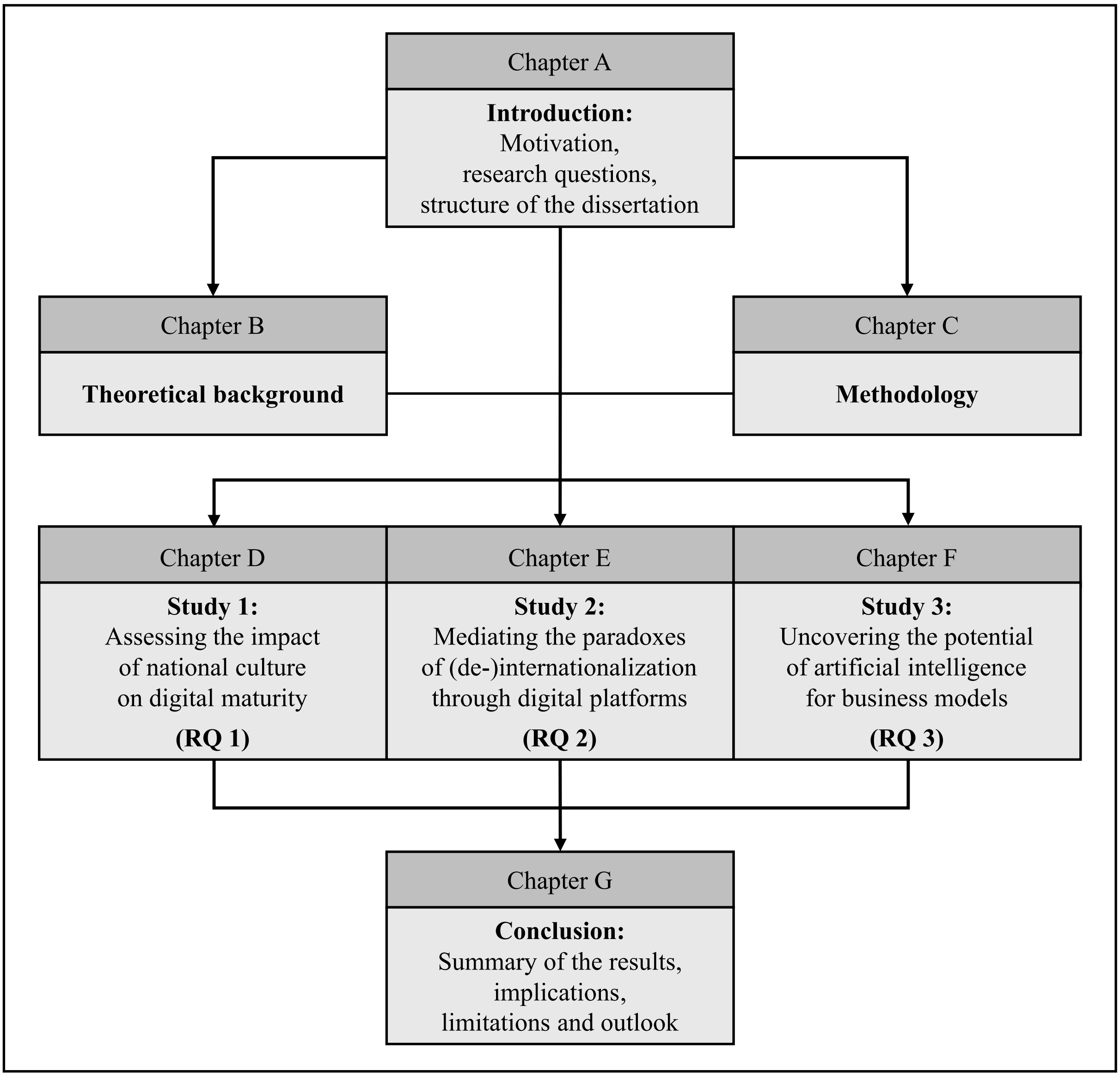

Figure A-2: Structure of the dissertation

(Own compilation)

Chapter B: Theoretical background

A theoretical foundation of digitalization is crucial to understanding how companies can benefit from emerging potentials and operate successfully in the digital age (Menz et al., 2021). While effects of specific digital technologies need to be differentiated, economics of digitalization provide overarching explanations. These economics also offer necessary explanations of how mechanisms of digitalization link contextual factors and outcomes of digitalization (Hanelt et al., 2021), as summarized in Table B-1.

Table B-1: Theoretical approaches to supplement the digitalization framework

<table>
<tr><th></th><th>Contextual factors</th><th>Mechanisms of digitalization</th><th>Explanations of these mechanisms</th><th>Outcomes</th></tr>
<tr><td rowspan="4">Study 1 (RQ 1)</td><td rowspan="4">National culture</td><td>Digital activities</td><td>Reduced coordination costs and transaction costs</td><td rowspan="4">Digital maturity</td></tr>
<tr><td>Digital business</td><td>Improved interaction (partly in business models and ecosystems)</td></tr>
<tr><td>Operational capabilities</td><td>VRIN resources that ensure competitiveness in the digital age</td></tr>
<tr><td>Dynamic capabilities</td><td>Adaptation of the resource base to dynamics in the digital age</td></tr>
<tr><td>Study 2 (RQ 2)</td><td>“New realities in international business” (geopolitical changes, de-globalization, new growth markets)</td><td>Digital platforms and digital ecosystems as mediators of tensions</td><td>Cooperation (value co-creation) in digital ecosystems across national borders to mitigate tensions</td><td>Success</td></tr>
<tr><td>Study 3 (RQ 3)</td><td></td><td>AI
Digital business models
• Value creation and delivery
• Value proposition</td><td>AI overcomes limitations in terms of
• Scale
• Scope
• Learning</td><td>Value capture</td></tr>
</table>

Companies are fundamentally systems that involve interdependent decisions, usually including internal and external interdependencies with stakeholders such as suppliers and customers as well as with various locations and subsidiaries in value chains (Porter, 1985; Tomkins et al., 2001). These are traditionally associated with expenses for communication and coordination of various activities and thus *transaction costs* (Williamson, 1981). These transaction costs rise with increasing distance and uncertainty (Cuypers et al., 2021). In this context, a distinction is made between geographical, cultural and psychic distance (Ojala, 2015). While geographical distance involves, among other things, more effort for travel, transportation and logistics, high cultural and psychic distance cause communication problems, behavioral uncertainty and markets to be perceived as foreign (Child et al., 2009; Hutzschenreuter et al., 2016). This is why, according to the Uppsala model (Johanson & Vahlne, 1977), companies first choose markets with low psychic and cultural distance for their activities and then stepwise increase the distance of their international operations.

However, digitalization makes it possible to overcome distance, limiting not only the negative effects of geographical distance but also the increase in transaction costs due to the psychic and cultural distance (Bergamaschi et al., 2021; Meyer et al., 2023). This is because digitalization enables a standardization of related interfaces as well as seamless integration and communication between stakeholders (Barker et al., 2024), thus automating activities and reducing interdependencies along the value chain. This is coupled with economics such as easier coordination, more transparent access to information and a decrease in search costs, including across national borders, which results in a drastic lowering of internal and external transaction costs (Birkinshaw, 2022; Drori et al., 2024; Nagle et al., 2025). This is an economic incentive for the digitalization of internal and external processes along the value chains in terms of companies' digital activities (Study 1). Different digital technologies contribute to these effects of digitalization in different ways. Blockchain technologies, for example, increase the transparency of transactions and increase the trust of the parties involved (Schmidt & Wagner, 2019), thereby reducing principal-agent problems and explaining economic benefits through agency theory (Eisenhardt, 1989). Cloud technologies, on the other hand, simplify storage and access to data and documents and thus lower the coordination effort of joint work (Ahi et al., 2022). By reducing coordination costs, digitalization also increases the orchestration possibilities of MNEs (Autio et al., 2021).

In particular, the diverse economic potentials of artificial intelligence (AI) can make a far-reaching contribution to automation and reducing transaction costs (Keding, 2021; Kemp, 2024; Loureiro et al., 2021). This is because they enable companies to overcome previous limits in terms of scale, scope and learning (Iansiti & Lakhani, 2020; Verganti et al., 2020). AI makes it possible to recognize patterns and learn from data, which enables the evaluation of strategic decisions (Doshi et al., 2025; Hillebrand et al., 2025) or customized individual solutions (Gama & Magistretti, 2025), among other things. More specifically, AI makes it easier for companies to scale and to broaden their scope (Iansiti & Lakhani, 2020; Verganti et al., 2020), by performing recurring activities, identifying new suppliers and customers, improving trade negotiations, predicting currency trends, analyzing heterogeneous requirements and thus reducing the effort needed to enter foreign markets and industries (Menzies et al., 2024;

Messner, 2022; Ratten et al., 2024). In this context, a distinction is made between augmentation, which refers to the complementation of human capabilities by AI and creates iterative cycles of human-machine learning, and automation, which refers to the substitution of humans by AI in specific tasks and enables short-term cost efficiencies (Krakowski et al., 2023; Raisch & Krakowski, 2021). While business has traditionally been hampered due to human limitations in information processing and the emergence of diseconomies of scale and scope when exceeding a certain level of size and complexity (Sakhartov, 2017), AI can succeed in overcoming these limits as described (Verganti et al., 2020), creating the basis for more unrestricted economies of scale, scope and learning in companies (Macher & Boerner, 2006). For this reason, AI is sometimes even linked to zero-marginal costs (Iansiti & Lakhani, 2020).

The simplification of transactions through digitalization leads to more *interaction*. In this context, interaction based on digital technologies can be a new source for creating value and thus new business models (Ancillai et al., 2023), which companies manage as part of their digital business (Study 1). For example, the emotional intelligence of large language models (LLMs) assigned to AI technologies even enables emotionally charged interactions with customers (Huang & Rust, 2024). The potential for business models based on the presented AI mechanisms is explored in more detail in Study 3. However, the increased interaction in the context of digitalization is also driven by platforms. Such digital platforms can be understood as interfaces or technological infrastructures for facilitating interactions (Jacobides et al., 2024). The economic advantages of digital platforms are mainly based on seven platform effects (Hagiu & Rothman, 2016), namely network effects, modularization, complementarity, value co-creation with customers, limiting the capability drain, pricing mechanisms and data-based learning, which are examined more closely in Study 2. In the literature, a distinction is made between innovation platforms and transaction platforms as well as hybrid platforms, which combine the two previous forms (Cusumano et al., 2019; Gawer, 2021; Gawer & Bonina, 2024; Jacobides et al., 2024). On the one hand, innovation platforms serve "as a venue for innovation" (Nambisan et al., 2019). On the other hand, transaction platforms act as multi-sided marketplaces for the exchange of goods, assets and activities (Cennamo, 2021; Rietveld & Schilling, 2021; Rochet & Tirole, 2003). Transaction platforms are particularly relevant for this dissertation, as they also connect actors globally and can make goods and assets available across national borders (Nambisan et al., 2019). The term "platformization" of the global value chain is therefore gaining ground (Kano et al., 2020).

In this context, a paradigm shift in international corporate strategies towards ecosystems is increasingly being considered (Cha, 2020), with ecosystems being enabled by digital platforms (Kapoor et al., 2021). So, while digital platforms provide the technological surface for interactions, ecosystems are interorganizational value architectures based on collaborative partnerships (Jacobides et al., 2024). According to Adner (2017), such structural ecosystems are characterized by an alignment structure, a multilateral group of partners, interaction and a focal value proposition that is to be created. Especially in internationally active companies, platform-based ecosystems enable a transformation of value creation with global partners through a resource combination in foreign markets (Nambisan & Luo, 2021). Accordingly, joint value creation can take place in ecosystems with these partners, which can be explained via biform games from game theory (Brandenburger & Stuart, 1996; 2007). Hence, there can be cooperative and non-cooperative phases within the ecosystems that allow joint activities while retaining the autonomy of the partners. However, this theoretical framework of ecosystems needs to be differentiated (Gans & Ryall, 2017; Ross, 2018) to include a service-dominant logic (Vargo & Lusch, 2004; 2008), which takes into account value co-creation with customers, and additionally the resource-based view (Peteraf, 1993; Helfat et al., 2023; Wernerfelt, 1984), which considers the importance of the critical “VRIN” (valuable, rare, inimitable, non-substitutable) resources (Barney, 1991). As the resource-based view mainly places companies’ own resources at the core of its reasoning, economic explanations of ecosystems are finally supplemented by the relational view, according to which competitive advantages arise through relationships and resource combinations between companies (Dyer & Singh, 1998; Dyer et al., 2018). Consequently, the theoretical framework of ecosystems must consider value creation partnerships in which the partners create additional value through superior complementarity (Jacobides et al., 2018). In this way, competitive advantages can be realized across national borders through “foreign partners’ asset bundling” (Nambisan & Luo, 2021). Ecosystems based on digital transaction platforms therefore allow companies and individuals to “interact in ways not otherwise possible with the potential for nonlinear increase in utility and value” (Cusumano et al., 2019). Study 2 explores in more detail how this can help to mitigate paradoxical tensions stemming from contextual factors related to companies’ international operations.

Due in part to these new opportunities for facilitated interaction and transactions, digitalization leads to discontinuous change and an increase in *market dynamics* (Cozzolino & Rothaermel, 2018; Knobbe & Proff, 2020). In this context, it enables companies from emerging economies to grow faster and catch up (Meyer et al., 2023). Alongside many disruptive innovations, among other things, this is altering the competition at an ever-faster pace. As a result, the highly dynamic environment caused by digitalization and societal contexts requires companies to undergo a wide range of adjustments (Bodrožić & Adler, 2022; Leso et al., 2024).

This is also accompanied by a need to adapt a company's own resource base (Konopik et al., 2022), as shown in Study 1. In line with the resource-based view (Peteraf, 1993; Wernerfelt, 1984), this includes the operational capabilities in the company, which are often also understood as ordinary or zero order capabilities (Collis, 1994; Winter, 2003). They form the basis for companies' day-to-day business and are a key source of competitive advantage in refined form as core competencies (Prahalad & Hamel, 1990). However, these can lose their value over time and must be realigned both at an individual and organizational level as part of digitalization (Helfat et al., 2023; Konopik et al., 2022). In strategic management, an explanation for handling high environmental dynamics and the loss of value of resources emerged at the end of the 1990s with the dynamic capabilities approach (Eisenhardt & Martin, 2000; Teece et al., 1997). According to this approach, companies need dynamic capabilities, which are reflected in microfoundations in terms of sensing, seizing and reconfiguring (Teece, 2007), to be able to adapt to changes and exploit the opportunities offered by digitalization (Ellström et al., 2022; Warner & Wäger, 2019). Dynamic capabilities are therefore understood as first order capabilities and can extend, modify or create operational capabilities over time, with additional second or higher order dynamic capabilities being able to adapt the companies' dynamic capabilities themselves (Collis, 1994; Winter, 2003). In this way, it can be ensured that a company's resource base remains valuable over time in the digital age (Ambrosini et al., 2009; Schilke et al., 2018).

Figure B-1 provides an overview of the theoretical explanations described, while sound methodological approaches for answering the research questions related to digitalization are discussed in the next chapter.

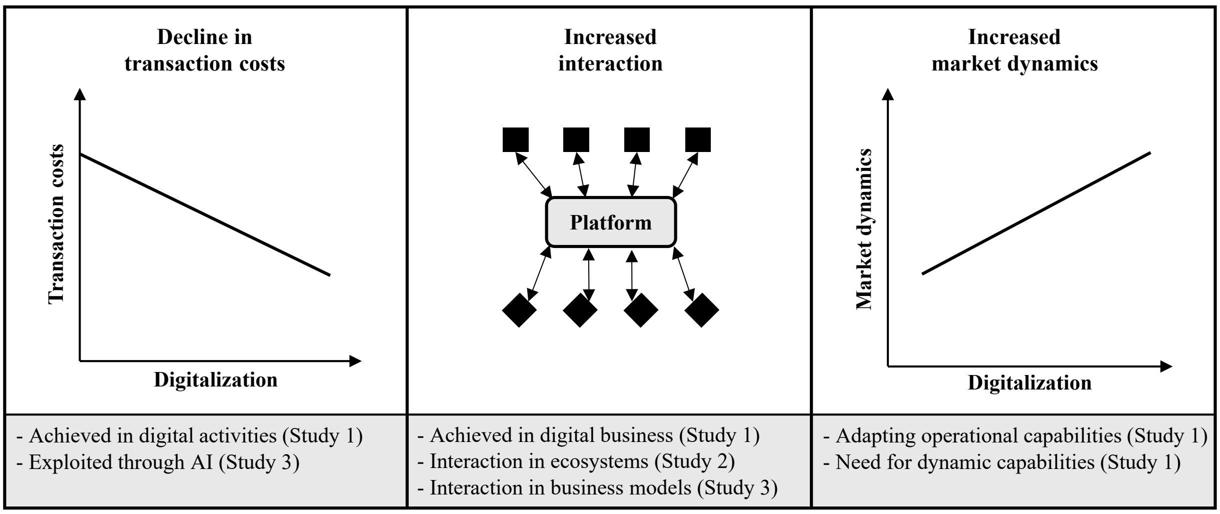

Figure B-1: Theoretical explanations of digitalization
(Own compilation)

Chapter C: Methodology

In all three studies, relevant relationships between contextual factors, mechanism and outcomes of digitalization were derived from the literature and converted into hypotheses to pursue the research questions (Scandura & Williams, 2000). The hypothesized relationships thus involved variables of both endogenous and exogenous nature as well as mediators and moderators. Quantitative approaches were chosen in all three studies to measure the effects between these different variables. Although they are less able to clarify questions of "how", quantitative approaches have the advantage over qualitative approaches that they allow larger samples to be analyzed and generally ensure greater objectivity (Barnham, 2015; Luoma & Hietanen, 2024). In addition, quantitative approaches enable hypotheses to be tested by means of statistical evaluations (Bettis et al., 2014).

To this end, the relevant variables first had to be operationalized. This is necessary in order to be able to derive them from a real survey and apply them to a research model (Becker et al., 2012). Operationalization must be carried out in such a way that even complex variables can be captured by a survey and measured in a reasonable way. For this purpose, appropriate scales from the literature were selected or, if necessary, own scales for assessing variables were developed. A 7-point Likert scale was chosen as an appropriate gradation in all three surveys (Dolnicar & Grün, 2013). Instead of representing a clear standpoint, Likert scales allow respondents to indicate a certain level of agreement (Heo et al., 2022), such as "(strongly) disagree" to "(strongly) agree". The choice of the 7-point scale was made due to the fact that it has a neutral middle point (e.g., as a "neither agree nor disagree" option) and at the same time offers enough gradations without becoming too complex (de Rezende & de Medeiros, 2022).

The operationalized variables were captured with the help of online questionnaires in companies. The three surveys were conducted exclusively in manufacturing industries. For the study on the role of national culture for digital maturity (Study 1), various sub-sectors of the manufacturing industry, such as the chemical industry, automotive industry or other mechanical engineering industries, were taken into account in order to exclude the effects of industry culture. The other two studies focused exclusively on the automotive industry, as it is emblematic of an asset- and capital-intensive sector dominated by global supply chains (Buck et al., 2023; Teece et al., 2016). In both studies, OEMs and suppliers were surveyed to map the value chain on a broader basis. Avoiding a cross-industry approach also had the advantage of preventing distorting effects occurring between different sectors. Table C-1 provides an overview of the surveys conducted and methods used in this dissertation.

Table C-1: Overview of the methodology used in the dissertation

Survey	Study 1 (Chapter D)	Study 2 (Chapter E)	Study 3 (Chapter F)
Survey year	2023	2022	2024
Type	Online questionnaire	Online questionnaire	Online questionnaire
Content	Digital maturity	International operations, platforms effects and economic success	AI and business model elements
Items	41 items + control variables	19 items + control variables	39 items + control variables
Scale	7-point Likert scale	7-point Likert scale	7-point Likert scale
Industry	Manufacturing industry	Automotive industry	Automotive industry
Sample size	603 companies	286 companies	250 companies
Analysis methods	Index + multiple regression analysis (OLS estimation)	PLS-SEM (formative)	PLS-SEM (reflective)

Different statistical methods were applied to obtain reliable statements on the relationships and correlations between the variables from the data gained in the surveys. In Study 1 (Chapter D), the first approach chosen was to use several sub-indices to form an index allowing a digital maturity degree to be mapped for a company (Montero Guerra et al., 2023; Sommer & Proff, 2023). Multiple regression analysis was then used to test the hypotheses between digital maturity and national culture. Multiple regressions allow the examination of the influence of several independent variables on a dependent variable. The ordinary least squares (OLS) estimation is the most common method of regression techniques and is reliable if an endogeneity problem in terms of reverse causality can be ruled out (Bascle, 2008; Hill et al., 2021). As this could be excluded due to the stability of national culture, the OLS method was used accordingly to determine the strength of the regression in Study 1. Moreover, control variables were integrated into the OLS estimations for increased validity of the results.

In Study 2 (Chapter E) and Study 3 (Chapter F), complex interrelationships between variables were suspected, for which structural equation modeling (SEM) was used (Hair et al., 2024). SEM offers both covariance- and variance-based methods (Cepeda-Carrion et al., 2019; Dash & Paul, 2021), with the latter in the form of partial least squares (PLS-SEM) methodology having established itself in management research (Henseler et al., 2015). PLS-SEM supplements the regression analysis with parallel factor analyses (Haenlein & Kaplan, 2004), enabling a calculation of extensive models involving latent variables even with smaller sample sizes (Vaithilingam et al., 2024). This is why this approach was applied to the problems presented. Latent variables are variables that cannot be assessed directly. They are therefore referred to as constructs in structural models and measured using manifest variables as observable indicators (Diamantopoulos et al., 2008).

Accordingly, PLS-SEM distinguishes between an inner model, which is described by the direct and partially moderating relationships between the latent constructs and labeled by path coefficients, and outer models, which form the measurement models (Rönkkö & Evermann, 2013). The way in which constructs and indicators relate to each other can be either reflective or formative in nature, leading to a further differentiation between reflective and formative measurement models (Chin et al., 2008; Cook & Forzani, 2023). Within the course of this dissertation, the research model in Study 2 was formatively specified and the model in Study 3 was reflectively specified. In reflective measurement models, indicators are basically interchangeable, share a superordinate subject area, have positive intercorrelations and are influenced by their constructs, whereas in formative measurement models, the indicators define the construct, do not necessarily have to be intercorrelated and cannot be easily removed from or added to the measurement model without significantly influencing the results (Coltman et al., 2008). Consequently, the direction of the relationship and therefore also that of its arrows in graphical representations is reversed between reflective and formative models, as shown in Figure C-1.

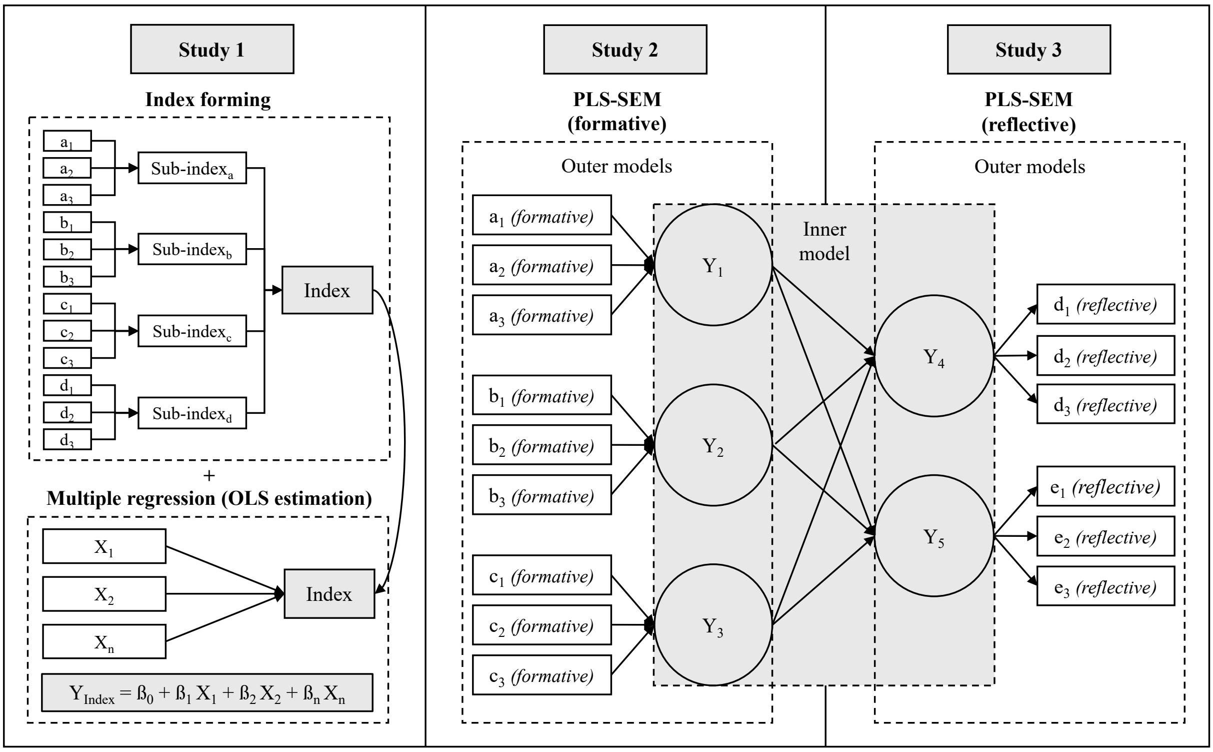

Figure C-1: Overview of the analysis methods

(Based on Hair et al., 2014)

Using a PLS-SEM algorithm, the inner and the outer model can be determined, for which the algorithm first makes iterative estimates of the values for the constructs (Hair et al., 2011). Moderation effects can also be computed within the inner model of structural equation modeling (Sarstedt & Liu, 2024), which was done in the case of Study 3. To test the significance of the estimated paths, a bootstrapping methodology can be applied. Bootstrapping refers to the "non-parametric resampling procedure that assesses the variability of a statistic by examining the variability of the sample data" (Streukens & Leroi-Werelds, 2016). In both studies, 5,000 bootstrap samples were used in accordance with Hair et al. (2011) to determine the required p-values. The algorithm and the bootstrapping were carried out in all cases using SmartPLS 4 software. By means of the path coefficients or regression coefficients obtained and the corresponding p-values, the hypotheses put forward could finally be accepted or rejected. Again, control variables were included to further increase the validity of the results. This ultimately allowed reliable conclusions to be drawn concerning the research questions on digitalization.

Chapter D: Assessing the impact of national culture on digital maturity

Study 1

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Abstract

Companies are progressing with their digital transformation. However, in order to successfully manage this transition to a high degree of digital maturity, they must not only adopt digital technologies but also use them to optimize their processes, products, services and business models and develop the necessary capabilities. As part of the search for drivers and antecedents, this article sheds light on the influence of national culture on firms' digital maturity. To this end, hypotheses on the effects along Hofstede's six cultural dimensions are derived from the literature and then tested in a quantitative study of 603 companies from the manufacturing industry applying multiple regression analysis. The results confirm that digital maturity is fostered by strong uncertainty avoidance and long-term orientation and hampered by strong individualism and indulgence. In contrast, no significant effects were found for power distance and masculinity. The study thus contributes to research by affirming the culture-bound nature of digital maturity and encouraging companies to incorporate conducive values of national culture into their global strategies for digital transformation.

Keywords: Digital transformation; digitalization; national culture; cultural dimensions; capabilities

1. Introduction

Digitalization and related digital technologies are advancing and opening up numerous opportunities that companies are trying to exploit as part of their digital transformation (Hanelt et al., 2021; Verhoef et al., 2021). To name just a few examples, digitalization can help to deal with change, optimize processes, reduce costs, create added value for customers and enter into new markets (Autio et al., 2021; Lanzolla et al., 2020; Meyer et al., 2023), enabling it to be a key contributor to firm performance from an economic point of view (Ribeiro-Navarrete et al., 2021). In addition, digital technologies allow for companies to increase their sustainability in terms of social and environmental aspects (George & Schillebeeckx, 2022; Ye et al., 2024).

The successful course of the digital transformation can therefore be crucial for securing competitive advantages (Adner et al., 2019; Porter & Heppelmann, 2014), although barriers need to be overcome (Volberda et al., 2021). For this reason, management research has been concerned with the search for influencing factors, antecedents and drivers of digital transformation, which have been identified in the form of internal factors such as firm size or the characteristics of top management teams as well as external factors such as legal and infrastructural conditions (Balakrishnan & Das, 2020; Yang et al., 2024). For example, large companies are, on average, more digitally mature than SMEs (Eller et al., 2020), while the latest crises, particularly the COVID-19 pandemic, have accelerated the digital transformation of companies in recent years (Barker et al., 2024; Bürgel et al., 2023).

Moreover, culture is repeatedly emphasized as an influencing factor in this regard (Butt et al., 2024), triggering a discussion about “cracking the culture code for successful digital transformation” (Pedersen, 2022). Unfortunately, previous research has mainly focused on organizational culture in relation to digital transformation (Hanelt et al., 2021; Kane et al., 2015; Plekhanov et al., 2023; Vial, 2019), although culture consists of several layers (Chen & Lin, 2021; Leung et al., 2005). However, national culture is another layer of culture that could play a decisive role in the digitalization process of companies. This is due to the fact that the course of firms' digital transformation depends on the openness to change, behavior and decision-making of their organizational members, which in turn are strongly shaped by a country's national culture (Geletkanycz, 1997; Srivastava et al., 2020; Vaara et al., 2021).

For this reason, the role of national culture should be examined more closely as a possible factor influencing the digital transformation of companies. While the impact of national culture on the adoption of information and communication technologies (ICT) (Erumban & de Jong, 2006) and innovation (Efrat, 2014; Tian et al., 2018), among other things, has already been extensively researched, there is hardly any literature to date that sheds light on the influence of national culture on a firm's digital transformation directly. Rubino et al. (2020) already examined the influence of national culture on digitalization in companies in Europe but only considered digitalization as the adoption of digital technologies in their study. However, digital transformation “encompasses changes in several spheres” (Cavalcanti et al., 2022) and therefore much more than the mere integration and adoption of a few technologies in companies. Thus, “technology itself is only part of the complex puzzle” (Vial, 2019) that companies need to put together as a response to digitalization in order to increase their digital maturity (Holopainen et al., 2022; Leso et al., 2024). Beyond just implementing digital technologies, the existing literature also deals with the leveraging of these technologies in order to design new digital offerings and business models (Ancillai et al., 2023; Kraus et al., 2021; Yoo et al., 2012) as well as obtaining required capabilities (Heubeck, 2023; Ostmeier & Strobel, 2022) as part of digital transformation. This article therefore contributes to closing the research gap identified and to understanding the role of national culture in the digital transformation towards comprehensive digital maturity in companies.

2. Theoretical background

2.1. Digital transformation and digital maturity

Digitalization is changing countless aspects of everyday life and thus has far-reaching significance for individuals, companies and entire societies (Barker et al., 2024). The term digitalization is widely used and describes “the increased generation, analysis, and use of data” (Björkdahl & Holmén, 2019). Although the internet is a key enabler of digitalization in the first place, the great potential of digitalization in recent years has been based in particular on advances in hardware and software technologies (Vadana et al., 2020). In companies, digital technologies such as blockchain, the Internet of Things, big data, cloud computing and artificial intelligence (AI) generate numerous possibilities (Yang et al., 2024). Accordingly, digitalization is changing firms' processes, products, services and business models discontinuously (Knobbe & Proff, 2020), reshaping global value chains (Ahi et al., 2022) and transforming entire industries (Benner & Waldfogel, 2023). These changes and various effects of digital technologies create a high degree of uncertainty as a result (Bodrožić & Adler, 2022; Kraus et al., 2021). In line with this, management research has also identified a “dark side” of digitalization with obstacles and disadvantages (Lanzolla et al., 2020; Verbeke & Hutzschenreuter, 2021). The exploitation of the potential of digitalization is hampered by barriers such as high investment costs (Gebauer et al., 2020; Hossnofsky & Junge, 2019), the emergence of tensions (George & Schillebeeckx, 2022; Smith & Lewis, 2011), obstacles to acceptance and user privacy (Calderon-Monge & Ribeiro-Soriano, 2024), the enormous complexity of digital technologies (Iansiti & Lakhani, 2017) and lacks of digital know-how (Grimpe et al., 2023).

Despite these barriers, companies are trying to push ahead with their digital transformation, which "describes a company-wide change" (Verhoef et al., 2021) in response to digitalization in order to exploit the emerging advantages. Digital transformation can therefore be understood as a maturation process (Leso et al., 2024). In this context, the term digital maturity is used to indicate how strongly a company has responded to digitalization to date and the extent to which necessary adjustments as part of the digital transformation have already taken place (Kane et al., 2017). The term is often used synonymously with digital readiness (Montero Guerra et al., 2023) or strategic readiness (Holopainen et al., 2022) and thus additionally emphasizes the securing of a preparedness for changes in the context of digitalization (Nasiri et al., 2022). Maturity basically describes a certain state in a process that strives to be completed or perfected, making digital maturity "the result of a continuous and ongoing process of adaptation to a changing digital landscape" (Mettler & Pinto, 2018).

In recent years, numerous models for assessing digital maturity have therefore emerged (Thordsen & Bick, 2023), differing greatly in their underlying components, as the exemplary overview in Table D-1 shows. Strategy features as a component in many models, which primarily refers to a strategy for dealing with changes due to digitalization. In particular, the models for manufacturing companies or Industry 4.0 models of the selection, such as that of Sjödin et al. (2018), strongly emphasize the technologies and associated processes and operations in production as essential components. Although culture is also frequently a representative component, it is again limited to the organizational culture in the models.

This article follows the understanding of digital maturity by Sommer and Proff (2023), as it takes both an operational and a strategic perspective and pays attention to necessary capabilities such as dynamic capabilities. Moreover, digital maturity according to this understanding covers most of the components of other maturity models, which can be summarized on four overarching spheres consisting of digital activities and digital business as well as operational capabilities and dynamic capabilities for digitalization (Table D-1).

Table D-1: Components of digital maturity models

Source	Model	Components			
		Digital activities	**Digital business**	**Operational capabilities**	**Dynamic capabilities**
Berghaus & Back (2016)	Digital maturity model	Information technology, process digitalization	Product innovation, customer experience, collaboration	Organization	Strategy, transformation management
Colli et al. (2019)	Industry 4.0 maturity model	Technology, connectivity	Value creation	Competences	Governance
De Carolis et al. (2017)	Digital readiness model for manufacturing companies	Technology, process, monitoring & control		Organization	
Devi et al. (2022)	Digital capability maturity model		Digital services creation	Individual capability, organizational capability	Alignment strategy
Fleury et al. (2024)	Digital maturity capability model	Digital technical capability, data management capability		People management capability, culture-crafting capability, organizational design capability	
Gökalp & Martinez (2022)	Digital transformation capability maturity model	Information & technology	Digital process transformation	Workforce management	Strategic governance
Holopainen et al. (2022)	Framework for managing digital operations	Supply chain	Customers	Organization & culture	Strategy, management
Hortovanyi et al. (2023)	Digital capability maturity model	Technology, operations	Customers	Organization & culture	Strategy
Pinto et al. (2023)	Digital maturity model	Technology, operations	Market	Culture	Strategy
Rafael et al. (2020)	Industry 4.0 maturity model for machine tool companies	Smart factory, smart operations, data driven	Smart products	Employees	Strategy
Schumacher et al. (2016)	Industry 4.0 maturity model	Technology, operations	Products, customers	People, culture, leadership	Strategy, governance
Sjödin et al. (2018)	Smart factory maturity model	Technology, process		People	
Sommer & Proff (2023)	Digital maturity model	Digital technologies, digital processes	Digital products & services, digital business models	Individual capabilities, organizational capabilities	Sensing, Seizing, Reconfiguring
Valdez-de-Leon (2016)	Digital maturity model for telecommunications service providers	Technology, operations	Innovation, customer, ecosystem	Organization	Strategy
Williams et al. (2019)	Digital maturity model	Technology, processes	Products & services	People & culture	Strategy, management

2.1.1. Maturity in digital activities

Companies can optimize structures, processes and activities using digital technologies (Valero-Gil et al., 2024). One goal here is growth, but for most companies, the focus so far has been on increasing efficiency along the value chain (Björkdahl, 2020; Yang et al., 2021). In this respect, the benefits of digitalization for companies can be explained primarily by transaction cost economics (Williamson, 1996). In the course of digital transformation, companies can improve processes in coordination within departments, between departments, with subsidiaries and with external stakeholders such as suppliers by optimizing data transfer, establishing standards, modularizing systems and enhancing communication even in global value chains (Ahi et al., 2022; Meyer et al., 2023). This reduces information asymmetries (Barker et al., 2024) and therefore advances the speed, transparency and efficiency of processes in and between companies (Calderon-Monge & Ribeiro-Soriano, 2024).

For instance, the digital technology of blockchain can raise trust between involved actors (Hanafizadeh & Alipour, 2024; Schmidt & Wagner, 2019), while AI enables automated decision-making (Raisch & Krakowski, 2021). In terms of Industry 4.0, factories can be completely modernized and their production efficiency can be increased by digitizing manufacturing procedures (Delke et al., 2023). With regard to internationalization processes, digitalization has the potential to bridge distances and barriers to entry (Cassetta et al., 2020; Verbeke & Hutzschenreuter, 2021). In general, digital technologies can lower the effort required for searching for information, monitoring activities and exchanging data (Autio et al., 2021; Loebbecke & Picot, 2015). The result of all these mechanisms is a sharp reduction in internal and external coordination costs and thus in transaction costs (Chen & Kamal, 2016; Iansiti & Lakhani, 2017).

2.1.2. Maturity in digital business

With regard to the customer, digitalization enables companies to modify their products, services and business models (Calderon-Monge & Ribeiro-Soriano, 2024; Kraus et al., 2021). This helps to create and appropriate more value for the firm and is necessary due to continuously varying customer needs (Verhoef et al., 2021). Digital technologies can “radically change the nature” of firms' offerings (Yoo et al., 2012) and enable disruptive customer solutions this way (Llopis-Albert et al., 2021). For example, physical products can be supported by intelligent functions and services through connection to the internet, thus enriching their benefits for the customer and creating an added value (Porter & Heppelmann, 2014). This is often observed in manufacturing companies under the term “digital servitization” (Shen et al., 2023). In this context, some industries are revealing a complete dematerialization of originally physical products, now being substituted by digital means (Miller & Wang, 2024).

Besides, a more pronounced relationship with customers is often sought (Matarazzo et al., 2021), in which customers become co-creators of value through increased interaction (Plekhanov et al., 2023). In terms of co-creation, companies can furthermore collaborate with other firms in ecosystems to establish an integrated value proposition in the market (Stonig et al., 2022). Thus, services based on collaboration with complementary partners in ecosystems (Adner, 2017; Jacobides et al., 2018) can meet the needs of customers and often of multiple stakeholders in a new way (Snihur et al., 2021). These ecosystems are usually enabled by digital platforms (Kapoor et al., 2021), which have the potential to achieve strong dominance in the market (Birkinshaw, 2022; Khanagha et al., 2022).

Digitally enabled forms of collaboration lead to new business models (Foss & Saebi, 2017; Snihur & Markman, 2023; Volberda et al., 2021). Business models consist of different components as part of value creation and delivery, value proposition and finally value capture (Clauss, 2017), which can be enhanced, extended or redesigned in terms of digitalization (Berman, 2012). Among other things, the possibilities of personalization and digitalizing the customer experience can be exploited (Ancillai et al., 2023; Lanzolla et al., 2020; Li, 2020). As part of the digital transformation, business models are thus incrementally expanded and adapted by potentials based on digitalization, while existing, inefficient ones are replaced by new business models (Loebbecke & Picot, 2015).

2.1.3. Maturity through digital operational capabilities

Operational capabilities, also referred to as ordinary capabilities, are crucial for firm performance, as they determine the basis for “how firms create economic rents” (Makadok, 2001). From a resource-based view (Helfat et al., 2023), new digital operational capabilities are therefore needed, including both organizational and individual capabilities in times of digitalization (Ritter & Pedersen, 2020). Accordingly, the development of those capabilities is seen as an antecedent for a successful digital transformation (Konopik et al., 2022; Piwowar-Sulej et al., 2024).

On the one hand, organizational capabilities in particular are based on the working atmosphere, the organizational structure as well as company-specific routines (Csaszar, 2012; Teece, 2012), which evolve over the course of time through complex interactions (Amit &

Schoemaker, 1993). To cope with the dynamics of digitalization, the need for organizational agility, by means of flat hierarchies and decentralized decision-making, is increasingly discussed in the literature (Teece et al., 2016; Verhoef et al., 2021; Walter, 2021). Moreover, cross-functional teams can support the development of a common digital understanding, coordination and the diffusion of information and digital knowledge between departments (Singh et al., 2020).

On the other hand, individual capabilities refer to the resources that can be provided by individual organizational members (Sommer & Proff, 2023). With regard to the exploitation of digital options, this particularly includes the know-how of employees and leadership competencies (Ostmeier & Strobel, 2022; Saarikko et al., 2020; Schiuma et al., 2024). Digital skills ranging from basic knowledge of ICT to advanced programming skills are essential at employee-level for a successful digital transformation in the company (Grimpe et al., 2023; Scuotto et al., 2021). In order to be able to use the growing amount of data in the company to its advantage, strong analytical expertise is also required within the company's workforce (Lanzolla et al., 2020). Training to improve the necessary digital capabilities of employees can therefore increase the performance of companies (Ribeiro-Navarrete et al., 2021). Conversely, digital technologies have the potential to support employees' capabilities and improve their operational performance (Schafheitle et al., 2020).

2.1.4. Maturity through dynamic capabilities

From a strategic perspective, companies need certain capabilities to adapt and benefit from technological changes (Barreto, 2010; Leso et al., 2024). In this context, the dynamic capabilities approach has progressed and become established in management research (Peteraf et al., 2013; Schilke et al., 2018). Dynamic capabilities are thus considered particularly important as part of the digital transformation (Chirumalla, 2021; Warner & Wäger, 2019). According to the approach, companies need capabilities of sensing in order to recognize changes caused by digitalization and the associated opportunities and risks, capabilities to seize resulting potentials and, finally, capabilities to adapt accordingly by expanding, combining or, if necessary, reconfiguring (Teece, 2007). Thus, dynamic capabilities can adapt the operational capabilities, including the organizational capabilities, in order to master the digital transformation in companies (Konopik et al., 2022).

The capabilities of sensing, seizing and reconfiguring are subjected to varying degrees of stress in an exploratory, a building and an expanding phase of adjustment triggered by digitalization (Yeow et al., 2018). For instance, in the exploratory phase, these capabilities may take the form of continuous but sequential cross-industry digital monitoring (Ellström et al., 2022). While they were originally mainly considered important for upper management decision making, research has shown that processes at almost all levels of a company can be facilitated by dynamic capabilities (Schilke et al., 2018). In this way, dynamic capabilities can frequently contribute to value creation and firm performance in a highly dynamic environment affected by digital technologies (Drnevich & Kriauciunas, 2011; Sjödin et al., 2023), therefore ensuring the necessary governance and strategic readiness (Holopainen et al., 2022).

2.2. National culture and intercultural differences

A country's culture has long been ascribed the role of one of its most significant environmental features (Steenkamp, 2001). Alongside individual, group and organizational layers, national or country culture can be regarded as one layer of the multi-level or multi-layer construct of culture (Chen & Lin, 2021; Leung et al., 2005). Being understood as something that people who live in a country have (Moore, 2020), national culture can be "broadly defined as values, beliefs, norms and behavioral patterns of a national group" (Leung et al., 2005). These values and patterns are seen as relatively stable (Taras et al., 2023) and affect people's perceptions (Engelen & Brettel, 2011).

While culture plays a major role in society, it also has a significant impact on companies and organizations in general, since the actions of organizational members are significantly determined by cultural imprints (Vaara et al., 2021). For instance, Li et al. (2013) were able to prove in this respect that imprints of national culture affect managerial decision-making. For decades, culture has been a central research topic in international management and in international business for this reason (Tung & Verbeke, 2010). In these fields, culture has been linked to topics such as forms and modes of entry, transnational cooperation, resources and knowledge transfer, expatriate and international expansion (Caprar et al., 2015). Additionally, a large number of studies have been conducted on the influence of cultural values and intercultural differences on various variables at firm-level (Kirkman et al., 2017; Srivastava et al., 2020).

Intercultural or cross-cultural differences refer to the deviations between different cultures and are usually related to the differences between national cultures (Richter et al., 2016; Taras et al., 2016), between which the construct of cultural distance arises (Kogut & Singh, 1988). Awareness of intercultural differences is considered to be of great importance, which can be explained by the fact that taking such intercultural differences into account can significantly improve the quality of decisions under uncertainty in organizations (Csaszar & Eggers, 2013). Therefore, it is necessary to be able to grasp and quantify cultural distances between nations. Since culture is a latent variable, it must be made tangible in the form of manifestations (Javidan et al., 2006). Researchers introduced different dimensions of culture in order to measure and aggregate the huge amount of these manifestations and provide simplified overviews of the different national cultures (Kaasa, 2021). In doing so, researchers usually utilize cultural distance measures (Tung & Stahl, 2018). These refer to operational variables that form proxies for these dimensions, allowing estimates of the magnitude of differences between countries within these cultural dimensions (Tung & Verbeke, 2010). Today, more than a hundred sets of cultural dimensions exist as a result (Taras et al., 2009).

Hofstede (1980) is regarded as the first to have established a meaningful framework to evaluating national culture. His dimensions were originally based on a survey of over 100,000 IBM employees, resulting in cultural dimensions conceptualized as bipolar factors. This has led to discussions about the extent to which the aggregation of individual values provides reliable values at country-level, especially when samples are based only on specific groups or companies (Schwartz, 2014). In this context, for example, it is criticized that national borders are not always ideal for representing culturally homogeneous areas due to the presence of subcultures in some cases (Minkov & Kaasa, 2021), meaning that cultural differences within a country can be just as pronounced as cultural differences across countries (Beugelsdijk et al., 2017). Indeed, cultural dimensions are often seen as overly generalized and devalued as subjective creations (Minkov & Kaasa, 2022). However, despite this criticism, those cultural dimensions still provide the most established way of measuring intercultural differences and their effects in research (Jackson, 2020). In line with this, publications such as Schwartz (2014) confirm that methods for deriving cultural values for countries from aggregated individual values are reliable and that aggregated individual values can indeed explain differences in attitudes and behavior at country-level if suitable samples are selected.

Accordingly, after revising and addressing earlier issues (Hofstede et al., 2010), Hofstede's framework has become the basis for numerous cross-cultural studies. It comprises the six dimensions of power distance, individualism vs. collectivism, masculinity vs. femininity, uncertainty avoidance, long-term vs. short-term orientation and finally indulgence vs. restraint. Other well-known cultural dimensions stem, for example, from Schwartz (2008) and from the GLOBE (Global Leadership and Organizational Behavior Effectiveness) study (House et al., 2004), as shown in Table D-2.

Table D-2: Cultural dimensions

Framework	Hofstede (2011)	Schwartz (2008)	GLOBE (House et al., 2004)
Cultural dimensions	Power distance	Hierarchy vs. egalitarism	Power distance
	Individualism vs. collectivism		In-group collectivism
			Institutional collectivism
	Masculinity vs. femininity	Mastery vs. harmony	Gender egalitarianism
			Assertiveness
			Performance orientation
			Humane orientation
	Uncertainty avoidance		Uncertainty avoidance
	Long-term vs. short-term orientation		Future orientation
	Indulgence vs. restraint	(Affective and intellectual) autonomy vs. embeddedness	

The dimensions introduced by Schwartz are also aligned in opposite directions. The GLOBE study shows strong similarities with the terms from Hofstede's framework but expands it with additional dimensions. In any case, many overlaps exist between the cultural dimensions of the various frameworks (Kaasa, 2021). Accordingly, "each of these frameworks partly captures the same variation in cross-cultural values and partly some unique variation not picked by any of the other frameworks" (Beugelsdijk et al., 2017). However, Hofstede's dimensions are considered comprehensive enough to capture the influence of the most important facets of national culture without becoming too complex, underlining their clarity, simplicity and high resonance with managers (Kirkman et al., 2006). This is why they are most frequently used in cross-cultural studies compared to other frameworks (Engelen & Brettel, 2011). Their suitability is also confirmed by the continuous updating of the values for Hofstede's cultural dimensions in countries worldwide. Thus, for the purpose of the analysis in the context of digital maturity, Hofstede's cultural dimensions are also used in the further course of this study.

3. Hypotheses development

Since the essential actions and decisions in the context of the digital transformation of companies depend on their organizational members and these are shaped by values of national culture (Vaara et al., 2021), it can be assumed that digital maturity is influenced by national culture along its various dimensions. Below, the extent to which Hofstede's six cultural dimensions have a positive or negative impact on digital maturity is therefore examined.

3.1. Influence of power distance (PDI) on digital maturity

The first dimension of PDI describes how much people accept hierarchies. In cultures with high PDI values, hierarchy, subordination and the authority of a few over the many are common (Beugelsdijk & Welzel, 2018). In contrast, a low PDI expresses that inequality of power is more strongly rejected within a culture. Accordingly, a low PDI is associated with egalitarianism and supports autonomy and independence within an organization, potentially fostering employee motivation under transformative conditions (Kirkman et al., 2009). A reason for this is that in countries with a small PDI and a corresponding tendency towards less authoritarian leadership, companies tend to create an organizational environment in which employees generally feel more comfortable (Huang et al., 2017). This can lead to employees showing more initiative and making suggestions for the conversion to new digital processes and products, thus strengthening capabilities such as sensing of digital options. While a low PDI usually results in individuals of an organization acting as a team and sharing resources (Boone et al., 2019), a high PDI can lead to critical information, access to resources and decision-making rights being further restricted to people at higher hierarchical levels (Bogatyreva et al., 2019). The introduction of changes as part of the digital transformation is also less likely in companies in countries with a high PDI, as changes are partly avoided here by decision-makers in order not to endanger existing power structures (Leung et al., 2005). In addition, companies in countries with a high PDI often have hierarchical structures that make bottom-up communication from technical employees to top management difficult (Qu et al., 2011). However, this type of communication is crucial for efficient adjustments in companies in the context of digitalization. It can therefore be assumed that a large PDI is an obstacle to the implementation of digital processes and technologies, to the establishment of digital offerings as well as to necessary capabilities. This leads to the first hypothesis:

H1: A high PDI has a negative impact on the digital maturity of companies in a country.

3.2. Influence of individualism (IDV) on digital maturity

The one pole of this dimension, with the expression IDV, describes countries in which people care almost exclusively for themselves and their families (Brewer & Venaik, 2011). That is why a high IDV is associated with self-orientation. Collectivism, by contrast, is characterized by an individual's sense of responsibility towards a group or organization. As a result, collectivist cultures therefore attach great importance to group membership and are marked by tightly-knit social structures (Handley & Angst, 2015). On the one hand, people in cultures with high IDV are less oriented towards shared values and the previous norms of the group than more collectivistic cultures. Previous studies have demonstrated a positive influence of IDV on, for example, ICT adoption (Erumban & de Jong, 2006) or innovation (Efrat, 2014). However, the results from prior studies on the impact of IDV are partly contradictory (Tian et al., 2018) and digital maturity needs certain organizational capabilities (Sommer & Proff, 2023) that thrive collectively in the group and require joint coordination between individuals in the organization. In this context, cross-cultural research has often emphasized the positive effects of collectivism based on its focus on group work and team spirit (Knein et al., 2020). Moreover, collectivism might have a positive effect on digital business. This can be explained by the fact that many new digital offerings and business models are based on a joint orientation of a multilateral set of partners with complementary resources in ecosystems based on digital platforms (Adner, 2017; Jacobides et al., 2018; Kapoor et al., 2021), but also on value co-creation with customers (Plekhanov et al., 2023). In this sense, a high IDV poses barriers to new forms of joint value creation in times of digitalization. Accordingly, the following hypothesis emerges:

H2: A high IDV has a negative impact on the digital maturity of companies in a country.

3.3. Influence of masculinity (MAS) on digital maturity

Hofstede's most controversial dimension includes the social distribution of roles between the genders (Sent & Kroese, 2022). The dimension presents income and recognition as typically masculine traits, whereas a good relationship with superiors and colleagues is considered a feminine goal. Although the study of Rubino et al. (2020) has demonstrated a negative correlation between MAS and the use of digital technologies in companies, most of the literature sees a positive influence of MAS on variables such as innovativeness (Tian et al., 2018) and ICT adoption (Erumban & de Jong, 2006). The reason for this is that masculine cultures emphasize values such as wealth, success, ambition, materialism and achievement (Hofstede et al., 2010). Therefore, individuals in these cultures are more eager to seek and exploit digital opportunities and to acquire skills or improve existing skills that can enhance their success, especially digital operational capabilities, which tend to be promising and are increasingly demanded (Scuotto et al., 2021). In this context, companies in cultures with a high MAS are also more likely to be able to develop the required dynamic capabilities for the digital transformation (Ellström et al., 2022) in addition to the individual digital capabilities of their employees (Ritter & Pedersen, 2020). From this follows:

H3: A high MAS has a positive impact on the digital maturity of companies in a country.

3.4. Influence of uncertainty avoidance (UAI) on digital maturity

The dimension of UAI describes the degree to which people get stressed in situations that they perceive as unclear, unforeseeable or unstructured (Hofstede, 2011). A high degree of UAI is therefore accompanied by a need for rules, standards and laws. However, it should be noted that UAI should not be equated with risk avoidance. The main aim of avoiding uncertainty is to reduce ambiguity, not to reduce risks in the first place. Cultures with a high degree of UAI are often even willing to take risks in order to contain ambiguous situations and strive for structure in their organizations (Hofstede et al., 2010).

As the high speed of technological progress leads to complex and dynamic circumstances, changes brought about by new digital technologies are often perceived as uncertain and ambiguous (Bodrožić & Adler, 2022). For this reason, cultures with a high level of UAI in particular may find the changes in their environment resulting from digitalization uncomfortable and may be more likely to try to control them (Taras et al., 2016). Anyway, there is evidence in the literature that digital, computer-based control systems can limit uncertainty (Björkdahl & Holmén, 2019). In this sense, digitalization can be used to track processes such as deliveries or production steps, keep an eye on the market and competitors, automatically evaluate data about customers and even monitor the skills and performance of a company's own employees (Schafheitle et al., 2020). A high level of UAI is therefore accompanied by better sensing of the environment for observing risks and potentials through digitalization (Yeow et al., 2018) as well as by sensing capabilities, which are optimized through digital technologies. Since companies are subject to the consequences of ambiguity and uncertainty in the context of external technological development anyway, it can be assumed that companies in countries with high UAI use the control options of digitalization to the best of their ability to monitor and reduce uncertainty. The following hypothesis on UAI is formulated accordingly:

H4: A high UAI has a positive impact on the digital maturity of companies in a country.

3.5. Influence of long-term orientation (LTO) on digital maturity

The dimension focusing on time describes the extent to which cultures orient their actions and behaviors towards the short-term or the long-term. This dimension thus shows whether within a nation the tendency is to strive for short-term results or sustainable success. A high degree of LTO is associated with perseverance, thrift, persistence and a view of the future (Hofstede et al., 2010). The arguments on the influence of LTO are somewhat divergent in the literature. On the one hand, some arguments indicate that a high LTO is a hindrance to digital maturity in companies. In order to drive digital transformation and implement changes quickly, companies generally have to act fast and agile at short notice. Digital opportunities do not only have to be recognized but also have to be seized promptly and resulting changes have to be implemented quickly in the company by adapting existing resources and processes (Teece et al., 2016). The rationale for this is that in fast-changing digital environments, a low response speed is not sufficiently effective (Verhoef et al., 2021). Organizational agility, which goes hand in hand with a certain short-termism (Walter, 2021), is necessary for companies in this context. On the other hand, cultures with a high degree of LTO think beyond current conditions and attach greater importance to situations in the distant future than to immediate outcomes (Sent & Kroese, 2022). Since the positive effects and financial benefits of implementing digital technologies in companies usually only arise in the distant future (Hossnofsky & Junge, 2019), a high LTO could increase the likelihood of investment decisions being made in digital technologies. Moreover, while short-term oriented societies regard traditions as sacrosanct, long-term oriented cultures place greater emphasis on adaptation to changed circumstances (Hofstede, 2011) and are therefore more willing to embark on new paths in the context of digitalization. In accordance with the second line of reasoning, the hypothesis on the effect of LTO is as follows:

H5: A high LTO has a positive impact on the digital maturity of companies in a country.

3.6. Influence of indulgence (IVR) on digital maturity

The final dimension encompasses the two opposing poles of indulgence and restraint. While indulgence is represented by a high happiness, high optimism, having many friends and a sense of high control over one's own life, restraint is associated with a lower sense of happiness, more pessimism, a perception of helplessness and stricter norms (Hofstede, 2011). Accordingly, this dimension can be described “as the extent to which members of society enjoy pleasures and express emotions" (Sent & Kroese, 2022). Following the study of Alipour and Yaprak (2022), companies in societies with a high degree of IVR are more willing to take risks, increasing the likelihood of risky investments in digitalization in these societies. Due to the sense of freedom associated with indulgence, employees in such companies are additionally more likely to take action (Bogatyreva et al., 2019). However, employees are often uncomfortable with changes to the familiar due to ingrained habits. This means that adjustments as part of the digital transformation could be at odds with employees' preferences, leading to resistance to change (Hon et al., 2014). Since employees in cultures with a high indulgence are more focused on their interests and the pursuit of their own happiness, they are therefore more likely to refuse necessary changes (Warner & Wäger, 2019). In contrast, in cultures where the values of the restraint side are more pronounced, members of the organization are more likely to accept undesirable adjustments in the context of digitalization, partially because they see themselves as less empowered to prevent changes (Hofstede et al., 2010). This results in the final hypothesis:

H6: A high IVR has a negative impact on the digital maturity of companies in a country.

An overview of the six hypotheses and assumed effects on digital maturity is given in Figure D-1.

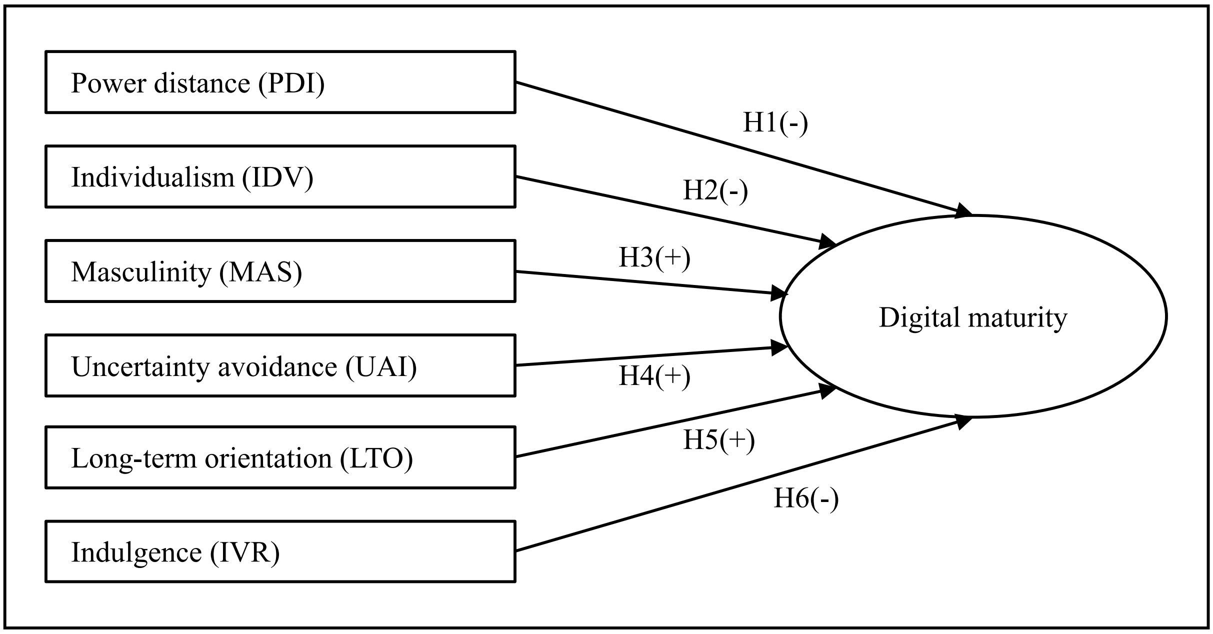

Figure D-1: Impact of the cultural dimensions on digital maturity
(Own compilation)

4. Methodology and data

This study attempts to examine the influence of intercultural differences on digital maturity in companies. A quantitative analysis is therefore carried out to test the hypotheses put forward. Regression analyses have proven their worth in management research for examining influences of this kind (Weaver & Wuensch, 2013). Since an influence of national culture on digital maturity is to be expected, but national culture as a stable variable at country-level cannot be influenced by the endogenous variable of digital maturity at firm-level, the methodology of ordinary least squares (OLS) is used for this study. OLS estimation is the most commonly used form of regression analysis and is considered a suitable method for assessing influences between variables if, as shown, an endogeneity problem can be ruled out (Bascle, 2008).

4.1. Data collections

For the purpose of the study, various cultural characteristics were made tangible using Hofstede's cultural dimensions. In order to contrast the influence of different cultural values, the countries Germany, Japan and the USA were considered for the study. These countries were chosen since they are located in different global regions. Moreover, all three countries play a significant role in the global economy and are therefore subject to relatively similar macroeconomic factors compared to developing or emerging countries, minimizing distorting factors at country-level (Engelen & Brettel, 2011). Finally, the three countries were also selected for the study because, as often recommended, they differ relatively strongly from one another in terms of the values within the cultural dimensions (Kirkman & Shapiro, 2001). In this context, the scores from Hofstede et al. (2010) were used to determine the values of the variables for the six cultural dimensions PDI, IDV, MAS, UAI, LTO and IVR, as their validity and reliability have been repeatedly confirmed in tests (Kogut & Singh, 1988). These scores range from 0 to 100 for each of these bipolar cultural dimensions in Germany, Japan and the USA, reflecting the distribution of the different cultural values in these countries (Table D-3).

Table D-3: Scores of Hofstede's cultural dimensions

Country	PDI	IDV	MAS	UAI	LTO	IVR
Germany	35	67	66	65	83	40
Japan	54	46	95	92	88	42
USA	40	91	62	46	26	68

The data on digital maturity was collected in a survey of companies in Germany, Japan and the USA in 2023 using an online questionnaire. The companies were predominantly from the manufacturing industry in order to ensure comparability of the transformation process, as born-digital firms “simply started with a different set of management principles” (Birkinshaw, 2022). In order to reduce distortions of a possibly existing industry culture, data was obtained from companies of different sub-industries of the manufacturing sector, such as the automotive industry, the chemical industry or other mechanical engineering industries. Only participants from top management or middle management were surveyed in order to obtain the most reliable feedback possible on the digital transformation in these companies.

4.2. Variable construction

To examine digital maturity, a measurement model is necessary to assess the quality of the digital transformation process of the companies in different countries. This article therefore follows the common approach of using an index (Kromann et al., 2019) in the sense of a digital maturity index (Montero Guerra et al., 2023). The digital maturity index was derived via the four sub-indices of digital activity, digital business, digital operational capabilities and dynamic capabilities (Figure D-2). To this end, the indices were collected using a total of 41 items, which were operationalized as variables in response to digitalization extended to Sommer & Proff (2023). The operationalization takes into account frequently represented items from other maturity models (Table 1) and is also based on a theoretical foundation (see sections 2.1.1 to 2.1.4). A Likert scale with options ranging from 1 (no digital maturity) to 7 (full digital maturity) was used to obtain data in this context (Dolnicar & Grün, 2013). From the responses received, a mean value was calculated for each of the four sub-indices, assuming an equal weighting for all items. An overall value for digital maturity was then calculated as the average of the mean values of the sub-indices.

The digital activity index contains 16 items (A1-A16) for altering processes and technologies to improve coordination and interaction. Based on the value chain according to Porter (1985), components for the optimization of processes and reduction of costs are included in different areas of the company. Further items focus on shortening product development times and the time between order and delivery, the use of digital technologies for data analytics, data generation in real-time, central integrated IT systems and the digitalization of the supply chain, even beyond company boundaries (Adner et al., 2019; Plekhanov et al., 2023).

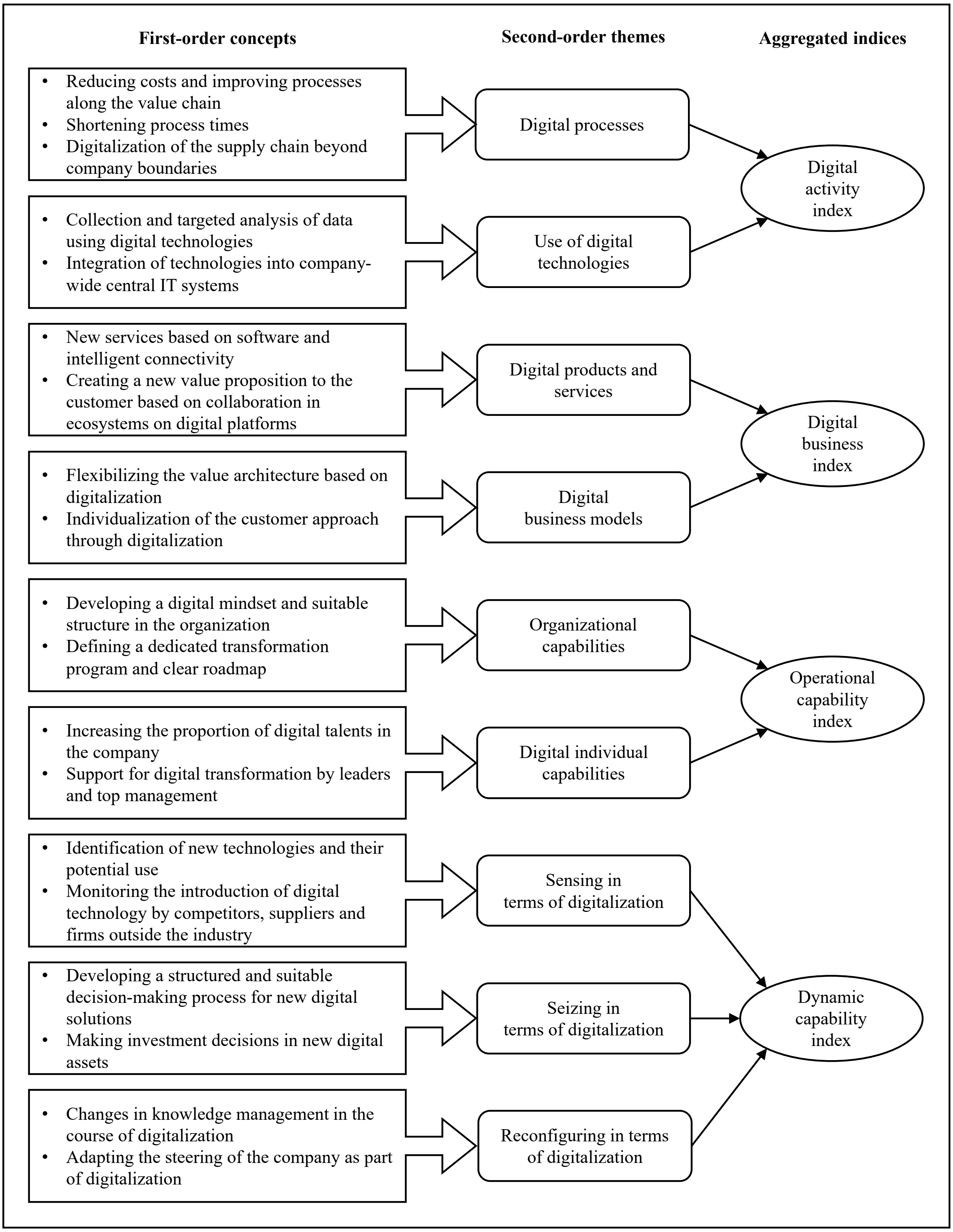

Figure D-2: Data structure
(Own compilation)

Consisting of 10 items (B1-B10), the digital business index focuses on the digitalization of products, services and business models. These items comprise software-enabled offerings, intelligent connected offerings, an individual and specific approach to the customer, proactive actions in the competition, change in the use of resources, flexible value architecture and partner network in the course of digitalization (Ancillai et al., 2023; Li, 2020). To consider platform-based ecosystems, questions were developed on multilateral partnerships, joint value co-creation with multiple companies and the creation of a focal value proposition for customers in times of digitalization (Adner, 2017; Jacobides et al., 2018).

The operational capability index reflects the operational capabilities for digitalization and includes 5 items (C1-C5). This encompasses a roadmap for the digitalization initiatives, support from top management in the implementation of the digital transformation, a digital mindset in the organization and the number of digital talents (Grimpe et al., 2023; Scuotto et al., 2021; Volberda et al., 2021).

Finally, the dynamic capability index comprises 10 items (D1-D10) and reflects the extent of capabilities to adapt in the era of digitalization. The operationalization was carried out on the basis of Teece (2007) and Warner and Wäger (2019). Concerning the sensing of companies, it has been taken into account the identification of new technologies, observation of new technologies of competitors and suppliers, monitoring of technology outside of the own industry and target market analyses. The items decision development for digital solutions, structured decision-making, investment decisions in new assets and decisions involving stakeholders were used in view of the seizing of digital opportunities in companies. Finally, the reconfiguring of capabilities due to digitalization was operationalized by changes in knowledge management and corporate governance.

In addition, control variables were included at firm-level. As the size of companies is seen as a factor influencing their digital transformation (Eller et al., 2020), the number of employees is used as a control variable. Alongside this, the duration of a firm's digital transformation to date was subsumed on the basis of its starting year.

5. Results

5.1. Descriptive statistics

603 companies took part in the survey on digital maturity, with almost equal numbers headquartered in Germany, Japan and the USA. All of them have yearly revenues of at least 80 million US dollars. Of these organizations, just 13.1% of them have fewer than 1000 employees, around 31.5% employ between 1000 and 10,000 and the rest, that is, more than half of the companies surveyed, have 10,000 or more employees. The number of small, medium-sized and larger companies, as well as the number of companies from the sub-segments of the

manufacturing industry, are distributed evenly across the three countries in order to minimize distortions regarding the analysis of the influence of national culture. The descriptive statistics of the 41 items surveyed are summarized in Table D-4.

Table D-4: Descriptive statistics of the surveyed items

Item	Mean	SD
A1	4.254	1.545
A2	4.360	1.689
A3	4.347	1.607
A4	4.337	1.609
A5	4.300	1.677
A6	5.164	1.454
A7	5.113	1.478
A8	5.028	1.484
A9	5.290	1.375
A10	3.698	1.277
A11	3.352	1.256
A12	3.700	1.267
A13	3.768	1.391
A14	3.773	1.293
A15	3.720	1.305
A16	3.758	1.270
B1	5.431	1.289
B2	5.184	1.534
B3	5.109	1.474
B4	5.139	1.474
B5	5.191	1.464
B6	5.088	1.510
B7	5.050	1.522
B8	5.078	1.333
B9	5.187	1.375
B10	5.013	1.425
C1	5.184	1.464
C2	5.315	1.394
C3	5.158	1.410
C4	5.222	1.465
C5	3.446	1.274
D1	4.949	1.433
D2	5.217	1.460
D3	5.085	1.462
D4	5.186	1.478
D5	4.985	1.453
D6	5.420	1.385
D7	5.177	1.429
D8	5.093	1.486
D9	5.028	1.461
D10	5.292	1.556

Notes: SD = Standard deviation; N = 603; scale from 1 to 7

Sub-indices were calculated from the surveyed items, which were then used to form a digital maturity index assuming equal weighting (Table D-5). In order to test the reliability of the items used to form the sub-indices for digital activity, digital business, digital operational capabilities and dynamic capabilities, the values for Cronbach's alpha were determined (Bonett & Wright, 2015). They lie between 0.866 and 0.939 for all four sub-indices and are therefore well above the generally recommended guideline values of 0.7 for acceptable or 0.8 for high internal consistency of the items (Cho & Kim, 2015).

Table D-5: Indices of digital maturity

Indices	Cronbach's alpha	Mean	SD
Digital activity index	0.895	4.248	0.899
Digital business index	0.928	5.147	1.124
Digital capability index	0.866	4.865	1.132
Operational capability index	0.939	5.143	1.172
Digital maturity index	-	4.851	1.001
Notes: SD = Standard deviation; N = 603			

With an average value of 4.248, the digital activity index is markedly lower than the values of the three other sub-indices, which are around 5. This results in an overall digital maturity index with a value of 4.851 (out of a maximum of 7). When viewed at country-level, the results show that there are country-specific differences in terms of the digital maturity of the surveyed companies. Of the three countries considered, the companies headquartered in Germany have the highest digital maturity with an average value of 5.040. The average digital maturity index of the companies with headquarter in Japan is 4.900, compared to only 4.610 in the USA.

5.2. Hypotheses testing

To test the hypotheses, the influence of Hofstede's scores for the dimensions on the digital maturity index of the companies was analyzed by applying multiple regression in the form of an OLS estimation. As there are high intercorrelations between Hofstede's cultural dimensions (Hofstede et al., 2010), the six dimensions were each tested separately in six models together with the control variables as dependent variables, as is usual for cross-cultural research with this methodology (cf. Geletkanycz, 1997). The results of the OLS estimation are presented in Table D-6.

Table D-6: Multiple regression results: Standardized beta coefficients (standard error)

Variable	Digital maturity index					
	Model 1 (R^2=0.042)	**Model 2** (R^2=0.064)	**Model 3** (R^2=0.047)	**Model 4** (R^2=0.059)	**Model 5** (R^2=0.076)	**Model 6** (R^2=0.083)
Firm size	0.110**	0.105**	0.107**	0.105**	0.107**	0.108**
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
Duration	0.152***	0.174***	0.160***	0.170***	0.183***	0.184***
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)
PDI	-0.005					
	(0.005)					
IDV		-0.150***				
		(0.002)				
MAS			0.070			
			(0.003)			
UAI				0.128**		
				(0.002)		
LTO					0.197***	
					(0.003)	
IVR						-0.204***
						(0.003)
Notes: *p < 0,05; **p < 0.01; ***p < 0.001; N = 603						

Starting with the control variables, the results confirm the positive influence of both variables. In all six multiple regression models, the company size in the form of the number of employees is significant at a 1 % level, while the duration with which the digital transformation has already been implemented in the company is even significant at a 0.1 % level.

Continuing with the test of hypotheses, the multiple regression models reveal that PDI and MAS have no significant influence on digital maturity. Although the calculated directions of effect of these dimensions correspond to the expected directions of effect in the hypotheses, the standardized regression coefficients, especially for PDI with $\beta = -0.005$, but also for MAS with $\beta = 0.070$, are too low. Hypothesis 1 and hypothesis 3 must therefore be rejected.

However, the four other cultural dimensions show a stronger effect on digital maturity. IDV with a coefficient of $\beta = -0.150$ as well as IVR with a coefficient of $\beta = -0.173$ show a significant negative influence (both p-values <0.001) on digital maturity and thus prove the effect derived from the literature. Accordingly, hypothesis 2 and hypothesis 6 can be accepted. Finally, UAI and LTO both have a significant positive influence on digital maturity. Model 4 and model 5 result in coefficients of $\beta = 0.128$ (p-value <0.01) for UAI and a coefficient of $\beta = 0.197$ (p-value <0.001) for LTO, thereby also confirming hypothesis 4 and hypothesis 5.

6. Discussion and implications

6.1. Discussion

The findings of the study demonstrate that national culture has a significant impact on digital maturity. However, only four of the six hypotheses along the cultural dimensions can be confirmed. Although various indications from the literature suggested a negative effect of PDI on the degree of digitalization of companies, no significant impact of this dimension can be revealed on the basis of the statistical analysis. In line with the argumentation of Kirkman et al. (2009) on the influence of the PDI, this result might be explained by the fact that in times of transformation, employees partly expect and need clear instructions and solutions along the hierarchy. In this context, such employees are often more likely to accept solutions from leaders and not from colleagues at the same hierarchical level. Accordingly, for this type of employee, an appropriate environment with a high PDI and clear instructions can be advantageous in terms of digital transformation. Besides, radical strategic actions initiated by managers or leaders as a result of digitalization are much more likely to be implemented without resistance or questioning in cultures with a high PDI (Crossland & Hambrick, 2011). Because even if these radical changes contradict their own preferences or mean personal sacrifice, employees in cultures with a high PDI want to prove themselves to their superiors and follow instructions (Jiang et al., 2022), counteracting the presented arguments that see a high PDI as a barrier to digital maturity.

As part of hypothesis 3, the results of the study provide a positive correlation coefficient, which, however, is not significant and therefore does not significantly prove the expected positive effect of MAS on digital maturity. This could be due to the fact that the values assigned to the female side can also be partly conducive in this respect, with their emphasis on human relationships helping to create a favorable trust-based and conflict-free climate for the implementation of digital technologies (Rubino et al., 2020). The impacts of masculine and feminine values therefore seem to neutralize each other with regard to digital maturity. This is in line with the results of previous studies on the influence of culture on change processes in companies, concluding "that values attributed to gender fail to substantively contribute" (Geletkanycz, 1997).

Although four of the six dimensions have a statistically significant impact, the relatively small R^2 values in the regression models show that only a small proportion of the variance in digital maturity can be explained by national culture. However, this is not surprising, as digital maturity is dependent on several other factors (Balakrishnan & Das, 2020; Yang et al., 2024).

6.2. Theoretical implications

The findings contribute to research that focuses on drivers and influences in the context of digital transformation. In doing so, they expand the findings of research on culture, which have so far been predominantly limited to organizational culture (Hanelt et al., 2021; Vial, 2019). The study therefore sheds more light on the impact of the layer of national culture in this respect.

It has been shown that digitalization in companies is bound up with national culture, which, according to the available results, exerts significant influences on their digital maturity apart from the PDI and MAS dimensions. By demonstrating in this context, for example, a low IDV and a high UAI as drivers of digital maturity, the study complements and refutes other cross-cultural studies, such as the work of Erumban and de Jong (2006) and Rubino et al. (2020), which assume and partially prove reverse effects in these two dimensions on the adoption of technologies. Moreover, the results on the positive impact of collectivism underline that intercultural differences between countries should not only be seen as a disadvantage, but as an opportunity by taking "cultural attractiveness" into account in firms' international strategies. Following Li et al. (2017), it is possible this way to improve global collaboration by considering which cultural values complement one's own values in the pursuit of digital maturity or which cultures the employees of one's own company enjoy working with. In this sense, the study by Boone et al. (2019), for example, was further able to prove the positive effect of national diversity in the top management teams of companies.

Finally, this study contributes to research as it considers multiple dimensions of digital transformation in addition to the dimensions of national culture (Plekhanov et al., 2023), by holistically capturing the response of companies in terms of their digital maturity (Kane et al., 2017; Leso et al., 2024). Accordingly, the results imply that national culture influences factors of organizational capabilities that are relevant for digital transformation. In this context, previous studies such as those by Eisend et al. (2016) or Knein et al. (2020) have already been able to demonstrate a moderating effect of national culture on the impact of organizational culture on third variables, which would also be conceivable in the case of digital maturity. Besides, the holistic view of digital maturity in this study provides a tool for better understanding and tackling the emergence of the digitalization paradox often discussed in research (Gebauer et al., 2020). This arises when companies do not achieve the expected results from their investments in digital technologies and therefore "struggle with capturing value from digitalization" (Kohtamäki et al., 2020).

6.3. Managerial implications

Companies can benefit from the approach presented as a tool for monitoring and measuring their digitalization activities. The results on the digital maturity index and the sub-indices show that, on average, the companies surveyed are already advanced with the digital transformation and have a medium to middle-high level of digital maturity, though they are neither fully exploiting the opportunities of digitalization nor possessing complete strategic readiness (Holopainen et al., 2022). They must therefore continue to tackle digital transformation in all its facets and, in addition to the use of technologies, build up the necessary capabilities in their organizations and among their workforces. The responses from the companies surveyed showed that the digitalization of their activities is still the least advanced part of their digital maturity. Companies should therefore examine the extent to which improvements can still be made at this point, both within the company and beyond its boundaries. The suitable implementation of Enterprise Resource Planning (ERP) and Supply Chain Management (SCM) systems can be an important step towards optimizing processes in this regard. This is demonstrated, for example, by Hendricks et al. (2007), whose study shows that investments in such systems in most cases lead to increased profitability in companies.

Moreover, companies should also consider the findings on the influence of the various cultural dimensions. While the layer of national culture is virtually unchangeable (Taras et al., 2023), companies should try to transfer the conducive cultural values that can be derived from the dimensions of national culture into the organizational culture. Accordingly, companies should, for example, align their organizational structure in a collectivist manner in order to optimize processes, their business and the resource base in the context of digitalization. For this purpose, companies could, among other things, encourage teamwork and trust within the organization (Eisend et al., 2016). Since the results do not confirm PDI as an inhibitor, companies should also consider having their digital transformation more strongly guided by leaders (Schiuma et al., 2024; Volberda et al., 2021), especially in countries with high PDI, where clear instructions are expected from employees at lower hierarchical levels (Kirkman et al., 2009). To this end, companies could introduce new positions such as Chief Digital Officers (Singh et al., 2020). These recommendations are also founded on the study by Schaubroeck et al. (2007), in which organizations with a higher PDI as well as higher collectivism benefited more from such transformational leadership and demonstrated higher team performance.

Finally, Hofstede's scores provide managers with guidance that applies not only to the three countries examined in this study. On this basis, multinational companies should take the various cultural influences into account in terms of their global transformation programs, including with regard to their globally distributed locations and subsidiaries. For example, multinational companies should target nations with supportive prevailing cultural values for the location of their IT headquarters and digital transformation offices. Managers should take these and further aspects to heart and thereby strive for a "strategic design of culture for digital transformation" (Butt et al., 2024).

7. Conclusions and future research

The study reveals important findings in relation to the cultural bond of digital maturity, however, it is not exempt from limitations. While the data on digital maturity was collected from a sufficiently large number of companies, these companies were only headquartered in three highly industrialized countries. Although Engelen and Brettel (2011) show in their content analysis of 99 cross-cultural studies that 65 % of these articles even only consider two countries, the quality of the results could be improved by including additional national cultures in future research. This also encompasses consideration of emerging and developing countries for which the findings of this study cannot be generalized. Indeed, strong deviations in macroeconomic factors lead to different conditions for the digital transformation of companies (Bodrožić & Adler, 2022). For example, outside of industrialized countries, capital and highly skilled labor are generally less available, creating barriers to investing in digital technologies or building the necessary operational capabilities.

In this context, limitations arise from the fact that the results on the influence of national culture might be affected by other country-level effects such as the macroeconomic conditions mentioned above, even within the research sample focused on high-income nations. Future research could validate the results of this study by applying statistical methods of hierarchical linear modeling or multilevel analysis (Peterson et al., 2012), which can be used to partially rule out distorting effects at country-level. Multilevel analysis provides a useful methodology when the underlying variables and data have a nested hierarchical structure (Hitt et al., 2007), for example, with country-level and firm-level variables. Although Tung and Stahl (2018) also recommend multilevel analyses in principle, they primarily point to the need "to explore other national differentiators" in addition to national culture. This appeal is underlined by the low R2 values in the regression models of this study, which illustrate that alongside to national culture, various other potential factors such as the technological infrastructure or institutional environments must be taken into account in order to fully explain the degree of digital maturity in companies.

Despite their widespread use, Hofstede's cultural dimensions are further subject to criticism, such as for aggregating data from individuals to the higher country-level and neglecting intranational cultural differences (Beugelsdijk et al., 2017). In this context, the quality of the results is limited by the fact that the study does not take into account cultural diversity within countries, nor interrelationships between various cultural dimensions (Richter et al., 2016). Future research should therefore validate the results of this study by means of investigations based on alternative cultural dimensions, for example, according to Schwartz (2008) or the GLOBE study (House et al., 2004).

A further important aspect for future research relates to the need for a dynamic view of national culture, digital maturity and their interactions, as this study was conducted at one point in time. Although national culture is considered relatively stable (Taras et al., 2023), it is not entirely devoid of dynamics, especially as recent geopolitical and societal shifts have led to an increased rate of cultural change (Tung & Stahl, 2018). However, the dynamic is much stronger on the digitalization side. Since digital technologies are constantly evolving, the requirements for perfect digital maturity are also continuously shifting (Nasiri et al., 2022). In particular, the rapid technological advances in the field of AI are currently creating entirely new possibilities that did not exist a few years ago (Helfat et al., 2023; Raisch & Krakowski, 2021; Sjödin et al., 2023). Accordingly, “digital maturity is a relative and subjective construct that either improves or worsens over time” (Mettler & Pinto, 2018). Digital transformation, which is already defined as a dynamic process, therefore requires different capabilities in companies at different times during this process (Konopik et al., 2022; Schilke et al., 2018; Yeow et al., 2018). Longitudinal studies could contribute to a better understanding of the temporal development of digital maturity, its requirements and the role of culture as an influencing factor in this respect.

In addition to the potential that arises over time, the dangers and side effects of digitalization for companies need to be noted and should not be underestimated (Lanzolla et al., 2020; Verbeke & Hutzschenreuter, 2021). For example, enormous productivity losses result from frequent interruptions due to “digital distraction” (Jarrahi et al., 2023), the erosion of competencies is accelerating in the digital age (Meyer et al., 2023) and great risks of being hacked exist if cybersecurity is inadequate (Ribeiro-Navarrete et al., 2021). These side effects can ultimately lead to companies not achieving the expected economic success through their digital transformation (Kohtamäki et al., 2020). Apart from economic performance, companies should also pay attention to adverse effects such as electronic waste and increased energy consumption in terms of their ecological and social performance in order to increase their sustainability through digital technologies (Valero-Gil et al., 2024; Ye et al., 2024).

Finally, although the study has contributed to a better understanding of the influence of national culture on digitalization in firms, it does not yet provide any insights into the extent to which there is a reverse effect of these variables in the long term. The question of whether the effect of culture on digitalization or whether the effect of digitalization on culture prevails has long been the subject of research in this regard (Kane et al., 2015). However, this is important to clarify, as digital technologies have simultaneous impacts on the growth of cultural divergence and convergence (Leung et al., 2005). Considering that culture as a multi-layer construct has several levels with diverse interactions between them (Chen & Lin, 2021), research has already identified new cultural layers as a result of digital technologies and included, for example, “platform culture” in its discussions (Alt, 2022). Thus, research needs to further address the impact of digitalization and the associated globalization on culture, but also “the interplay of organizational and national culture” (Knein et al., 2020). This is important to provide even sharper insights for digital transformation in the future.

Chapter E: Mediating the paradoxes of (de-)internationalization through digital platforms

Study 2

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Abstract

Due to risks in the supply chain and the need for sustainability, among other things, concepts of de-internationalization are increasingly being considered, while at the same time the potential of growing markets motivates MNEs to continue investing in international operations despite the often large distances involved. This can lead to paradoxical tensions in companies between motives for scaling back and expanding the international footprint, particularly in the capital-intensive automotive industry. To mediate these tensions in the sense of paradox theory from a "both-and" approach, a link is made to transaction ecosystems based on digital platforms that enable the exchange of complementary resources across national borders with reduced transaction costs. Hypotheses are theoretically derived and then empirically tested using structural equation modeling in a quantitative study of 286 internationally active automotive companies. Although the results of the study confirm the suitability of such digital platforms for mitigating paradoxical tensions in international business, they also show that the performance impact of these ecosystems for companies is still low and needs to be further improved through the optimized use of various platform effects.

Keywords: Digital platforms, ecosystems, paradoxical tensions, de-globalization, international operations, automotive industry

1. Introduction

Research in the field of international business (IB) has for many decades been concerned with the internationalization of multinational enterprises (MNEs) (Rugman et al., 2011), which can be regarded as companies engaging in foreign direct investment (FDI) and which own or control value-added activities in multiple countries (Dunning & Lundan, 2008). In those countries, companies hope to raise sales of their products and services, buy cheaper or of better quality, benefit from better host country conditions or escape poor conditions in their home markets (Cuervo-Cazurra et al., 2015). As a result, the offshoring of companies has become highly relevant in IB and practice (Pedroletti & Ciabuschi, 2023). Today, MNEs are therefore represented with locations worldwide and are responsible for long global value chains (Burger et al., 2018).

However, the COVID-19 pandemic in particular has triggered various developments that have a notable influence on the global business landscape (Davlembayeva et al., 2024). A discussion on “de-internationalization” (Kafouros et al., 2022; Tang et al., 2021) is increasingly evident in recent years, picking up on debates on social and environmental sustainability (George & Schillebeeckx, 2022; Ghauri et al., 2021), economic nationalism (Buckley, 2020; Lubinski & Wadhwani, 2020), and difficulties in global supply chains in times of crisis (Ciravegna & Michailova, 2022; Sharma et al., 2020). Alongside various obstacles that have always hampered internationalization (Cuervo-Cazurra et al., 2007), the high volatility of the capital markets (Batra et al., 2024) increases the pressure on companies to pursue asset-light strategies (Wang et al., 2020), while promising expansion in growth markets at a great distance from companies’ home markets is very capital-intensive. These developments contradict the intentions that companies seek with their internationalization processes. Accordingly, paradoxical tensions (Smith & Lewis, 2011) between the contradictory motives behind further investments in international operations and the scaling back of global value chains can be assumed in companies.

The literature suggests exploiting the advantages of digital technologies related to internationalization processes (Ahmad & Kitchen, 2008) as well as global value and supply chains (Herbst, 2021). This results in a discussion about “a paradigm shift in the global strategy of MNEs towards business ecosystems” (Cha, 2020) across national boundaries (Nambisan et al., 2019), usually enabled by digital platforms (Kapoor et al., 2021). From a structural point of view, such ecosystems are “defined by the alignment structure of the multilateral set of partners that need to interact in order for a focal value proposition to materialize” (Adner, 2017).

Ecosystems might be valuable in times of conflicting changes on a global level, as they help to deal with high capital intensity (Mees-Buss et al., 2019; Meyer et al., 2020), such as in the automotive industry (Teece et al., 2016), and supply chain inefficiencies. In doing so, they enable markets to be reached beyond national borders, making service abroad without a physical presence increasingly sustainable.

Since both internationalization and de-internationalization have only been extensively studied separately (Pillich, 2025; Steinhäuser et al., 2021; Tang et al., 2021), this article sheds more light on the contradictions between internationalization and de-internationalization from the perspective of paradox theory (Cunha & Putnam, 2019). To this end, it will examine the extent to which the paradoxical tensions actually affect companies and how these tensions can be reduced, establishing a link to the research field of digital platforms and the resulting ecosystems (Gawer, 2021). In this context, the influence of various platform effects on cross-border transactions will be considered. By collecting and analyzing data from companies in the capital-intensive automotive industry, this article contributes to how platform-based ecosystems can act as a mediation solution and enhance the success of companies in the face of tensions in IB.

2. Literature Review

2.1. Paradoxical tensions in international management

Contradictions arise between the motives for expanding international operations and conflicting motives for reducing international operations (Cha, 2020). International Operations can be understood very comprehensively as "location-mode-combinations" that define the scope of a firm's international footprint (Békés et al., 2021). After first highlighting these contradictory motives, ways of dealing with the opposing forces are presented from a paradoxical lens.

2.1.1. Motives for investments in international operations

Companies are intrinsically and extrinsically motivated (van Tulder, 2015) by numerous drivers to expand into foreign markets (Buckley et al., 2007; Cuervo-Cazurra et al., 2015). According to Dunning (1979; 2009), companies internationalize through FDI motivated by natural resource seeking, strategic asset seeking, efficiency seeking and market seeking, resulting in ownership, location and internalization (OLI) advantages. In more specific terms, companies are hoping for benefits such as securing low-cost raw materials and production supplies of suitable quality, along with the use of strategic assets such as know-how to increase competitiveness. In addition, there are drivers of internationalization such as achieving risk diversification and economies of scale and scope in order to increase efficiency as well as expanding sales, especially in countries with large market sizes and large growth markets (Cui et al., 2014).

In this context, the important growth markets for MNEs are still located in countries outside Europe, North America and Japan (Ghauri et al., 2021; Narula & Dunning, 2000). In the automotive industry, for example, these growth markets are expected to be in the BRIC countries (Brazil, Russia, India and China) and the MIST countries (Mexico, Indonesia, South Korea and Turkey) in the coming years. Alongside the good sales opportunities, the local knowledge from these markets is important for MNEs (Meyer et al., 2020), motivating MNEs to invest in international operations and strengthen global supply chains (Contractor, 2022).

2.1.2. Motives for the dismantling of international operations

Despite all the motives for expanding, there have always been barriers and difficulties in the context of internationalization (Cuervo-Cazurra et al., 2007). These include, for example, trade tariffs (Kafouros et al., 2022), geographical distance and intercultural differences (Beugelsdijk et al., 2018; Clark & Pugh, 2001; Kraus et al., 2015) between the countries in which companies operate, making coordination along the value chains more difficult (Reuber et al., 2021). Those coordination and adjustment processes along global value chains and between different country markets usually result in high transaction costs for the companies involved (Osarenkhoe, 2008). The products, services and processes of companies cannot usually simply be replicated in new countries but have to be adapted to local requirements and needs (Tippmann et al., 2023). In this context, companies may have difficulties transferring the value of resources and the resulting advantages to new country markets, as they often lack the complementary resources needed to expand, compete or operate in new markets (Cuervo-Cazurra et al., 2007). With increasing complexity due to international operations in countries that are often very heterogeneous, diseconomies of scope set in at a certain point and efficiency advantages diminish (Sakhartov, 2017). Buigues et al. (2015) have shown that there is an ideal degree of internationalization that can be exceeded by companies and can lead to “over-internationalization”, which in turn causes companies to reduce their international footprint.

Thus, in recent years, the terms “de-internationalization” (Kafouros et al., 2022; Pillich, 2025; Tang et al., 2021) as well as “slowbalization” (Ghauri et al., 2021) and “de-globalization”

(Luo & Witt, 2022; Petricevic & Teece, 2019; Witt, 2019) have been gaining popularity in practice and in the IB literature. This development also stems from the growing tendency towards economic nationalism (Buckley, 2020; Lubinski & Wadhwani, 2020), as can be seen in Brexit, as well as from the increasing importance of climate protection, sustainability (Arena & Chiaroni, 2014; George & Schillebeeckx, 2022) and corporate social responsibility (Buckley & Casson, 2021). Due to recent crises such as the war in Ukraine and the COVID-19 pandemic (Ciravegna & Michailova, 2022; Sharma et al., 2020), the number of publications dealing with the dismantling of global supply chains is also rising (Buckley, 2020; Orlando et al., 2022). Cui et al. (2023), for example, speak of a "new vulnerability of globalization". What is more, MNEs, especially capital-intensive ones such as companies in the automotive industry, are pushed towards asset-light strategies (Wang et al., 2020). As a result, the literature increasingly suggests the concept of reshoring (Mukherjee et al., 2023; Pedroletti & Ciabuschi, 2023), referring to the relocation of international operations back ("backshoring") to the home country (Dachs et al., 2019) or at least nearer ("nearshoring") to the home country of a company (Ancarani et al., 2019).

2.1.3. Paradoxical tensions and ways of managing them

Tensions are to be expected between these contradictory motives of companies to continue investing in new growth markets on the one hand and to scale back international operations on the other. Those tensions can be paradoxical when elements are contradictory but nevertheless interrelated (Smith & Lewis, 2011). The conflicting goals and motives of the various stakeholders (Gavidia, 2016), who advocate either a focus on internationalization or de-internationalization, are both interconnected and contradictory. In this context, the term dilemma is used when competing choices arise (Smith & Lewis, 2011) and actors weigh up the pros and cons and make trade-offs (Putnam et al., 2016).

In the literature on paradox theory (Lewis & Smith, 2022), two possible types of response to these tensions are proposed (Agarwal et al., 2022). Defensive responses can take the form of "either-or" decisions (Hargrave & van de Ven, 2017), for example by separating the opposing elements in time or space or by favoring one of the elements. However, these "either-or" decisions can lead to poor performance if the opposing elements are both important for the success of a company. Accordingly, there are more active and more integrative "both-and" approaches that attempt to reconcile both poles of the paradox (Raisch et al., 2018). To do this, these opposing poles need to be balanced in the long term (Agarwal et al., 2022), and ways of mitigating (Berti & Simpson, 2021) or mediating (Michaud, 2014) them have to be found.

In the case of the "(de-)internationalization paradox", both poles are necessary and can hardly be separated from each other in terms of temporal and spatial aspects, which is why a "both-and" approach (Raisch et al., 2018) in the form of a mediation solution should be followed instead. This solution could lie in ecosystems based on digital platforms (Gawer, 2021).

2.2. Ecosystems based on digital platforms

In contrast to the original sociological understanding (Hawley, 1986) or the broad understanding of Moore (1993), ecosystems today are usually understood as partnership networks, in which the individual value streams are geared towards the realization of a joint solution (Dattée et al., 2018). This replaces what used to be called "mastering the value chain" with "alignment among partners" (Adner, 2021). In this respect, such ecosystems make it possible to coordinate a number of different but interdependent organizations without complete hierarchical ties (Jacobides et al., 2018) and thus reach country markets beyond their own companies without a physical presence, especially if the partners contribute strategic resources and asset-specific knowledge (Meyer et al., 2020). This allows individuals or organizations to come together so that "they can innovate or interact in ways not otherwise possible" (Cusumano et al., 2019). Being enabled by digital platforms (Kapoor et al., 2021), ecosystems therefore offer new ways to compete globally (Bhatti et al., 2022).

In this context, a distinction is made between ecosystems based on innovation platforms and transaction platforms (Cusumano et al., 2019; Gawer, 2021). While ecosystems based on innovation platforms are understood as venues for the emergence of innovations (Cusumano et al., 2019), transaction ecosystems based on transaction platforms (Rochet & Tirole, 2003) create multi-sided marketplaces for the managed exchange of activities and assets worldwide (Nambisan et al., 2019). With this in mind, digital platforms form the infrastructure that directly connects sellers, buyers and other stakeholders in transaction ecosystems and they facilitate the exchange of values between them (Cennamo, 2021), even across national borders.

Examples of such transaction platforms in the automotive industry are the platforms of Catena-X, Gaia-X, E2open or Material.One. These promise to connect various players along the automotive value chain both vertically and horizontally and to optimize their exchange and coordination processes. Accordingly, the remainder of this article does not consider innovation platforms for the mediation of the paradoxical tensions. Instead, it focuses on transaction platforms and associated ecosystems, which enable a transformation of value creation through an exchange between actors on a global level (Nambisan & Luo, 2021) and therefore a market expansion in an asset-light way without large investments.

2.3. Potential of digital platform effects for global strategy

The ability of transaction ecosystems to optimize exchange processes globally and thus mediate the paradoxical tensions is enabled by several platform effects (Hagiu & Rothman, 2016). First, digital platforms in ecosystems allow for increased modularization (Baldwin & Clark, 1997; Schmidt & Foss, 2025) by decomposing complex systems into smaller systems and subsystems (Herbst, 2021). This means that interdependent components of a system can be produced or used jointly by different actors worldwide via standardized interfaces (Dai, 2023; Loonam & O'Regan, 2022), with limited coordination and without major capital investment (Cha, 2020).

Next, digital platforms facilitate the use of complementarities (Dyer et al., 2018; Milgrom & Roberts, 1990), which can be explained by economies of scope (Sakhartov, 2017; Teece, 1982). Complementarities are a prerequisite for joint value creation in ecosystems (Jacobides et al., 2018) and create supply-side economies of scope in production. Such economies of scope are possible globally by means of joint task performance or division of labor via platforms, allowing global "access to a variety of goods and services" (Cusumano et al., 2019). In line with the resource-based view (Peteraf, 1993; Peteraf & Barney, 2003), complementarities result from the critical VRIN (valuable, rare, inimitable and non-substitutable) resources (Barney, 1991) of the partner companies. On a global level, this enables a transformation of value creation through "resource combination in foreign markets" (Nambisan & Luo, 2021).

In addition, there are complementarities in consumption (Jacobides et al., 2018). According to the service-dominant logic (Vargo & Lusch, 2004; 2008), these are explained by demand-side economies of scope via value co-creation with customers. Since transaction ecosystems foster the exchange with global customers through platforms, value co-creation with these customers is possible by adapting to their wishes and incorporating their suggestions for improvement (Nambisan & Luo, 2021).

Viewed from a scaling in the network, digital platforms enable economies of scale (Gawer, 2021). While supply-side economies of scale play a key role in limiting costs, economies of scale on the demand side arise from network effects (Agarwal et al., 2023) between market and hierarchy, including across global platforms (Iansiti & Lakhani, 2020). On this basis, network externalities can be justified (Rietveld & Schilling, 2021), in which the benefit of an individual or organization from a good depends on the number of other users of that good (Dai, 2023). Thus, digital platforms can be seen as an enabler or accelerator of scaling across borders with limited costs for cross-border transactions (Tippmann et al., 2023).

On digital platforms, it is also possible to manage prices (Weyl, 2010) and quantities on multiple sides separately by pricing in multi-sided markets (Cusumano et al., 2019). One side can be subsidized where it is advisable to subsidize the more price-sensitive side of the network and to switch the side that increases its demand more in response to the growth of the other side (Eisenmann et al., 2006). In this way, pricing on digital platforms contributes to distributing additional costs among the partners.

Enabled by increasing amounts of data, digital platforms can benefit from data-based learning, for which the potentials of artificial intelligence need to be decisively exploited (Iansiti & Lakhani, 2020). Data can thus be used for scaling, continuous improvement and to create something new (Verganti et al., 2020). These learning effects create an adaptation mechanism in the dynamic stability of the ecosystem, in that permanent learning is used to adapt to changes or to compensate for outflowing knowledge. Thus, learning effects are a prerequisite for strategic flexibility (Rialti et al., 2020) and for a high degree of automation (Raisch & Krakowski, 2021) within these platforms, which promotes asset-light paths in companies.

Despite all the advantages of digital platforms, it should be noted that there is a risk of resources and capabilities being diverted to the partners in the network (Sommer, 2022). This is particularly critical when companies operate in a situation of cooperation with competitors (Hannah & Eisenhardt, 2018) in the sense of "coopetition" (Bengtsson & Raza-Ullah, 2016). Accordingly, limiting the outflow of capabilities to partners, especially to competitors, is necessary (Krylova et al., 2016) through effective governance in transaction ecosystems (Chen et al., 2022; Dyer et al., 2018). This is possible, for example, through rules and regulations, including data security and access to platforms (Cusumano et al., 2019).

3. Hypotheses

In the IB literature, the existence of motivational tensions in connection with internationalization processes is discussed between global and local activities (van Tulder, 2015), with, for example, tensions between headquarters and subsidiaries being identified

(Ambos et al., 2020). Recent developments in the corporate environment of MNEs are leading to increased discussions about the de-internationalization of companies (Tang et al., 2021). It can therefore be assumed that companies are under pressure from various stakeholders to increase sustainability and pursue asset-light strategies, among other things. As a result, there are increasing calls for a reduction in global supply and value chains, especially considering the recent crises. Although the risks in supply chains due to increasing dynamics, uncertainty and man-made as well as naturally occurring crises have long been recognized (Singhal et al., 2011), the importance of resilience (Hillmann, 2021) to these risks is now becoming more widely acknowledged. On the other hand, however, the benefits of investing in international activities still exist and new growth markets reveal great potential (Cui et al., 2014). Thus, companies have to make trade-offs with regard to their global strategies and are subject to tensions. These considerations are also supported by Heucher et al. (2024), who see the emergence of knotted tensions as a result of the sustainability transformation, especially in the context of global strategies in MNEs.

Accordingly, a strongly perceived "(de-)internationalization paradox" can be supposed in MNEs, arising from tensions between investing in new growth markets and scaling back international activities. This raises the first hypothesis:

H1: MNEs are experiencing a high degree of paradoxical tensions between motives to expand into new country markets and to scale back international operations.

There are various approaches to reacting to paradoxical tensions on the basis of paradox theory (Lewis & Smith, 2022). For the "(de-)internationalization paradox", approaches from the "both-and" category, which offers the use of mitigation solutions (Berti & Simpson, 2021) or mediation solutions (Michaud, 2014), are suitable. The use of digital platforms (Gawer & Cusumano, 2014; Kapoor et al., 2021) can create online marketplaces for the managed exchange of goods, activities and assets in transaction ecosystems (Rochet & Tirole, 2003), even globally (Nambisan et al., 2019). Enabled by the several platform effects (Hagiu & Rothman, 2016), exchange processes can be optimized across national borders in this context. For example, platforms strengthen standardization on a global level (Loonam & O'Regan, 2022) as well as interfaces between individual business activities along value chains (Cano-Kollmann et al., 2016). In this way, they reduce transaction costs (Deng et al., 2022; Hagiu & Wright, 2015), including the costs of cross-border transactions (Tippmann et al., 2023). Digital platforms further help as companies often lack the complementary resources which they need in addition to their own ones, to expand into foreign markets (Cuervo-Cazurra et al., 2007). By collaborating with complementary partners on digital platforms in transaction ecosystems (Jacobides et al., 2018), companies can obtain and share the resources they require to operate successfully in foreign markets (Nambisan & Luo, 2021). In this context, supply-side economies of scope can arise within digital platforms, which can be decisive in further increasing efficiency and they thus contribute significantly to reducing investment costs when reaching foreign markets. Moreover, network effects offer, for example, the strategic opportunity to reach new customers across national borders (Banalieva & Dhanaraj, 2019) quickly and without additional costs via platforms and thus allow for easy and cost-neutral scaling on the demand side (Dai, 2023).

These platform effects therefore enable "making business scalable flexibly without investments in heavy assets" internationally (Cha, 2020). Just as globalization in the 1990s was driven by falling transport, travel and communication costs, the exchange via digital platforms today is driving the possibilities of new forms of global cooperation (Meyer et al., 2020). In this way, transaction platforms could counterbalance the paradoxical tensions described above and enable MNEs to benefit from new international markets without having to invest heavily in these markets and build up local activities. Against this background, it can be assumed that the more strongly companies are affected by the paradoxical tensions, the more likely it is that they will seek and apply mediation solutions and thus use digital platforms that could offer such a solution. This poses the next hypothesis:

H2: The higher the degree of paradoxical tensions between motives to expand into new country markets and to scale back international operations, the greater the use of transaction ecosystems based on digital platforms in MNEs.

According to paradox theory, the success of companies increasingly depends on how they are able to address contradictory requirements (Smith & Tracey, 2016). It can therefore be assumed that the mediation of the paradoxical tensions through joint value creation in transaction ecosystems has a positive influence on the success of companies.

Explanations of joint value creation in ecosystems are based on game theory explanations using biform games (Brandenburger & Stuart, 2007; Ross, 2018), according to which the participating partner companies autonomously contribute value creation activities in a non-cooperative phase and negotiate about how the added value will be shared in the cooperative phase. Thus, the success of the ecosystems as a mediation solution could be reflected in the form of relational rents (Dyer et al., 2018; Lavie, 2006), which Dyer & Singh (1998) define as "supernormal profit jointly generated in an exchange relationship that cannot be generated by either firm in isolation and can only be created through the joint idiosyncratic contributions of the specific alliance partners”. This is because ecosystems make it possible to generate rents from global customers who can only be reached in cooperation with partners from foreign markets via transaction platforms. This gives rise to the first hypothesis on success in companies:

H3: The greater the use of transaction ecosystems based on digital platforms in face of paradoxical tensions related to international operations, the higher the relational rents in MNEs.

In addition, a growth in a company’s success as a result of platform use could be reflected in the form of increased performance (Kumar et al., 2022), since the effects of digital platforms (Hagiu & Wright, 2015) reduce costs and the loss of value of resources.

In MNEs, resources can already be transferred between several subsidiaries (Patriotta et al., 2013). Unfortunately, resources as well as competences (Prahalad & Hamel, 1990) and capabilities (Gaur et al., 2019) are generally classified as quasipublic goods (Buchanan, 1965), which, contrary to public goods (Morgan & Tumlinson, 2019), are not transferrable as often as desired (Zander & Kogut, 1995). Being integrated into complex processes and routines (Bloodgood, 2019) and with each reuse therefore causing high transaction costs (Burmeister et al., 2016), the transferability of these resources is constrained. Via digital platforms, however, complementary resources (Dyer et al., 2018) within the transaction ecosystem can be considered public goods, with low transaction costs at best, also globally (Nambisan & Luo, 2021). In this context, if more than two partners share stable information on digital platforms, their interaction increases (Gawer & Cusumano, 2014) and joint solutions are likely to be even more successful (Autio et al., 2021; Benner & Waldfogel, 2023). This is due to the fact that platforms enable companies to limit the loss of value of the transferred resources and capabilities through effective governance (Chen et al., 2022). Rules and norms help to set a common standard, as foreign markets vary greatly due to cross-cultural differences (Stallkamp & Schotter, 2021). As a result, the performance should increase due to the use of platform-based ecosystems, for example through optimized global customer search, the company’s worldwide presence and the immediate transmission of information (Deng et al., 2022), even with a high number of cross-border transfers (Tippmann et al., 2023). This justifies a further hypothesis with regard to success:

H4: The greater the use of transaction ecosystems based on digital platforms in face of the paradoxical tensions related to international operations, the higher the performance in MNEs.

4. Methodology

The hypotheses have to be validated by a quantitative study and include several variables that are linked by multivariate correlations and can be statistically tested by a causal analysis. Causal analyses with latent variables can be carried out using structural equation modeling (SEM). Through the simultaneous combination of factor analyses and regression approaches (Haenlein & Kaplan, 2004), such SEM methods allow a comparatively simple discussion of complex relationships and models (Dash & Paul, 2021), which would not be possible using regression analysis exclusively. With covariance-based SEM (CB-SEM), and SEM with partial least squares (PLS-SEM), two main types of SEM are available for statistical analyses (Cepeda-Carrion et al., 2019). In business research, particularly in the context of often complex issues in IB (Richter et al., 2022), PLS-SEM has become established for the estimation of causal models containing latent variables (Henseler et al., 2015). The superiority of PLS-SEM is particularly emphasized for the investigation of mediation effects (Sarstedt et al., 2020), such as those present in this article. In addition, this form of structural modeling provides reliable results even with relatively small samples in large models (Vaithilingam et al., 2024). Accordingly, the PLS-SEM approach is used for this study.

4.1. Variables

The individual variables were operationalized (Table E-1) so that they can be measured (Eisend & Kuß, 2017) in a survey and later transferred to a structural equation model. The variables used to determine the paradoxical tension between internationalization and de-internationalization are constructs for the opposing poles. In order to ensure sufficient reliability and validity, it has become established in research to use at least three indicators per construct. The internationalization side was therefore operationalized through motives for investing in international operations in order to gain access to growth markets [Int1] and to adapt to different customer requirements [Int2] and intercultural characteristics [Int3]. The de-internationalization side, in contrast, was operationalized via motives for withdrawing from foreign markets with the aim of reducing capital requirements and acting in an asset-light way [De-int1] as well as reacting to rising nationalism [De-int2] and increasing sustainability [De-int3] within the company. It should be noted that international operations were not further specified in this context, for example, as different modes (such as trade via exports or imports and production via outsourcing or foreign direct investment) or different regions or countries to calculate the international footprint (Békés et al., 2021) or a transnationality index (Buigues et al., 2015; Casella & Formenti, 2018). Using a seven-point Likert scale (Dolnicar & Grün, 2013), the variables were captured from "Does not apply at all" (1) to "Fully applies" (7).

The use of digital platforms in transaction ecosystems is included in the model as a latent variable and therefore as a construct that cannot be measured directly. This construct is calculated from observable indicators within the framework of structural equation models (Hair et al., 2017). The use of digital platforms was therefore determined via indicators in the form of latent variables that arise from the various platform effects. In line with the previous literature review, modularization [Modul], (supply-side) complementarities [Complement], value co-creation with customers [Co-Creation], network effects [Network], pricing [Pricing], data-based learning [Learning] and limitation of the outflow of resources and capabilities [Limit] were included, as all of these indicators are relevant for recording platform utilization in the face of tensions. The seven variables are formative as they form the construct together as indicators and are not manifestations of the construct, as is the case with reflective variables (Diamantopoulos et al., 2008). In this context, these indicators were selected in such a way that they extend the impact of the platform effects to the special framework conditions of the paradoxes between the internationalization and de-internationalization of companies. The variable modularization across transaction platforms in an ecosystem [Modul] draws, for example, on sources of modularization (Baldwin & Clark, 1997; Jacobides et al., 2018), but also considers the specificities of globally used transaction platforms (Cusumano et al., 2019; Nambisan et al., 2019; Rochet & Tirole, 2003). Again, the indicators were formed using a seven-point Likert scale ranging from "Does not apply at all" (1) to "Fully applies" (7).

Success was also operationalized with formative scales, on the one hand, by relational rents [Rents] (Dyer & Singh, 1998; Dyer et al., 2018) according to Lavie (2006), as revenues that in part no longer have to be shared [Rents1] as well as revenues that are distributed among the partners through fixed agreements [Rents2] and negotiations [Rents3]. A seven-point Likert scale from ("Does not apply at all") to 7 ("Fully applies") was again used for this purpose. On the other hand, a record is made of the potential improvement in a company's performance [Performance] by collaboration in transaction ecosystems via global transaction platforms. To this end, variables were used to capture the increase in profitability [Perf1] (Kumar et al., 2022), the share of total revenues achieved with such collaboration [Perf2] (Wang et al., 2021) and cost savings [Perf3] (Ramanathan & Gunasekaran, 2014), all on a seven-point Likert scale from 1 (0%) to 7 (>25%). Finally, the amount of revenue, the number of (full-time) employees and the number of countries in which a company operates were surveyed as control variables. The operationalization results in a formative research model.

Table E-1: Operationalization of the variables

Construct	Indicator	Operationalization	Source
Paradoxical tensions related to international operations [Tensions]	Motives for internationalization [Int1]	Consistent investment in markets outside Europe, North America and Japan to secure access to these growing markets.	Narula & Dunning, 2000; Ghauri et al., 2021
	Motives for internationalization [Int2]	Consistent investment in markets outside Europe, North America and Japan to meet the diverse customer needs there.	
	Motives for internationalization [Int3]	Consistent investment in markets outside Europe, North America and Japan to meet the cross-cultural specificities there.	
	Motives for de-internationalization [De-int1]	Consistent reduction of international operations to reduce capital intensity (according to “asset-light” strategies).	Cha, 2020
	Motives for de-internationalization [De-int2]	Consistent reduction of international operations to meet the rising nationalism in many countries.	Buckley, 2020
	Motives for de-internationalization [De-int3]	Consistent reduction of international operations to meet the increasing demands for sustainability.	Ghauri et al., 2021
Digital Platforms in transaction ecosystems (Cusumano et al., 2019; Nambisan et al., 2019; Rochet & Tirole, 2003) [Platform]	Modularization [Modul]	Improving international activities through exchange with partners via digital platforms with clear interfaces.	Baldwin & Clark, 1997; Jacobides et al., 2018
	Complementarity [Complement]	Improvement of international activities through task sharing with complementary partners via digital platforms.	Milgrom & Roberts, 1990; Jacobides et al., 2018
	Co-creation [Co-Creation]	Improvement of international activities through exchange with worldwide customers via digital platforms in the partner network.	Vargo & Lusch 2004; 2008
	Network [Network]	Improvement of international activities through new customers in other country markets, which can be won in the network via platforms at minimum costs.	Rietveld & Schilling, 2021
	Pricing [Pricing]	Improvement of international activities through cross-subsidization of customers in individual country markets via digital platforms in partner networks.	Eisenman et al., 2006; Cusumano et al., 2019
	Learning [Learning]	Improving international activities through joint learning via digital platforms in partner networks.	Iansiti & Lakhani, 2020
	Limiting [Limit]	Improving international activities by limiting the outflow of resources and skills to network partners via digital platforms.	Krylova et al., 2016

4.2. Conduct of the survey

A standardized questionnaire was developed to conduct the research. Whether the questionnaire would be properly understood was evaluated by a pre-test with 20 companies, which checked the comprehensibility of the operationalization and question formulations to ensure the validity of the survey (Hair et al., 2017). The reliability of the survey was secured by programming the online questionnaire as user-friendly as possible.

The survey was conducted using an online questionnaire completed by automotive companies (OEMs and suppliers) with their headquarters in countries with an important automotive industry in Europe, North America or Asia and with revenues of more than $50 million. Focusing on one industry had the advantage of increasing the comparability of companies, since industry effects were eliminated (Miozzo & Yamin, 2012). The automotive industry was chosen because it is particularly capital-intensive, characterized by global supply chains and subject to growing conflicts of interest (Munten et al., 2021; Teece et al., 2016). A total of 3,000 automotive companies were contacted in April and May 2022. 456 companies participated in the study. 125 of these companies had to be eliminated due to incompleteness or undifferentiated response behavior (for example, if a scale value of 4 was always indicated).

To ensure that the companies surveyed had a sufficient ecosystem orientation, four questions on the ecosystem criteria according to Adner (2017) were included in the questionnaire, which were used as exclusion criteria. Accordingly, of the remaining 331 companies, a further 45 companies (13.6%) were eliminated as they showed a lack of ecosystem focus (i.e., they answered the four questions on the ecosystem criteria with “I do not agree at all” (scale value 1) or with “I do not agree” (scale value 2)). In this way, data from 286 companies was generated for the next analysis stage. The response rate was 9.5%. The contacts were people from the strategy or organization departments of the companies in question. For smaller companies, the CEO or a member of the management board was requested to participate in the survey.

A PLS-SEM algorithm (Henseler et al., 2015) in the Smart PLS4 software was used to estimate the structural model (Figure E-1) with the collected data of the included variables. Additionally, the reliability and validity of the variables and the model (Hair et al., 2020) as well as the significance of the path coefficients were checked. To this end, the bootstrapping method was performed as a two-tailed test at a significance level of 0.05 with 5000 samples.

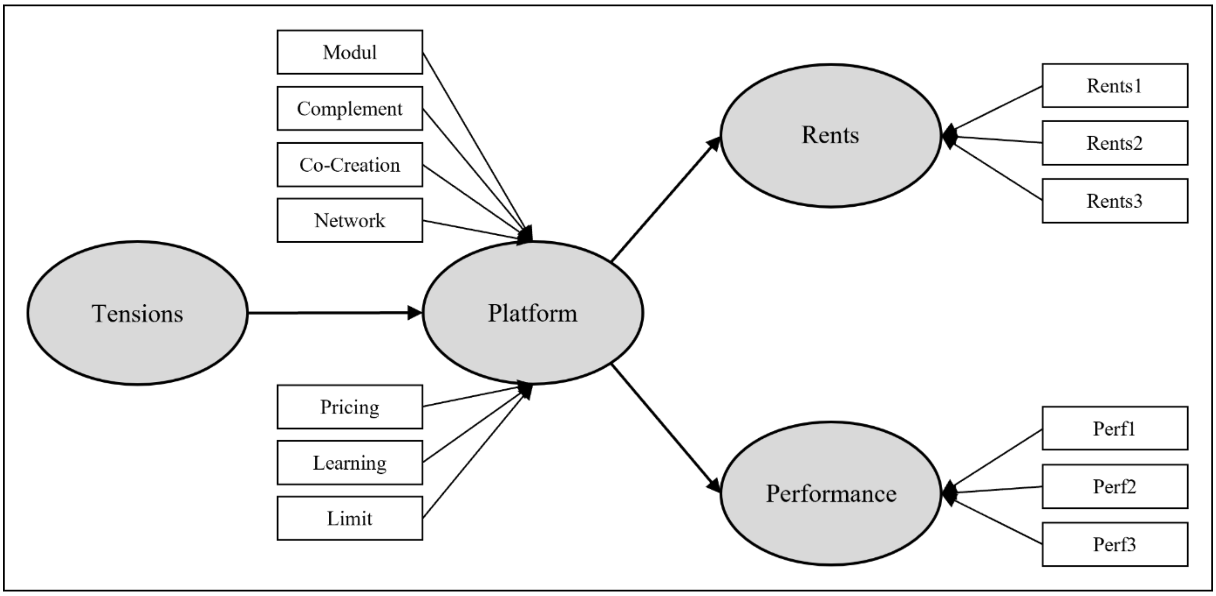

Figure E-1: Structural model
(Own compilation)

Since the PLS-SEM algorithm is not suitable for calculating the extent of the paradox, a different approach had to be chosen in a first step to determine this variable. For this purpose, mean values for the side of internationalization [Int-mean] and the side of de-internationalization [De-int-mean] were first formed from the variables consisting of motives for further internationalization [Int1, Int2, Int3] and for withdrawal from foreign markets [De-int1, De-int2, De-int3]. As the mean values of these two opposing poles contrast with each other, the desired magnitude of the extent of the paradoxical tension that arises between these two poles cannot be formed by a further mean value between these values. Instead, the mean values of both poles were divided into the three categories “weak” (mean values from 1 to 3), “medium” (mean values from 3 to 5) and “strong” (mean values from 5 to 7), which represent weak, medium and strong motives for investing in foreign markets or scaling back international operations. Based on the two opposing poles, a new variable was then determined, which represents the extent of the perception of the paradoxical tensions [Tensions] with a range of 1 to 4. This perception of paradoxical tensions by companies was classified as strong (4) if the motives for both poles are “strong”, medium (3) if the motives for one pole are “strong” and for the other “medium”, weak (2) if the motives for both poles are “medium”, and not present (1) if the motives for at least one of the two poles are “weak”. Accordingly, the variable of paradoxical tensions was later included in the structural equation model without underlying variables.

5. Results

Out of the 286 companies from the automotive industry surveyed, 50% (143 companies) have their headquarters in Europe (Germany, Spain, France, Italy, Poland or UK), 32.9% (94 companies) in North America (USA, Canada or Mexico) and the remaining 17.1% (49 companies) in Asia (Japan, South Korea and China).

Of these, 3% are automotive manufacturers (OEMs), the remaining 97% are suppliers, so 111 (38.8%) companies have revenues below $1bn (17 or 5.9% between $50m and $100m) and 103 (36%) have revenues between $1bn and $5bn. In 72 companies (25.2%) the revenues are $5bn or higher. The distribution of (full-time) employees is similar. 144 (50.3%) of the automotive companies surveyed have fewer than 10,000 employees, 87 (more than 30%) have between 50,000 and 10,000 employees and only 55 companies (19.7%) have more than 50,000 employees. This is in line with the result that 174 of the companies surveyed (60.8%) deal with between two and 10 foreign markets, 48 (16.8%) between 11 and 30 foreign markets, 42 (14.7%) between 31 and 100 foreign markets and only 22 companies (7.7%), Tier 1 suppliers and OEMs in particular, deal with over 100 foreign markets. An overview of the mean values and standard deviations of the variables surveyed in these companies is given in Table E-2.

Table E-2: Results of the survey

Group	Variable	Mean	SD	Min	Max
Internationalization	Int1	5.300	1.350	1	7
	Int2	5.390	1.320	1	7
	Int3	5.320	1.400	1	7
	Int-mean	5.340	1.190	1	7
De-internationalization	De-int1	4.900	1.590	1	7
	De-int2	4.790	1.640	1	7
	De-int3	5.120	1.610	1	7
	De-int-mean	4.940	1.480	1	7
Paradoxical tensions	Tensions	3.180	1.100	1	4
Digital platform	Modul	5.180	1.260	1	7
	Complement	5.200	1.270	1	7
	Co-Creation	5.540	1.220	1	7
	Network	5.410	1.190	1	7
	Pricing	5.370	1.210	1	7
	Learning	5.350	1.220	1	7
	Limit	5.370	1.290	1	7
Rents	Rents1	5.270	1.180	1	7
	Rents2	5.330	1.220	1	7
	Rents3	5.420	1.140	1	7
Performance	Perf1	3.810	1.530	1	7
	Perf2	3.700	1.440	1	7
	Perf3	3.510	1.460	1	7

Notes: SD = Standard deviation; Min = Minimum; Max = Maximum

Regarding international operations, the results show that the companies' motives for further investing in new markets are slightly stronger (Int-mean = 5.34) than the motives for scaling back international operations (De-int-mean = 4.94). All internationalization variables achieve similarly high values. This shows how important these new growth markets are for automotive companies and that these companies cannot afford to leave the sales potential and other advantages they expect to gain in foreign markets unexploited. However, the variables on the motives for de-internationalization also achieved high results, with the intention to increase sustainability (De-int3 = 5.12) having the highest value.

This means that both poles are very pronounced in their average values, which matches the results on the extent of the perceived paradoxical tensions. As the distribution in Figure E-2 shows, more than half of the companies surveyed perceive strong paradoxical tensions between investing in new growth markets and scaling back international operations, while only 14% experience no tensions at all. In this context, the sample shows a high average score of 3.18 for recognized tensions, on the scale from 1 (no perception of tensions) to 4 (strong perception of tensions). Thus, hypothesis H1 on the extent of paradoxical tensions can be confirmed, since the surveyed variables of both poles, internationalization and de-internationalization, as well as the formed variable on the extent of tensions, show significant values.

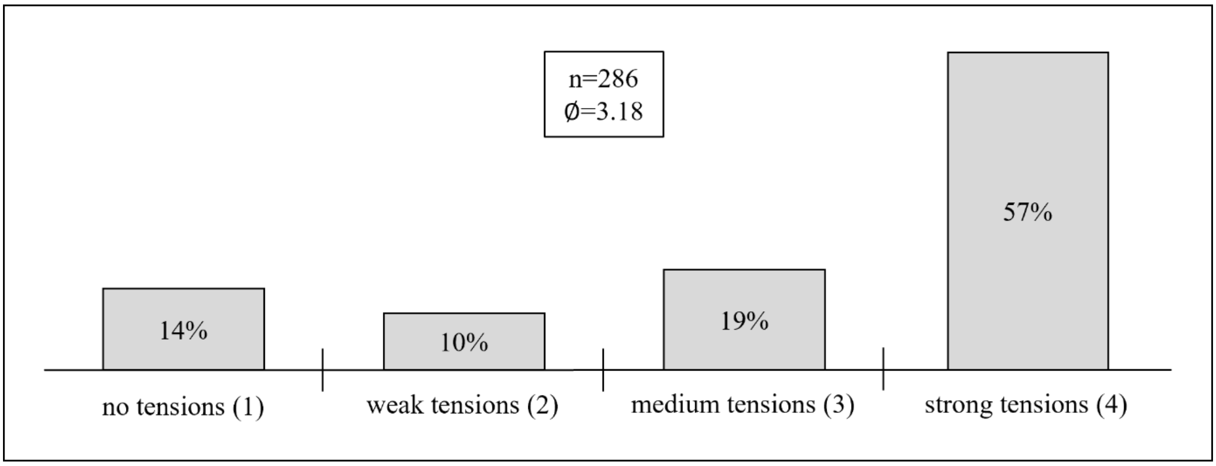

Figure E-2: Extent of paradoxical tensions related to international operations
(Own compilation)

With regard to the structural model, criteria were examined to verify the validity and reliability of the variables and the model. The variance inflation factor (VIF) can be used to rule out a potential collinearity problem (Diamantopoulos et al., 2008), as the VIF for all variables is between about 1 and 3 and therefore well above the recommended minimum value of 0.2 and well below the recommended upper limit of 5 (Hair et al., 2017). In the evaluation, criteria such as the Standardized Root Mean Square Residual (SRMR = 0.033 < 0.08) and the Normed Fit Index (NFI = 0.969 > 0.9) also indicate a very good model fit. According to Hair et al. (2017), the outer weights are the primary criterion to evaluate the relative importance of indicators in formative measurement models.

The results relating to indicators in the PLS-SEM are summarized in Table 3. The calculation of the PLS-SEM model shows that, with a value of 0.629, there is a high path coefficient between the variable paradoxical tensions and the latent variable for the use of digital platforms (Tensions → Platform). With a p-value of 0.000, this coefficient is highly significant. Hypothesis H2 and thus the use of such platforms as a mediation solution for paradoxical tensions in relation to international operations can therefore be confirmed. The coefficient of determination R^2 for the latent platform variable is 0.395 and thus clearly exceeds the threshold value of 0.26 demanded by Cohen (1988) for the explained variance in order to be considered substantial.

Each of the seven manifest variables, which were operationalized via the platform effects, has a positive influence on the latent platform variable (Table E-3). The platform effects of limiting the outflow of resources and capabilities (Limit → Platform), modularization (Modul → Platform) and complementarity (Complement → Platform) have the highest outer weights and can be demonstrated with a significance level of $p < 0.01$. However, the effects of data-based learning (Learning → Platform), pricing (Pricing → Platform) and value co-creation with global customers (Co-Creation → Platform) have to be discarded because the three outer weights are not significant (all three p-values > 0.05).

Table E-3: Results relating to the indicators of the PLS-SEM

Latent variable	Indicators	Outer weights	P-value	VIF
Platform	Modul → Platform	0.293**	0.000	2.396
	Complement → Platform	0.246**	0.000	2.250
	Co-Creation → Platform	0.087	0.203	1.928
	Network → Platform	0.116	0.072	1.979
	Pricing → Platform	0.078	0.236	2.323
	Learning → Platform	0.002	0.973	2.427
	Limit → Platform	0.398**	0.000	2.139
Rents	Rents1 → Rents	0.292**	0.000	1.721
	Rents2 → Rents	0.481**	0.000	1.657
	Rents3 → Rents	0.416**	0.000	1.611
Performance	Perf1 → Performance	0.357	0.675	2.921
	Perf2 → Performance	1.148	0.241	2.543
	Perf3 → Performance	-1.340	0.221	2.481

Notes: ** significant at a level of 0.01

The study further confirms that greater use of transaction platforms in ecosystems in the face of tensions relating to international operations will increase companies' success. A significant path coefficient of 0.751 ($p = 0.000$; $R^2 = 0.563$) was calculated from platform use to relational rents (Platform → Rents) regarding the impact on success in companies. However, the other results show that the impact of platforms on performance (Platform → Performance) is not significant ($p = 0.488$; $R^2 = 0.009$). Thus, the performance, neither in terms of profits nor costs, has so far been influenced using platforms as a mediation solution. Accordingly, only hypothesis H3 on the positive influence on relational pensions can be confirmed, while hypothesis H4 on the influence on performance must be rejected. These results are also supported by the effect sizes f^2, which, according to Cohen (1988), expresses a large effect of independent variables on dependent variables in SEM starting at a value of 0.35. The results relevant to the hypotheses tested via PLS-SEM (H2, H3 and H4) are summarized in Table E-4.

Table E-4: Results relating to the hypotheses tested in PLS-SEM

Path	Path coefficient	P-value	R^2	f^2	Hypotheses
Tensions → Platform	0.629**	0.000	0.395	0.653	H2 confirmed
Platform → Rents	0.751**	0.000	0.563	1.290	H3 confirmed
Platform → Performance	0.097	0.488	0.009	0.009	H4 rejected
Notes: **significant at a level of 0.01					

By including the control variables, the results on the use of platforms in the face of paradoxical tensions are further validated. When calculating an alternative model in which, next to the path from tensions to platform, three further paths to platform use are added from the control variables of number of employees, amount of revenue, and number of operating countries, the correlation between the paradoxical tensions and the platforms remains very high with a path coefficient of 0.58. In this model, the number of employees has no significant influence, the number of operating countries has a weak negative influence (path coefficient -0.17), and the amount of revenue has a slightly positive influence (path coefficient 0.21) on platform use.

6. Discussion and implications

6.1. Discussion of results

The study shows that the companies surveyed in the automotive industry as a traditional, global industry largely have the topic of building ecosystems on their agenda. At the same time, however, it has become obvious that the companies are not allowing themselves to be pushed into dismantling their global structures by crises, nationalization tendencies, supply chain problems, the need for sustainability or the high volatility in capital markets. More than 85% of the 286 companies from the study perceive at least partial tensions between the need for asset-light strategies and a reduction of international operations on the one hand and investment in the expansion of international activities in growing markets outside the triad on the other hand. However, they are seeking solutions to deal with this paradox. Digital platforms are an active problem-solving opportunity for MNEs, not just a reaction to changes in the competitive environment. Kafouros et al. (2022) distinguish between voluntary and forced de-internationalization and re-internationalization in this respect. MNEs are already striving for asset-light internationalization, since otherwise a negative effect on performance in the medium term is certain in any case with regard to the external circumstances.

However, the results show that digital platforms in transaction ecosystems have not yet had a major impact on the performance of automotive companies. This can be partly explained by the fact that automotive companies were heavily affected by the crises of the Ukraine war and the COVID-19 pandemic in 2022. Another explanation is that automotive companies, as "traditional" companies, are only just beginning to make greater use of the opportunities offered by digital platforms. This is because although the added value of digital platforms is known, the diffusion and adoption of these platforms in companies' processes is not automatically guaranteed and they usually have to be introduced gradually (Vega & Chiasson, 2021). The influence of digital platforms on the performance of companies from other sectors is likely to be significantly more positive in some cases. For example, companies from the IT sector such as Google or Meta, which have been relying on platform solutions for some time or have already built their offerings on them from the outset, have more experience in exploiting platform effects for themselves (Hartmann & Henkel, 2020).

In this context, the study shows that complementarity, limiting the outflow of resources and capabilities as well as modularization, are currently playing an important role in the development of transaction platforms, as companies are already taking actions in these areas. However, they are not yet tackling pricing, value co-creation with the customer and data-based learning. This fits with the results relating to success, according to which relational rents are already significantly higher today than performance. This is because, according to Dyer & Singh (1998) and Dyer et al. (2018), relational rents are based on complementary resources and capabilities and effective governance (limiting the capability drain), complemented by interfirm relation-specific assets and interfirm knowledge-sharing routines (Weber et al., 2016), which support complementarity and governance. Improving performance through collaboration in platform-based ecosystems also requires, among other things, value co-creation together with the customer and data-based learning.

6.2. Implications for research

The results from this study contribute to the existing research on paradoxical tensions in (international) management (Heucher et al., 2024; Lewis & Smith, 2022), in particular to research dealing with the mitigation of contradictory yet interrelated poles through a "both-and" approach (Berti & Simpson, 2021). In this context, it could be shown that digital platforms in transaction ecosystems are used as a third variable to balance and mediate the tensions between contrasting motives for further internationalization and for de-internationalization. In contrast to a determination of core values, which mediates the conflict about shared cultural values between a parent company and subsidiaries as a result of multiple embeddedness (Meyer et al., 2011) on a sub-level (Proff, 2018), the tensions are addressed here on the higher cross-company level of ecosystems based on digital platforms. These considerations should be further investigated. Digital platforms in ecosystems differ from the product platforms, which have been increasingly used in the automotive industry in recent decades in the sense of shared use of physical components (Agrawal et al., 2013), since they are less capital-intensive and they help to pursue asset-light strategies.

The results also contribute to the existing research on the “paradigm shift in the global strategy of MNEs towards business ecosystems” (Cha, 2020) across country borders (Tippmann et al., 2023), in particular using transaction platforms (Nambisan et al., 2019). However, there is still a lot of research to be done on how the paradigm shift can succeed, even if more research has already been undertaken than is being translated into action in corporate practice. This is because, although the companies surveyed are not yet addressing all platform effects sufficiently, a great deal of research is already being carried out on these issues (Hagiu & Rothman, 2016).

However, the possibilities of effective governance seem to have been much less thoroughly explored than their significant influence on digital platforms and the relatively high relational rents of the companies surveyed would suggest. Specifically, further consideration needs to be given to the implementation and protection of the outflow of resources and capabilities to partners who are competitors outside the network (Krylova et al., 2016). This requires stronger wiring of effective governance mechanisms (Cusumano et al., 2019; Dyer et al., 2018). That is why Gawer (2021), for example, demands a deeper look inside the joint value creation and value capture in global transaction ecosystems, followed by Adner (2021), who calls for more research on value capture by the partners in a transaction ecosystem between their own business model optimization and maximization of the joint ecosystem effects.

The still low impact of the use of digital platforms in ecosystems on performance, given the paradoxical tensions related to international operations that emerge from the study, also justifies the importance of further research to study the design and alignment of ecosystems over time (Dattée et al., 2018). This involves a dynamic perspective on how minimum viable ecosystems can be built and can then improve performance, for example, by incubating, identifying and integrating stakeholders (Rong et al., 2015). In addition, the role of the location of MNEs' head office should be examined more closely in this context, since Stallkamp & Schotter (2021), for example, emphasize the influence of cultural differences as well as of geographic distance.

Finally, there should also be further investigation of the potential significance of ecosystems for existing IB theories (Cha, 2020), for example because the theory of internalization (Buckley & Casson, 1976) now needs to be linked with network theory (Buckley, 2020; Nambisan & Luo, 2021). Instead of the ownership, localization and internalization (OLI) advantages in the eclectic theory of Dunning (1979), "ecosystem-specific advantages" are now possible (Li et al., 2019; Nambisan et al., 2019; Nambisan & Luo, 2021), as described, for example, by Luo (2021) with open resource, linkage and integration (new OLI) advantages for digital globalization.

6.3. Implications for practice

Moreover, several practice-related implications can be drawn from the study. MNEs should face up to the conflicting goals in international management and not hastily follow the demands for an exclusive focus on domestic markets in view of the tendency towards de-globalization (Buckley, 2020; Petricevic & Teece, 2019). As the study shows, the use of digital platforms in transaction ecosystems at a global level makes it possible to realize asset-light internationalization (Mees-Buss et al., 2019; Meyer et al., 2020) with reduced physical presence in geographically distant markets and defuse paradoxical tensions associated with international operations.

Therefore, capital-intensive MNEs need to focus on using ecosystems to their full potential. Value co-creation with global customers and data-based learning have to be implemented more intensively in the future in light of this. To this end, companies must exploit the possibilities of artificial intelligence (Verganti et al., 2020) for optimized use of existing data, which could improve learning from customers, suppliers and other stakeholders and thus simplify scaling on a global level as well. Furthermore, even if MNEs have already started to establish governance, they should improve its effectiveness, to, among other things, increase trust (Vahlne & Johanson, 2021), reduce conflicts within the ecosystem (Wareham et al., 2014), and urgently address all current and future results of the ecosystem research. For example, rules are important, such as regulations on platform access and data protection (Cusumano et al., 2019). In the process, MNEs need to address conflicts between improved transferability of skills and competencies (Patriotta et al., 2013) and protection against their unwanted outflow (Krylova et al., 2016; Sommer, 2022) particularly strongly (Contractor, 2022).

Finally, MNEs should also think about using innovation platforms as a venue for innovation (Cusumano et al., 2019; Gawer, 2021) in innovation ecosystems (Dattée et al., 2018), particularly because there is an increasing need for them to exploit technological opportunities beyond digital platforms. For example, companies in the automotive industry should deal with the shift towards technologies related to connectivity, autonomous driving, shared mobility and electrified powertrains (CASE) (Adner & Lieberman, 2021).

7. Limitations and conclusion

This article shows that paradoxical tensions exist between the motives for entering new growth markets (pole of internationalization) and motives for scaling back international operations for the purpose of asset-light strategies and an increase in sustainability (pole of de-internationalization) and these are perceived to a high degree by companies in the automotive industry. It is further shown that digital platforms in transaction ecosystems can reduce these paradoxical tensions in IB, thereby achieving relational rents. Since these ecosystems are just emerging in the automotive industry analyzed in this study, no performance impact is yet apparent. However, as this impact may be possible in the future, further research on this topic is important.

The general validity of the present study's results is limited mainly by the fact that only companies from the automotive industry and therefore from one sector are considered. Although paradoxical tensions with regard to international operations were to be expected in this capital-intensive industry and the elimination of effects between different industries facilitated the analysis (Miozzo & Yamin, 2012), tech companies such as Google and Apple already rely much more on platform-based ecosystems and are largely taken into consideration in the ecosystem literature (Adner, 2021; Gawer, 2021; Jacobides et al., 2018). Apple, for example, facilitates exchanges between app providers and users that complement one another in the Apple operating system (iOS), making it highly valued by capital markets (Gawer & Srnicek, 2021). In capital-intensive industries, asset-light strategies are likely to conflict not only with investments in international operations but also with the necessary investments in new technologies (Adner & Lieberman, 2021) and the associated digital transformation (Autio et al., 2021).

Another limitation of the study is that it was only carried out at one point in time in spring 2022. An analysis over time (comparative static or preferably dynamic) would allow the developments of platform effects to be examined. Thus, a dynamic consideration of the designing and aligning of ecosystems (Dattée et al., 2018) is important. To this end, the argumentation about the "(de-)internationalization paradox", leading to the use of platform-based ecosystems as a mediation solution, could be supplemented by different approaches. For example, the results could be validated by providing direct empirical evidence with statistical data on at least two different points in time to examine whether the number of value-adding foreign subsidiaries increases or decreases.

The study is also limited because "international operations" are considered in an undifferentiated way. A further study should take a closer look at foreign entry modes and regions or the degree of transnationality (Buigues et al., 2014; Cassella & Formenti, 2018) and thus a company's "international footprint" (Békés et al., 2021). To what extent reshoring is forced by external pressure or follows a voluntary strategic de-internationalization, to what extent it is partial or full in a region and, if considered dynamically, to what extent it is part of a cyclical de- and re-internationalization could also be investigated (Kafouros et al., 2022).

However, ecosystems, like all collaboration strategies, are auxiliary strategies that support other strategies and do not create a competitive advantage on their own. In the end, the question of whether (automotive) companies will de-internationalize or further internationalize in the future will therefore not be decided solely by the use of ecosystems as a conflict resolution mechanism for international operations.

Chapter F: Uncovering the potential of artificial intelligence for business models

Study 3

Under review for publication in:
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Abstract

With the rapid technological advances of recent years, AI offers huge potential for companies, partly by removing previous limits in terms of scale, scope and learning. Since then, managers and academics have increasingly turned their attention to the question of how AI can be used to improve business models and add value. This article therefore contributes to closing the gap of measuring the influence of AI on the elements of business models. To this end, a quantitative study was carried out in 250 [internationally active] companies in the automotive industry, from which the data collected was evaluated in a structural equation model to examine the impact. The results reveal, among other things, that AI enables a strong optimization of scale and scope economies, in particular with regard to value creation and delivery, while the great potential of AI-based learning for the value proposition to the customer is only weakly exploited in the asset-intensive companies surveyed. Besides, value capture is not yet significantly affected directly by AI. On this basis, firms are recommended to focus not solely on automation and growth. Instead, they should intensify their use of AI to learn from their customers and adapt to their individual needs.

Keywords: Business models; AI; learning; value capture

1. Introduction

Artificial intelligence (AI) is increasingly perceived as a path breaking digital technology and an opportunity to achieve competitive advantages (Helfat et al., 2023; Krakowski et al., 2023). It has the potential, among other things, to solve problems of various kinds more precisely, faster and more efficiently than humans or prior technologies (Babina et al., 2024; Sestino & De Mauro, 2022) and to customize offerings and customer interaction in new ways (Vaid et al., 2023; Verganti et al., 2020). AI thus enables companies to grow and learn to a degree not previously possible (Iansiti & Lakhani, 2020). Unfortunately, many companies fail to fully exploit this potential and to generate added value by adapting their organization as a result of investing in AI (Ångström et al., 2023; Fountaine et al., 2019). Management research and many executives of companies are therefore looking for the right strategy to deal with and adapt to the rapid changes brought about by AI-related technological developments and increasing digitalization (Faraj & Leonardi, 2022).

According to Chesbrough (2010), the economic value of a technology such as AI remains hidden until it is embraced via a business model. At the same time, AI is seen as an enabler and a key characteristic of new business models (Snihur & Markman, 2023). Consistent with this, in a Delphi study by Mariani & Dwivedi (2024), almost 90 percent of the participating experts agreed with the assessment that AI might significantly modify business models.

This article therefore aims to contribute to the currently growing body of literature that deals with the impact of AI on business models. However, while several qualitative studies already exist in this context (Åström et al., 2022; Burström et al., 2021; Sjödin et al., 2021), insufficient attention has been paid to how the effect of AI on business models can be quantified (Kanbach et al., 2024). Besides, the potential of AI has so far been highlighted above all in companies with digital and platform-based businesses such as financial or streaming services (Iansiti & Lakhani, 2020). The extent to which this potential can be exploited in asset-intensive companies, which typically trade with physical products, require significant capital investment and are integrated into complex value chains (Buck et al., 2023), still needs to be determined more closely.

Accordingly, this article addresses this research gap by grasping the potential and the measurable impact of AI on business models in asset-intensive companies. To this end, the terminological basics and theoretical foundations of both AI and business models are first clarified. Subsequently, hypotheses on the potential effects of this digital technology with regard to scale, scope and learning (Iansiti & Lakhani, 2020) on the business model elements of value creation and delivery, value proposition and value capture are formulated and tested in a large-scale study in the automotive industry using structural equation modeling.

2. Literature and theoretical framework

2.1. Artificial intelligence

AI can be defined "as a system's ability to interpret external data correctly, to learn from such data, and to use those learnings to achieve specific goals and tasks through flexible adaptation" (Kaplan & Haenlein, 2019). Primarily, AI is a set of methods, such as deep learning and machine learning, for statistical predictions that attempt to mimic human intelligence (Davenport, 2018). What all AI-related techniques have in common is that they take in input data, process it using algorithms and output a result (Janiesch et al., 2021; Paschen et al., 2020). Routine tasks have already been taken over by AI in many companies for some time, but recent technological advances in machine learning, lower computing costs and simplified data availability (Fountaine et al., 2019; Huang & Rust, 2021; Sestino & De Mauro, 2022) increasingly allow AI to take over more far-reaching functions (Raisch & Krakowski, 2021).

Accordingly, AI enables companies to overcome fundamental limitations in terms of scale, scope and learning (Iansiti & Lakhani, 2020), unlocking potential for enhanced scale, scope and learning economies (Macher & Boerner, 2006). First, AI provides an enhanced "ability to learn and adapt on the fly" (Verganti et al., 2020) in companies. With supervised, unsupervised and reinforcement learning, AI offers different approaches to learn from data in labeled and unlabeled form as well as through trial and error to maximize rewards in a given environment (Janiesch et al., 2021). In this way, AI constantly strives to improve what it is programmed to achieve and learns independently (Hautala & Ahlqvist, 2024). In doing so, the learning of the algorithms does not stand still but evolves over time based on the input and thus adapts to changing environmental conditions without any great delay. This is because algorithms can take actions and make decisions without employees having to be involved (Johnston & Cortez, 2024; Mariani & Dwivedi, 2024), reducing or even eliminating iterations that previously required human adjustments and caused latency. However, the accuracy of AI-based learning in a company usually depends not only on the capabilities of the machine learning methods and the algorithms used but also largely on the input arising from the quantity and quality of a firm's available data (Gregory et al., 2021). Accordingly, the management literature refers to "the rising importance of data as a strategic resource" (Hartmann & Henkel, 2020). In line with the resource-based view, data is therefore partly regarded as a valuable, rare, inimitable and non-substitutable (VRIN) resource through which competitive advantages can be achieved (Barney, 1991; Helfat et al., 2023).

Moreover, AI enables improvements in scaling and a broadening of the scope of companies (Iansiti & Lakhani, 2020; Verganti et al., 2020), which makes it much easier to expand beyond previous boundaries such as national and market borders. In general, the growth of companies in terms of scale and scope occurs geographically, vertically along the value chain or horizontally along products and industries (Jansen et al., 2023). However, there have always been obstacles to growth, which include crossing national borders, navigating in global value chains or managing diverse human resources (Reuber et al., 2021). In many cases, companies' activities and offerings cannot simply be replicated in other countries, as local requirements, divergent customer needs and cultural differences require products, services and processes to be adapted (Tippmann et al., 2023). The expansion of companies' scope of activity is also subject to fundamental boundaries, as it goes hand in hand with increasing complexity (Vermeulen & Barkema, 2002), thereby turning advantages of resource sharing and diversification into diseconomies of scope at a certain point (Sakhartov, 2017). The limitations described above can partly be mitigated by AI as it helps companies to deal with new requirements, needs and complexity. This explanation is also in line with transaction cost economics (Williamson, 2010). Thanks to its ability to act largely autonomously, AI can optimize and accelerate communication and exchange processes during expansions, minimizing search, coordination and negotiation efforts. This is why AI is partly associated with zero marginal costs (Iansiti & Lakhani, 2020).

With AI-based scaling, additional advantages arise from the fact that the amount of data for training the algorithms increases as more information is obtained from customers. While individualization declines in traditional business models as the number of users grows, the opposite is true for AI-based models (Verganti et al., 2020). Due to the rising density of data, machine learning technologies can better predict the interests and behavior of individual customers as the number of customers increases (Gregory et al., 2021), adding value (Figure F-1). This effect is even amplified by direct and indirect network effects in digital business models based on digital platforms with optimized flows of data (Haftor et al., 2021).

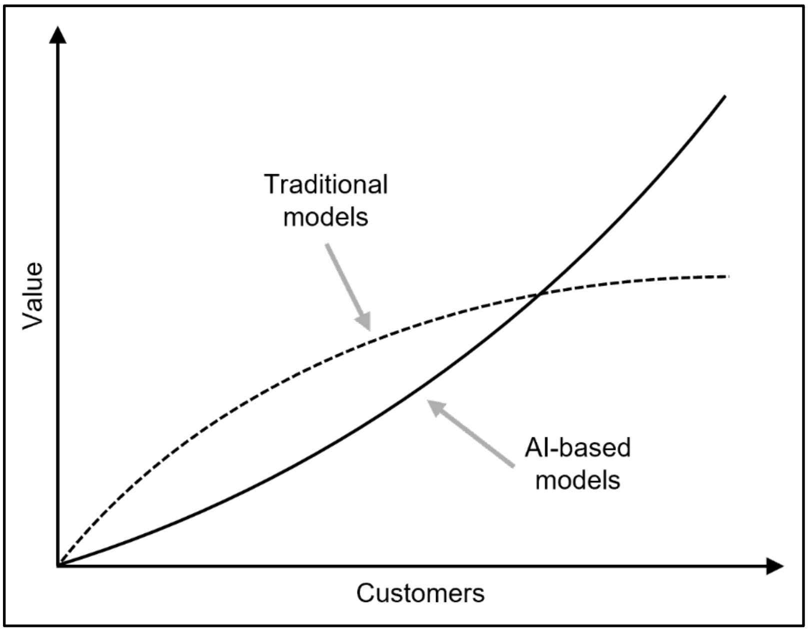

Figure F-1: Gap between traditional and AI-based models
(Adapted from Iansiti & Lakhani, 2020)

2.2. Business models

Although the potential of AI is huge, AI and other technologies alone do not create value for companies, but value can be created when technologies are commercialized through business models (Chesbrough, 2010). Using a combination of these technologies and ideas, it is the function of business models to transform latent value into economic output (Massa et al., 2017). Definitions of the term business model vary widely in the literature and refer to different aspects such as a description, an architecture, a concept, a model or a pattern (Li, 2020; Zott et al., 2011). Teece (2018) defines the term as “an architecture for how a firm creates and delivers value to customers and the mechanisms employed to capture a share of that value”. The importance of value occupies a central position in much of the literature on business models (Li, 2020).

Explanations of the creation and capture of value can be traced back to Brandenburger & Stuart (1996). According to their work, the part of the value creation that individual companies can appropriate is the difference between the sales price to their customers and payments to their suppliers. The business model, however, has broadened “the traditional boundaries of mainstream theories of value creation and capture” (Massa et al., 2017). Consequently, the value proposition, as one of the key elements of business models (Richardson, 2008), has gained relevance with an increasing emphasis on the demand side in business model research (Massa et al., 2017; Zott et al., 2011). This new customer centricity is closely linked to the emergence of digital technologies (Snihur & Markman, 2023). In this context, the value proposition is primarily concerned with providing added value for customers, following a service-dominant logic (Vargo & Lusch, 2008). This logic stresses a stronger customer orientation, seeing the customer as a co-creator, though not always a co-producer, of value for whom a suitable value proposition must be provided. Accordingly, companies can capture value in their business models by reducing their costs on the one hand and by increasing the value for customers and therefore the customers' willingness to pay on the other (Bigelow & Barney, 2021).

In line with this, this article regards business models based on the three major elements of value creation and delivery, value proposition and value capture (Bocken et al., 2014; Clauss, 2017; Richardson, 2008). Additionally, building blocks help to make business models more tangible (Osterwalder et al., 2005) and describe the elements (Figure F-2). All elements and related building blocks must be appropriately balanced for the associated business model to be profitable (Teece, 2018).

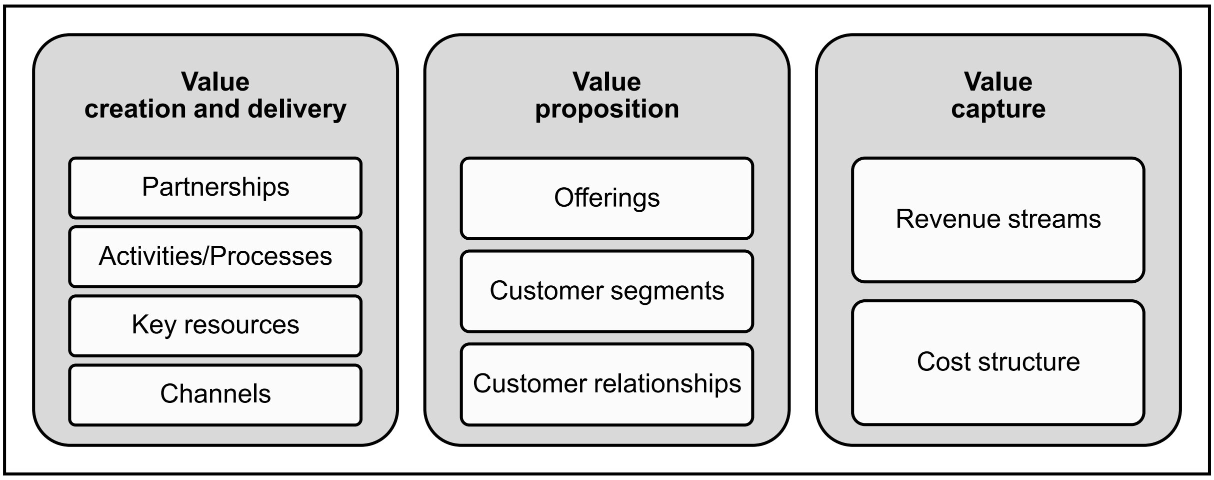

Figure F-2: Business model elements and their building blocks
(Based on Bocken et al., 2014; Clauss, 2017; Osterwalder et al., 2005)

Value creation and delivery deal with required resources, central partnerships and channels, as well as ongoing processes and activities (Osterwalder et al., 2005). The value proposition is primarily concerned with how customers can be offered added value for which they are willing to pay (Richardson, 2008). In addition to the offering itself, it also includes the customer relationship and segments (Clauss, 2017). Finally, value capture refers to how the value of customers can be monetized and thus how revenue streams can be generated (Massa et al., 2017), while simultaneously covering cost structures. Hence, optimizing value capture means maximizing the difference between customers' willingness to pay and firms' costs (Bigelow & Barney, 2021).

3. Hypotheses development

In the following, the possible impact of AI on the elements of business models is examined for asset-intensive companies and relevant hypotheses are formulated (Figure F-3). To this end, AI is broken down according to its potential in terms of scale, scope and learning.

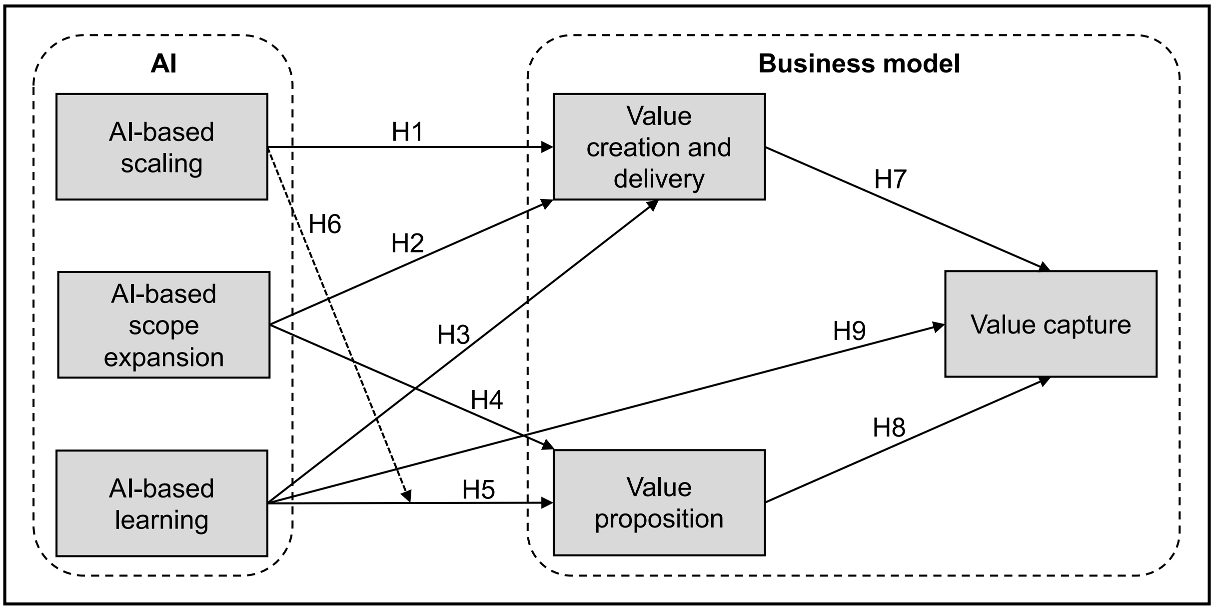

Figure F-3: Potential of AI for the elements of business models
(Own compilation)

3.1. Impact of AI on value creation and delivery

Value creation and delivery are affected in numerous ways. First, AI enables the automation of repetitive tasks, activities and processes (Huang & Rust, 2021; Johnston & Cortez, 2024), including physical tasks using robotic technologies (Davenport, 2018). Further activities such as risk management and decision-making might at least be augmented by AI (Loureiro et al., 2021; Raisch & Krakowski, 2021). These process adaptations along the whole value chain lead to increased efficiency and time savings (Åström et al., 2022; Babina et al., 2024), allowing a focus on value-adding tasks.

Moreover, AI leads to a shift towards new digital channels such as apps, social media and online platforms (Piaskowska et al., 2021), which enable increased data generation, network effects and the automation of processes related to customers. For example, firms can benefit from AI-controlled chatbots with round-the-clock availability (Davenport, 2018).

AI can also expand, complement and augment the capabilities of employees (Kaplan & Haenlein, 2019; Krakowski et al., 2023). These enhanced capabilities enable competitive advantages, for example, by serving as a knowledge base for innovation (Iansiti & Lakhani, 2020; Paschen et al., 2020). In addition, AI provides easy access to knowledge and resources for value creation and delivery, allowing employees to quickly find solutions even without extensive prior expertise (Mariani & Dwivedi, 2024). At the same time, AI makes it possible to save resources, both in terms of raw materials and production facilities through optimized processes, as well as in terms of necessary human resources. This is possible due to the fact that job roles of white-collar knowledge workers in particular can be replaced or reshaped by AI (Raisch & Krakowski, 2021).

With regard to the importance of partnerships in business models, AI allows the coordination of cooperations and value networks to be optimized (Sjödin et al., 2021). In this context, AI helps companies to improve their business models by increasing collaboration with an optimized "flow of data between stakeholders in the ecosystem" (Burström et al., 2021).

These potentials for value creation and delivery are largely attributable to AI in terms of scale, scope and learning. Consequently, three hypotheses arise:

H1: AI-based scaling can directly improve value creation and delivery in asset-intensive companies.

H2: AI-based scope expansion can directly improve value creation and delivery in asset-intensive companies.

H3: AI-based learning can directly improve value creation and delivery in asset-intensive companies.

3.2. Impact of AI on value proposition

Regarding the value proposition, AI allows new customer segments to be identified and addressed appropriately (Burström et al., 2021). Besides, AI helps to expand the range of products and services offered by companies by better bundling synergies, managing rising complexity and partially integrating AI into the offerings themselves (Kanbach et al., 2024).

H4: AI-based scope expansion can directly improve the value proposition in asset-intensive companies.

However, the potential of AI for the value proposition stems to a large extent from increased learning from customers in the sense of the service-dominant logic (Vargo & Lusch, 2008). Accordingly, AI-based learning makes it possible to innovate and adapt offerings (Paschen et al., 2020) and to align them more flexibly to meet customer needs. In particular, AI has great potential related to customer relationships, including in the business-to-business area. In this context, learning makes it possible to redesign the customer journey (Dhiman et al., 2023). This includes improved customer interaction in real time and thus increased customer engagement in terms of customer co-creation (Sjödin et al., 2021).

Learning from this enables companies to provide individual customers with much more precise, personalized and tailored experiences, increasing customer satisfaction and the willingness to pay (Li, 2020; Mariani & Dwivedi, 2024). Accordingly, it can be assumed that "the more learning there is, the more value is generated" (Haftor et al., 2021) for customers.

H5: AI-based learning can directly improve the value proposition in asset-intensive companies.

It can be assumed that this effect of AI-based learning on the value proposition is positively moderated by AI-based scaling as the related growth increases data availability (Gregory et al., 2021; Haftor et al., 2021). In this context, the more data is available from more customers, the better the predictions of AI are for the preferences of individual customers (Iansiti & Lakhani, 2020; Verganti et al., 2020), leading to improved personalization and interaction and hence more value for customers. Thus follows:

H6: AI-based scaling is a reinforcing moderator of the effect of AI-based learning on the value proposition in asset-intensive companies.

3.3. Impact of AI on value capture

AI also has the potential to improve companies' value capture (Burström et al., 2021). On the one hand, this is done by optimizing the cost structure. AI-based adjustments in value creation and delivery make it possible to cut overheads, automate repetitive tasks, support decision-making, save time, generate economies of scale and scope and boost operational efficiency (Iansiti & Lakhani, 2020; Kanbach et al., 2024). This reduces costs such as marginal costs, personnel costs and transaction costs of value creation (Williamson, 2010).

H7: AI can improve value capture via value creation and delivery in asset-intensive companies.

On the other hand, value capture can be improved by increasing revenue streams from customers. The rendering of new revenue streams can be achieved through an AI-improved value proposition (Åström et al., 2022; Dhiman et al., 2023), particularly in terms of adapted offerings, increased individualization and interaction with the customer, which ultimately lead to better coverage of needs, higher satisfaction and thus a higher willingness to pay (Mariani & Dwivedi, 2024).

H8: AI can improve value capture via the value proposition in asset-intensive companies.

Finally, AI enables more flexible revenue models (Burström et al., 2021), in which additional revenues are captured from the customer through improved learning in terms of pricing strategies (Snihur & Markman, 2023). These could benefit from the inclusion of value-based, dynamic pricing by estimating the consumer pricing elasticity (Campbell et al., 2020) and taking greater account of the customer's willingness to pay (Åström et al., 2022; Huang & Rust, 2021). In this context, AI-based learning increases the potential of pay-per-session and freemium models with some free and other charged services, which can help to capture further revenues (Kanbach et al., 2024). This leads to the final hypothesis:

H9: AI-based learning can directly improve value capture in asset-intensive companies.

4. Research Design

4.1. Methodology

A quantitative study using structural equation modeling (SEM) is conducted to test the hypotheses on the impact of AI (Henseler et al., 2015). The methodology of partial least squares (PLS-SEM) was chosen, as this is recommended for the estimation of complex interrelationships with many constructs and indicators (Cook & Forzani, 2023; Hair et al., 2024). To this end, the PLS-SEM algorithm in the SmartPLS4 software was used to determine the relationships between the relevant variables of AI and business models. However, these variables had to be operationalized beforehand so that they could be abstracted from a real-life survey and transferred to a research model.

4.2. Variables

The elements of the companies' business models were queried via their respective building blocks (Figure F-2). The already established scales from Clauss (2017) were used for this so that three questions were asked for each of the nine building blocks. Accordingly, value creation and delivery are reflected by partners (PAR1-PAR3), resources (RES1-RES3), processes (PRO1-PRO3) and channels (CHA1-CHA3), while the value proposition is derived from offerings (OFF1-OFF3), customer segments (SEG1-SEG3) and customer relationships (REL1-REL3). Lastly, variables relating to the revenue streams (REV1-REV3) and the cost structure (COS1-COS3) represent the value capture on the business model side.

The operationalization of AI was assessed via its potential in terms of scale, scope and learning (Iansiti & Lakhani, 2020; Verganti et al., 2020). AI-based scaling (SCALE1-SCALE4) was operationalized via items related to the use of AI to increase the number of customers (O'Reilly & Binns, 2019), quickly obtain the capacity for growth, achieve optimized economies of scale and reduce marginal costs (Piaskowska et al., 2021). AI-based scope expansion (SCOPE1-SCOPE4) was asked via the use of AI to expand the geographic and product scope (Jansen et al., 2023; Vermeulen & Barkema, 2002) as well as to improve the coordination of foreign subsidiaries (Vermeulen & Barkema, 2002) and the sharing of resources between businesses (Helfat & Eisenhardt, 2004; Sakhartov, 2017). Finally, AI-based learning (LEARN1-LEARN4) was operationalized via the ability to exploit AI to advance firms' understanding of consumer behavior (Campbell et al., 2020; Vaid et al., 2023), support firms' adaptation to the needs of customers and further stakeholders (Verganti et al., 2020), detect inefficiencies (Babina et al., 2024) and build a knowledge base for innovation (Paschen et al., 2020).

The variables on business models and AI were surveyed using a seven-point Likert scale, with all these variables being reflective indicators. Moreover, the annual revenue, the headquarters country and the number of employees were added as control variables.

4.3. Data

The data was collected as part of a study of 250 companies in the automotive industry using an online questionnaire in 2024. The study thus fulfills the sample size requirements, according to which in PLS-SEM, the largest number of structural paths of a latent variable, should exceed by a factor of 10 (Hair et al., 2011). The focus on the automotive industry was chosen because it corresponds to the typical characteristics of asset-intensive industries (Buck et al., 2023) and is not traditionally based exclusively on digital services (Ferràs-Hernández et al., 2017). In addition, by focusing on one industry, distorting effects between different sectors could be avoided. Around 20 percent of participants came from OEMs, over 40 percent from Tier 1 automotive suppliers and the rest from other suppliers. Only people at middle or higher management levels were surveyed to obtain the most reliable results. The global survey was mainly conducted in 13 countries from the three continents of Europe, North America and Asia.

5. Analysis and results

5.1. Evaluation of the measurement model

First, the validity and reliability of the outer model were examined. As the business model variables for value creation and delivery, the value proposition and value capture have already been validated by Clauss (2017), the focus at this point is on estimating the reliability of the variables of AI (see Table F-1).

Table F-1: Evaluation of the latent variables and indicators

Construct	CA	CR	AVE	Indicator	Loading	VIF
AI-based scaling	0.838	0.842	0.672	SCALE1	0.828	1.916
				SCALE2	0.835	1.811
				SCALE3	0.805	1.745
				SCALE4	0.812	1.801
AI-based scope expansion	0.826	0.836	0.657	SCOPE1	0.799	1.661
				SCOPE2	0.855	2.081
				SCOPE3	0.743	1.542
				SCOPE4	0.840	1.929
AI-based learning	0.824	0.826	0.655	LEARN1	0.811	1.740
				LEARN2	0.800	1.786
				LEARN3	0.795	1.635
				LEARN4	0.830	1.837

Note: CA=Cronbach's alpha; CR=Composite reliability; AVE=Average variance extracted; VIF=Variance inflation factor

All three constructs on AI fulfill the quality criteria for reflective measurement models. The indicators used for these constructs have sufficiently high outer loadings with values between 0.743 and 0.855, which surpasses the common cut-off value of 0.7 (Hair et al., 2011) and ensures high indicator reliability. The constructs further demonstrate high internal consistency reliability by exceeding the recommended threshold value of 0.7 for Cronbach's alpha (CA) and for composite reliability (CR) (Hair et al., 2024). Moreover, the average variance extracted (AVE) is well above 0.5 (Hair et al., 2011) for the three constructs. The heterotrait-monotrait ratio (HTMT) between the constructs of the AI and the business models was determined, with corresponding values of the HTMT below the limit of 0.85 (Henseler et al., 2015), further demonstrating discriminant validity. Finally, all indicators, including the indicators of the business model elements, show a variance inflation factor (VIF) under the recommended limit of 5, ruling out multicollinearity.

5.2. Hypothesis testing

The path coefficients were determined via the PLS-SEM algorithm, whereby the p-values were additionally calculated via bootstrapping with 5,000 samples to examine their significance (Hair et al., 2011), as shown in Figure F-4.

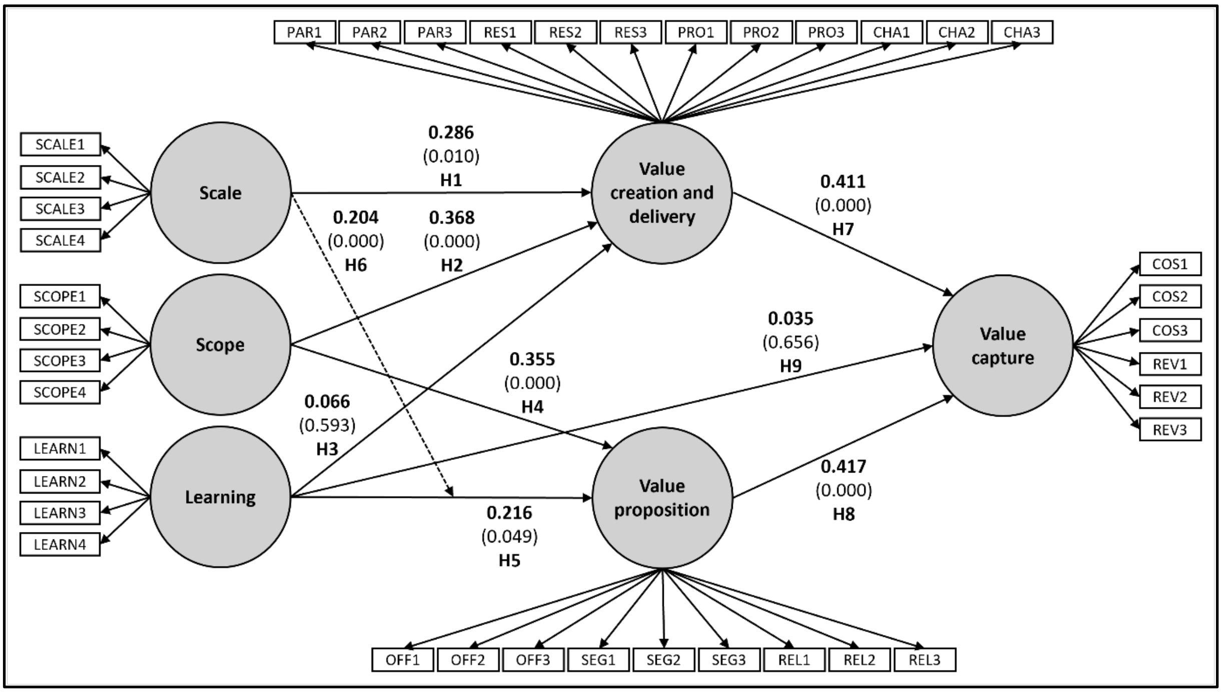

Figure F-4: Results of the structural model
(Own compilation)

Only the direct paths from learning to value capture and to value creation and delivery show no significant effects. H3 and H9 must therefore be rejected. The effects of AI-based scaling on value creation and delivery and of AI-based learning on the value proposition are significant with a p-value below 0.05, supporting H1 and H5. The remaining effects on the endogenous variables all have highly significant path coefficients, thus confirming H2, H4, H7 and H8.

With regard to the moderating effect, the approach of a simple moderation analysis was chosen instead of a multi-group analysis, as the moderation effect is hypothesized to be on the specific path between AI-based learning and the value proposition and not on the entire model (Memon et al., 2019). A highly significant coefficient of 0.204 confirms the strengthening role of AI-based scaling as a moderator of this relationship and thus H6. Consequently, while hardly any positive effect results from AI-based learning in the case of weak scaling, stronger scaling enables AI-based learning to noticeably improve the value proposition (Figure F-5).

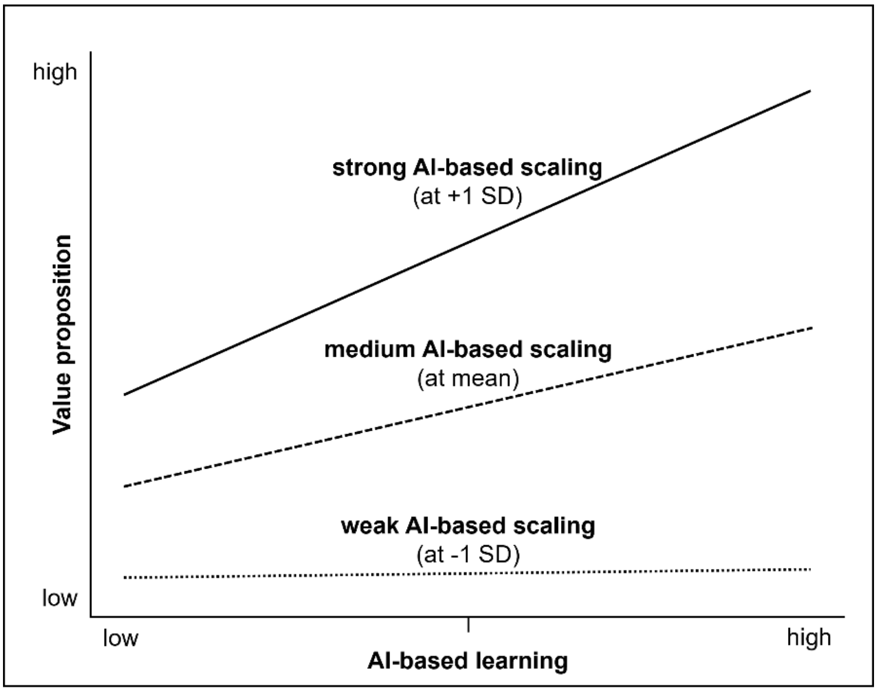

Figure F-5: Moderating effect
(Own compilation; SD=standard deviation)

The reliability of these results is verified by the coefficients of determination R^2 of the endogenous variables, which can be described as moderate on average in this study (Hair et al., 2011). The model explains around half of the variance in value creation and delivery (R^2=0.465) as well as in value proposition (R^2=0.509) and two-thirds of the variance in value capture (R^2=0.677). Additionally, a goodness-of-fit (GoF) value of 0.508 was calculated, thereby exceeding the cut-off value of 0.36 and validating the global fit of the structural model (Wetzels et al., 2009). Finally, the results were validated by including the control variables. These showed hardly any significant effects on the endogenous variables, while the effects along the hypotheses remained almost unchanged.

6. Discussion and implications

6.1. Discussion of the results

It turns out that the automotive companies surveyed optimize their value creation and delivery and are primarily growth-oriented by using AI to overcome limitations in scaling (ß=0.286; p=0.010; H1) and expanding the scope of their business (ß=0.368; p=0.000; H2). This is in line with the assessments of large parts of the literature, which see the reduction of required resources and automation of processes and activities as the main impacts of AI (Davenport, 2018; Raisch & Krakowski, 2021).

However, the results also show that although AI-based learning can improve the value proposition, this effect is small and only marginally significant in this sample (ß=0.216; p=0.049; H5), while the effect of AI-based scope expansion on value proposition is far stronger (0.355; p=0.000; H4). Besides, AI-based learning has no direct significant effect at all on value creation and delivery (ß=0.066; p=0.593; H3) and on the value capture of the companies surveyed (ß=0.035; p=0.656; H9). Instead, AI is at most indirectly responsible for optimizing value capture in this study by lowering costs via value creation and delivery (ß=0.411; p=0.000; H7) and increasing revenues via the value proposition (ß=0.417; p=0.000; H8). Thus, the results only partially confirm the potential of AI for business models (see Table F-2).

Table F-2: Results on the impact of AI

Industry type	**Study**	**Impact of AI for business models**		
		Scale	**Scope**	**Learning**
Asset-light	e.g. Burström et al., 2021; Iansiti & Lakhani, 2020; Kanbach et al., 2024	High	Medium to high	High
Asset-intensive	This study	High as expected	High as expected	(Still) low to medium and thus not as expected, probably due to a focus on growth and a lack of capabilities in learning from data

The unexpected results for AI-based learning may have occurred because, in contrast to IT companies, automotive companies have less prior knowledge of intelligent learning from customer data (Ferràs-Hernández et al., 2017), since this has not been an emphasis of their business so far. Unfortunately, it takes some time for data networks with customers and AI algorithms to mature (Hautala & Ahlqvist, 2024). The study's unexpected findings on AI-based learning could also be attributed to the companies' focus on using AI for growth, which is common in asset-intensive industries. Particularly in the automotive industry, investments have traditionally been covered by an optimization of scale and scope economies and by a strong degression of unit costs (Helfat & Eisenhardt, 2004; Reuber et al., 2021).

6.2. Implications

This article contributes to closing the gap on measuring the influence of AI on business models as the dependent variable (Kanbach et al., 2024). To this end, the effect of AI was examined in more detail and a reliable measurement model for AI in terms of scale, scope and learning (Iansiti & Lakhani, 2020) was developed. The results quantitatively demonstrate how AI can improve business models along with their elements. Additionally, the study clarifies further interdependencies (Bigelow & Barney, 2021). In this context, the moderation analysis underlines that the value-adding effect of AI-based learning is heavily dependent on the scaling and related accumulation of data (Figure F-5). This confirms the propositions put forward by Gregory et al. (2021) with regard to what they call “data network effects”.

On this foundation, companies should acknowledge the growing importance of data as a strategic resource (Hartmann & Henkel, 2020; Helfat et al., 2023). Given the additional importance of learning (Foss & Saebi, 2017), companies are recommended to continue scaling and broadening their business, but in doing so, focus more on gathering data that enables them to learn from their customers and better customize their offerings by AI. Asset-intensive companies such as those in the automotive industry surveyed should therefore not only rely on automation and growth but also expand their services to complement physical products, increasing their interaction with customers. Besides, more consideration should be given to the direct potential of AI for value capture, such as dynamic pricing (Campbell et al., 2020). Finally, in accordance with Raisch and Krakowski (2021), companies should prepare their human resources for the rising volume of tasks being carried out or augmented by AI.

7. Limitations and conclusion

The article has outlined how AI removes traditional limitations in terms of scale, scope and learning and how it can be used to optimize business models. However, as the automotive companies surveyed are still struggling to exploit AI-based learning sufficiently in this context, the results indicate that many companies are not yet using the full potential of AI. Thus, future research should examine more closely which barriers to AI-based learning exist in asset-intensive industries and how these can be overcome.

Despite its contribution, this article is not entirely free of limitations. The study was only conducted in automotive companies, which is why the results should be validated in further cross-industry studies. Moreover, the impact of AI should be examined beyond the value elements of business models by quantifying effects at building block level (Osterwalder et al., 2005). Focusing on the transition, tensions could arise between existing and new AI-based business models, which implies a balancing act in terms of shifting resources from old to new business models (Chesbrough, 2010). This underlines the need for dynamic approaches and longitudinal studies related to the transformation through AI, as this study, conducted at one point in time in 2024, cannot address this issue. Besides, the focus of this study was placed on economic value creation in business models, which is why future research should shed light on the potential for social and ecological aspects (Loureiro et al., 2021).

Finally, AI itself is subject to limitations such as customer unreadiness, data dependency or biases (Huang & Rust, 2021), leading to data privacy threats, discrimination and ethical issues (Janiesch et al., 2021; Paschen et al., 2020). Regulations, although currently heterogeneous from region to region, are therefore of crucial importance (Åström et al., 2022). Nevertheless, this article has shown how far-reaching the impact of AI can be. The technological development of AI, its acceptance, decisions by regulatory authorities and the ability of companies to exploit existing potentials will show how much more far-reaching this impact might actually become, both positively and negatively.

Chapter G: Conclusion

1. Summary of the results

The three studies in chapters D-F provided numerous conclusions on how companies can successfully manage digitalization, including many international aspects. In this context, significant results were obtained that help answer the research questions posed in Chapter A.

First, the article in Chapter D was able to synthesize literature and identify relevant components that companies must take to heart in times of digitalization. Various components in terms of digital activities, digital business as well as operational and dynamic capabilities for achieving digital maturity could therefore be systematized. Against the background of RQ 1, a consideration of national culture along Hofstede's six cultural dimensions was implemented. The results from the multiple regression analysis carried out using an OLS estimation revealed that digital maturity is promoted by strong collectivism, long-term orientation, restraint and high uncertainty avoidance (or hindered by strong individualism, short-term orientation, indulgence and low uncertainty avoidance). However, no significant results were found for the dimensions power distance and masculinity vs. femininity in Study 1. Moreover, the determined R^2 values indicate that the degree of digital maturity in companies is only partially dependent on national culture, confirming that further contextual factors on a country-level and other levels can be decisive in this regard.

Study 2 (Chapter E) took a closer look at conflicts within contextual factors of companies' international activities. These are shaped by trends towards de-globalization and de-internationalization on the one hand and the contrasting potential of new growth markets and therefore further investments in international operations on the other. In this context, the evaluation of the survey revealed that of the participating automotive companies, 57% were subject to strong, 19% to medium and 10% to at least weak paradoxical tensions as a result, while only 14% of the participants perceived no paradoxical tensions at all within their international operations. This underlines the need to answer RQ 2 and thus clarify whether digital platforms can reduce such tensions in international operations and increase the success of companies. The structural equation modeling carried out for this purpose was able to identify significant paths showing that digital platforms are indeed suitable as mediation solutions and can mitigate the tensions. However, the use of digital platform and related transaction ecosystems in the automotive companies surveyed has so far only led to a significant increase in output on the relational rents end, but not on the performance end. One reason for this was identified within the platform effects considered in the study, since these were partially underutilized. Although the automotive companies surveyed were able to exploit the effects of modularization, complementarity and limiting the outflow of resources in the average case of the study, value co-creation, pricing and network effects as well as data-based learning have hardly been able to contribute to successful platform use to date. However, it is important to exploit all these effects in order to be able to interact efficiently within ecosystems. To this end, the emerging potential of data-based learning using AI in particular should be fully leveraged, leading onto Study 3.

Study 3 (Chapter F) comprised a further survey of automotive companies, but examined the potential of AI in the context of business models. The potential of AI was differentiated related to its ability to overcome previous limitations in terms of scale, scope and learning. Business models were integrated into the structural equation modeling along with their main elements, namely value creation and delivery as well as value proposition and the output in terms of value capture. In this way, results of a statistical analysis were obtained that allowed responses to RQ 3. These results showed once again that the potential of data-based learning through AI is little exploited by the automotive companies surveyed, in this case within the business models of these companies, although in theory it should be able to deliver enormous added value. However, the study was able to confirm the enormous potential of AI-based scaling and scope expansion, which companies are using significantly to enter new country markets and improve their value creation and delivery as well as value proposition in this asset-heavy industry. Moreover, the results of the study indicate that the companies' value capture can also be optimized, even if this does not benefit directly from AI, e.g., in the sense of dynamic pricing. Finally, Study 3 demonstrated via a moderation effect that the positive effect of AI-based learning on the value proposition also increases with rising scaling (and thus with rising data availability). This underlines the great importance of data as a strategic resource (Hartmann & Henkel, 2020; Helfat et al., 2023).

Overall, the three studies provide insights into various aspects of digitalization, covering firstly contextual factors, secondly mechanisms and thirdly the output of digitalization for companies. Table G-1 summarizes the results of this dissertation along these lines, thereby providing a more substantial framework for digitalization in companies, particularly from an international perspective.

Table G-1: Summary of the results within the framework of digitalization

	Contextual factors	**Mechanisms of digitalization**	**Implementation**	**Outcomes**
Study 1 (RQ 1)	Cultural dimensions of national culture • High collectivism, long-term orientation, restraint and uncertainty avoidance act as drivers • Masculinity and power distance are neutral in this context	Digital activities (Reducing transaction costs and coordination effort)	• Digital processes and value chain • Technology use	Digital maturity (EBIT impact)
		Digital business (Improving interaction in business)	• Digital products and services • Digital business models • Digital ecosystems	
		Operational capabilities (Obtaining/retaining VRIN resources that offer competitive advantages in the digital age)	• Individual capabilities • Organizational capabilities	
		Dynamic capabilities (Adapting the resource base to dynamics in the digital age)	• Sensing • Seizing • Reconfiguring	
Study 2 (RQ 2)	Motives for internationalization • Access to new growth markets • Meet diverse customer needs • Meet cross-cultural specifies Motives for de-internationalization • Reduced capital intensity • Rising nationalism • Demand for sustainability Opposing forces lead to paradoxical tensions	Digital platforms Platform effects • Modularization *(strong exploitation)* • Complementarity *(strong exploitation)* • Limiting the resource outflow *(strong exploitation)* • Value co-creation *(low to medium exploitation)* • Pricing *(low to medium exploitation)* • Network effects *(low to medium exploitation)* • AI-based learning *(low exploitation)*	Ecosystem strategies: Cooperation in digital ecosystems across national borders can indeed mitigate tensions related to international operations	Success: Digital platforms/ ecosystems • Lead to significant relational rents • But do not (yet) lead to improved performance outcome in this sample
Study 3 (RQ 3)	Data availability	AI overcomes limitations in terms of • Scale *(strong exploitation)* • Scope *(strong exploitation)* • Learning *(low to medium exploitation)*	Digital (AI-enhanced) business models • Increased value creation and delivery (partnerships, activities/processes, key resources, channels) • Increased value proposition (offerings, customer segments, customer relationships)	Increased value capture (higher revenue streams, optimized cost structure)

The *contextual factors*, which occur both internally and externally, trigger and shape the digitalization of companies (Hanelt et al., 2021). From an international perspective, these include the potential of new growth markets as well as the need to meet diverse customer needs and cross-cultural specificities in different country markets, which motivate companies to invest in an expansion of their international footprint. However, the survey from Study 2 also shows that the "new realities for international business" (Ghauri et al., 2021) do indeed have a major impact on companies that are being pressured to scale back their international activities. Corresponding contextual factors in this sense are increasing nationalism and protectionism due to geopolitical changes, the need to reduce capital and the growing demands for sustainability, which, according to the survey from Study 2, affect the participating companies the most. It has also been shown that the contextual factors are marked by paradoxical tensions regarding international activities. In addition, these determinants are complemented by the drivers of digital maturity identified along cultural dimensions, namely restraint, uncertainty avoidance, long-term orientation and collectivism (Study 1). Moreover, as already discussed above, the great importance of data, especially for AI-based learning, was demonstrated (Study 3).

Various *mechanisms* of digitalization, which must be exploited via digital and partly internationalization strategies (Meyer et al., 2023), represent a bridge between the contextual factors just mentioned and the desired outcomes. As the results from Study 1 and Study 3 show, this includes a digital business strategy in which approaches to the innovation of offerings and the establishment of new forms of business models are pursued (digital business index = 5.147 on a scale up to 7, Study 1). In this context, companies' business models can largely benefit from the mechanisms of AI in terms of scaling and scope expansion and, at least in theory, from AI-based learning (Study 3). The findings also confirm the potential in terms of digital activity to improve processes along (global) value chains based on digital technologies (digital activity index = 4.248 on a scale up to 7, Study 1). The digital business of a company is also pursued via ecosystem strategies. These induce mechanisms for interaction via digital platforms that enable joint value creation with partners and customers (Study 2), even if these mechanisms remain partially underutilized in terms of the presented platform effects. The mechanism of these digital platforms and associated ecosystems as conflict resolvers or mediators of paradoxical tensions was also confirmed in this regard (Study 2). The other mechanisms are related in particular to the companies' resource base and capabilities. In this context, necessary mechanisms comprise, on the one hand, operational capabilities, which are needed both at the organizational level itself and among the individuals within the organization and were on average medium to highly developed in the manufacturing companies surveyed (operational capability index = 5.143 on a scale up to 7, Study 1). On the other hand, dynamic capabilities are required in times of digitalization, which were somewhat weaker in the manufacturing companies surveyed but also still medium to medium-high (dynamic capability index = 4.865 on a scale up to 7, Study 1). It is worth emphasizing at this point that Study 2 revealed that the mechanism of limiting the outflow of resources and capabilities has the strongest weight among the platform effects, meaning that automotive companies are giving high priority to this to protect and maintain the value of their resource base in the face of cooperation.

Finally, the desired *outcomes*, which represent the consequences of digitalization for companies, can be achieved by making appropriate strategic use of these mechanisms while also taking contextual factors into account. Outcomes can be hoped-for changes in the setup of companies, including the proven increase in speed in processes (Study 1) or the platformization of international value chains (Study 2). This also includes asset lightness by creating and offering joint solutions with partners (Study 2) and constant adaptation and individualization of the customer journey and offerings to customers' needs (e.g., through AI, Study 3). Outcomes related to economics in companies were recorded by decreasing transaction costs (Study 1, Study 3). By implementing the mechanisms described, companies ultimately achieve greater digital maturity. Further studies (e.g., Sommer & Proff, 2023) and the data from the survey in Study 1 show significantly ($p < 0.05$) that digital maturity is also associated with a higher EBIT impact as output, at least if a critical level of digitalization in a company is reached. Finally, increased relational rents as a branched-off part of jointly created value (Study 2) and a general optimization of the created and offered value and thus ultimately the value capture (Study 3) could be proven within this dissertation.

2. Implications

2.1. Implications for research

The results help to sharpen the economics of digitalization in manufacturing companies, especially in asset-heavy industries. In doing so, they complement the current understanding of digitalization by broadening the view from, among other things, pure Industry 4.0 or supply chain management considerations to a holistic, strategic and international management of digitalization in companies. In this context, the findings lead to a framework of digitalization in companies along contextual factors, mechanisms and outputs of digitization (Hanelt et al., 2021). For example, this dissertation expands the much-discussed role of culture to include national culture as a contextual determinant of digitalization, whereas to date exclusively organizational culture had been considered in connection with digitalization (Butt et al., 2024). Clear influences along different cultural dimensions could be differentiated, which helps to understand to what extent characteristics of different cultural groups on a country-level lead to relevant components of digitalization being accelerated or slowed down in companies (RQ 1). However, the interplay between national and organizational culture for digitalization could not yet be clearly explained as part of this work.

Based on paradox theory, the dissertation confirms that further contextual factors in the global environment, such as rising protectionism, sustainability requirements and altered capital access, are placing a strain on companies and leading to paradoxical tensions. This is because companies are simultaneously facing pressure to exploit the potential of new foreign growth markets. The results thus make it possible to establish a new paradox between motives for de-internationalization and motives for internationalization, which has hardly been mentioned so far. This new "(de-)internationalization paradox" expands the view on tensions in international business, which has so far been dominated by the paradoxes between centralization and de-centralization or "global-local" tensions (Heucher et al., 2024) that deal with the permanent contradictions between global standardization and local adaptation (Prahalad & Doz, 1987).

At the same time, however, the dissertation contributes to the search for suitable mechanisms for mediating such tensions and dealing with these contradictory contextual factors (RQ 2). It confirms that digital transaction platforms can act as conflict resolvers and reduce paradoxical tensions. In this context, the findings extend previous research on ecosystems, thereby refining the understanding of increased interaction enabled by digitalization. The consideration of platform effects as enablers of joint value creation in ecosystems across national borders also provides relevant insights for the discussion on the platformization of global value chains (Kano et al., 2020) and the paradigm shift towards ecosystems in the global strategies of internationally active companies (Cha, 2020).

Further insights in terms of value co-creation were gained in the research on business models, particularly with regard to the potential of AI for value creation and delivery, value proposition and value capture (RQ 3). The results from Study 3 imply that the promising opportunities of AI-based learning for improving business models are subject to obstacles in asset-heavy companies, as the expected high results in this regard have not emerged, in contrast to previous studies in more asset-light sectors (e.g., Burström et al., 2021; Iansiti & Lakhani, 2020; Kanbach et al., 2024). This should be evaluated further, with a more concrete assessment of the role of data as a strategic resource (Hartmann & Henkel, 2020; Helfat et al., 2023). Not only the results, but also the items and scales developed in this dissertation to capture the contextual factors, mechanisms and outcomes advance research in the field of digitalization, both specifically for individual digital technologies and holistically for full digital maturity.

Finally, the dissertation contributes to the discussion on the development of firm scale, scope and boundaries in the digital age (Menz et al., 2021), as presented in Figure G-1. While digitalization increases the efficiency of the interaction of actors and thus market-based transactions (decline of external transaction costs), it can be assumed that the scale and scope within company boundaries could decrease. In this context, Study 2 shows that country and product markets can be covered by cooperation with external partners on digital platforms as part of asset-light ecosystem strategies. In contrast, digitalization also increases internal efficiency (decline of internal transaction costs), which enables companies to expand their scale and scope (Luo, 2021). This was underpinned by Study 3 with regard to the mechanisms of AI to overcome previous limits in terms of scale and scope. Nevertheless, it still remains unclear whether the influence of falling internal or external transaction costs on firm scale and scope will predominate (or neutralize each other in this respect) in the course of digitalization. Thus, it remains equally unclear how corporate boundaries will shift in the long term as a result.

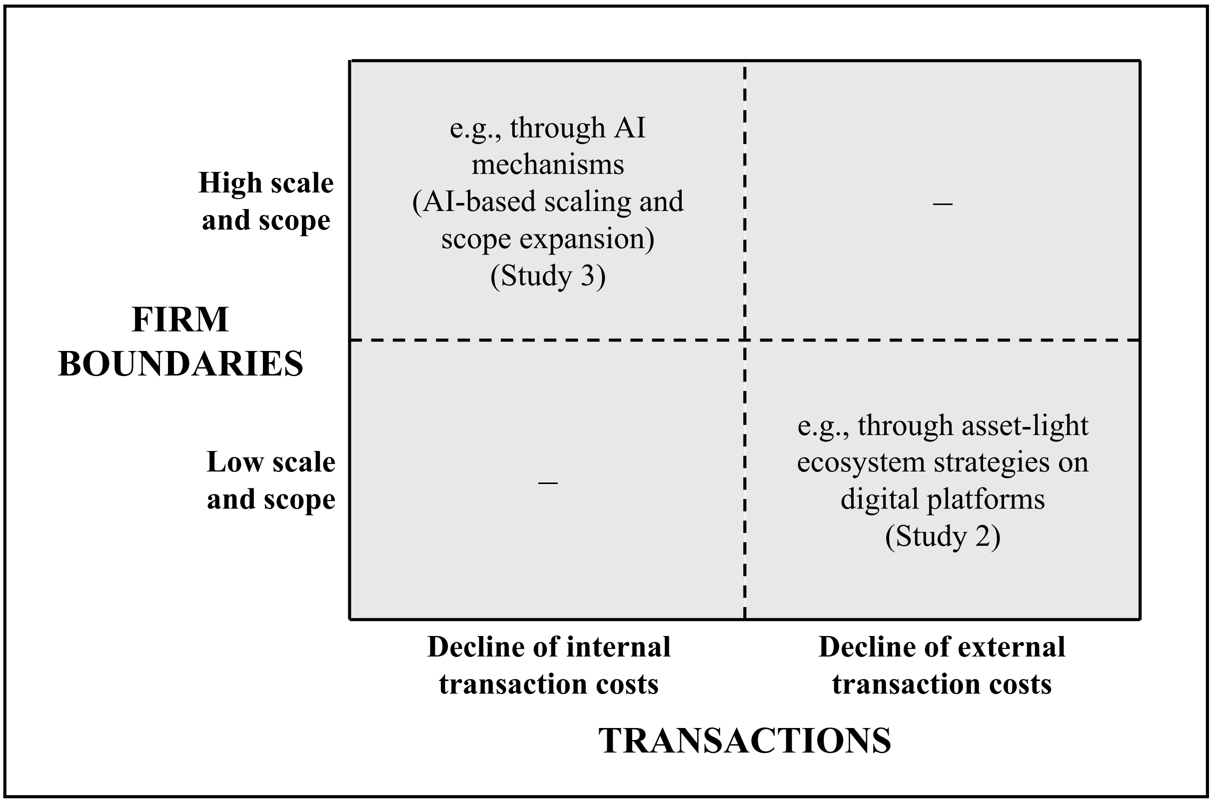

Figure G-1: Transactions and firm boundaries in the digital age
(Based on Menz et al., 2021)

2.2. Implications for practice

The dissertation confirms that companies must also tackle digitalization beyond the mere investment of technologies. Accordingly, they need to manage digital transformation along with their digital activities, digital business and operational and dynamic capabilities to achieve digital maturity. For this to happen successfully, numerous contextual factors and mechanisms that determine the output of digitization must be taken into account, as the overall results show (Table G-1).

Key findings relate to the potential of digitalization for greater interaction and joint value creation, which urgently needs to be exploited. This refers to value co-creation with customers as well as with other companies, for which digital platforms and AI are of central importance. To this end, existing business models may have to be adapted so that customer interaction, which benefits from or fosters data-based learning, is pushed even more strongly in the future. Companies that mainly offered physical products therefore need to consider how the customer journey can be adjusted or how material goods can be expanded to include interactive services ("servitization", Kohtamäki et al., 2020). This supports companies following a service-dominant logic to operate closely with individual customer's needs (Vargo & Lusch, 2008).

In addition, companies are encouraged to operate with partners in ecosystems, enabling a new way of asset-light access to foreign markets and complementary resources. As discussed along RQ 2, companies should also take this into account in their global strategies and mitigate existing conflicts and tensions where necessary. However, managers should always bear in mind that jointly created value with partners must ultimately be split between them. Thus, it must be ensured that the resulting relational rents are high enough for a participating company after the division among partners. Moreover, it must be noted that resources may flow to partners and lose value as a result (e.g., they might partly lose their VRIN properties). This is also critical insofar as the partner companies may even be competitors in the same industry, acting together within the ecosystem in the sense of "coopetition" (Nalebuff & Brandenburger, 1997). For this reason, careful consideration must be given within the companies participating in the ecosystem as to which resources and capabilities are brought in openly and which strategically crucial resources remain protected. Additionally, effective governance is needed on digital platforms (Chen et al., 2022).

While the digital technologies highlighted, such as digital platforms and AI, promise great potential on their own, it is crucial that companies combine the potential of several digital technologies and use them jointly. This is necessary in order to operate as efficiently as possible along the entire value chain, to create and offer as much value as possible from the customer's perspective and at the same time to maintain the VRIN nature of the companies' resource base in times of digitalization. From Study 2 and Study 3, it is possible to deduce how the combined use of digital technologies can mutually increase their potential. For example, companies are recommended to use AI to benefit more from the effect of data-based learning on digital platforms. Conversely, companies should exploit the possibilities of digital platforms and the associated partner interaction in ecosystems to leverage a larger database as a prerequisite for AI algorithms that need to be trained with this data (see also Gregory et al., 2021).

Although digitalization helps to overcome national borders and reduce distance, companies must still consider the specifics of contextual factors at country level. In this context, they should draw on the findings of this dissertation with regard to RQ 1 and be aware of the influence of national culture. To this end, digital technologies such as AI can also help to understand cultural heterogeneity and thus support management internationally (Messner, 2022). With regard to the findings of this dissertation on AI and RQ 3, companies should make particular use of the potential in terms of scale, scope and learning in order to further optimize their business models. Moreover, companies are encouraged to get prepared for the rising automation and augmentation by AI (Raisch & Krakowski, 2021), replacing and reshaping jobs and necessary individual capabilities of white-collar knowledge workers in particular (Kanbach et al., 2024). This transformation will thus have a massive impact on the required operational capabilities of companies and should motivate companies to further develop their dynamic capabilities in the coming years in order to even become more adaptable.

Accordingly, companies must manage digitalization holistically and at various levels while at the same time aligning it with their other strategies, e.g., in terms of expansion and internationalization.

3. Limitations and outlook

This dissertation expands the understanding of managing digitalization in companies, especially in an international context. It offers an insight into the relevant contextual factors, mechanisms and outputs of digitization in internationally active companies in three studies. As shown, various implications for research and managerial recommendations can be derived from these. However, the studies in this dissertation are subject to certain limitations, which restrict the results in some areas.

First, the findings of the dissertation are mainly based on quantitative approaches. Even though this provides a high degree of objectivity and statistically reliable results, these results should be supplemented by in-depth qualitative methods. For example, expert interviews could enrich the findings of the quantitative surveys in the sense of mixed-method research (Harrison, 2013). It must also be pointed out that the studies carried out were static observations. The surveys were all conducted within a period of a few weeks in 2022, 2023 and 2024, which is why they do not provide any information about developments over time. However, this is important, especially regarding the rapid technological advancements and the numerous changes in companies over time in the digital era. Even if, for example, national culture is considered to be time-stable, this does not necessarily apply to its effects on digitalization (Beugelsdijk et al., 2017). Thus, dynamic aspects should be addressed in future research, e.g., via longitudinal studies.

Further limitations arise from the focus of the study samples on companies in industries and country markets with certain characteristics, which is why the results cannot be generalized for deviating characteristics. On the one hand, this dissertation mainly surveyed companies based in countries that are highly developed and can be regarded as industrialized regions, such as Germany, France, Spain, Japan, South Korea, Canada and the USA. Accordingly, future research should compare its findings with the digitalization of companies from emerging and developing countries, since not only national cultures but also other decisive contextual determinants such as macroeconomic factors, technological infrastructures or privacy laws shape the digitalization of companies (Meyer et al., 2023). On the other hand, the studies were only conducted within asset-heavy, manufacturing industries, in particular the capital-intensive automotive industry, whereby the transferability to industries with completely different conditions is constrained. This is because asset-heavy industries generally focus on physical products in their business and are characterized by long global supply chains (Buck et al., 2023). “Born digitals”, in contrast, comprise usually digital business models and offer non-physical services, enabling them to grow so quickly (Birkinshaw, 2022). Traditional companies will therefore have to adapt to enormous dynamism in their industries and the entry of new players (Adner & Lieberman, 2021). To this end, they should take advantage of the various opportunities offered by digitalization as outlined in this dissertation and leverage the associated transformation along all relevant components of digital maturity. They are encouraged to also consider strategies in the context of ecosystems and data-based learning through digital platforms and AI in this regard.

However, it should be noted that the focus of this paper has been on the economic perspective of digitalization. Digital technologies should therefore be considered more broadly in future research, especially in terms of environmental and social sustainability in companies' business models (Melkonyan et al., 2017). Despite the various potentials from an economic perspective and beyond, the risks, boundaries and side effects of digitalization must not be ignored. These arise in general and are related to specific digital technologies. For instance, AI technologies such as large language models (LLM), even with the high expectations placed on them, are not able to find solutions beyond what they encountered within the training data (Felin & Holweg, 2024), while also problems of data protection and digital exclusion are feared. These and many further negative aspects of digitalization have often been overlooked or neglected in the management literature in the past and give rise to further in-depth studies, although at least some research on the "dark and unexpected sides of digitalization" (Trittin-Ulbrich et al., 2021) and the "dark side of digital globalization" (Verbeke & Hutzschenreuter, 2021) has already been carried out.

Ultimately, digitalization can be a great opportunity, but at the same time a huge threat for companies. In particular, the managers in the predominantly traditional companies surveyed as well as their digital, global strategies will determine whether and under what circumstances these companies will remain part of the future international competitive landscape.

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