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The impact of China's e-mobility development on German motor vehicle manufacturers

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List of abbreviations

ADAS(s)	Advanced driver-assistance system(s)
AI	Artificial intelligence
ASSB(s)	All-solid-state battery(ies)
BEV(s)	Battery-electric vehicle(s)
CAFC	Corporate average fuel consumption
CEVA	China Electric Vehicle Association
CEVCIPA	China Electric Vehicle Charging Infrastructure Promotion Alliance
CKD	Completely knocked-down
E/E	Electrical and electronic
E-mobility	Electric mobility
ESV(s)	Energy-saving vehicle(s)
EU	European Union
EV(s)	Electric vehicle(s)
FCEV(s)	Fuel-cell electric vehicle(s)
HEV(s)	Hybrid electric vehicle(s)
ICE	Internal combustion engine
ICEV(s)	Internal combustion engine vehicle(s)
IEA	International Energy Agency
IPO	Initial public offering
MIC 2025	Made in China 2025
MIIT	Ministry of Industry and Information Technology
MEB	Modular Electric Drive Kit
MOF	Ministry of Finance
MOST	Ministry of Science and Technology
NDRC	National Development and Reform Commission
NEV(s)	New energy vehicle(s)
NIE	New institutional economics
OEM(s)	Original equipment manufacturer(s)
OTA	Over-the-air
PHEV(s)	Plug-in hybrid electric vehicle(s)
PPE	Premium Platform Electric
R&D	Research and development
CAQDAS	Computer-assisted qualitative data analysis software
SAC	Standardization Administration of China
SASAC	State-Owned Assets Supervision and Administration Commission

SOE(s)	State-owned enterprise(s)
SKD	Semi knocked-down
SSP	Scalable Systems Platform
TVTC	Thousands of Vehicles, Tens of Cities
U.S.	United States (of America)
VW	Volkswagen
VWC	Volkswagen Consulting
VWCV	Volkswagen Commercial Vehicles
WFOE(s)	Wholly foreign-owned enterprise(s)
xEV(s)	See “EV(s)”

1. Introduction

The motor vehicle industry is currently experiencing a profound transformation. Besides having to deal with a variety of geopolitical challenges, motor vehicle manufacturers around the world are currently navigating their businesses towards connectivity, automated driving, and electric mobility (Mohr et al., 2016, p. 3; Sebastian, 2022, p. 12). Electric mobility, abbreviated as e-mobility, generally refers to the use of electricity for the purpose of mobility in various transport modes (Ajanovic et al., 2021, pp. 1–16). What is relevant to this study is the electrification of the motor vehicle industry. Compared with other changes that this industry is currently experiencing, the trend towards e-mobility is a special case: as part of the green transformation, e-mobility was not originally driven by disruptive technologies but by official targets and green industrial policies that induced manufacturers to electrify their vehicle portfolios (Altenburg & Pegels, 2012, pp. 5, 12, 17-18; IEA, 2022a, pp. 32, 108; Lütkenhorst et al., 2014, pp. 10, 12). Countries have decided to promote the electrification of their motor vehicle industries for various reasons, e.g., to reduce carbon emissions, prevent air pollution, ensure energy security, or, in the case of some emerging economies, catch up with or leapfrog the industries of developed countries. In the case of China[1], air pollution reduction and aspirations for technological leadership were two particularly important motivations (Altenburg et al., 2012, p. 81; Altenburg, 2014, pp. 8–10; Altenburg et al., 2022, p. 1).

Compared to other nations, China was especially early and ambitious in rolling out an e-mobility policy package that was both comprehensive and generously funded. In combination with technology strategies at the company level, these policies have created a thriving electric vehicle (EV) industry (Altenburg et al., 2022, pp. 3, 9). In 2021, China was the country with the highest public spending on e-mobility, the most EVs sold, and the largest charging infrastructure (IEA, 2022a, pp. 16, 25, 82). Technologically, the country is already one of the world's leading players in the fields of EV batteries and electric buses (Altenburg et al., 2022, pp. 7–8; IEA, 2022a, p. 156). In other areas such as the passenger car sector, the situation is less clear. According to Altenburg et al. (2022), Chinese passenger car manufacturers are still catching up but starting to challenge their rivals – primarily in China but also increasingly in other markets around the world (pp. 1, 7). As a result, the electrification of this part of the industry is a particularly interesting field to study.

Yao Yang, an economics professor at Peking University, predicted in fall 2022 that the new generation of Chinese EVs will be highly competitive and take a large part of German carmakers' market share (Yao Yang 姚洋, 2022). This development concerns not only German carmakers, which rely on their China revenues to generate profits for reinvestment (Sebastian, 2022, pp. 5, 9), but also the German economy as a whole, which is to a certain degree dependent on the success of

[1] Within this study, 'China' refers to the People's Republic of China.

German automotive companies (Schwabe, 2020a, p. 1108). Given this exposure, the impact of China's e-mobility development on German carmakers is an issue worth studying.

In the past, many studies have been conducted on Chinese e-mobility policies and their effects on EV adoption, air quality, etc. (Hsieh et al., 2022; Kalthaus & Sun, 2021; Li et al., 2019). However, relatively little is known about the impact of these policies on individual businesses. Regarding the competitive environment, Altenburg et al. (2022) have "assess[ed] the technological capabilities and competitive performance of the Chinese automotive industry" (p. 1) in the field of e-mobility, both in China and internationally. In addition, a limited amount of research has been conducted on the role of German firms in the context of China's e-mobility transition; for example, Schwabe (2020a) examined the bargaining processes between Chinese authorities and German and other non-Chinese automotive firms, and Sebastian (2022) analyzed the research and development (R&D) activities and EV investments of German carmakers in China. Nevertheless, literature on the ways in which Chinese firms have changed the competitive landscape in the era of e-mobility and thereby influenced German carmakers remains sparse. The aim of this study is to address these research gaps by examining how China's e-mobility development – through changes in formal institutions and market forces – has affected German automakers and their competitive situation inside and outside of China. Hence, this paper seeks to answer the following two research questions:
Question 1: *In the context of the automotive industry's transition towards e-mobility, how have German motor vehicle manufacturers been affected by changes in China's formal institutions?*
Question 2: *Against the backdrop of China's e-mobility development, how have German motor vehicle manufacturers' competitive environment and positions changed (in China and globally)?*

To explore possible answers to the proposed questions, this study is guided by two strands of research – new institutional economics (NIE) and strategic management literature – and adopts a qualitative research approach (Creswell, 2007, p. 39). A holistic multiple-case design (Yin, 2009, p. 46) is applied to examine five German motor vehicle manufacturers. To obtain information from inside the cases, qualitative data are collected through semi-structured interviews (Saunders et al., 2019, p. 437) with people who (used to) work at the respective firms. The data are then analyzed following the six steps of thematic analysis suggested by Braun and Clarke (2006, p. 87). The proposed answers to the research questions may be relevant for researchers studying the automotive sector as well as for industry participants. In addition, this paper may also be of interest to NIE and strategic management scholars, since it is one of the first studies to explore the impact of China's recent e-mobility transition on German carmakers by combining concepts from NIE and strategic management literature, thereby contributing to the conversation between the two research streams.

The scope of this study is limited in several ways. Although many types of vehicles qualify as motor vehicles, the main focus of this thesis is on passenger cars. Terms like motor vehicle manufacturers, passenger car manufacturers, carmakers, and automakers are used interchangeably to refer to original equipment manufacturers (OEMs) that produce passenger cars. To further narrow the scope, this study only looks at incumbents whose German passenger car brands are sold in large numbers, whose revenues exceed 10 billion euros, and who sell their cars in China. Besides, this thesis does not attempt to cover the full range of EV concepts but instead concentrates on two types, namely, battery-electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs).

This paper is structured as follows: firstly, chapter 2 provides the reader with theoretical background information, reviewing relevant literature in the fields of NIE and strategic management. Next, chapter 3 introduces the reader to the context of this paper: the transition towards e-mobility, a global trend that is reflected, among others, in the trajectory of China's automotive industry as well as the business reality that German carmakers face. The case study firms (BMW Group, Mercedes-Benz Group, Volkswagen Group, Audi AG, and Porsche AG), their relationships with China, and their e-mobility approaches are introduced in chapter 4. Chapter 5 covers the research methods used, the reasons for choosing them, as well as their limitations. The findings of the study are outlined in chapter 6. They mostly evolve around five main themes: general observations regarding the e-mobility transition, changes in China's formal institutions, the competitive environment, and the case study firms' value chains, as well as the internationalization of Chinese e-mobility players. Chapter 7 discusses the findings with reference to selected concepts from NIE and strategic management literature. Lastly, chapter 8 concludes.

2. Theoretical background

2.1. Combination of two strands of literature

To explore the impact of China's e-mobility development on German motor vehicle manufacturers, this study combines two perspectives. This sub-chapter provides a brief introduction into the underlying rationale. As Altenburg et al. (2022) point out, the recent boom in China's EV industry is attributable to a "combination of a comprehensive policy package and firm-level technology strategies" (p. 3). This illustrates the dual nature of China's e-mobility development: featuring policy-induced changes in the institutional environment, on the one hand, and changes in the automotive industry's competitive environment, on the other hand, all of which are expected to have an impact on German incumbents. To account for the complex and dynamic nature of these changes, this paper suggests a combination of two strands of research: NIE and strategic management literature. There are two key reasons why this approach is deemed adequate.

Firstly, the two strands of literature complement each other. NIE, on the one hand, provides general theoretical concepts for the analysis of institutions and gives insight into the nature of institutional change (Ménard, 2018, pp. 7-8; Ménard & Shirley, 2022, p. 5; Murrell, 2005, p. 668;

Ostrom, 2005, p. 823). Strategic management literature, on the other hand, provides techniques for external and internal analysis (Barney, 2014, pp. 9–10). While external analysis can help to examine the competitive forces in an industry, internal analysis can help to understand changes related to a firm's value chain and potential to generate competitive advantage (Barney, 2014, pp. 10, 141, 283; Porter, 1998a, pp. 33, 37, 2008, p. 80). In combination, the two strands of literature can be expected to be conducive to finding comprehensive answers to the two research questions.

Secondly, the ideas and topics researched by NIE and strategic management scholars are interconnected. For instance, there are several interfaces between strategic management literature and the Williamsonian branch of NIE (see 2.2.1), including the fields of transaction cost economics and organizational arrangements, which have attracted the attention of researchers from both disciplines in the past (Harrigan, 1984, p. 638; Klein, 2005, p. 445; Ménard & Shirley, 2022, p. x, 72, 89; Porter, 1998b, p. 300). In addition, scholars from both disciplines have generated research related to technological change – researching different aspects but sometimes borrowing concepts from one another (North, 1990, pp. 76, 103; Porter, 1985, 60, 75, 77, 2008, pp. 85, 87, 88). Given the overlapping fields and examples of mutual inspiration between NIE and strategic management literature, the researcher considers a joint use of both perspectives a promising endeavor.

2.2. New institutional economics

2.2.1. General overview

The first stream of literature referred to in this paper, NIE, "is not a single theory, but a dynamic tree with branches growing from a strong trunk of shared fundamental concepts" (Ménard & Shirley, 2022, p. 1). It was initiated by Ronald Coase, who in 1937 pondered the reason for the existence of firms. He theorized that transaction costs are usually positive and that institutions are important for the organization of economic activities. The term NIE was first mentioned by Oliver Williamson in 1975; Williamson is regarded as the founder of one of the three branches of the 'NIE family tree' (Ménard & Shirley, 2022, pp. 9, 11). While the Williamsonian branch focuses on organizational arrangements and the institutions through which organizations are governed, the Northian branch – created by Douglass North – is mostly concerned with the institutional environment's underlying rules (Ménard & Shirley, 2022, p. 3). The third branch came into being in the 1990s when Elinor Ostrom analyzed common pool resources, which tend to be overexploited due to the absence of property rights (Ménard & Shirley, 2022, p. 10). Due to its tree-like and open structure, NIE is a dynamic and diverse field of research. This explains NIE's success in contributing to interdisciplinary research advances (Ménard & Shirley, 2022, pp. x, 18).

Despite the diversity of its branches, the NIE movement is united by a set of commonly accepted concepts (Ménard & Shirley, 2022, p. 1). Based on neoclassical economic theory, NIE supports certain concepts of this theory but rejects others. For instance, NIE accepts neoclassical economic "assumptions of scarcity and competition" (Ménard & Shirley, 2005, p. 2), but it rejects the idea that all information is perfect and that all actors behave perfectly rationally. Instead, NIE argues that markets are imperfect, that economic agents make decisions in situations of uncertainty, that economic agents have their own subjective versions of reality, and that the rationality of these agents is limited (Ménard & Shirley, 2022, pp. 14, 18). Moreover, NIE adapted certain concepts from neoclassical theory and changed them into something new. For instance, NIE assumes that transaction costs are positive, that there are problems regarding the definition and enforcement of property rights, and that contracts tend to be "incomplete and plagued by hazards" (Ménard & Shirley, 2022, p. 15). Further concepts that NIE scholars generally agree upon include the existence of information asymmetries and the inclination of economic agents to engage in opportunistic behavior (Ménard & Shirley, 2022, pp. 92, 109). Finally, and perhaps most importantly, "NIE considers choices to be embedded in institutions" (Ménard & Shirley, 2005, p. 2).

Interestingly, many of the NIE concepts described above can not only be applied to economic agents, but also to political ones. For instance, NIE rejects the neoclassical idea that a state strives towards the maximization of social welfare; instead, it views state actors as agents that have motivations of their own (Ménard & Shirley, 2022, p. 15) and may therefore make decisions that maximize their own benefit rather than public welfare. If the motivations of different state actors differ, this explains why political agents engage in bargaining behaviors when it comes to policymaking (Ménard & Shirley, 2022, p. 116). The transaction cost logic, too, can be applied not only to economic but also to political transactions (Ménard, 2018, p. 4). The following sub-chapters cover three aspects of NIE that are especially relevant in the context of this paper: institutions and their analysis, institutional change, and organizational arrangements.

2.2.2. Institutions and their analysis

Due to the important role of institutions in NIE theory (Ménard & Shirley, 2022, p. 1), this sub-chapter explains how institutions are defined and how they can be analyzed. Different NIE scholars have defined institutions in different ways. North is one of the scholars whose definition has been most frequently cited and used (Ménard & Shirley, 2022, p. 2). According to North (2005), "[institutions] are the rules of the game – both formal rules, informal norms and their enforcement characteristics. Together they define the way the game is played" (p. 22). He clearly distinguishes institutions from organizations: "[organizations] are the players. They are made up of groups of individuals held together by some common objectives" (North, 2005, p. 22). Organizations usually act within the boundaries of a given set of rules; how frequently they deviate from these rules depends on the enforcement mechanisms in place (Ménard & Shirley, 2022, p. 2). Scholars like Richter and Furubotn (2010, pp. 11–12) define institutions in a broader sense, encompassing not only institutions according to North, which they call ‘institutions without people’, but also organizations according to North, which they call ‘institutions with people’. Due to the ambiguity of the broader definition, this paper uses the term ‘institutions’ in the stricter, Northian sense.

As mentioned above, NIE literature distinguishes between formal and informal institutions – terms that were coined by North. Formal institutions, according to Ménard and Shirley (2022), are “codified, traceable, and transmissible rules, usually written, and enforced by organized third parties such as state legal systems” (p. 5). They include “written rules and agreements that govern contractual relations and corporate governance, [as well as] constitutions, laws and rules that govern politics, government, finance, and society more broadly” (Ménard & Shirley, 2005, p. 1). Regulations also fall into this category (Ménard & Shirley, 2005, p. 1). Regarding informal institutions, most NIE scholars agree in defining them as “humanly designed, unwritten rules [that] shape behavior, persist over time, and are enforced by society or have been so internalized by individuals as to be self-enforcing” (Ménard & Shirley, 2022, p. 6). They include “unwritten codes of conduct, norms of behavior, and beliefs” (Ménard & Shirley, 2022, p. 1).

Although a distinction between formal and informal institutions may not always be perfectly clear, and despite the consideration that informal institutions can have an influence on formal institutions (Nee & Swedberg, 2005, p. 809), the focus of this paper is on formal institutions. This decision is based on the expectation that, in the context of the transition towards e-mobility, changes in China’s formal institutions are easier to observe and have a more pronounced and direct impact on German carmakers than possible changes in China’s informal institutions.

When analyzing institutions, NIE scholars take into account that “[decisions] about rules at any one level are usually made within a structure of rules existing at a different level. Thus, institutional studies need to encompass multiple levels of analysis” (Ostrom, 2005, p. 823). Most NIE scholars agree that a distinction can be made between a macro level, where the overall rules of the game can be studied, and a micro level, where transaction costs and contracts can be analyzed (Murrell, 2005, p. 668). The macro level corresponds to what North calls the ‘institutional environment’ (Ménard, 2018, p. 7); the micro level mostly follows the Williamsonian tradition, and NIE scholars sometimes refer to this field as ‘institutional arrangements’ or the ‘economics of organization’ (Ménard, 2018, p. 5; Ménard & Shirley, 2022, p. 68). Ménard (2018) complements this view by adding an intermediate level of ‘meso-institutions’, which he defines as “the set of devices and mechanisms through which specific rules (embedded in general ones) are delineating the domain of transactions that are possible and allowed and the modalities of their enforcement. […] For example, a regulation is a mechanism; a regulatory agency is a device” (p. 8).

This paper is interested in all three levels: on the macro level, it is concerned with formal aspects of the institutional environment of China's automotive industry. The meso-level perspective is of particular relevance as it allows to examine the specific formal institutions set and implemented by China's regulatory agencies to encourage e-mobility development – at national, regional, and local levels of analysis. Finally, the micro lens allows to look at firm-level choices of German car manufacturers and how they are impacted by macro- and meso-level institutions.

2.2.3. Institutional change

This sub-chapter aims to shed light on institutional change, a concept that mostly refers to institutions at the macro or meso levels. The institutional environment, as pointed out by North (1990), is usually stable, allowing only for incremental changes; discontinuous, radical changes in the formal institutional frameworks are comparatively rare (pp. 68, 89). NIE scholars, on the one hand, have identified factors that hinder major institutional changes; on the other hand, they also provide insights into how institutional change is brought about.

A major factor preventing radical changes is path dependence (Ménard & Shirley, 2022, p. 133). Previously disregarded by regulation literature, history and path dependence play an important role in the NIE discussion (Benham, 2005, p. 600). The concept was introduced by North (1990), who drew a connection between technological and institutional change: "[once] technology develops along a particular path, given increasing returns, alternative paths and alternative technologies may be shunted aside and ignored" (p. 76). This can lead to a 'lock in' of the prevailing technology as it becomes increasingly difficult to switch to alternatives, even if they are superior (North, 1990, p. 94). According to North, both "[technological] change and institutional change […] exhibit the characteristics of path dependence" (North, 1990, p. 103). Market failures, bounded rationality, and coordination failures contribute to this phenomenon (Altenburg et al., 2012, pp. 70–71; Murrell, 2005, p. 668; Pegels et al., 2018, p. 27). In the context of path dependence, NIE scholars often speak of technological and institutional 'paradigms' that reinforce existing 'trajectories' and thereby prevent major changes (E. Anderson & Gatignon, 2005, p. 406).

Ménard and Shirley (2022) point out that "[despite] path dependency, institutions do change" (p. 134). Institutional change can proceed at different speeds and be initiated by different agents. In some cases, institutions change slowly and incrementally without external input; in other instances, exogenous shocks or crises open windows of opportunity that allow for sudden and more radical changes (Ménard & Shirley, 2022, pp. 134–135; Shirley, 2005, p. 629). Moreover, institutional change can not only be initiated by policymakers but by various types of agents and organizations (Nill et al., 2001, p. 83); at a micro level, firms do not just passively receive changing rules they need to comply with; they can actively engage in collective action and thereby shape the institutional environment they operate in (Nee & Swedberg, 2005, p. 801; Nill et al., 2001, p. 83).

2.2.4. Organizational arrangements

Research about organizational arrangements, also known as the Williamsonian branch, is the third aspect of NIE highlighted in this paper. This branch "opens the neoclassical black box of the *firm*" (Ménard & Shirley, 2022, p. 15) and takes a micro-level view of the choices made inside. The make-or-buy decision – or, in other words, the question of vertical integration – has attracted a lot of empirical research based on transaction cost theory (Klein, 2005, p. 455).

According to NIE, firms base their vertical integration decisions on a comparison of the transaction costs associated with different organizational arrangements. (Ménard & Shirley, 2022, pp. 26, 79). Organizational arrangements can be divided into markets ('buy'), hierarchies ('make'), and hybrid arrangements ('make jointly') (Ménard & Shirley, 2022, p. 87). Markets correspond to a complete absence of vertical integration, while hierarchies correspond to the highest possible degree of vertical integration. Between these two extremes, there is a continuum in which a variety of hybrid arrangements are possible (Klein, 2005, p. 438). Examples for hybrid arrangements include franchising, strategic alliances, long-term contracts (Klein, 2005, p. 445; Ménard, 2018, p. 6), as well as "'plural forms' in which decision-makers opt for simultaneously managing similar transactions through different organizational arrangements" (Ménard & Shirley, 2022, p. 89). Hybrid arrangements are chosen when the joint usage of resources and/or the coordination of decisions are expected to be financially beneficial (Ménard, 2005, p. 295, 2018, p. 6).

The transaction costs associated with organizational arrangements depend on their underlying transactions, which can differ in three ways: "(1) the specificity of assets required for a transaction to be completed, (2) the uncertainties specific to a transaction that could plague its organization, and (3) the frequency with which a transaction is repeated"[2] (Ménard & Shirley, 2022, p. 79). After conducting a transaction cost analysis, a firm can opt for the most efficient organizational arrangement available. However, since the available options may be limited by the formal institutional environment, the selected option is not necessarily ideal (Klein, 2005, p. 455).

Transaction cost economics and the concept of vertical integration have spread from NIE to other fields of research, including strategic management literature (Ménard & Shirley, 2022, p. 72). In this context, new terms have been coined. For instance, a distinction is made between 'backward vertical integration', i.e., integration upstream towards the origins of the raw materials, and 'forward vertical integration', i.e., integration downstream towards the end customer (Harrigan, 1984, pp. 647-648). Furthermore, the term 'taper integration' is used to refer to a situation in which "firms are backward or forward integrated but rely on outsiders for a portion of their supplies or

[2] According to Williamson, the first point – asset specificity – refers to site specificity, physical asset specificity, human asset specificity, brand-name capital, 'dedicated assets', and temporal specificity (Klein, 2005, pp. 438-439).

distribution" (Harrigan, 1984, p. 643). Arguably, this roughly corresponds to the NIE notion of plural forms. Further concepts from the realm of strategic management are presented in 2.3.

2.3. Strategic management literature

2.3.1. General overview

Strategic management is a broad management field that is concerned with strategic external and internal analysis, strategic choices at the business and corporate levels, as well as their implementation. The main goal of strategic management is to generate and sustain competitive advantage (Barney, 2014, pp. 5, 10, 15, 17). Unlike NIE, which provides a basic set of generally applicable concepts that have inspired research from disciplines as diverse as "political science, management, law, and sociology" (Ménard & Shirley, 2022, p. x), strategic management literature pursues a comparatively narrow and practically-oriented approach, strongly focusing on firms and providing tools that can be used in real-life business contexts. This paper applies a strategic management lens to study how German motor vehicle manufacturers' competitive environment and positions have changed – and thereby develop answers to the second research question.

When analyzing a firm's external environment, strategic managers usually follow two steps. First, they analyze the 'general environment', which is exogenous to the firm. For instance, they may use the so-called PESTEL model to explore potential opportunities and threats in the political, economic, sociocultural, technological, ecological, and legal environment of the individual geographies they operate in. Changing regulations, for instance, would fall under the category of the legal environment. As a second step, strategic managers zoom in on the competitive environment that their firm has some influence over, i.e., they analyze the industry structure of the business(es) they are involved in (Porter, 2008, pp. 80, 88; Rothaermel, 2015, pp. 58, 65). Due to limited scope, this paper only examines the legal aspect of the first step, focusing on changes in China's formal institutions. The second step, however, is covered in greater detail.

In addition to analyzing the external environment, strategic managers can conduct an internal analysis to identify their firm's strengths and weaknesses, which can lead to competitive advantages and disadvantages[3]. Strategic management literature has suggested a variety of tools for internal analysis, including some value-chain models (Barney, 2014, pp. 10, 126-127). Porter's (1998a) generic value chain is one of them; it can be used to analyze strategically relevant activities (p. 33) and serves as one of the key concepts in this paper; further details are provided in 2.3.4.

[3] The state between competitive advantage and competitive disadvantage is called competitive parity. According to Barney (2014), it is possible for a firm to "simultaneously [have] competitive advantages in some value-chain activities, competitive parity in other activities, and even competitive disadvantages in other activities" (p. 127).

Based on findings generated through external and internal analyses, strategic managers can make strategic choices, thus influencing their firm's competitive position (Barney, 2014, p. 5). Strategic choices can be made at different levels: business strategies are formulated with respect to a specific market or industry that a firm operates in, while corporate strategies strive for competitive advantage in "several markets or industries simultaneously" (Barney, 2014, p. 283).

At the business level, Porter (1998b) distinguishes between three generic strategies: 'cost leadership', 'differentiation' by creating a unique offer, and 'focus' on a certain target group, segment, or geography (pp. 35-39). Furthermore, different strategies are recommended depending on whether an industry is emerging, mature, or declining (Barney, 2014, pp. 83–93; Porter, 1998b, pp. 215–274). Meanwhile, from a strategic entrepreneurship perspective, other authors argue that there is "no life cycle of businesses but only of products" and that, "[with] an adequate […] strategy, an innovative firm can influence the development of a whole industry" (Nill et al., 2001, p. 88).

Corporate strategy determines the degree of vertical integration, the range of products and services offered, as well as the geographic scope of a firm's activities (Rothaermel, 2015, p. 242). The first of these three points, vertical integration, corresponds to the NIE notion of the choice of organizational arrangements as described in chapter 2.2.4. The other two points correspond to the concept of diversification: a firm can diversify its activities by offering additional products or services or by expanding its activities to new geographies (Rothaermel, 2015, p. 257).

Because the automotive industry is characterized by intricate and geographically diversified corporate structures, both business and corporate strategies are relevant in the context of this paper. While the focus lies on the business strategies of the case study firms' major German passenger car brands, this paper also considers corporate strategies if they are related to the passenger car business and contribute to answering the research questions. The following sub-chapters shed light on three key aspects briefly mentioned above: the industry-level analysis of the competitive environment, the concept of competitive advantage, and the firm-level analysis of the value chain.

2.3.2. Analysis of the competitive environment

This sub-chapter is dedicated to the second step of the external analysis: it provides additional details on the analysis of the competitive environment or, in other words, the industry structure (Porter, 2008, pp. 80, 88). As the name suggests, the analysis is conducted at a business level, only looking at one industry. A framework commonly used is the one proposed by Porter (1979), which identifies five competitive forces that "determine the profitability of an industry" (p. 3). Based the five forces model, strategic managers can find out more about the position of their firm vis-à-vis other firms in the industry and thus identify "possibilities for strategic action" (Porter, 2008, p. 88).

Despite its popularity, the five forces model has two weaknesses. Firstly, it was originally designed as a static model that fails to consider industry dynamics (Lynch, 2015, p. 92). This paper, however, aims to find out how the competitive environment of German carmakers has changed. Therefore, this paper uses Porter's model as a starting point and then, instead of analyzing the status quo, specifically looks out for changes related to the five forces, as proposed by Porter himself in one of his later works (Porter, 2008, p. 87). Secondly, there is a risk of defining industry boundaries – in terms of product and geographic scope – too broadly or too narrowly (Porter, 2008, p. 80). At the same time, this flexibility in defining the geographic scope is also an opportunity, as it makes it possible to analyze the competitive environment both in China and globally.

The following part provides an overview of Porter's five forces: threat of new entrants, bargaining power of suppliers, bargaining power of buyers, threat of substitute products or services, and rivalry among existing competitors (Porter, 2008, p. 91). Firstly, the threat of entry depends on the existence of entry barriers, among others. Such barriers can stem from economies of scale and other incumbency advantages, switching costs, capital requirements, access to distribution channels, as well as government policy. Secondly, the power of suppliers depends on the number of suppliers (as well as the number of buyers of these suppliers), the uniqueness of the products offered by the suppliers, and the risk of suppliers integrating forward into the industry. Thirdly, the power of buyers depends on the differentiation of the industry's products and the buyers' price sensitivity, as well as other points that are not listed here because they only apply to business-to-business customers. Fourth, the threat of substitutes depends on the substitute's price-performance trade-off as compared to the industry's product, as well as on possible switching costs. Fifth and finally, rivalry among existing competitors depends on the number of competitors, speed of industry growth, height of exit barriers, rivals' commitment to the business, and likelihood of price competition (Porter, 2008, pp. 81–85).[4] Porter's overview of the five forces is shown in figure 1.

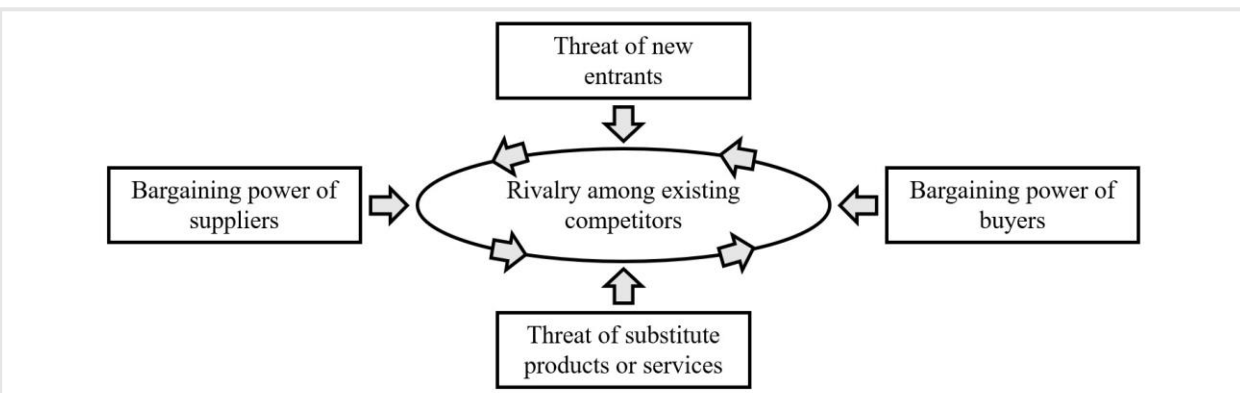

Figure 1: The five forces that shape industry competition – adapted from Porter, 2008, p. 80

[4] In response to other authors, Porter (2008) further points out that industry growth rate, technology, innovation, government, and complements are best understood as factors that influence the strength of the five forces (pp. 86-87).

Finally, one last detail worth mentioning in the five forces context is the concept of industry segmentation. Industry segments are created through differences in product varieties or buyers (Porter, 1998a, pp. 233–236). Industry segments have different levels of attractiveness and require different competitive strategies (Lynch, 2015, p. 99; Porter, 1998a, p. 255). Rivalry is especially high between firms that operate in the same segment. This is due to the fact that relatively attractive segments are protected by 'mobility barriers' that prevent players from other segments to join. The concept of industry segmentation is relevant in the external analysis context because Porter's five forces affect different industry segments in different ways (Rothaermel, 2015, pp. 83-86).

2.3.3. Competitive advantage

The second aspect to be discussed is the concept of competitive advantage. In contrast to Porter's (1990) diamond model, which allows for a national-level analysis (p. 5), this paper takes a narrower perspective, applying the concept of competitive advantage to firms only. Competitive advantage emerges as a result of a firm's competitive positions, i.e., "resource and capability and/or industry positions" (Regnér, 2012, p. 186). According to Barney (2014), "a firm has a competitive advantage when it is able to create more economic value than rival firms" (p.15); economic value meaning the difference between the customer value and the costs of a product (Barney, 2014, p. 15). At a business level, strategic managers can achieve this kind of value-cost relationship through strategic positioning within their industry, i.e., by pursuing the generic strategies mentioned in 2.3.1 (Porter, 1998b, pp. 35–39). Because of industry dynamics, they constantly need to monitor the five competitive forces and "refine and improve their strategic position over time" (Porter, 2008, p. 88).

Resources and capabilities play a role not only at a business but also at a corporate level; as Barney (2014) points out, firms can "gain competitive advantage by leveraging their resources and capabilities across several markets or industries simultaneously" (p. 283). This quote combines the resource-based view and the dynamic capabilities view. Both perspectives have shaped the competitive advantage discourse; they are briefly explained below. According to the resource-based view, firm attributes such as financial, physical, human, and organizational capital are seen as sources of competitive advantage. Different scholars have called these attributes 'resources', 'capabilities', or 'competencies'; usually, these terms can be used interchangeably (Barney, 2014, pp. 124–126). Following the resource-based view, "competitive advantage can be either temporary or sustained" (Barney, 2014, p. 16); "[if] a resource or capability is valuable, rare, and costly to imitate, exploiting this resource will generate a sustained competitive advantage." (Barney, 2014, p. 141). The dynamic capabilities view, on the other hand, is less static, takes into account external changes (Rothaermel, 2015, p. 114), and regards competitive advantage as the result "of a firm's capacity to modify and leverage its resource base in a way that enables it to gain and sustain competitive advantage in a constantly changing environment" (Barney, 2014, p. 113).

In a nutshell, aspects that play a role in generating sustained competitive advantage include a firm's resources, dynamic capabilities, and strategic positioning (Regnér, 2012, p. 186). "One way to identify resources and capabilities that have the potential for creating competitive advantage […] [is the] *value-chain analysis*" (Barney, 2014, p. 126), which is outlined below.

2.3.4. Analysis of the value chain

As indicated in 2.3.1, the analysis of the value chain is a tool for internal analysis. It is the last strategic management concept covered in this paper. Compared with the model developed earlier by McKinsey & Company, the generic value chain proposed by Porter is more comprehensive (Barney, 2014, p. 129), which is why it was selected for the purpose of this study.

Porter (1998a) argues that the origins of competitive advantage can only be understood by analyzing a firm's individual activities: "[a] firm gains competitive advantage by performing these strategically important activities more cheaply or better than its competitors" (pp. 33-34). However, before diving into the details of these activities, it is important to understand the overall context first. In Porter's terms, each firm has its own value chain; in combination, these value chains form a 'value system'. As most other authors use the term 'value chain' for both the internal value chain and the entire value system, this paper will do likewise. According to Porter, the value chains of competing firms may differ, depending on their degrees of vertical integration and diversification, as well as on the industry segments and geographic markets they serve. Furthermore, alliances with other firms can be formed along the value chain. These value chain differences can have an impact on competitive advantages or disadvantages (Porter, 1998a, p. 34).

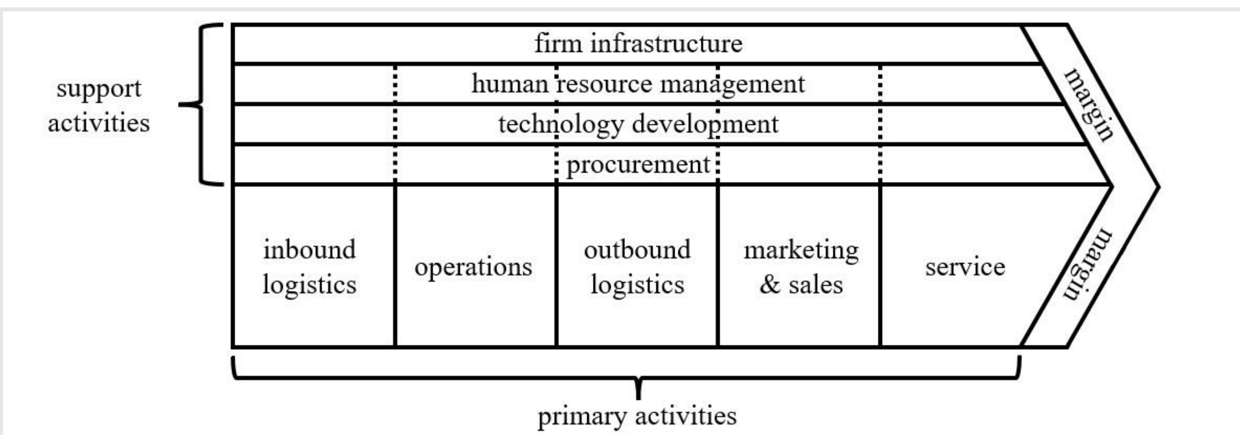

Figure 2: Porter's generic value chain – adapted from Porter, 1998a, p. 37

When it comes to the generic value chain, Porter (1998a) distinguishes two basic types of activities: primary and support activities (p. 37). Primary activities, on the one hand, are "involved in the physical creation of the product and its sale and transfer to the buyer as well as after-sales assistance" (Porter, 1998a, p. 38). They can be divided into five categories: inbound logistics, operations, outbound logistics, marketing and sales, as well as services (Porter, 1998a, p. 37). Support activities, on the other hand, "support the primary activities and each other" (Porter, 1998a, p. 38); in Porter's (1998a, p. 37) model, they include four categories: firm infrastructure, human resource management, technology development, and procurement. "These activities, and how they are linked to one another, can be thought of as a firm's resources and capabilities" (Barney, 2014, p. 128). Collectively, they can create competitive advantage – and therefore a profit margin, which is visualized in Porter's (1998a) value chain as well (p. 37), as can be seen in figure 2.

This study uses Porter's value-chain model to find out how the case study firms' activities and competitive advantages have changed. Due to the limited scope of this study, the focus is mainly on primary activities (except for marketing); with respect to support activities, only procurement and technology development are included. The selected activities are those that are the most promising in terms of their contribution to answering the research questions.

3. Context: Transition towards e-mobility

3.1. Global overview

3.1.1. Introduction to e-mobility

Having reviewed relevant literature from the fields of NIE and strategic management, this paper goes on to introduce the reader to the context of this study, namely, the transition of the automotive industry towards e-mobility. To begin with, a global overview is provided (3.1), followed by a section on the Chinese case (3.2). The last part of this chapter (3.3) looks at the role of German carmakers in the e-mobility transformation and their exposure to China's e-mobility approach. In 3.1, to gain a global overview regarding the e-mobility transition, the reader first learns about the overall concept of e-mobility, including definitions and information on the motives for promoting it (3.1.1). This part is followed by a discussion of how the e-mobility transition represents a paradigm shift (3.1.2). The final section provides insights into the current situation (3.1.3).

For the concept of e-mobility, a variety of definitions have been suggested in the past. As has been briefly mentioned in the introduction, the broadest definition refers to all kinds of private and public transport modes that use electricity for the purpose of mobility, ranging from road to rail and rope transport and beyond (Ajanovic et al., 2021, pp. 1–16). As rail and rope transport modes have largely been electrified already (Ajanovic et al., 2021, pp. 2, 15), the term e-mobility is more commonly used in a narrower sense, referring to the use of electricity in different kinds of vehicles that can drive on roads, ranging "from bicycles, scooters and three-wheelers to passenger cars, vans, buses" (Altenburg et al., 2012, p. 69), and trucks. This paper is interested in the electrification of the automotive industry, focusing on passenger cars. It therefore uses the term e-mobility in the narrower sense and mostly in the passenger car context.

The next paragraphs provide an overview of different vehicle types. A car powered by an internal combustion engine (ICE) is usually referred to as an ICE vehicle (ICEV)[5] (Kampker et al., 2021, p. 60). When it comes to EVs, on the other hand, “several powertrain and car concepts” (Altenburg, 2014, p. 2) can be distinguished, all of which are powered by an electric engine (K. Dudenhöffer, 2015, p. 13). Sometimes, these concepts are collectively termed ‘xEVs’ (Becker, 2021, p. 211). Information on four major EV concepts is provided below.

Firstly, hybrid electric vehicles (HEVs) “have a conventional combustion engine supported by an electric motor. […] The batteries are charged by the electricity generated by the engine and brake energy recuperation” (Altenburg, 2014, p. 4). Secondly, PHEVs “are similar to HEV[s] but in addition offer the possibility of plugging them into the power grids” (Altenburg, 2014, p. 4) to recharge their batteries. Thirdly, BEVs “use an electric motor with batteries for electricity storage. The batteries provide energy for all motive and auxiliary power onboard the vehicle. They are recharged from grid electricity and brake energy recuperation” (Altenburg, 2014, p. 4). Finally, fuel-cell electric vehicles (FCEVs) “use an electric motor and a fuel cell for energy supply. The fuel cell converts energy from hydrogen” (Altenburg, 2014, p. 4). While PHEVs and BEVs can be plugged into the electric grid, this is not the case for HEVs and FCEVs (Altenburg, 2014, p. 4).

The abbreviations listed above are used in different geographies around the world. Some additional terms have been coined by the Chinese government. For instance, policy support has been provided for so-called new energy vehicles (NEVs). This term subsumes PHEVs, BEVs, and FCEVs (Kampker et al., 2021, p. 62). Furthermore, the Chinese government uses the term energy-saving vehicles (ESVs) to refer to ICEVs that have a low consumption (Retzer et al., 2018, p. 14). Major EV concepts and corresponding umbrella terms are summarized in figure 3.

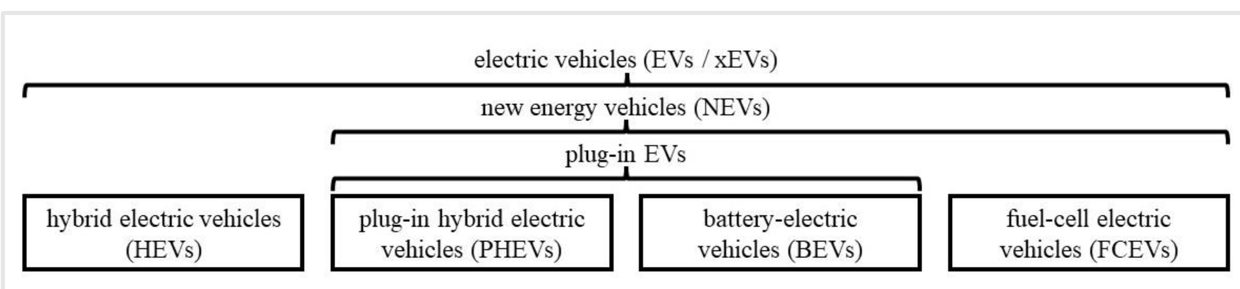

Figure 3: Overview of major electric vehicle concepts – own illustration based on Altenburg, 2014, p. 4; Becker, 2021, p. 211; Kampker et al., 2021, p. 62; Retzer et al., 2018, p. 14

As noted in chapter 1, this paper focuses on BEVs and PHEVs. The researcher made this choice for two reasons. Firstly, BEVs and PHEVs both qualify as NEVs, which means that their development has been supported by the Chinese government. Secondly – unlike FCEVs, which

[5] ICEVs also include cars that run on e-fuels. Since e-fuel technology is not yet mature, it is not the focus of this paper.

also qualify as NEVs – BEVs and PHEVs are the two prevalent EV types. FCEV registrations, in comparison, "remain more than two orders of magnitude lower" (IEA, 2022a, p. 33); furthermore, by 2021, China and Germany only accounted for negligible shares of global passenger car FCEV stock (IEA, 2022a, p. 33). It can thus be assumed that BEVs and PHEVs are more relevant for the analysis of the impact of China's e-mobility development on German passenger carmakers.

Although the history of EV technology development can be traced back to the 1830s, featuring multiple episodes of rising and falling enthusiasm, it was not until the mid-2000s that the latest wave of e-mobility development started (K. Dudenhöffer, 2015, pp. 11–12). The renewed attention is likely linked to the realization that EVs offer solutions to multiple problems at once, as touched upon in the introduction. At the global level, the electrification of the automotive industry has the potential to reduce carbon emissions and mitigate global warming (Altenburg, 2014, pp. 8–9). However, such an effect depends on the corresponding energy mix. Simply put, "[if] electricity comes from […] fossil fuel-based power plants, then electromobility [sic] only shifts emissions from combustion in cars to combustion in power plants" (Altenburg, 2014, p. 9). On a side note, e-mobility targets and policies may also play a role in a country's environmental diplomacy (Hove et al., 2021, p. 8); for instance, by pursuing ambitious goals, a country may enhance its prestige at the international stage. In addition, the e-mobility transition can help countries solve various issues nationally. For instance, it is a way to prevent urban air pollution and resulting health issues such as respiratory problems (Altenburg, 2014, pp. 9–10; Altenburg et al., 2016, p. 467). Moreover, there is a geopolitical effect: by replacing its ICEVs with EVs, a country can reduce its dependence on fuel imports, thus enhancing its energy security (Altenburg, 2014, p. 10). Finally, some fast-growing economies have viewed the e-mobility trend as an opportunity to catch up with developed countries and potentially rise to technological leadership "in the newly emerging electric vehicle and related industries" (Altenburg et al., 2022, p. 1). Although similar motivations for e-mobility development can be observed across different nations, the importance attached to these motives differs from country to country, depending on national circumstances (Altenburg, 2014, pp. 8, 10).

3.1.2. Paradigm change

This sub-chapter discusses how the e-mobility transition presents a paradigm change. Vehicles powered by ICEs "have been the dominant design for an entire century, and other societal institutions […] have developed alongside this technology and reinforced its dominance" (Altenburg et al., 2016, p. 466). Now, for the first time, "the automotive industry is undergoing a technological paradigm shift, as the combustion engine technology is gradually being replaced by electric engines" (Schwabe, 2020b, p. 1). As part of the green transformation, electrification entails not only technological but also institutional change (Altenburg et al., 2012, p. 69), which is why Altenburg et al. (2022) call it a "techno-economic and socio-institutional paradigm shift" (p. 2).

Unlike most other technological disruptions in history, the green transformation originally was not triggered by new inventions but by ecological risks that have led to changes in policies (Altenburg et al., 2022, p. 2). The electrification of the automotive industry is a case in point. As mentioned in 3.1.1, exogenous factors like climate change and air pollution triggered countries around the world to alter their formal institutions so as to "deliberately disrupt established pathways and replace them with new, sustainable ones" (Pegels et al., 2018, p. 29) – i.e., phase out polluting ICE technologies and newly build up a sustainable EV industry. To achieve this, coordination failures need to be addressed. This requires a joint effort and coordinated policy push by multiple government agencies (Altenburg et al., 2012, pp. 70–71). Such a policy push allows policymakers to solve the coordination problem by ensuring that rapid progress is simultaneously made in terms of technology development, removal of entry barriers, charging infrastructure construction, standardization, consumer education, and EV adoption (Altenburg & Pegels, 2012, p. 17; Lütkenhorst et al., 2014, p. 12). Furthermore, policymakers need to adapt their policy mix over time "as [the] technology moves along the deployment curve" (Altenburg & Pegels, 2012, p. 17).

As indicated above, in the context of the e-mobility paradigm shift, governments have an important role to play. This applies to firms as well (Schwabe, 2020b, p. 2). Besides having to comply with changing institutional environments in different countries, they also need to respond to changing market dynamics. The following paragraph looks at general changes related to the automotive value chain and what this means for different kinds of firms; the last paragraph specifically focuses on the implications of the e-mobility paradigm shift for incumbent carmakers.

By inducing a gradual change in propulsion technologies, e-mobility exerts a transformative force on automotive value chains, making hundreds of components related to the ICE, drivetrain, and exhaust redundant (Erich & Witteveen, 2017, p. 13; Schwabe, 2020b, pp. 1, 4), while introducing new components such as batteries, "electric engines, charging devices, new thermo [sic] management systems and innovative lightweight materials" (Altenburg et al., 2022, p. 2). This shift affects the competitive advantages of existing firms, as previously important technologies, assets, and capabilities are replaced by new ones. Carmakers, for example, need to develop new competencies related to battery technology; meanwhile, specialized suppliers may realize that the components they produce have become redundant. Moreover, entry barriers are lowered: for instance, due to the decreased complexity of building an EV as compared to an ICEV, it has become easier for new carmakers to enter the market. Furthermore, firms may exploit new business opportunities related to the EV charging infrastructure and the reuse and recycling of EV batteries (Altenburg, 2014, p. 19; Altenburg et al., 2016, p. 465; Altenburg et al., 2022, pp. 1–2).

For established carmakers, the paradigm change means that they need to reconfigure their organizational arrangements and carefully navigate a changing competitive landscape. Firstly, in terms of organizational arrangements, they need to decide which parts of the EV to make, buy, or make jointly (Kampker et al., 2021, pp. 63–64; Lüthje, 2022, p. 316). As Lütkenhorst et al. (2014) point out, “there is a great potential for change alliances across conventional boundaries” (p. 38). Besides EV production, this also applies to other steps in the value chain. Secondly, they need to monitor shifts in the competitive landscape. As the paradigm change has “[created] new windows of opportunity for catch-up and leapfrogging” (Altenburg et al., 2022, p. 8), incumbent firms need to pay attention not only to existing market players but also to new entrants, which might use new technologies or business models to vertically integrate or diversify into their segment and thereby threaten their competitive position and financial situation (Altenburg et al., 2012, p. 72; Schwabe, 2020b, p. 4). It is therefore crucial for incumbents to prevent their business from being disrupted and, instead, achieve a smooth transition towards the new paradigm (Altenburg et al., 2016, p. 474).

3.1.3. Current situation

This sub-chapter gives the reader insights into the current situation – not only qualitatively in terms of technological trends, but also quantitatively in terms of concrete figures from the global EV market. The following paragraphs provide a non-comprehensive list of recent technological trends, starting with those more strictly and ending with those more loosely related to e-mobility.

Firstly, carmakers are currently working to optimize EV performance and reduce EV production costs. They are striving to optimize thermal management and other aspects related to the electric powertrain (Dabelstein et al., 2021, pp. 3, 6; Kampker et al., 2021, p. 61), improve the energy density, driving range, and lifespan of their EV batteries (Kampker et al., 2021, pp. 61, 64), and develop alternatives to the prevailing lithium-ion battery technology; “[all]-solid-state batteries (ASSBs) are the anticipated next step” (IEA, 2022a, p. 184). Moreover, in contrast to the usual arrangement of battery cells in packs, some firms are developing cell-to-chassis technologies that allow for a direct integration of cells into the vehicle structure (F. Dudenhöffer, 2021, pp. 9–10). Finally, battery recycling represents another technological frontier (Backhaus, 2022, pp. 11, 13).

Secondly, firms are advancing their battery swapping and charging technologies (Danilovic et al., 2021, p. 12). Grid integration and smart charging – an umbrella term covering various aspects such as off-peak, unidirectional managed, and bidirectional managed charging – are currently attracting the attention of carmakers and grid operators alike (IEA, 2022a, pp. 193, 194, 204).

Thirdly, many EVs nowadays have digital features different from those included in conventional cars. Carmakers therefore need to develop new capabilities in “software, electronics, and local ecosystems for applications and services” (Dabelstein et al., 2021, p. 2). According to Dabelstein et al. (2021), though not strictly related to e-mobility, “[advanced] electrical and electronic (E/E) capabilities, such as advanced driver-assistance systems (ADAS) and over-the-air (OTA) software updates" (p. 3), have become essential for carmakers' success in the EV market.

Having reviewed technological trends, this paper goes on to provide a selection of recent data from the global EV market in terms of sales, vehicle stock, available models, battery supply, charging infrastructure, and public spending. Due to the unavailability of 2022 full-year data at the time of writing, this section mainly draws on data provided by the International Energy Agency (IEA) covering the period up to the end of 2021.

According to the IEA (2022a), global EV sales "doubled in 2021 from the previous year to a new record of 6.6 million" (p. 4), which corresponds to a 9% share of global car sales. Out of the 6.6 million EVs sold in 2021, 3.3 million (50%) were sold in China, 2.3 million (35%) in Europe, and 630,000 in the United States (U.S.) (10%). Together, these three markets accounted for 95% of global EV sales. As a result of the strong increase in sales, the global EV stock tripled within three years, reaching a total number of 16.5 million cars in 2021 (IEA, 2022a, pp. 14, 16).

As of 2021, about 450 EV models were available worldwide, 15% more compared to the previous year and five times as many as in 2015. The broadest portfolio – counting about 300 EV models – was offered in China (IEA, 2022a, pp. 4, 20). A more recent report by Strategy&, the consulting unit of PwC, analyzed the top-selling models in major EV markets (i.e., China, the U.S., and a combination of the four largest European EV markets) in the first three quarters of 2022, based on EV registration data. According to this study, the top 10 EV models sold in these three markets were largely dominated by domestic brands (Kuhnert et al., 2022, p. 7).

With regard to EV batteries, the IEA (2022a) found that the doubling of global EV sales in 2021 has also led to a doubling of EV battery demand, which "was met in 2021 due to sufficient battery factory capacity" (p. 138). The IEA further points out that "China dominates production at every stage of the EV battery supply chain downstream of mining" (IEA, 2022a, p. 156) in terms of market share; more details on this topic will be provided in 3.2.3.

In terms of charging infrastructure, "publicly accessible chargers worldwide approached 1.8 million charging points […] in 2021, of which a third were fast chargers" (IEA, 2022a, p. 46). The IEA report further points out that, in 2021, "public charging account[ed] for roughly a third of the charging market as the majority of EVs [were] charged at home" (IEA, 2022a, p. 116).

The acceleration of EV deployment was fostered by public spending. In 2021, according to the IEA, worldwide "[government] spending, such as through purchase subsidies and tax waivers, […] doubled to nearly USD 30 billion" (IEA, 2022a, p. 26) as compared to the previous year.

"However, government spending on a per electric car basis decreased from about USD 5000 to USD 3750, in a declining trend since 2016 highs" (IEA, 2022a, p. 26).

The strong upwards trend in global EV deployment has continued at least at the beginning of 2022, and global EV sales are expected to keep rising in the foreseeable future: firstly, because the European Union (EU) and China have committed to achieving net zero emissions by 2050 and 2060, respectively; and, secondly, because these goals are also reflected in the ambitious electrification plans that have been announced by several carmakers (IEA, 2022a, pp. 4, 32, 108).

3.2. Transition of the Chinese automotive industry towards e-mobility

3.2.1. Country-specific aspects

Against the background of the global e-mobility transition, chapter 3.2 discusses the Chinese case. It highlights China-specific aspects (3.2.1), provides an account of how the e-mobility transition has been institutionally supported in China (3.2.2), gives an overview of recent e-mobility-related data (3.2.3), and presents a selection of major players in the Chinese e-mobility context (3.2.4).

The Chinese case is unique in several ways. One special aspect is the historical background of the Chinese car industry. "Although China's automotive production goes back to the early years of the People's Republic of China, the industry only took off in the 1990s after being declared strategic for China's economic development" (Altenburg et al., 2016, p. 469); it was not until 1995 that private car ownership was permitted (Altenburg et al., 2016, p. 469). Since then, China rapidly developed to become "the largest car manufacturing hub in the world […] in 2013" (Altenburg et al., 2016, p. 471). To date, as a result of China's gradual transition from a centrally planned to a 'socialist market economy', its automotive players include both private and state-owned enterprises (SOEs) (Altenburg et al., 2016, p. 468; Lardy, 2018, p. 330; Peck & Zhang, 2013, p. 368).

Secondly, China is a country with a unique political-economic environment. Run by a single party (Heilmann, 2016, p. 7), China's political system differs from those of other major automotive nations. The corresponding economic system is sometimes referred to as 'state capitalism' or 'authoritarian capitalism' (Lardy, 2018, p. 329). However, despite the authoritarian nature of this system, institutional changes are not always implemented in a top-down manner; they often follow an experimental approach based on trial and error (Nee & Swedberg, 2005, pp. 808–809). Furthermore, political power is to a certain degree decentralized as regional governments compete against one another (Jefferson, 2008, p. 192). As a result, instances of local protectionism can be observed; the field of EV development is no exception (World Economic Forum, 2016, p. 7).

Thirdly, the importance attributed to different motives for promoting e-mobility is unique to the Chinese case (Altenburg, 2014, p. 8; see chapters 1 and 3.1.1). For instance, compared to climate protection, the fight against air pollution in large cities has played a more important role in China (Altenburg et al., 2012, p. 78; Altenburg et al., 2022, p. 3). Furthermore, the country has regarded the e-mobility trend as an opportunity to rise to technological leadership and seize a considerable share of the global EV market (Altenburg et al., 2012, p. 81; Howell et al., 2014, p. 1).

Lastly, China features a special market environment. For instance, a study by the Chinese car company Nio has found that a majority of Chinese “NEV users drive less than 80km per day” (Danilovic et al., 2021, p. 62) and that “only 68% of electric vehicles have their own charging pile” (Danilovic et al., 2021, p. 62). In light of these conditions, it is not surprising that many “Chinese firms are investing in battery swapping” (Altenburg et al., 2016, p. 472) rather than relying on conventional charging options only. In addition, the average EV sold in China is “typically smaller than in other markets” (IEA, 2022a, p. 4), which reflects the existence of a customer segment whose purchasing power is relatively low (Altenburg et al., 2016, p. 473).

3.2.2. Institutional support

This sub-chapter provides an account of how China has institutionally supported its e-mobility transition. It introduces the reader to major state actors, overarching national developments, and details about specific policies, regulations, and measures related to China’s e-mobility development.

In the electrification of China’s car industry, several state agents play a role. Besides the State Council’s inner cabinet, which is responsible for the adoption and publication of industrial policies, four government departments are especially important. Firstly, the National Development and Reform Commission (NDRC) formulates cross-sectoral industrial policies. In addition, it publishes industrial plans and investment catalogues regarding the automotive sector (Heilmann, 2016, p. 347). In the e-mobility context, the NDRC reviews research programs and pilot projects as well as the plans of large corporates (Retzer et al., 2018, p. 13). Furthermore, it defines NEV-related measures (Retzer et al., 2018, p. 13), “[sets] national targets […] [, and] plays a coordinating role across different bureaus” (Helveston, 2016, p. 10). Secondly, the Ministry of Industry and Information Technology (MIIT) formulates and publishes industrial policies and plays a key role in their implementation (Heilmann, 2016, p. 347). It manages the “permits for automotive companies and their products [,] develop[s] technical regulations and standards [and is responsible for] testing and managing incentive measures” (Retzer et al., 2018, p. 13). Thirdly, the Ministry of Science and Technology (MOST) participates in the formulation of technology policies and takes over parts of their implementation (Heilmann, 2016, p. 347). Moreover, it “coordinat[es] scientific projects for NEV development” (Retzer et al., 2018, p. 13). Fourth, The Ministry of Finance (MOF) coordinates and implements financial and tax measures (Heilmann, 2016, p. 347); e.g., it finances “new energy vehicle R&D and deployment of supporting infrastructure” (Helveston, 2016, p. 10).

Besides the State Council and the four government departments mentioned above, several other authorities contribute to China's e-mobility development as well. At the national level, the Standardization Administration of China (SAC) is in charge of "the development, approval, publication, and promotion of the national standards for electric vehicles and charging facilities" (Tagscherer, 2012, p. 2), and the State-Owned Assets Supervision and Administration Commission (SASAC), a special organ of the State Council, supervises China's automotive SOEs (Heilmann, 2016, p. 61). At lower levels of government, provinces and cities formulate local industrial policies, locally implement national frameworks, and support the local industry (Heilmann, 2016, p. 347).

China's institutional support of the e-mobility transition must be viewed in the context of some overarching national developments. Firstly, the importance attributed to China's automotive industry has risen in recent decades, and its development has been promoted by numerous cross-sectoral and sector-specific industrial policies (Altenburg et al., 2022, p. 3; Heilmann, 2016, pp. 348–349). Secondly, during the past decade, Xi Jinping has promoted the Chinese Dream, i.e., the idea of a national rejuvenation (Zenglein & Holzmann, 2019, p. 10). Under this slogan, China's government crafted a strategic plan in 2015; named *Made in China 2025 (MIC 2025),* it strives for industrial modernization and global leadership in various fields, including the emerging ESV and NEV sector (Wübbeke et al., 2016, pp. 17, 19). Thirdly, another concept put forward by Xi Jinping is his "vision of creating an 'ecological civilization'" (Zenglein & Holzmann, 2019, p. 21); China's e-mobility development can thus be seen as one of the paths that China follows to achieve 'carbon peaking' by 2030 and 'carbon neutrality' by 2060 (Hove et al., 2021, p. 8; McGrath, 2020).

The remainder of this sub-chapter provides details about specific policies, regulations, and measures related to China's e-mobility development. As a first step, a timeline is presented to give the reader an understanding of important milestones in the evolution of China's institutional support of e-mobility (as illustrated in table 1). As a second step, this paper offers an overview of the measures included in China's policy mix.

Table 1: Evolution of China's institutional support of e-mobility – own table

Year	Institution supporting China's e-mobility development	Source(s)
1991	*8th Five-Year Plan (1991-1995):* first EV R&D efforts	(Q. Wang & Mah, 2022, p. 198)
1996	*9th Five-Year Plan (1996-2000):* start of an EV demonstration operation attempt	(Q. Wang & Mah, 2022, p. 198)
2001	*10th Five-Year Plan (2001-2005):* start of the *Electric Vehicle Key Project* under the *863 Program* [6] [MOST]	(Howell et al., 2014, p. 8; Jin et al., 2021, p. V)
2004	*Automobile Industry Development Policy* [NDRC]	(Q. Wang & Mah, 2022, p. 199)
2006	*11th Five-Year Plan (2006-2010):* start of the *Energy-Saving and NEV Key Project* under the *863 Program* [MOST]	(Jin et al., 2021, p. V)
	China Science and Technology Medium- and Long-Term Development Plan [State Council]	(Gong et al., 2013, p. 211)
2007	*NEV Production Admittance Management Rules* [NDRC]	(Q. Wang & Mah, 2022, pp. 199, 205)
2008	The Olympic Green Vehicle Demonstration	(Jin et al., 2021, p. V)
2009	*Automotive Industry Readjustment and Revitalization Plan* [State Council]	(Howell et al., 2014, p. 8; Q. Wang & Mah, 2022, p. 199)
	Notice on Implementing Energy-Saving and NEV Pilot Program [MOST, MOF] and *Notice on NEV Demonstration and Subsidies*: start of the *Thousands of Vehicles, Tens of Cities (TVTC) Program*	(Gong et al., 2013, pp. 211–212; Howell et al., 2014, p. 8)
	13 NEV pilot cities in the *TVTC Program*	(Jin et al., 2021, p. V)
2010	*Decisions on Accelerating the Cultivation and Development of Emerging Strategic Industries* [State Council]: NEV industry considered strategic	(Gong et al., 2013, p. 212)
	Notice on the Pilot Program to Subsidise Private Purchases of NEVs [MOST, MIIT, MOF]	(Early et al., 2011, p. 8; Q. Wang & Mah, 2022, p. 202)
	Key Technology and System Integration Project for Electric Vehicles under the *863 Program*	(Early et al., 2011, p. 8)
	25 NEV pilot cities in the *TVTC Program*; subsidies for private purchases in 5 cities	(Howell et al., 2014, p. 8; Jin et al., 2021, p. V)
2011	*12th Five-Year Plan (2011-2015): 12th Science & Technology Development Five-Year Plan; 12th Five-Year Plan for Electric Vehicles* [MOST]	(Gong et al., 2013, p. 212; Howell et al., 2014, p. 9; Q. Wang & Mah, 2022, p. 199)
2012	*12th Five-Year National Strategic Emerging Industry Development Plan* [State Council]	(Q. Wang & Mah, 2022, p. 200)
	Energy-Saving and New Energy Automotive Industry Development Plan (2012-2020) [State Council]	(Howell et al., 2014, p. 9; Jin et al., 2021, p. V)
	Vehicle & vessel tax reduction for ESVs (50%) and exemption for NEVs	(Jin et al., 2021, p. V; Q. Wang & Mah, 2022, p. 203)

[6] The *863 Program*, also called *National High-tech R&D Program*, was managed by the MOST and included a variety of programs, including some that were related to the NEV industry (Howell et al., 2014, p. 8).

2013	*Opinion on Accelerating the Development of Energy Conservation and Environmental Protection Industries* [State Council]	(Q. Wang & Mah, 2022, p. 200)
	Air Pollution Prevention Action Plan	(Jin et al., 2021, p. V)
2014	*Implementation Plan for the Purchase of NEVs by Government Agencies and Public Institutions*	(Jin et al., 2021, p. V; Q. Wang & Mah, 2022, p. 200)
	Vehicle purchase tax exemption for NEVs (from September 2014 to December 2017)	(Jin et al., 2021, p. V; Q. Wang & Mah, 2022, p. 203)
	Subsidies for charging infrastructure construction	(Jin et al., 2021, p. V)
	Notice on Electricity Pricing Policies for EVs	(Q. Wang & Mah, 2022, p. 202)
2015	*Made in China 2025*	(Jin et al., 2021, p. V)
	National Key Research and Development Program – Key Special Implementation Plan for NEVs [MOST]	(Q. Wang & Mah, 2022, p. 200)
	88 NEV pilot cities in the *TVTC Program*	(Jin et al., 2021, p. V)
2016	*China 6 Emission Standards for Light-Duty Vehicles*	(Jin et al., 2021, p. V)
	Gradual reduction of NEV subsidies	(Altenburg et al., 2022, p. 4)
2017	*Medium- & Long-Term Development Plan for the Automotive Industry*	(Jin et al., 2021, p. V)
	Management Rule of NEV Manufacturer & Product Market Entrance	(Jin et al., 2021, p. V)
	NEV Mandate Policy [MIIT]: method for parallel administration on corporate average fuel consumption and NEV credit for passenger cars (starting in 2018)	(Cui, 2018, p. 1; Retzer et al., 2018, p. 21)
2018	*Notice on Distributing the Three-Year Action Plan for Winning the Blue-Sky Defense War* [State Council]	(Q. Wang & Mah, 2022, p. 201)
	Announcement of removal of foreign ownership caps	(Jin et al., 2021, p. V)
2020	NEV subsidy standards to decline in 2021 and 2022	(Q. Wang & Mah, 2022, p. 203)
	NEV Industry Development Plan (2021-2035) [State Council]: target of 20% NEV share by 2025	(Altenburg et al., 2022, p. 4; IEA, 2022a, p. 62)
2021	*14th Five-Year Plan (2021-2025):* higher quality and standards for NEV manufacturing; battery R&D	(IEA, 2022a, pp. 62, 161)
	14th Five-Year Plan for Circular Economy Development (2021-2025) [NDRC]: battery recycling and traceability	(IEA, 2022a, p. 161)
	14th Five-Year Plan for the Development of a Modern Integrated Transport System (2021-2025) [State Council]: charging & battery swap network construction	(IEA, 2022a, p. 82)
	Notice on Starting the Pilot Application of New Energy Vehicle Battery Swap Mode [MIIT]: 11 pilot cities	(IEA, 2022a, p. 82)
2022	Full foreign ownership allowed for passenger carmakers	(T. Wang, 2021)
	Guidance on Enhancing Electric Vehicle Charging Infrastructure Services [10 ministries and commissions]	(IEA, 2022a, p. 82)
	End of the phase-out of EV purchasing subsidies	(Yan & Goh, 2023)

As can be seen in the above timeline, the origins of China's e-mobility development can be traced back to the 1990s, when China started its first R&D and demonstration projects (Q. Wang & Mah, 2022, p. 198). However, it was only during the period of the *10th Five-Year Plan (2001-*

2005) that China's government started to channel larger amounts of funding into the development of new EV technologies through the *863 Program* managed by the MOST (Brunnengräber & Haas, 2020, p. 238; Howell et al., 2014, p. 8). The NDRC further promoted China's e-mobility development by issuing its *Automobile Industry Development Policy* in 2004 (Q. Wang & Mah, 2022, p. 198) and its *NEV Production Admittance Management Rules* in 2007; the latter was the first document that officially defined NEVs (Q. Wang & Mah, 2022, p. 205).

Following these early developments, "2009 mark[ed] a turning point for China's EV policy as the government began to focus on rapid deployment" (Howell et al., 2014, p. 8). In response to the financial crisis, the State Council issued plans for several industries, including the *Automotive Industry Readjustment and Revitalization Plan*, which made new investments conditional on the development of technological competencies in the field of e-mobility (Gong et al., 2013, p. 211; Heilmann, 2016, p. 349; Howell et al., 2014, p. 8; Q. Wang & Mah, 2022, p. 199). Soon after the release of this plan, the *Thousands of Vehicles, Tens of Cities (TVTC) Program* was initiated in 13 Chinese cities (Gong et al., 2013, p. 212; Q. Wang & Mah, 2022, p. 199) "to test car fleets, roll out charging infrastructure and familiarise citizens with electromobility [sic]" (Altenburg et al., 2022, p. 3). In the following year, the State Council selected China's NEV industry to be one of several emerging strategic industries (Gong et al., 2013, p. 212). The number of pilot cities in the *TVTC Program* grew to 25 and, while the focus had initially been on public vehicle fleets, "five more cities were selected in 2010 to experiment with purchase subsidies for private [EVs]" (Altenburg et al., 2012, p. 76). Interestingly, different cities followed different approaches. For instance, Marquis et al. (2013) report that Beijing made use of preferential policies and fostered cooperation among key players; Shanghai created an international platform in Jiading District and developed a car rental business; Shenzhen experimented with a financial leasing model; Hangzhou was a pioneer in terms of battery swapping; and Chongqing developed fast-charging batteries (p. 55).

During the period of the *12th Five-Year Plan (2011-2015)*, the Chinese government issued further policy documents strengthening the support of the country's developing NEV sector and setting targets related to BEV and PHEV deployment as well as charging and battery swapping infrastructure (Gong et al., 2013, p. 212; Howell et al., 2014, p. 9; Q. Wang & Mah, 2022, pp. 199–200). The *Energy-Saving and New Energy Automotive Industry Development Plan (2012-2020)*, published by the State Council in 2012, further built on these policies (Howell et al., 2014, p. 9). During this time period, NEV deployment was promoted through various policy measures, ranging from public procurement and construction of charging infrastructure to electricity pricing benefits, vehicle and vessel tax exemptions, and purchase tax exemptions. Furthermore, the number of NEV pilot cities grew to 88 (Jin et al., 2021, p. V; Q. Wang & Mah, 2022, pp. 200–203).

In 2015, the Chinese government released its strategic plan *MIC 2025* (Wübbeke et al., 2016, p. 17); in this context, the ESV and NEV sector was identified as one "in which China aims to become a dominant global player" (Yeung, 2019, p. 44). According to the 2017 version of the corresponding *MIC 2025 Technology Roadmap*, domestic NEV sales were planned to account for 90% of China's total NEV market in 2025 (Zenglein & Holzmann, 2019, pp. 8, 35). Similarly, concrete targets were set regarding the market shares of domestic EV batteries and motors (Yeung, 2019, p. 44). Derived from *MIC 2025*, four additional ESV and NEV-specific plans were published at the national level in 2015 and 2017 (Zenglein & Holzmann, 2019, p. 35). To increase the competitiveness of Chinese EV players and at the same time reduce public spending, the Chinese government "gradually reduced [NEV purchase subsidies] from 2016 onwards and replaced [them] with regulatory targets and indirect subsidies […] conditional upon technological performance" (Altenburg et al., 2022, p. 4). Notably, the MIIT introduced the *NEV Mandate Policy* in 2017. In addition, China announced a removal of foreign ownership restrictions for NEV joint ventures in 2018 (Jin et al., 2021, p. 8), hoping for foreign firms to develop their newest EV technologies in China and thereby increase local competition and innovation (Altenburg et al., 2022, p. 4).

A more recent milestone is the State Council's issuance of the *NEV Industry Development Plan (2021-2035)* in 2020, which reaffirmed China's technological ambitions (Q. Wang & Mah, 2022, p. 201), set the target for NEVs to account for about 20% of total new car sales in 2025 (IEA, 2022a, p. 62), and reaffirmed the existing trend "towards international openness [and] market-led development" (Altenburg et al., 2022, p. 4). The ambitions of this plan were also reflected in the *14th Five-Year Plan (2021-2025)* and its industry-specific and regional specifications (IEA, 2022a, pp. 62, 82, 161). In addition to setting sales and production targets, they aim for "higher quality and standards for EV manufacturing" (IEA, 2022a, p. 161), advances in terms of battery recycling and traceability, and the extension of China's charging and battery swapping infrastructure (IEA, 2022a, pp. 62, 161). More recently, the start of 2022 saw the lifting of the restrictions on foreign ownership in the manufacture of all kinds of passenger cars and the removal of "[the] rules restricting a foreign company from establishing more than two joint ventures" (T. Wang, 2021). Furthermore, the EV purchase subsidy phase-out ended at the end of 2022 (Yan & Goh, 2023).

Having reviewed important milestones in the evolution of China's institutional support of e-mobility from the early 1990s to the end of 2022, this paper goes on to offer an overview of the measures included in China's policy mix. This overview does not claim to be exhaustive; it is rather to be understood as a summary of the main measures. In addition, it should be noted that the set of measures has changed over time and that there have been considerable differences at the regional and local levels (Altenburg et al., 2022, pp. 3–4). Generally, the overall direction and goals of China's e-mobility development are provided by national plans, which subsequently offer guidance to provincial and local governments and form the basis for the formulation of more specific laws and regulations (Schwabe, 2020a, p. 1107). Such goals, for instance, may include sales targets and technological priorities (Kennedy, 2018, p. 15). China's pilot projects – like the *TVTC Program* – are special in that they are initiated at the national level but involve highly diverse local experiments, the learnings from which can later inform policies at various levels as best practices are rolled out more broadly (Marquis et al., 2013, p. 54). The policy mix of China's e-mobility transition combines aspects that promote new EV technologies with those that aim to reduce the pollution caused by ICE technologies (Altenburg et al., 2022, p. 2). A broad distinction can be made between demand and supply-side measures (Altenburg et al., 2012, p. 77); both types are presented below.

Firstly, on the demand side, the Chinese government has engaged in public procurement and encouraged consumers to change their purchasing behavior (Altenburg et al., 2022, p. 3; Lutsey et al., 2018, p. 26). Especially at the beginning of China's e-mobility development, "[public] procurement ensured early deployment of electric vehicles, particularly public bus and taxi fleets" (Altenburg et al., 2022, p. 3).

In terms of consumer support, a differentiation can be made between financial and non-financial incentives (Retzer et al., 2018, p. 28). Financial incentives, in particular, have been repeatedly adjusted over time (Jin et al., 2021, p. V; Retzer et al., 2018, p. 17; Q. Wang & Mah, 2022, pp. 202–203). Notably, China's central as well as many local governments provided subsidies for privately purchased EVs; starting from 2016, these subsidies were gradually reduced and finally phased out by the end of 2022 (Altenburg et al., 2022, pp. 3–4; Yan & Goh, 2023). In addition, tax incentives were offered; for instance, vehicles that were produced in China and listed in the 'NEV catalogue' were exempted from purchase tax between 2014 and 2017 (Altenburg et al., 2022, p. 3; Retzer et al., 2018, pp. 17, 28). Further financial incentives include preferential loan measures, discounts on car insurance, as well as price concessions related to NEV charging and battery swapping (K. Dudenhöffer, 2015, p. 32; Q. Wang & Mah, 2022, pp. 202–203).

Non-financial measures include the expansion of charging and battery swapping networks in cities, in the countryside, and along major highways (IEA, 2022a, pp. 82, 161) as well as several city-level measures that make NEVs more attractive than ICEVs. For instance, to register a car in Beijing, people need to go through a lottery system; while the chances of obtaining an ICEV license plate are extremely low, "chances in the separate NEV license plate lottery are far higher" (Retzer et al., 2018, p. 28). In Shanghai, people can only obtain an ICEV license plate by going through an auction; NEVs, however, are exempted from this system (K. Dudenhöffer, 2015, p. 32). In addition to restricting new registrations of ICEVs, Beijing and Shanghai also limit the use of these cars inside their inner cities, e.g., through driving ban days; NEVs are excluded from these restrictions

(Altenburg et al., 2012, p. 3; Altenburg et al., 2016, p. 469; Retzer et al., 2018, p. 28). Furthermore, some cities have granted NEVs preferential lane and/or parking access (Lutsey et al., 2018, p. 26).

Secondly, on the supply side, China's government has introduced measures related not only to EV manufacturers but also to their suppliers – especially those that produce batteries. Both kinds of firms have received subsidies for the development of EV-related technologies (Altenburg et al., 2012, p. 77; Altenburg et al., 2022, p. 3; Lutsey et al., 2018, p. 26). Furthermore, China's central government is pursuing a comprehensive plan regarding the development of e-mobility standards – not only strictly related to EV manufacturing but also to the production and recycling of batteries, charging, battery swapping, etc. (Retzer et al., 2018, p. 30). Besides standards, there are a variety of additional requirements that the Chinese government imposes on different kinds of e-mobility-related firms; a selection of the requirements targeted at carmakers is presented below.

Chinese supply-side measures have affected carmakers in at least four ways: investment restrictions, manufacturing licenses, the credit system of the *NEV Mandate Policy*, and – in the case of foreign carmakers – ownership restrictions. Firstly, the Chinese government has put into place "restrictions for investing in new ICE vehicle manufacturing plants" (Altenburg et al., 2022, p. 3). Secondly, for quality and safety reasons, a system of NEV manufacturing licenses was introduced. Carmakers had to fulfill certain requirements to obtain such a license and thereby make their NEVs eligible for subsidies (Retzer et al., 2018, pp. 24, 28). Thirdly, as mentioned before, the MIIT introduced its *NEV Mandate Policy* in 2017. This policy is also referred to as the 'dual-credit policy' (Cui, 2018, pp. 1–2) and applies to all firms that sell at least 30,000 passenger cars annually in China, regardless of whether these cars are locally produced or imported (Retzer et al., 2018, p. 21). The policy introduced a dual system of corporate average fuel consumption (CAFC) and NEV credit points. Depending on whether a firm complies with the prescribed NEV production quotas and CAFC limits, it may buy or sell credit points through a trading platform or, in the worst case, face severe sanctions (Retzer et al., 2018, p. 23). The *NEV Mandate Policy* aims to gradually phase out ICEV production while simultaneously phasing in NEV production. Lastly, the ownership of foreign automotive manufacturers in China used to be capped at 50%, which effectively led these firms to be "reluctant to use cutting-edge technologies in Joint Ventures with Chinese partners, fearing leakage of core competencies" (Altenburg et al., 2012, p. 4). However, to incentivize foreign firms to develop their latest EV technologies in China, the central government lifted this restriction in recent years – first only for NEV production, later for the manufacture of passenger cars in general (Altenburg et al., 2012, p. 4; T. Wang, 2021).

3.2.3. Recent data

As was briefly addressed in the introduction, China's institutional support has led the domestic EV industry to thrive. This sub-chapter provides an overview of recent figures and information related to China's e-mobility transformation. In terms of sales, China is already dominating the global EV market; in 2021, one in two EVs was sold in China (IEA, 2022a, p. 16). This dominance is reflected in the sales figures of various vehicle types; for instance, in 2021, China accounted for about 95, 93, and 90% of the global sales of electric two/three-wheelers, buses, and trucks (IEA, 2022a, pp. 29, 35-36). Furthermore, regarding passenger cars, China has been the largest light-duty EV market in the world since it surpassed the U.S. in 2015 (Jin et al., 2021, p. 11). According to Strategy&, about 4.7 million EVs were sold in China in the first three quarters of 2022, with BEVs and PHEVs accounting for 18.4 and 5.1% of the country's total car market (Kuhnert et al., 2022, pp. 14, 22).

Although China has higher sales figures than other countries, it should be noted that these figures could only be achieved through extensive public spending; Bhatti et al. (2022) estimate that Chinese EVs will not become price competitive with ICEVs before 2024 (p. 25). In 2021, China was the country that spent the most on e-mobility, accounting for 40% of global public spending on e-mobility (IEA, 2022a, pp. 25-26). However, it needs to be noted that China's government support per unit steadily decreased between 2016 and 2021 (IEA, 2022a, p. 25) and that China was "the first country to eliminate all sorts of subsidies on NEVs" (Bhatti et al., 2022, p. 24) at the end of 2022. The impact of this measure on sales is yet to be seen (Bhatti et al., 2022, p. 24).

When it comes to EV stock, "China's fleet of electric cars remained the world's largest at 7.8 million in 2021" (IEA, 2022a, p. 16), representing 47% of the worldwide EV stock (IEA, 2022b). EVs, in this case, include BEVs and PHEVs. More precisely, 55% of the BEVs and 30% of the PHEVs in the world were registered in China in 2021 (IEA, 2022b). In terms of total EV stock, China is an international leader not only at the national level, but also with regard to specific cities. According to Jin et al. (2021), as of 2019, out of the world's top 25 cities with the most electric cars, 14 were Chinese, with Shanghai, Beijing, and Shenzhen ranking first, second, and third (p. 15). This, however, is not surprising given the size of China's population. Future research could generate per-capita figures that allow for more precise international comparisons.

Further aspects in which China has emerged as a global leader include the number of EV charging points as well as various activities along the EV battery supply chain. Firstly, according to the IEA (2022a), China has built "the largest EV charging infrastructure in the world, with more than 1.1 million public charging points" (p. 82) in 2021, "[counting] about 85% of the world's fast chargers and 55% of slow chargers" (IEA, 2022a, p. 46), and has ambitious plans of expanding its network of battery swapping stations and advancing related technologies (IEA, 2022a, p. 82). Secondly, Chinese battery companies have joined their Japanese and Korean rivals as technological leaders (Altenburg et al., 2022, p. 8). As noted in 3.1.3, the technological competencies of Chinese companies in the EV battery sector are already reflected in terms of market share: China "produces three-quarters of all lithium-ion batteries[,] […] is home to 70% of production capacity for cathodes and 85% of production capacity for anodes" (IEA, 2022a, pp. 6–7), and conducts "[over] half of global raw material processing for lithium, cobalt and graphite" (IEA, 2022a, p. 156).

Finally, with respect to the technologies used to produce EVs, as noted in the introduction, an analysis of patents and qualitative data by Altenburg et al. (2022) indicates that China has leapfrogged ahead in the domain of electric buses but has not yet done so in the domain of electric passenger cars. However, Chinese carmakers are perceived to be catching up rapidly (pp. 6-8).

3.2.4. Major Chinese players

This sub-chapter is the last one related to the Chinese automotive industry's e-mobility transition. In this context, it introduces the reader to major Chinese players and their activities – which include, for instance, the production of EVs and their components, the provision of the required infrastructure and equipment, and the collaboration with or investment in other e-mobility-related businesses. Due to the large number of companies involved, only a selection of those that are most relevant and/or most commonly mentioned by other authors is provided (see table 2). The list does not follow any particular order. Furthermore, it should be noted that some of the firms fit into several categories; nevertheless, to avoid duplication, they are only listed once.

Table 2: Major Chinese players in the context of China's e-mobility transition – own table

Type	Names of major players		Source(s)
Automotive incumbents	*State-owned:* • SAIC Motor • FAW Group • Dongfeng Motor • Changan Automobile • GAC Group *Privately-owned:* • Geely	 • BAIC Group • Chery • Brilliance Auto • JAC Motors • Wuling Motors • Great Wall Motor	(Dabelstein et al., 2021, p. 2; Kennedy, 2018, pp. 20, 23; Lutsey et al., 2018, pp. 2, 5; Sebastian, 2022, pp. 6, 9; Yeung, 2019, p. 50; Zenglein & Holzmann, 2019, p. 71)
Automotive start-ups	• XPeng Motors • Li Auto • Nio • Aiways Automobiles	• Hozon Auto • Leapmotor • Weltmeister • Kandi	(Altenburg et al., 2022, p. 7; Cheng, 2023; Dabelstein et al., 2021, p. 2; Kuhnert et al., 2022, p. 17; Sebastian, 2022, p. 9)
Battery suppliers	• CATL • CALB • Sunwoda	• BYD • Gotion High-tech • Eve Energy	(Kuhnert et al., 2022, p. 7; Ren, 2023; Sebastian, 2022, pp. 15, 19)
Electronics manufacturers	• Foxconn	• Xiaomi	(Knight, 2022; Lüthje, 2022, p. 322)
Internet companies	• Baidu • Tencent	• Alibaba	(Jiang & Lu, 2018, pp. 494, 498; Lüthje, 2022, p. 323)
Grid operators	• State Grid Corporation of China	• China Southern Power Grid	(H. Wang & Kimble, 2011, p. 322)

Oil companies	• SinoPec • China National Petroleum Corp.	• China National Offshore Oil Corp.	(H. Wang & Kimble, 2011, p. 322)
Charging pile companies	• Tgood • YKCCN	• Star Charge	(Sebastian, 2022, p. 20; Sina.com.cn, 2023)
Battery swapping operators	• Aulton		(Danilovic et al., 2021, p. 34)
Chinese joint ventures	*Car manufacturing:* • Changan Nio New Energy Vehicle *Battery swapping:* • Shanghai Jieneng Zhidian New Energy Technology		(Bhatti et al., 2022, p. 23; Zheng, 2022)
International joint ventures (only a selection of Sino-German ones listed here)	*Car manufacturing:* • SAIC Volkswagen • Volkswagen Anhui • Shenzhen Denza New Energy Automotive *Charging:* • CAMS	• FAW Volkswagen • Beijing Benz • BMW Brilliance • Spotlight	(Brunnengräber & Haas, 2020, p. 235; Ren, 2022; Reuters, 2021; Schwabe, 2020a, p. 1113 Sebastian, 2022, pp. 9, 19; Volkswagen Group China, 2022)

As can be seen in table 2, various types of companies play a role in China's transition towards e-mobility. Perhaps most obviously, existing carmakers have added EVs to their product portfolios. While some Chinese SOEs have launched their own models independently, others have preferred to collaborate with or invest in other firms with complementary expertise (Bradsher, 2021; Peck & Zhang, 2013, p. 371; Sebastian, 2021, p. 11; van Wyk, 2022). Private automotive incumbents that have entered the e-mobility sector include Geely with its EV brand Zeekr and Great Wall Motor with its EV brand Ora, among others (Kiefer, 2022, p. 8; White, 2023).

In addition, during the period when the Chinese government provided generous subsidies, many new start-ups entered the automotive market, aiming to skip ICEVs and go straight to the production of EVs. However, it turned out that certain sales figures were faked and that many of the new EV models were of mediocre quality. As a result, Chinese regulators decided to gradually remove the subsidies to consolidate the market until a select few companies remained (Lüthje, 2022, p. 321; Retzer et al., 2018, p. 11; Tyfield & Zuev, 2018, p. 263; H. Wang & Kimble, 2011, p. 315). Table 2 includes some of the more successful firms still in business today, e.g., XPeng, Hozon Auto (founder of the brand Nezha), Li Auto, Leapmotor, and Nio, all of which were among the top 15 producers in terms of market share in the Chinese EV market in the first eight months of 2022 (Cheng, 2023; Sebastian, 2022, p. 9). Chinese EV start-ups are often backed by venture capitalists, internet companies, and/or other major players (Hove et al., 2021, p. 33; Lüthje, 2022, p. 321).

In several cases, the e-mobility transition has led companies from other lines of business to interface with the automotive sector. One such field is the battery industry. Large and powerful batteries were not needed in ICEVs but are a key component of any BEV or PHEV (Altenburg et al., 2022, p. 3). The six Chinese battery companies listed in table 2 are among the world's top 10 EV battery manufacturers (Ren, 2023). The most prominent among them are CATL and BYD; in the first 11 months of 2022, they held 37.1 and 13.6% of the global EV battery market, respectively (Kim, 2023). BYD is a special case because it has vertically integrated the car industry; indeed, it produces many different models under its own name and was the most successful EV brand in China in terms of market share in the first eight months of 2022, with four models ranking among China's top 10 in the first three quarters of the same year (Kuhnert et al., 2022, p. 7; Lüthje, 2022, pp. 321–322; Sebastian, 2022, p. 9).

Furthermore, the electrification of the automotive sector has coincided with trends towards connected cars and automated driving. As a result, digital features that go beyond the original expertise of conventional carmakers have become an important source of customer value for EV buyers. Thus, in addition to battery manufacturers, companies with digital expertise have also developed an interest in the automotive sector and seized the opportunity to diversify their portfolios. For instance, the electronics contract manufacturer Foxconn, which assembles 70% of Apple's iPhones, has started to contract manufacture cars for Geely, invested in XPeng, and recently stated its goal of building 5% of global EVs by 2025. In addition, several internet giants have started to venture into the e-mobility field. Baidu, Alibaba, and Tencent, among others, have invested in EV start-ups like Nio and XPeng; they also cooperate with established automakers and their suppliers. Furthermore, internet companies like Baidu have announced entering the car business themselves (Altenburg et al., 2022, p. 3; Bernhart, 2017; Dabelstein et al., 2021, p. 3; Knight, 2022; Lüthje, 2022, pp. 319–323; Sebastian, 2022, pp. 7, 20; Valdes-Dapena, 2022).

As mentioned in 3.1.2, the electric transformation can only succeed if EV technologies and the required infrastructure are developed at the same time (Altenburg et al., 2012, p. 68). Therefore, China's state-owned grid operators and oil companies have become involved in the development of charging and battery swapping networks (Danilovic et al., 2021, pp. 39, 42; H. Wang & Kimble, 2011, p. 322). Besides these established firms, new players have started to provide the related equipment and infrastructure; examples include charging pile companies, such as Tgood and Star Charge, and the battery swapping operator Aulton, which signed an agreement with at least 14 automakers, including many Chinese incumbents (F. Dudenhöffer, 2021, p. 9; Sina.com.cn, 2023).

The descriptions above are of course a simplified portrayal of reality. One aspect that has been mentioned only briefly so far is the existence and evolution of strategic alliances among different companies. For instance, Chinese partners have founded joint ventures, e.g., in the areas of car manufacture and battery swapping (Bhatti et al., 2022, p. 23; Zheng, 2022). In addition, there are international joint ventures between Chinese firms and those from other countries. In the Sino-

German context, for instance, certain joint ventures between German and Chinese carmakers have a history that dates back to the early years of China's Reform and Opening in the 1980s; moreover, new joint ventures and other types of EV investments have been added more recently, partly as a result of the loosening of restrictions on ownership and the permitted number of joint ventures (Altenburg et al., 2022, p. 4; Sebastian, 2022, p. 19; T. Wang, 2021; Q. Wang & Mah, 2022, p. 197). Notably, this is not only true for automotive manufacturing but also for other EV-related areas. One example for this is CAMS, a charging joint venture founded by Volkswagen Group, Star Charge, and the two Chinese incumbents FAW and JAC (Volkswagen Group China, 2022).

Due to the scope of this paper, only a selection of Sino-German joint ventures is listed in the table; of course, there are many other examples of joint ventures between Chinese carmakers and those from other countries (Kennedy, 2018, p. 20), many of which enjoy considerable success in the EV business. The Wuling Hongguan Mini is a case in point; produced by the Sino-American joint venture SAIC-GM-Wuling, the small car was the best-selling EV model in China in the first three quarters of 2022 (Kennedy, 2018, p. 23; Kiefer, 2022, p. 8; Kuhnert et al., 2022, p. 7). Moreover, since the scrapping of the 50% foreign ownership cap in the passenger car sector, some firms have built up wholly foreign-owned enterprises (WFOEs) in China; the American player Tesla, for instance, was the first company to do so in 2018 – and held a 7% share in China's EV market in the first eight months of 2022, ranking third just after BYD and SAIC-GM-Wuling (CBS News, 2018; Sebastian, 2022, p. 9; T. Wang, 2021). However, since this sub-chapter focuses on players that are (at least partly) Chinese-owned, WFOEs will not be discussed in further detail here.

In addition to joint ventures and equity investments, more low-key alliances without equity participation have also been forged in the context of China's e-mobility transition. These include, for example, the China Electric Vehicle Charging Infrastructure Promotion Alliance (CEVCIPA), the China Electric Vehicle Association (CEVA), and the Top 10 Electric Vehicle Alliance, to name a few; often, the participating firms hoped to gain financial and standardization-related advantages from their membership in these alliances (Altenburg et al., 2012, p. 77; Hove et al., 2021, p. 27).

Finally, it should be noted that the activities of the players listed above are not necessarily limited to the Chinese territory. Instead, many players (e.g., EV manufacturers and battery suppliers) are currently expanding their sales and, in some cases, R&D or production activities to new markets around the globe (Kiefer, 2022, pp. 7–8; Kuhnert et al., 2022, pp. 4, 8; Sebastian, 2022, p. 15).

3.3. German motor vehicle manufacturers in the e-mobility transition

3.3.1. Key players

Following a more general outline of China's e-mobility transition, chapter 3.3 addresses the role that German carmakers play. While the first part (3.3.1) focuses on major German automakers, their characteristics, and their electrification strategies, the second and last part (3.3.2) looks at these firms' exposure to China's e-mobility approach.

Germany is home to several carmakers. The largest by annual revenue are Volkswagen Group, Mercedes Benz Group (formerly Daimler AG), and BMW Group – in this order, ever since 2006. As of 2020, these three groups were among the country's top four companies by revenue, which illustrates their importance for the German economy. Each of the companies comprises various business units and/or brands; Volkswagen Group, for instance, includes Audi AG and Porsche AG, among others (Fortune, 2021; Mercedes-Benz Group, 2022a; Statista, 2021).

German carmakers have some characteristics that distinguish them from their non-German rivals. For example, "Germany's automotive industry, with the Mercedes, BMW, Audi and Porsche brands among others, has a particular strength in the luxury and upper middle-size classes; and even in the smaller car categories, German manufacturers sell in the highest price range" (Altenburg, 2014, p. 1). However, there are exceptions to this; unlike the aforementioned premium and luxury brands, Volkswagen, for instance, is considered a volume brand (Winton, 2022). In addition to the high-end positioning of most brands, Altenburg (2014) further points out that the German car industry has a "long history of automotive innovations […] [, an] R&D-intensive and collaborative automotive innovation system […] [, and a] high degree of internationalisation" (pp. 28–29). In addition, German carmakers tend to adopt an "in-house driven approach to development with close interaction with suppliers over a long cycle" (Hafner & Modic, 2020, p. 64).

In terms of e-mobility, German carmakers have followed a latecomer strategy; they only launched their first EV models several years after their international competitors (Altenburg, 2014, pp. 29–30). Interestingly, they were not concerned by their delayed start into the EV market but "confident that they [could] launch PHEV or BEV fast enough once the respective markets develop[ed]" (Altenburg et al., 2016, p. 470); their confidence mostly stemmed from the strength of Germany's automotive innovation system (Altenburg et al., 2012, p. 74; Altenburg et al., 2016, p. 473). In the case of German premium and luxury brands, the decision to enter the EV market rather late partly stems from their specialization in high-end vehicles with strong ICEs (Altenburg et al., 2016, p. 470). Volkswagen's logic, on the other hand, was to wait for EV demand to increase to the point where economies of scale can be realized and where "the technology is sufficiently mature to ensure the same driving comfort as an ICE[V]" (Altenburg, 2014, p. 31) in order then to pursue cost leadership "through modularisation and standardisation" (Altenburg, 2014, p. 31).

In addition, there are several other similarities between the e-mobility approaches of German carmakers. For instance, they first focused on improving their ICE technologies as a short-term strategy (Altenburg, 2014, p. 32); they all "pursue[d] the development of hydrogen and fuel-cell technology as a medium to long-term alternative" (Altenburg, 2014, p. 32); and, while they developed hybrid models for all kinds of vehicles, they initially tested BEV technology on a smaller scale and primarily in smaller-sized cars (Altenburg, 2014, p. 32). Moreover, Volkswagen was not the only firm that sought to reduce costs through modularization; other companies also recognized the potential of this approach in simultaneously reducing costs while "mitigating the risk that comes from not knowing which technology will actually become the dominant design" (Altenburg et al., 2016, p. 471). In addition, Altenburg already pointed out the "gap in [Germany's] innovation system regarding (lithium-ion) battery technology" in 2014 (p. 29); however, this field was neglected by the German players, who considered "the production of [battery] modules […] to be a relatively low-tech activity that is not critical for driving performance and can thus be outsourced to low-cost locations" (Altenburg et al., 2016, p. 471). Those players who were especially late in recognizing the battery cells' strategic value are likely to face a shortage of battery cells in a few years' time (Hucko & Freitag, 2022, p. 63). Finally, another commonality is that, as of 2021, all German carmakers were developing chargeable EVs, but none of them were investing in battery-swapping technologies (Danilovic et al., 2021, p. 67; F. Dudenhöffer, 2021, p. 9).

Regarding more recent developments, sales figures from the first three quarters of 2022 suggest that the models from Volkswagen's electric 'ID. family' obtained a considerable share of the EV market in Europe and the U.S., reaching the 9^{th} or 10^{th} rank of the best-selling models. In China, however, not a single German EV model reached the top 10 (Kuhnert et al., 2022, p. 7). The same holds true for the representation of German carmakers in China's top 10 EV producers in the first eight months of the same year; Volkswagen's joint ventures with SAIC and FAW only ranked 14^{th} and 15^{th} (Sebastian, 2022, p. 9). While total sales figures can be used to assess the performance of volume brands like Volkswagen, this is not the case for the other German car brands. To assess their performance, one would need to look at the more specific sales figures from the premium and/or luxury EV markets; however, these were unavailable at the time of writing.

Table 3: Electrification goals of German carmakers – own table

Company	Goals	Source(s)
BMW Group	*BMW Group:* • > 50% BEV share by 2030[7]	(BMW Group, 2021b)
Mercedes-Benz Group	*Mercedes-Benz Group:* • Up to 50% xEVs by 2025 • Up to 100% xEVs by 2030 "where market conditions allow"	(Mercedes-Benz Group, 2022l)
Volkswagen Group	*Volkswagen Group:* • 50% BEV share by 2030 • Nearly 100% zero-emission vehicles by 2040 *Volkswagen brand:* • > 70% BEV share in Europe by 2030 • > 50% EV share in China and the U.S. by 2030	(Volkswagen, 2021; Volkswagen Group, 2021b)
Audi AG	*Audi brand:* • Production of combustion models to be phased out by 2033	(Audi AG, 2022m)
Porsche AG	*Porsche AG / Porsche brand:* • > 50% EV share by 2025 • > 80% BEV share by 2030	(Porsche AG, 2022b)

Looking to the future, all German carmakers have announced goals regarding their electric transition; these are summarized in table 3. To achieve these sales goals, German firms will launch several new EV models in the upcoming years; chapter 4 provides more details on this topic.

3.3.2. Exposure to China's e-mobility approach

Sub-chapter 3.3.2 looks at German motor vehicle manufacturers' exposure to China's e-mobility approach and wraps up the chapter that provides information on the context of this study. To begin with, it is necessary to point out that Germany's largest carmakers are global players. As a result, they are affected by e-mobility-related developments in many different geographies; China is just one of them. Nevertheless, China is an important geography in several respects. For instance, as of 2021, foreign direct investment (FDI) by German firms in China's automotive sector "accounted for 42 percent of EU FDI in China" (Sebastian, 2022, p. 5). In addition, the three German conglomerates "BMW, Mercedes-Benz, and Volkswagen have become accustomed to high China revenues, with roughly a fifth of their global revenue originating in the country" (Sebastian, 2022, p. 9). Furthermore, these revenues generated "in China could be instrumental to secure profits for reinvestment and maintain the strength of German companies in their home and third markets" (Sebastian, 2022, p. 5). Considering the "importance of the automotive industry for the German

[7] While BEV market share targets have been announced for the entire BMW Group and its brands MINI and Rolls-Royce (BMW Group, 2021b), to the author's knowledge, no specific target has been set for the BMW brand.

economy" (Schwabe, 2020a, p. 1108), the above points illustrate the dependence of German carmakers – as well as the German economy – on the Chinese market (Schwabe, 2020a, p. 1108).

In recent years, there has been a two-fold development. On the one hand, Germany's new government has urged German firms to reduce their dependence and diversify away from China. This position is reflected in the official positions expressed by German chancellor Scholz. In addition, more concrete measures have been taken (Benner, 2022; Kiefer, 2022, p. 6; Scholz, 2022); for instance, "[in] May 2022, the [German] government denied Volkswagen's request to prolong the investment guarantees […] for some of its China investments" (Sebastian, 2022, p. 4).

On the other hand, as their market shares are being diminished by Chinese competitors (Kiefer, 2022, p. 6; Sebastian, 2022, p. 9), German carmakers tend to "consider greater local presence a rational response" (Sebastian, 2022, p. 4). This presence comes in different forms. For example, German car manufacturers have increased certain R&D activities in China: not only in strictly e-mobility-related fields like battery technology but also in more loosely related areas like digital connectivity solutions. While battery R&D in China is attractive for German firms due to the dominance of Chinese firms in the global battery supply chain, cooperation between German carmakers and Chinese internet companies can be explained by the fact that China's digital ecosystem is to a large extent decoupled from the world beyond China's Great Firewall, making it necessary to develop China-specific solutions (Sebastian, 2022, pp. 7, 10, 12; Zenglein & Holzmann, 2019, p. 14). A similar trend of increased local presence can be observed in the field of (EV) production (Sebastian, 2022, pp. 15, 19); "German carmakers are increasingly eager to use their production plants in China for exports" (Sebastian, 2022, p. 15). Overall, these developments in the strategies of German carmakers can be described as a shift "from an 'in China, for China' […] strategy to […] an 'in China, for the world' one" (Sebastian, 2022, p. 2). Arguably, this strategic shift may help German firms to remain competitive, but, at the same time, it runs counter to the German government's hopes for diversification; "[going] forward, what is good for German carmakers in China might not be good for Germany (and Europe)" (Sebastian, 2022, p. 2).

As indicated above, the exposure of German automakers to China's e-mobility approach depends, among other things, on the scale of their China-specific investments and the size of their China-specific revenues as compared to those in other countries. This paper argues that, in light of this exposure, China's e-mobility development has a two-fold impact on these firms: through changes in formal institutions and through changes in the competitive environment. The below paragraphs present a summary of relevant findings generated by other researchers in this field.

Generally, changes in China's formal institutions affect all carmakers alike; however, in some respects, foreign firms are treated or impacted differently from their Chinese counterparts.

Although foreign firms and chambers of commerce may voice their views, thereby influencing Chinese regulations, this influence is smaller than that of Chinese firms, especially when it comes to state-owned ones. This partly explains why Chinese industrial policies sometimes favor state-owned over private companies and domestic over foreign ones (Heilmann, 2016, pp. 346, 350).

In the past, foreign car manufacturers in China have notably been affected by the fact that FDI in the automotive sector was for a long time only possible by entering into a joint venture with a Chinese carmaker (Heilmann, 2016, p. 349). Furthermore, there have been local content requirements, forced technology transfers, and restrictions on the import of completely knocked-down (CKD) and semi knocked-down (SKD) vehicles, which effectively meant that a large part of a foreign firm's activities had to be localized (Yeung, 2019, p. 43). Although several discriminatory policies have been removed in recent years (T. Wang, 2021; Yeung, 2019, p. 43), it can be assumed that some of them continue to influence the structure of the automotive industry to date.

In the context of China's institutional support of e-mobility, at least five policies and/or measures have had a special effect on foreign car manufacturers: demand-side financial incentives, domestic market share targets, market access regulations, the 'dual-credit policy', and restrictions on foreign ownership. Firstly, when it comes to financial incentives provided by central and local governments, the European Chamber (2017) expressed its discontent with the fact that Chinese NEV purchase subsidies only applied to locally-produced and not to imported NEVs (p. 43). Similarly, imported vehicles were not eligible for China's EV purchase tax exemption (Howell et al., 2014, p. 38; Retzer et al., 2018, p. 17).

Secondly, the *MIC 2025 Technology Roadmap* set "semi-official targets of market shares for domestic firms in various sectors including NEVs and components" (Schwabe, 2020a, pp. 1110–1111). Foreign companies were concerned about these goals as the *MIC 2025 Technology Roadmap* did not specify how the market share would be measured (European Chamber, 2017, p. 12) and whether the term 'domestic' referred to "[a] brand of Chinese origin or a locally produced product" (Schwabe, 2020a, p. 1111). Although MIIT officials downplayed these targets' significance (European Chamber, 2017, p. 12), research by Schwabe (2020a) indicates that the pursuit of these goals has led local governments to take discriminatory decisions (p. 1117).

Thirdly, foreign carmakers have been affected by Chinese market access regulations. For instance, as foreign EV battery suppliers "face[d] serious constraints on market access" (European Chamber, 2017, p. 39), "the selection of battery suppliers by international OEMs [has] in some cases [been] influenced by local governments in order to favor Chinese firms" (Schwabe, 2020a, p. 1116). Moreover, access to China's NEV market has depended on requirements; e.g., a carmaker had to "demonstrate that they [had] mastered the development and manufacturing technology for the complete NEV […] and possess[ed] core NEV-specific R&D capabilities" (European Chamber, 2017, p. 39); effectively, a foreign carmaker had to "disclose and transfer critical know-how to the [joint venture] and, presumably, localise it" (European Chamber, 2017, pp. 39–40).

Fourth, the 'dual-credit policy' applies to all companies selling motor vehicles in China, regardless of company ownership and whether the cars sold in China were locally produced or imported (Retzer et al., 2018, p. 21). Regarding a preliminary proposal of the CAFC credit system, the European Chamber (2017) criticized that, unlike Chinese shareholders, foreign shareholders were not allowed to transfer credits between different joint ventures in which they were invested (p. 43). In the proposed NEV credit system, foreign firms were not directly discriminated against, but they found it hard to predict what the regulations would eventually look like. As the final policy was only announced one year before taking effect, foreign firms were taken by surprise and had to speed up their NEV production plans. Meanwhile, Chinese competitors dealt with uncertainty in a different way and were therefore able to comply with the new requirements sooner than the German firms (European Chamber, 2017, p. 43; Schwabe, 2020a, pp. 1111–1113; Yeung, 2019, p. 54).

On a side note, the discrimination perceived by foreign OEMs often stems from a combination of factors. For instance, the cars they imported were not eligible for Chinese subsidies, their future share in China's EV market was limited, but they still had to meet the same NEV quotas as their Chinese rivals; these factors, in combination, led to discontent (European Chamber, 2017, p. 43; Schwabe, 2020a, pp. 1110–1111).

Fifth, as a result of China's e-mobility development, the foreign ownership restrictions in the passenger car sector were lifted (Altenburg et al., 2022, p. 4). Schwabe (2020a) argues that the removal of the joint venture requirement did not seem relevant for most foreign incumbents as it remained difficult to "[obtain] a production license for new wholly owned facilities" (p. 1112). Sebastian (2022), on the other hand, reports that "German carmakers […] have been eagerly making use of these policy changes" (p. 6); for instance, BMW and Volkswagen obtained a majority stake in existing joint ventures, hoping "to increase their profit margins and decision-making power" (Sebastian, 2022, p. 6). Also, as pointed out by Altenburg et al. (2022), several foreign carmakers succeeded in obtaining full ownership of local production facilities and thus "started to use China as an export hub for electric models" (p. 7).

As indicated above, in the context of the e-mobility transition, German carmakers have been influenced by changes not only in China's formal institutions but also in the competitive environment. In China, activities of Chinese firms have affected German car manufacturers both negatively and positively. On the negative side, the EVs offered by Chinese firms have become increasingly competitive. Chinese EV makers have made "massive technological advances over the past two years" (Dabelstein et al., 2021, p. 12); today, they "offer leading battery technology and are rapidly gaining ground in the development of the underlying E/E capabilities" (Dabelstein et al., 2021, p. 9). In addition, they have adopted a customer-centric approach and equipped their vehicles with many digital features appreciated by Chinese customers (Dabelstein et al., 2021, pp. 2, 9). Chinese start-ups have furthermore adopted direct sales models, which allow them to "integrate the online and offline worlds […] [and create] a more intimate consumer experience" (Zhang, 2022, pp. 3–4). As a result, many Chinese customers are willing to switch to domestic brands whose products suit their needs better (Dabelstein et al., 2021, p. 9). The German OEMs, on the other hand, "started to offer EV models in China very recently, and when they did so they failed to connect with the younger and more tech-focused Chinese consumers" (Sebastian, 2022, p. 9). As a result, they recently suffered "severe losses in market share" (Sebastian, 2022, p. 7). In 2021, the majority of passenger cars sold in China by German carmakers were still ICEVs. While Volkswagen, BMW, and Mercedes-Benz Group jointly accounted for 18.7% of China's total passenger car market, they only made up 5.4% of China's EV market (Sebastian, 2022, p. 8).

On a more positive note, to be able to compete with Chinese EV manufacturers, German carmakers have identified and seized new opportunities for cooperation – not just with regard to battery technology but also in the digital realm. For instance, German companies have collaborated with Chinese internet giants, companies specialized in artificial intelligence (AI) solutions, as well as telecommunications companies to be able to produce superior, digitally-connected EVs in the future (Altenburg et al., 2022, p. 3; Sebastian, 2022, p. 11; Tyfield & Zuev, 2018, p. 266).

The impact of China's e-mobility development is also evident outside the People's Republic, as Chinese players are changing the competitive landscape of the automotive industry globally. To the researcher's knowledge, literature about competition (and cooperation) between German and Chinese e-mobility firms outside of China and Europe is sparse. Therefore, although they also compete in other geographies around the world, the paragraphs below focus mainly on Europe.

As Kuhnert et al. (2022) point out, many Chinese EV makers are expanding internationally and "seeking to consolidate their foothold in Europe" (p. 3), thus increasing the competition that German OEMs face. Examples include Nio, which "plans to open 120 swapping stations in Europe" (Kuhnert et al., 2022, p. 6), Great Wall Motor, XPeng with the ultra-fast charging technology of its model XPeng G9 (Kiefer, 2022, p. 8), and BYD, which recently "signed a European long-term agreement to sell approximately 100,000 BEVs to German car rental company Sixt in the period up to 2028" (Kuhnert et al., 2022, p. 4). PwC forecasts "that by 2030, the Chinese newcomers will have captured between 3.8% and 7.9% of European BEV market share" (Kuhnert et al., 2022, p. 6).

In addition, several Chinese firms from the battery sector are currently "setting up plants in Europe to supply German and other European carmakers" (Sebastian, 2022, p. 15). For instance, CATL is investing "in a battery factory in Germany, for which it has already signed contracts with BMW" (Altenburg et al., 2022, p. 8), and "[further] upstream, battery equipment manufacturers like LEAD are equipping German carmakers' battery plants in Europe" (Sebastian, 2022, p. 15). These examples show that the Chinese firms entering Europe include not only direct competitors of German OEMs but also suppliers joining the European value chain and seeking cooperation.

Chapter 3 has presented contextual information about the automotive industry's transition towards e-mobility – globally, in China, and in relation to German carmakers. This study is interested in the examination of five cases: BMW Group, Mercedes-Benz Group, Volkswagen Group, Audi AG, and Porsche AG. Chapter 4 provides further details on each case, including general information about each firm, their e-mobility approach, and their involvement in China.

4. Case study: Five German motor vehicle manufacturers

4.1. BMW Group

Founded in 1916 and headquartered in Munich, "BMW Group is the world's leading premium manufacturer of automobiles and motorcycles and also provides premium financial and mobility services" (BMW Group, n.d.–a, 2023). In 2021, BMW Group operated 31 production sites in 15 countries, sold products in over 140 countries, employed nearly 119,000 people, and generated 111.2 billion euros of revenue (BMW Group, n.d.–a, 2023). Its portfolio includes three passenger car brands – BMW, MINI, and Rolls-Royce – and the motorcycle brand BMW Motorrad. In 2021, BMW Group delivered more than 2.5 million cars, thereof 87.8% BMW, 12.0% MINI, and 0.2% Rolls-Royce-branded vehicles (BMW Group, n.d.–b). The total number of EVs (BEVs and PHEVs) sold in 2021 exceeded 328,000 units, accounting for 13% of total deliveries (BMW Group, 2023).

Concerning the e-mobility transition, by 2025, BMW Group aims to achieve an EV share of 30%; five years later, the BEV share is supposed to reach 50% (BMW Group, 2022a, p. 25). One step towards this goal will be the introduction of the 'Neue Klasse' in 2025. This new class of cars will be based on a new architecture that "is specifically geared towards all-electric vehicles" (BMW Group, 2022a, p. 14); nevertheless, BMW Group continues to offer vehicles of various drivetrain types, including not only BEVs but also PHEVs and ICEVs (BMW Group, 2021a). In terms of R&D, BMW Group aims to present ASSBs by the end of the decade (BMW Group, 2022i).

To secure EV battery supply, BMW Group joined the 'Responsible Lithium Partnership' project in Chile in 2022, which had been initiated a year earlier by multiple German players, including Mercedes-Benz and Volkswagen Group (BMW Group, 2022c). Moreover, the company has signed contracts with CATL and Eve Energy to build four new battery cell factories in China and Europe and with the Japanese company Envision AESC to build another battery cell plant in the U.S.; details about a sixth factory are yet to be announced (BMW Group, 2022j, 2022k).

Downstream of battery cell production, the other steps in BMW Group's EV value chain are performed in-house, especially in Germany, but also in the U.S. and China (BMW Group, 2022g). In 2022, "[BMW Group] already [had] 15 fully-electric models in production – covering 90 percent of its current segments. In addition to existing models like the BMW i4, [the] BMW iX […] [, the] MINI SE […], the BMW 3 Series and BMW 5 Series, the BMW X1 and the BMW X3" (BMW Group, 2022d), BMW Group newly launched its BMW i7 in the third quarter of 2022. Furthermore, the company plans to launch its new BEV models BMW i5 and BMW iX5 in 2023 and 2026, respectively (Kuhnert et al., 2022, pp. 8, 18).

In China, BMW Group is involved in two joint ventures. The first one, BMW Brilliance, was founded in 2003 with Brilliance Auto; in 2022, BMW Group increased its ownership share from 50 to 75%. Today, the joint venture operates three production plants in Shenyang: Plant Tiexi, Plant Dadong, which was recently enlarged, and Plant Lydia, which was created in 2022. Among others, Plant Lydia assembles the BMW i3 eDrive35L, a BEV tailored to the Chinese taste. The second joint venture, Spotlight, was created by BMW Group and Great Wall Motor in 2019 with the aim of jointly developing and producing EVs, including MINI-branded BEVs to be sold around the world. Together, the four plants are expected to accelerate BMW Group's electrification (BMW Group, n.d.–a, 2010, 2019, 2022a, p. 55, 2022b, 2022e, 2022f, 2022h; Sebastian, 2022, p. 11).

Besides production, BMW Group also conducts R&D in China, e.g., in the e-mobility and digital realms. The company has its own R&D centers in Shenyang, Shanghai, Beijing, and Tianjin; in addition, it partners with various Chinese players. For instance, BMW Group created a R&D partnership related to charging with the State Grid Corporation of China in 2020 and is deepening its cooperation with Chinese tech incumbents and start-ups; partners include Baidu, Alibaba, Tencent, and the software company Archermind (Sebastian, 2022, pp. 7, 11, 20-22).

Finally, China was BMW Group's largest sales market in 2021, accounting for over 33.6% of global vehicle deliveries (BMW Group, 2022a, p. 110). In the same year, the firm held a 3.9 and 1.4% share of China's total passenger car and EV markets, respectively (Sebastian, 2022, p. 8).

4.2. Mercedes-Benz Group

Founded in 1926 and headquartered in Stuttgart, Mercedes-Benz Group consists of two business units. Mercedes-Benz AG produces premium and luxury vehicles and is divided into 'Mercedes-Benz Cars' and 'Mercedes-Benz Vans'; Mercedes-Benz Mobility AG offers mobility services (Mercedes-Benz Group, n.d.–b, n.d.–d). Today, Mercedes-Benz "Group has production facilities in Europe, North and South America, Asia and Africa" (Mercedes-Benz Group, 2022c, p. 44), and its products are available in almost all countries (Mercedes-Benz Group, n.d.–b). Its passenger car brand portfolio includes Mercedes-Benz, Mercedes-AMG, Mercedes-Maybach, and Mercedes-EQ. In 2021, Mercedes-Benz Group had 172,000 employees, achieved a revenue of nearly 168.0 billion euros, and sold more than 2.3 million vehicles, thereof 83.4% cars and 16.6% vans (Mercedes-Benz Group, n.d.–d). In the same year, Mercedes-Benz Cars delivered over 227,000 EVs, accounting for 11.7% of total car deliveries (Mercedes-Benz Group, n.d.–d, 2022d).

With respect to e-mobility, Mercedes-Benz Group has set itself the goals to offer a BEV alternative for every model, reach a 50% EV share, launch three new EV architectures by 2025, go all-electric around 2030, and achieve carbon-neutrality by 2039 (Mercedes-Benz Group, 2021b, pp. 4-5, 7, 10, 12). To achieve these goals, the company, among other things, "will deepen the level of vertical integration in manufacturing and development" (Mercedes-Benz Group, 2021a).

To ensure lithium supply to its battery cell production partners, Mercedes-Benz Group recently signed an agreement with the German-Canadian start-up Rock Tech Lithium (Mercedes-Benz Group, 2022k). Further down the supply chain, Mercedes-Benz Group plans to partner with other firms to build eight battery cell factories, e.g., with CATL in Hungary and Envision AESC in the U.S. (Mercedes-Benz Group, 2021a, 2022f, 2022i). In addition, Mercedes-Benz Group plans a "network of nine plants dedicated to building battery systems" (Mercedes-Benz Group, 2021a).

Moreover, to advance their battery technology, Mercedes-Benz Group is engaged in various R&D partnerships. For example, around the mid-2020s, the company will start using the silicon anode chemistry of the American firm Sila to increase the energy density of their EV batteries. Furthermore, Mercedes-Benz Group is collaborating with Taiwanese and American companies to develop ASSBs (Mercedes-Benz Group, 2021a, 2021d, 2022e, 2022g).

With regard to EV components other than the battery, Mercedes-Benz Group has "insource[d] electric drive technology […] [by acquiring the] UK based electric motor company YASA" (Mercedes-Benz Group, 2021a). Furthermore, the company expects that Chinese expertise "in EV components and software technologies […] [will] play a key role in accelerating the Mercedes-Benz electrification strategy" (Mercedes-Benz Group, 2021a).

Lastly, when it comes to the final assembly of EVs, Mercedes-Benz Group's six largest production plants – four of which are located in Europe, one in the U.S., and one in Beijing – were already capable of building EVs in 2021 (Mercedes-Benz Group, 2021b, p. 21). Models currently being produced and sold include the EQA, EQB, EQE, EQS, EQS SUV, and EQE SUV; the EQG launch is scheduled for 2024 (Kuhnert et al., 2022, pp. 17–18; Mercedes-Benz Group, 2022j).

In China, Mercedes-Benz Group has several joint ventures. Beijing Benz is a joint venture with BAIC Motor that produces not only Mercedes-Benz cars and corresponding spare parts but also battery systems (Mercedes-Benz Group, n.d.–a, 2022c, p. 238, 2022h); Fujian Benz is a joint venture in which multiple Chinese partners are invested and that produces Mercedes-Benz vans (Mercedes-Benz Group, n.d.–c); Shenzhen Denza New Energy Automotive is a joint venture with BYD (Mercedes-Benz Group, 2022c, p. 240); and the Smart brand was transferred to a newly-created 50-50 joint venture with Geely in 2020 (Smart Automobile Co. Ltd., 2019, 2020).

In recent years, Mercedes-Benz Group has invested considerable amounts of money in China – not only to scale up local EV production but also to conduct R&D. For example, the company opened a new tech center in Beijing in 2021, including an e-drive lab and a charging lab. In total, Mercedes-Benz Group was operating five R&D centers in China as of 2022. Furthermore, the company has R&D cooperations not only with its joint venture partners but also with several large companies in the field of battery technology as well as with Xiaomi, Baidu, and Tencent in the realms of connectivity and ADASs. In the future, Mercedes-Benz Group will further expand its R&D footprint in China (Mercedes-Benz Group, 2021c; Sebastian, 2022, pp. 6, 11, 19-21).

In 2021, China was the Mercedes-Benz Cars business unit's largest market, making up 36.5% of the 2.1 million cars globally delivered. 76.8% of the cars sold in China had been locally produced (Mercedes-Benz Group, 2022b, p. 18). In the same year, Mercedes-Benz held a 3.5% share of the total passenger vehicle market in China and a 0.3% share of its EV market (Sebastian, 2022, p. 8).

4.3. Volkswagen Group

"Volkswagen Group, with its headquarters in Wolfsburg, is one of the world's leading automobile manufacturers and the largest carmaker in Europe" (Volkswagen Group, n.d.–e). The company was originally founded as a SOE under the Nazi regime in 1937, operated by the British military after World War II, and finally privatized in 1960. Since then, the company has considerably grown; today, Volkswagen Group operates a total of 120 production plants in 29 countries and "sells its vehicles in 153 countries" (Volkswagen Group, n.d.–c, n.d.–e, 2022c, p. 5). In 2021, Volkswagen Group employed 668,000 people worldwide, and its sales revenue amounted to 250.2 billion euros (Volkswagen Group, 2022c, pp. 4, 14). Volkswagen Group's passenger car portfolio encompasses 10 European brands. The Volkswagen (VW) brand, Volkswagen Commercial Vehicles (VWCV), Škoda, Seat, and Cupra are considered as volume brands; Audi, Bentley, Lamborghini, and Ducati are classified as premium brands; and Porsche is regarded as a sport and luxury brand[8]. Furthermore, the software subsidiary CARIAD is also part of Volkswagen Group's passenger cars business area

[8] VWCV produces light commercial vehicles such as vans, and Ducati is a motorcycle manufacturer. Nevertheless, Volkswagen Group classifies these two brands as part of its passenger cars business area (Volkswagen Group, 2022c, p. 6; Volkswagen Group, n.d.–a; Volkswagen Group, n.d.–g).

(Sebastian, 2022, p. 6; Volkswagen Group, n.d.–b, 2022c, p. 6). Volkswagen Group delivered 8.9 million vehicles to its customers in 2021, thereof 5% BEVs (Volkswagen Group, 2022c, p. 18). In the same year, the three German brands VW, Audi, and Porsche respectively accounted for about 31.7, 11.8, and 3.5% of Volkswagen Group's total sales (Volkswagen Group, 2022f, p. 21).

By 2030, Volkswagen Group plans to launch about 70 all-electric models and reach a 50% BEV share across the Group; meanwhile, the VW brand will raise its BEV share to 70% in Europe and 50% in China and the U.S. (Volkswagen, n.d.–a, 2021; Volkswagen Group, 2021b). E-mobility – in terms of a new mechatronics platform, battery technology, charging and energy services – is also an important part of the Group's NEW AUTO strategy (Volkswagen Group, n.d.–f).

In terms of mechatronics platforms, Volkswagen Group has so far been using the Modular Electric Drive Kit (MEB) for its volume brands and the Premium Platform Electric (PPE) for its sport and premium brands. Starting from 2026, the new models of all brands will be based on the newly developed Scalable Systems Platform (SSP) (Volkswagen Group, n.d.–d).

Volkswagen Group founded its subsidiary PowerCo in July 2022 (Volkswagen Group, 2022i) to "steer all activities along the [EV battery] value chain – from mining and mineral processing to development and production of the unified cell through to recycling" (Volkswagen Group, 2022a). PowerCo and Umicore, a Belgian circular materials firm, recently announced a joint venture to supply Volkswagen Group with battery materials starting in 2025 (Kuhnert et al., 2022, p. 5; Volkswagen Group, 2022n). To advance its battery technologies, Volkswagen Group is also partnering with the Canadian quantum computing company Xanadu (Volkswagen Group, 2022m). Moreover, the Group has announced that it will, "in collaboration with partners, […] set up six battery cell factories in Europe by 2030" (Volkswagen Group, 2022b). To equip these plants, Volkswagen Group will cooperate with Bosch (Volkswagen Group, 2022e).

With regard to EV charging, Volkswagen Group is planning to set up "45,000 high power charging points […] worldwide by 2025" (Volkswagen Group, 2022g). It offers a wide "range of charging solutions for private customers and companies" (Volkswagen Group, 2022k) and plans to integrate EVs into the energy system. In Europe, its subsidiary Elli is an important player in this field (Volkswagen Group, 2022j, 2022k, 2022l). In addition, Volkswagen Group has partnered with players in China to create the charging joint venture CAMS (Volkswagen Group China, 2022).

In addition to the NEW AUTO strategy, the individual vehicle brands have formulated electrification strategies of their own. VW, for example, has been following its ACCELERATE strategy since 2021 to position itself for the electric and digital transformation; for instance, the brand plans to launch at least one new BEV model per year in order to speed up the electrification of its entire model range (Volkswagen, n.d.–b, 2022b). Since 2020, several all-electric ID. series models have been launched, including the VW ID.3, ID.4, ID.5, ID.6 X, and ID.6 CROZZ; the latter two are only available in China (Volkswagen, n.d.–a, n.d.–b). It is expected that the ID.7 will be launched in the second quarter of 2023, followed by another ID. family model in 2025. The first model to be based on the newly developed SSP is the VW Trinity, which is supposed to be launched in 2026 (Kuhnert et al., 2022, p. 19; Volkswagen, n.d.–b, 2023; Volkswagen Group, n.d.–d).

In China, Volkswagen Group built its first joint venture, SAIC Volkswagen, in 1984, followed by FAW-Volkswagen and Volkswagen Anhui (a joint venture with JAC Motors) in 1991 and 2017. More recently, 2021 saw the creation of the Audi FAW NEV Company, and a subsidiary of CARIAD was founded in Beijing in 2022. As of 2021, Volkswagen Group operated 40 production plants in China, including 23 component plants. As part of its NEW AUTO Strategy, the Group restructured its China operations in 2022. Among other things, a new China Board was established; the aim was to accelerate innovation, further localize technology development, and increase customer centricity (Sebastian, 2022, p. 6; Volkswagen Group, 2022c, pp. 28–29, 2022h).

Volkswagen Group’s e-mobility activities in China go beyond the production of EVs; the company has also increased its investments in local R&D. In terms of production, different joint ventures build different cars: SAIC Volkswagen produces VW, Audi, and Škoda-branded EVs; FAW-Volkswagen manufactures VW and Audi-branded EVs; Volkswagen Anhui will build Cupra-branded EVs; and the Audi FAW NEV Company will produce Audi-branded EVs (Audi AG, 2022i; Raymunt, 2022; Schwabe, 2020a, p. 1113). Concerning VW-branded BEVs, as of 2022, SAIC Volkswagen was producing the VW ID.3, ID.4 X, and ID.6 X, while FAW-Volkswagen was producing the VW ID.4 CROZZ and ID.6 CROZZ (Volkswagen Group, 2020, 2021a, 2022c, p. 15).

As mentioned above, Volkswagen Group has increased its R&D activities in China; over the past five years, it has established new R&D centers in six Chinese cities and announced several partnerships. For example, Volkswagen Group acquired a 26% equity share of the Chinese battery supplier Gotion High-tech in 2020; together, they develop a new battery cell that will be used in most of the Group’s EV models in the future. In addition, Volkswagen Group partners with the Chinese start-up DU-Power to conduct R&D related to charging (Sebastian, 2022, pp. 14, 19–21).

In addition to strictly e-mobility-related R&D partnerships, Volkswagen Group also works with Chinese firms in more loosely related areas such as connectivity and ADASs. For instance, the Group has announced cooperations with Alibaba, Baidu, Tencent, the telecommunications equipment and consumer electronics manufacturer Huawei, the drone maker DJI, and the AI company Horizon Robotics, with which CARIAD recently established a joint venture to develop ADASs for the Chinese market (Sebastian, 2022, pp. 19–20; Volkswagen Group, 2022n).

In 2021, 37.2% of the 8.9 million cars globally delivered by Volkswagen Group were delivered in China; this made China the Group's largest car market. Meanwhile, China accounted for 20.5% of the Group's worldwide BEV deliveries, ranking second after Europe. For the VW brand, China was the largest car market, too; every second VW (49.6%) was sold in China in 2021. In the same year, Volkswagen Group had a 16% share of China's total passenger vehicle market; the VW brand achieved an 11.3% share in this market and a 3.7% share in China's EV market (Sebastian, 2022, p. 8; Volkswagen, 2022a; Volkswagen Group, 2022d, 2022g).

4.4. Audi AG

Audi AG's origins can be traced back to 1932, when the four carmakers Horch, Audi, Wanderer, and DKW merged to become Auto Union, which was acquired by Volkswagen Group in 1965 and renamed Audi AG in 1985 (Audi AG, 2020; Volkswagen Group, 2022c, p. 5). Headquartered in Ingolstadt, Audi AG comprises Volkswagen Group's premium brands: Audi, Lamborghini, Ducati, and Bentley. In 2021, the company operated 20 production sites in 12 countries, sold cars in over 100 markets, employed over 85,000 people, reached an annual revenue of nearly 53.1 billion euros, and delivered nearly 1.7 million vehicles, thereof 99.5% Audi-branded cars and nearly 5% BEVs (Audi AG, 2022b, 2022e, pp. 15, 57, 2022f).

Audi AG's electric transformation is to a certain degree influenced by its parent company. As part of Volkswagen Group, Audi AG sometimes benefits from synergies. For example, Audi and Porsche AG jointly developed the PPE, thus saving R&D costs. However, certain aspects of the e-mobility transition remain Audi AG-specific. For instance, Audi AG is building an exclusive network of fast-charging stations in China and partnering with various firms to pilot smart charging and the reuse of batteries. By 2022, Audi AG's EV portfolio had grown to eight models, four of which (the Audi e-tron GT quattro, RS e-tron GT, Q4 e-tron, and Q4 Sportback e-tron) had been newly launched in 2021. According to its strategy 'Vorsprung 2030', Audi AG plans to offer 20 BEV models by 2026, exclusively launch BEV models thereafter, and stop ICEV production by 2033 (Audi AG, n.d.–b, 2022c, 2022f, 2022g, 2022h, 2022j, 2022k; Kuhnert et al., 2022, p. 18).

In anticipation of continued growth in China's premium segment, Audi AG continues to expand its business in China (Audi AG, 2021); this can be seen in a variety of fields, including production, R&D, and sales. Firstly, in terms of production, Audi-branded cars were being built in five Chinese production sites as of 2021; these sites were operated by FAW-Volkswagen and SAIC Volkswagen. In addition to the existing EV production sites in Changchun, Foshan, and Shanghai, the Audi FAW NEV Company, in which Audi AG holds a 55% share, will start producing PPE-based BEVs in 2024 (Audi AG, 2022a, 2022e, p. 16; Volkswagen Group, 2022c, p. 28).

Secondly, Audi AG has increased its R&D capacities in China throughout the past decade. One example illustrating this 'in China, for China' approach is the opening of new R&D centers in Wuxi and Beijing. Moreover, to develop new electronics architectures, ADASs, and connectivity offerings, Audi AG has cooperated with Chinese organizations like Baidu, Alibaba, Tencent, Huawei, Horizon Robotics, the mobile communications firm China Mobile, and local authorities (Audi AG, 2022a, 2022l; Sebastian, 2022, p. 11; Tyfield & Zuev, 2018, p. 266).

Thirdly, regarding sales, out of the 1.7 million Audi-branded cars delivered worldwide in 2021, 41.7% were sold in China (Audi AG, 2022b). Besides being Audi AG's largest market, China is also the country where Audi AG offers the most extensive variety of car models. In addition to the six BEV models offered in China at the end of 2022, five additional models tailored to the Chinese taste will follow mid-decade. Furthermore, in China, Audi-branded cars are no longer marketed and sold through dealerships only, but also through an online sales model, pop-up stores, urban showrooms, and a brand experience center (Audi AG, n.d.–a, 2022a, 2022d, 2022k).

4.5. Porsche AG

Founded in 1931 and headquartered in Stuttgart, Porsche AG is known for its sports and luxury cars, uniquely positioned in between the niche luxury brands and the premium brands (Porsche AG, n.d.–b, n.d.–c, 2022c, p. 36; Porsche SE, n.d.). Porsche AG has been a subsidiary of Volkswagen Group since 2012; in 2022, Porsche AG completed its initial public offering (IPO), which was the largest in European history by market capitalization (Porsche AG, 2022n; Volkswagen Group, 2022c, p. 5). While Porsche AG's two main production plants are located in Germany, the company also assembles cars in Slovakia and Malaysia (Porsche AG, n.d.–d). Porsche-branded cars are sold "in more than 120 countries […] across a network of more than 900 dealership and retail venues. Porsche's […] product portfolio […] includes six model families: the 911, the Taycan, the Macan, the Cayenne, the Panamera and the 718 Boxster and Cayman" (Porsche SE, n.d.). In 2021, Porsche AG employed almost 37,000 employees and generated 33.1 billion euros of revenue (Porsche AG, 2022g). In the same year, the company delivered nearly 302,000 cars; the all-electric Taycan – which was the only BEV model at the time – was sold about 41,000 times, leading to a BEV share of 13.7% in Porsche's overall sales (Porsche AG, 2022a, p. 64, 2022f; Wayland, 2022).

Porsche AG has set itself the goal to reach an EV share of 50% by 2025 and a BEV share of 80% by 2030 (Porsche AG, 2022h). To this end, the company makes investments related to EV batteries and charging solutions, among others, and develops new electric models. For example, Porsche AG and the German battery manufacturer Customcells founded the joint venture Cellforce in 2021 to develop and produce new battery cells (Porsche AG, 2021b); one year later, Porsche AG acquired a stake in the American company Group14 Technologies, which will supply Cellforce with battery materials (Porsche AG, 2022k). Similar to Audi AG, Porsche AG also benefits from

Volkswagen Group’s alliance-based charging network and additionally offers a selection of exclusive fast-charging locations (Porsche AG, 2022d, 2022j). Moreover, the company has piloted bidirectional charging (Porsche AG, 2022i). In addition to advancing its BEV-related technologies, Porsche AG has also been experimenting with e-fuels (Porsche AG, 2022e). Regarding the range of EV models, Porsche AG is currently offering BEV versions of the Taycan and PHEV versions of the Panamera and Cayenne; all-electric versions of the Porsche 718 and Macan are still under development (Kuhnert et al., 2022, p. 18; Porsche AG, n.d.–a).

Unlike the other four companies, Porsche AG has no joint ventures or production facilities in China (Holdenried, 2021); its local activities are mostly limited to the sale of imported cars and R&D. In China, Porsche-branded cars are sold through more than 130 points of sale; new sales and marketing channels like pop-up stores and digital platforms have been added more recently. Since 2015, China has been Porsche AG’s largest single market; in 2021, the country made up 31.7% of the Porsche brand’s global deliveries (Porsche AG, 2021a, 2022f). In terms of locally conducted R&D, the subsidiary Porsche Engineering has facilities in Shanghai and Beijing, Porsche Digital China was founded in 2021, and the creation of a new R&D satellite was announced in 2022. Local R&D focuses on high-voltage systems, ADASs, connectivity, and infotainment. Porsche AG is increasing its local R&D activities to be able to adapt its cars to China’s unique legal, infrastructure-related, digital, and market environment. Furthermore, some technologies might be developed in China first before being rolled out globally (Porsche AG, n.d.–d, 2021a, 2022l, 2022m).

5. Methods

5.1. Overall research design

Following the introduction of the five cases, Chapter 5 provides an overview of the overall research design (5.1), data collection (5.2) and analysis (5.3), as well as limitations (5.4). Generally, researchers can choose between qualitative, quantitative, and mixed methods approaches (Creswell, 2009, p. 4). Qualitative research is recommended when “a problem or issue needs to be explored” (Creswell, 2007, p. 39) in detail, existing theories fail to “capture the complexity of the problem […] [, and] statistical analyses simply do not *fit* the problem” (Creswell, 2007, p. 40). Since this study aims to generate insights into the complex and insufficiently explored impact of China’s e-mobility development on German motor vehicle manufacturers, it adopts a qualitative approach.

Literature distinguishes between different kinds of qualitative research strategies, including ethnography, grounded theory, phenomenological research, narrative research, participatory action research, discourse analysis, and case studies (Creswell, 2009, pp. 12–13). Case study research has been conducted by researchers from various disciplines, including business management (Creswell, 2007, p. 77; Saunders et al., 2019, p. 196), and makes it possible to explore an issue “through one or more cases within a bounded system (i.e., a setting, a context)" (Creswell, 2007, p. 73). To study how Chinese developments have influenced German carmakers in the wider context of the e-mobility transition, the researcher therefore considers the case study to be an adequate approach.

Yin (2009) further distinguishes single from multiple and holistic from embedded case study designs (p. 46). Firstly, a key rationale for choosing a multiple-case design is that it allows for a broader picture (Creswell, 2007, p. 74); furthermore, the insights generated through this approach – if found to be replicable across different cases – are considered more robust than those of a single-case study. On the downside, the analysis of several cases is time-consuming and, unlike the single-case study, does not allow for an in-depth analysis of a unique case (Yin, 2009, pp. 53–54). Nevertheless, this study adopts a *multiple-case* design to be able to examine several firms; to reduce complexity, it follows Creswell's (2007) advice to limit the number of cases to five (p. 76).

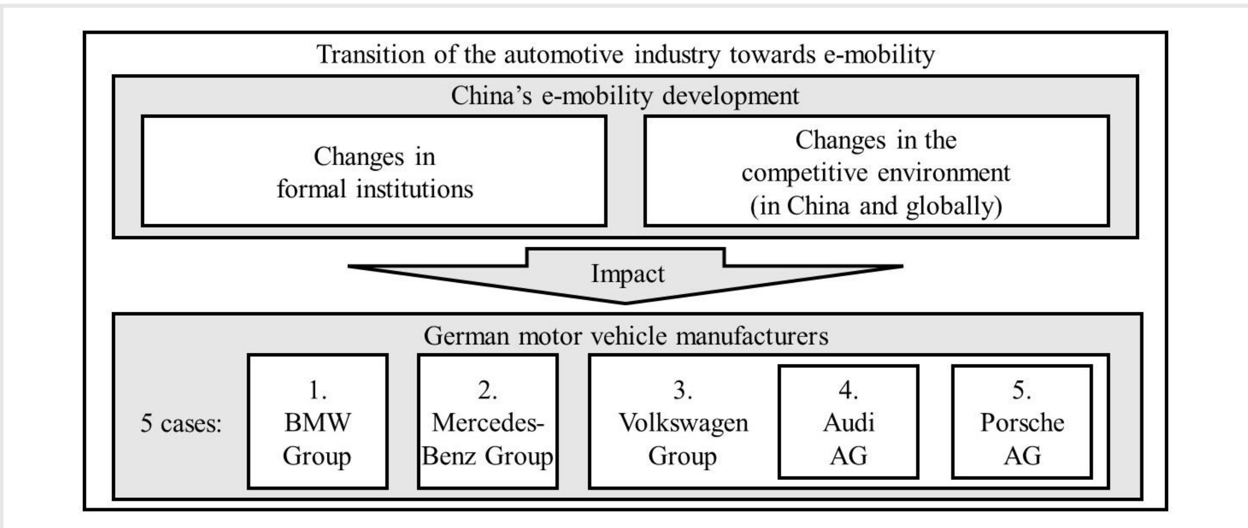

Figure 4: Visualization of this paper's case study design – own illustration

Secondly, an embedded approach makes it possible to investigate and compare smaller sub-units within a case (e.g., departments in a company), while a holistic approach looks at the case as a whole – without denying that each case has its own context (Saunders et al., 2019, p. 199; Yin, 2009, pp. 46, 50). This study follows a *holistic* multiple-case design as the focus lies on the carmakers and not on their departments. Despite the fact that Audi AG and Porsche AG are part of Volkswagen Group, this study treats each carmaker as a separate case. This is because the subsidiaries' operations are largely decoupled from the parent company and because their brands are uniquely positioned. Thus, it is worthwhile to study these firms on their own, while keeping in mind that some strategies or activities may be aligned or shared with other parts of the Group. Figure 4 visualizes the research design, i.e., the five cases and the context they are studied in.

5.2. Data collection

5.2.1. Sample selection

Sub-chapter 5.2 elaborates on how the data for this study were collected. More precisely, the reader will be informed how the sample was selected (5.2.1), what the sample characteristics were (5.2.2), and what interview technique was applied (5.2.3). The first sub-chapter explains based on which criteria the cases were chosen, what data types were used, and how the interviewees were selected.

While a case study approach can be applied to study various types of case subjects (Saunders et al., 2019, p. 196), this paper only analyzes one specific type of case subject, namely, German carmakers. As mentioned in chapter 1, this paper focuses on incumbents whose German passenger car brands are sold in large numbers, whose revenue exceeds 10 billion euros, and who sell cars in China. To cover a large part of the industry, the researcher decided that BMW Group, Mercedes-Benz Group, Volkswagen Group, and its German-branded subsidiaries Audi AG and Porsche AG should all be included in the case study – as has been indicated in figure 4.

"Qualitative researchers typically gather multiple forms of data, such as interviews, observations, and documents, rather than rely on a single data source" (Creswell, 2007, p. 38); a typical multiple-case study combines such data sources to create case descriptions and conduct a thematic analysis (Creswell, 2007, pp. 75, 79). This study adopts a slightly modified approach: the researcher indeed consulted several publicly available sources like journal articles, news releases, and news articles to describe the context and the five cases in chapters 3 and 4; however, the most relevant part of this study is the creation and analysis of just one type of data, namely, interviews.

The sampling method used in this study combines Miles and Huberman's (1994) 'criterion' and 'chain' methods (p. 28). Firstly, in line with the case study design, the researcher decided to purposefully select those interview partners that would be most likely to provide meaningful insights into the research problem (Creswell, 2007, pp. 75, 118). Potential interviewees, therefore, had to meet the following criteria: (1) currently working for one of the five case study firms or having left the firm no earlier than two years ago, (2) possessing knowledge about e-mobility and about China, and (3) being knowledgeable regarding China's formal institutions as well as (4) informed about their company's competitive environment and strategy. Furthermore, for practical reasons, the interviewees had to be (5) available for an interview before the end of 2022. Due to the nature of the study, characteristics like age, gender, or ethnicity were considered irrelevant.

Secondly, as the researcher did not know any interview partners personally, they had to be identified and acquired through an extensive search that resembled Miles and Huberman's (1994) 'chain' approach, which "[identifies] cases of interest from people who know people who know what cases are information-rich" (Miles & Huberman, 1994, p. 28). This meant that the researcher triggered several ‘chains’ by describing the above criteria to personal connections and asking them for referrals. Some of these initial contacts were existing connections; others were purposefully created at events in Munich and Wolfsburg. The researcher also submitted online forms to the firms and sent out ‘cold’ requests on LinkedIn. The search progress was carefully tracked; starting from 107 initial requests (thereof 29 personal contacts, 5 forms, and 73 ‘cold’ requests), the researcher entered a direct exchange with 27 adequate candidates, 12 of whom were available for an interview.

5.2.2. Sample characteristics

The 12 interviews were conducted between November 22 and December 6, 2022. Depending on the availability of the interviewees, the duration of the interviews ranged from 25 to 69 minutes, 49 minutes on average. The total duration of all interview material amounted to 9 hours and 50 minutes. An overview of the interview details is provided in table 4.

Table 4: Interview details – own table

No.	Interviewee	Duration	Medium	Company	Special unit	Location	Expertise
01	I-BMW-1	25 mins	Zoom	BMW Group	–	Germany	R&D
02	I-Audi-1	48 mins	Skype	Audi AG	Joint venture	China	Sales
03	I-Audi-2	60 mins	Teams	Audi AG	Joint venture	China	Logistics
04	I-BMW-2	26 mins	Teams	BMW Group	Joint venture	China	Sales
05	I-VW-1	60 mins	Skype	Volkswagen Group	VWC[9]	China	Consulting
06	I-Audi-3	44 mins	Zoom	Audi AG	–	Germany	Strategy
07	I-Porsche-1	65 mins	WhatsApp	Porsche AG	–	China	Sales
08	I-Audi-4	47 mins	Zoom	Audi AG	Joint venture	China	Logistics
09	I-BMW-3	44 mins	Zoom	BMW Group	MINI	Germany	Sales
10	I-VW-2	69 mins	Zoom	Volkswagen Group	–	Germany	R&D
11	I-MB-1	47 mins	Zoom	Mercedes-Benz Group	Joint venture	Germany	Strategy
12	I-Porsche-2	55 mins	Teams	Porsche AG	MHP[10]	Germany	Consulting

As highlighted by Creswell (2007), it is of utmost importance not “to place the participants at […] risk as a result of our research” (p. 44); therefore, the interviewees’ names were anonymized, as indicated in the second column of table 4. Personal details were omitted for the same reason. However, it can generally be stated that all but two interlocutors were male; most interviewees were Europeans raised in Germany except for two Chinese people and one person who had grown up between the two cultures; all but one had previously worked in China; and, during the interview period, most respondents were still working for the firms indicated in column five, except for two.

[9] Volkswagen Consulting (VWC) is Volkswagen Group’s in-house top management consultancy.
[10] Porsche AG’s subsidiary MHP is a management and information technology consultancy.

Due to geographical barriers[11], but also because it was considered most convenient and appropriate, all interviews were conducted through the internet and on a one-to-one basis (Saunders et al., 2019, p. 442). It was important for the researcher to accommodate the needs and wishes of her interview partners, so she let them choose their preferred time slot and medium; the interviews were thus conducted at different times of the day via Zoom, Teams, Skype, and WhatsApp.

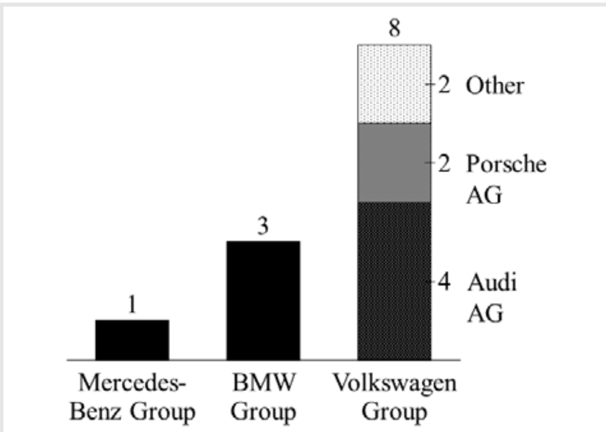

Figure 5: Number of interviews per company – own illustration

As can be seen in table 4 and figure 5, three respondents worked for BMW Group, one for Mercedes-Benz Group, four for Audi AG, two for Porsche AG, and two in other (non-Audi, non-Porsche) units of Volkswagen Group. Admittedly, the firms are unevenly represented in the interview data. As the search for further respondents proved fruitless, rather than exclude some of the over-represented interviews, the researcher decided to keep them all so as to be able to generate insights from all available data.

Another special aspect of the sample, as can be seen in the sixth column of table 4, is that five of the interview partners had been assigned to work at their companies' Sino-German joint ventures, two interlocutors were employed in consulting subsidiaries, and one of the interviewees was working for BMW Group's brand MINI. Although these business units are rather special, each of the candidates met the required criteria and thus qualified as a suitable interview partner. Moreover, the researcher stressed that the focus of the interviews was on their parent companies (those indicated in table 4, column five), thereby minimizing possible effects on the interview data.

Finally, as illustrated in table 4 in the column furthest to the right, the interlocutors had diverse fields of expertise. The exact names of the departments, positions, and levels of seniority are intentionally omitted from the table to protect the respondents' privacy (Creswell, 2007, p. 44). As can be seen, one third of the interviewees were working in sales, while the remaining ones were evenly distributed across the fields of logistics, R&D, strategy, and consulting. The interviewees' main field of expertise inevitably had an influence on the interview data. Naturally, a person is best informed about the field in which they have specialized and in which they currently work; they can therefore give more extensive and higher-quality answers regarding this field than others. On the downside, this means that a comparison between the statements of interviewees from different firms cannot be entirely accurate. On the upside, their complementary expertise makes it possible

[11] During the interview phase, 50% of the interlocutors were based in China; the other 50% were spread across Germany.

to obtain more comprehensive insights into the impact of China's e-mobility development on different parts of the value chain.

5.2.3. Interview technique

In line with the qualitative design of this study, the researcher chose to conduct semi-structured interviews (Saunders et al., 2019, p. 437). A major advantage of semi-structured interviews is that they "allow much more space for interviewees to answer on their own terms than structured interviews, but do provide some structure for comparison across interviewees in a study by covering the same topics, even in some instances using the same questions" (Edwards & Holland, 2013, p. 29). Moreover, this approach gives researchers the flexibility to ask follow-up questions and spontaneously digress from the thought-out structure whenever it makes sense.

Before the first interview, the researcher drafted an interview guide, which is a typical step in the semi-structured interview process (Saunders et al., 2019, p. 437). The interview guide included 10 core questions as well as back-up questions (see appendix 2). The same manual was then used in every interview; the only items that changed were the names of the case study firm and the interviewee. So as not to affect the nature of the responses, the researcher generally kept the manual to herself. However, three candidates specifically asked to see the manual before agreeing to participate in the interview, which is why the researcher decided to make exceptions. To prevent the candidates from feeling overwhelmed, the manual to be shared was reduced to a shortened version (see appendix 1). Interestingly, the sight of the interview guide prompted one candidate to state that he would not participate in the study, while the other two candidates agreed to be interviewed; one of them even used the guide to thoroughly prepare their answers.

Welch and Piekkari (2006) point out that the dynamics of an interview can differ depending on the language used (p. 422). Although it would have been ideal to interview each person in their native language, the researcher only offered German and English as possible options due to her limited Chinese language skills. Interestingly, everyone chose to be interviewed in German – including the two Chinese people, who were used to speaking German at work.

As illustrated in appendix 2, a typical interview was structured as follows: introductory remarks, introductory questions, main questions, wrap-up questions, and final remarks. At the beginning, the researcher welcomed the interlocutor, thanked them for being part of the interview, made clear that they were free to skip any question that they were unable or unwilling to answer, and informed them about the way in which the data would be treated (Creswell, 2007). Furthermore, she asked whether the conversation could be audio-recorded[12] to facilitate the transcription. In case

[12] Only Zoom offered a reliable recording function, so the other interviews were recorded on the researcher's phone.

of refusal, the researcher would have taken notes instead (Bell et al., 2019, pp. 445–446). Conveniently, all interview partners expressed their consent.

The introductory remarks were followed by introductory questions, which the researcher asked to gain a first impression of the interviewee’s intuitive response regarding the topic of this paper. Next, the researcher gave the respondent a brief definition of the term ‘formal institutions’ to ensure that they would understand the subsequent questions. The main questions were split into two parts: the first part was primarily related to formal institutions (i.e., to the first research question), while the second part was mainly related to competition and strategy (i.e., to the second research question). Due to the interconnected nature of the two research questions, the two parts were not seen as separate entities but as complementary and interactive parts of the same dialogue.

As suggested by Bell et al. (2019), towards the end of the interview, the interlocutors were encouraged to make any addition to their previous answers and “raise any issues that they [thought had been] overlooked” (p. 443). Lastly, they were asked whether they would like to retract any of their previous statements and whether any passages should be omitted from the transcription – not only to ensure the accuracy of the data but also for ethical reasons (Creswell, 2007, pp. 44, 46).

5.3. Data analysis

To analyze the interview data, the researcher conducted a thematic analysis, which is “[one] of the most common approaches to qualitative data analysis” (Bell et al., 2019, p. 519) and has a track record of being used in case study research (Creswell, 2007, p. 75). “Thematic Analysis involves a researcher coding her or his qualitative data to identify themes or patterns for further analysis, related to his or her research question” (Saunders et al., 2019, p. 651). It may fulfil deductive and inductive purposes and “allows the researcher to move between these approaches” (Saunders et al., 2019, p. 660). Moreover, it can “usefully summarize key features of a large body of data, […] highlight similarities *and* differences across the data set […] [, and] generate unanticipated insights” (Braun & Clarke, 2006, p. 97). On the downside, the coding approach applied in thematic analysis is sometimes criticized because it comes with the risk of “losing the context of what is said […] [and] result[ing] in a fragmentation of data” (Bell et al., 2019, p. 533). The researcher deemed the advantages to outweigh the disadvantages and thus chose to conduct a thematic analysis. Due to the holistic nature of the research design, all interview data were analyzed in a single process.

This study followed the six steps of thematic analysis suggested by Braun and Clarke (2006): “1. Familiarizing [oneself] with [one’s] data […] 2. Generating initial codes […] 3. Searching for themes […] 4. Reviewing themes […] 5. Defining and naming themes […] 6. Producing the report” (p. 87). As a first step, to familiarize herself with the data, the researcher transcribed the interview recordings and read the transcripts several times (Braun & Clarke, 2006, p. 87).

The transcription process involved the use of software. First, the researcher listened to the audio recordings and used the tool ‘Audacity’ to remove any passages where the names of the interview partners were mentioned. Next, the files were converted to mp3 format and uploaded to the website ‘F4x’, which used AI to generate a rough transcript of the interviews. F4x was chosen because it complies with the EU *General Data Protection Regulation* and allows for an instant deletion of the recordings after the download of the AI-generated transcripts. Next, the researcher manually revised the preliminary transcripts using the program ‘MAXQDA’, which facilitated the process, e.g., by making it easy to jump back and forth in the recording.

The researcher applied a denaturalized transcription approach in the sense of Oliver et al. (2005). Unlike “[naturalized] transcription, where utterances are transcribed in as much detail as possible” (Oliver et al., 2005, p. 1275), in the case of a denaturalized approach, the author is mostly interested in providing a faithful and accurate account of the informational content of the interview (Oliver et al., 2005, p. 1277). This means that interpretations and refinements need to be made so as to make the meaning of the speech understandable to readers who did not listen to the audio file (Da Silva Nascimento & Kalil Steinbruch, 2019, p. 421). Among other things, the denaturalized approach involves “grammar correction, the removal of existing noises […] [,] and the standardization of non-standard speeches and accents” (Da Silva Nascimento & Kalil Steinbruch, 2019, p. 419). In this study, the researcher corrected grammatical mistakes, omitted background noises, and excluded certain filler words to make the transcript understandable while retaining the original meaning. If certain words were difficult to understand, e.g., because the internet connection was unstable or the pronunciation was unclear, the researcher inserted what she thought she heard in brackets; if a passage was completely incomprehensible, this was also marked in the transcript.

Having familiarized herself with the data, the researcher used MAXQDA again in Braun and Clarke’s (2006) steps two to five – this time, to take advantage of the program’s data analysis functionalities. Computer-assisted qualitative data analysis software (CAQDAS) like MAXQDA can “help […] with regard to project management and data organisation, keeping close to [one’s] data, exploration, coding and retrieval of [one’s] data, searching and interrogating to build propositions and theorise, and recording [one’s] thoughts systematically” (Saunders et al., 2019, p. 695). Moreover, compared to the use of paper or tools like Word or Excel, CAQDAS is better suited for handling large amounts of data and for re-arranging codes and themes. After comparing different CAQDAS tools, the researcher opted for MAXQDA because of its good value for money.

In the second step of thematic analysis, the researcher systematically “[coded] interesting features of the data […] across the entire data set” (Braun & Clarke, 2006, p. 87). This involved passages being “uncoded, coded once, or coded many times, as relevant” (Braun & Clarke, 2006,

p. 89). Some codes[13] were inspired by theory; others newly emerged from the interview material (Saunders et al., 2019, p. 655). This illustrates the combination of deductive and inductive elements. Thirdly, the analysis commenced as codes were sorted into preliminary themes[14] (Braun & Clarke, 2006, pp. 87, 89). In this phase, the researcher "start[ed] thinking about the relationship between codes, […] themes, and […] different levels of themes" (Braun & Clarke, 2006, p. 89). As a fourth step, the researcher reviewed the themes by "[checking] if the themes work in relation to the coded extracts […] and the entire data set" (Braun & Clarke, 2006, p. 87). In the process, certain themes were "combined, refined and separated, or discarded" (Braun & Clarke, 2006, p. 91); furthermore, additional codes were assigned to passages that had been overlooked. Fifth, the themes were further refined and concisely named; moreover, the data of each theme were analyzed. Sixth and finally, the analysis was written up, presenting the story of each theme, using examples as evidence, and relating to the research questions[15] (Braun & Clarke, 2006, pp. 87, 91-93). For ethical reasons, the researcher slightly extended Braun and Clarke's (2006) sixth step: if interview partners specifically asked for it, they were given the chance to look at any passages related to their interviews before the thesis was submitted. Consequently, some quotations were omitted or completely anonymized[16].

5.4. Limitations

This study is subject to limitations. As C. Anderson (2010) points out, "[researchers] should critically examine their own influence on the design and development of the research, as well as on data collection and interpretation" (p. 5). For example, the researcher's background in business administration and the training she received during her graduate studies may have guided her decision to use a qualitative case-study approach – despite the criticism that qualitative research is deemed subjective and does not allow for empirical generalizations (Bell et al., 2019, pp. 374–375). Moreover, the holistic multiple-case design and the decision only to conduct a cross-case analysis had the drawback that specific cases could not be analyzed in as much depth (Creswell, 2007, p. 76).

In terms of sampling, the selection of the five cases was influenced by the researcher's decision to focus on passenger car manufacturers; to cover a larger spectrum of motor vehicle manufacturers, it may have been useful also to include manufacturers of electric motorcycles, buses, and trucks in the study. The selection and acquisition of interview partners also needs to be critically examined. For instance, time constraints put a limit on the size and composition of the

[13] According to Saunders et al. (2019), "[a] *code* is a single word or short phrase".

[14] According to Braun and Clarke (2006), "[a] theme captures something important about the data in relation to the research question, and represents some level of patterned response or meaning within the data" (p. 82).

[15] In this paper, step six of Braun and Clarke's (2006) thematic analysis is reflected in three chapters: the findings (chapter 6), where major themes are presented, the discussion (chapter 7), which analyzes the findings with reference to relevant theories, and the conclusion (chapter 8), in which the researcher suggests answers to the research questions.

[16] Such completely anonymized quotations are included in chapter 6 and appendix 3; they do not refer to the corresponding interviewees or their companies but are simply marked "anonymous interviewee".

sample. In addition, as the researcher combined Miles and Huberman's (1994) 'criterion' and 'chain' methods (p. 28), she had to rely on personal contacts to find suitable interviewees. Firstly, this approach limited the pool of potential interviewees and may have affected the characteristics of the sample[17]. Secondly, this meant that the researcher had to trust connections down the chain to check if the potential interviewees fulfilled the criteria. As a result, some respondents' regulatory knowledge proved less extensive than expected. Moreover, if time had allowed, it might have been a good idea to add interviews with external experts for triangulation (Creswell, 2007, p. 45).

In addition, there are several limitations related to how the interviews were prepared and conducted. According to Yin (2009), the way a researcher asks questions can be subject to bias (p. 106). For instance, the choice of the theories underlying the questions in the interview manual may have been influenced by the researcher's educational background. Moreover, the question type and sequence were not ideal. For example, a few questions addressed both the Chinese and the global situation, which led some interviewees to give partial or ambiguous answers[18]. Furthermore, the researcher asked first about formal institutions and then about competition, assuming that the latter topic might be perceived as more sensitive. Surprisingly, it turned out to be the other way around; many interviewees seemed tense when speaking about formal institutions but opened up when talking about competition. Another issue with the interview guide was that the part on formal institutions was designed so that one question led to the next; one interviewee struggled to answer the first one, which made it difficult to generate meaningful data from the questions that followed.

Further limitations are related to the fact that the interviews were conducted online. As pointed out by Bell et al. (2019), online calls are "prone to fluctuations in the quality of the connection […] [,] which make the flow of the interview less smooth […] [and] can result in poor recordings […], which makes transcription difficult" (p. 453). Such issues also occurred in some of the interviews conducted for this study. Usually, one advantage of video calls over audio calls is that they allow "interviewers and interviewees to see each other so that visual cues can be picked up" (Bell et al., 2019, p. 453); in some instances, however, it was technically impossible for the interlocutors to turn on their cameras, so the researcher could not receive their non-verbal signals.

Lastly, the process of data analysis has also been subject to limitations. Although the researcher attentively listened to the audio recordings several times, it cannot be ruled out that she misinterpreted certain statements; therefore, it is possible that the transcripts slightly deviate from

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[17] For example, due to her previous internship experience, the researcher had better access to potential interview partners from BMW Group's sales departments than to people who work in other companies and other fields. Further issues related to the heterogeneity of the sample and representation of firms in the sample have been discussed in 5.2.2.
[18] Partial answers often focused on China rather than other parts of the world. This may be because of the way the questions were asked or because Chinese carmakers are only now beginning to enter global markets, so that it was too early for the respondents to be able provide many details about the global situation at the time of the interviews.

what the interviewees intended to express (Da Silva Nascimento & Kalil Steinbruch, 2019, p. 421). In the subsequent steps of the thematic analysis, as a validation strategy, the researcher paid special attention to the context of the coded passages (Braun & Clarke, 2006, p. 89; Creswell, 2007, p. 207). However, as is the case for many types of qualitative research, the process remained somewhat subjective; a different researcher may have chosen different codes and obtained slightly different themes and findings (Bell et al., 2019, p. 374). Furthermore, it cannot be ruled out that some of the original meaning was lost as the researcher turned the German data into an English report[19]. Generally, the researcher paid attention to a transparent disclosure of her methods; nevertheless, due to the unstructured nature of the data, a replication of the study would be unlikely to result in perfectly identical findings (Bell et al., 2019, pp. 374–375).

6. Findings

6.1. General observations regarding the e-mobility transition

The findings from the 12 interviews can be grouped around five main themes: general observations regarding the e-mobility transition (6.1), changes in China's formal institutions (6.2), changes in the competitive environment (6.3), changes related to the case study firms' value chains (6.4), and the internationalization of Chinese e-mobility players (6.5). Regarding the e-mobility transition, the interviewees made remarks with respect to related trends, China's emergence as an e-mobility leader, and the question of whether German carmakers are latecomers in the e-mobility transition.

Different interview partners had different understandings of e-mobility. Some viewed it in a broader sense, comprising the topics of connectivity and automated driving – especially so when speaking about the Chinese context (I-MB-1, I-VW-2). As I-VW-2 put it, *"in the future, e-mobility does not only mean battery-electric vehicles; e-mobility also means connected and intelligent and autonomous driving in China"*. Others understood e-mobility in a stricter sense, only referring to the electrification of carmakers' product portfolios (I-Audi-1,3). Furthermore, related phenomena mentioned by the interviewees include digitalization and sustainable consumption, both of which extend beyond the automotive industry (I-Audi-1, I-BMW-3).

With respect to China, several respondents expressed the perception that the country has reached a leading position in the field of e-mobility as a result of strategic decisions taken by government bodies and private firms; some interviewees further mentioned China's supply with raw materials like lithium and rare earths as a supporting factor (I-BMW-1, I-Porsche-1, I-MB-1, I-VW-2). Many interlocutors pointed out that Chinese battery makers have emerged as global leaders and integrated the automotive supply chain (I-VW-1,2, I-MB-1, I-Porsche-2, I-BMW-1). They also gave credits to Chinese carmakers (I-Audi-2, I-Porsche-1, I-BMW-3); as I-Audi-2 put it,

[19] Whenever an interviewee was directly quoted, the original text and its translation were included in appendix 3.

"they have made massive progress, even caught up with us, perhaps even overtaken us in some regards". Moreover, several respondents highlighted the exceptional speed of China's electric transition, which, in their view, was induced by regulations, charging infrastructure construction, and the break-even of Chinese suppliers (I-Porsche-1, I-Audi-3, I-BMW-3, I-VW-2).

Regarding the question of whether German carmakers are latecomers in the e-mobility transition, the interlocutors offered different perspectives. Interviewees from BMW and Mercedes-Benz Group stressed that their firms were relatively early in launching their first EVs and investing into cell production but faced issues as demand for EVs was still weak and the German government failed to engage in a coordinated policy push (I-BMW-1,2,3, I-MB-1). Meanwhile, Volkswagen Group only started developing its MEB platform in 2015 (I-VW-2). Regardless of when their firms first started to conduct e-mobility-related R&D, most respondents agreed that German carmakers are currently under serious pressure to accelerate the electrification of their product portfolios. This situation is partly due to the unexpectedly rapid development of China's EV market; nevertheless, developments in other countries also played a role (I-BMW-3, I-VW-2, I-Porsche-1, I-Audi-2,3).

6.2. Changes in China's formal institutions

All interview partners were aware of the long-term nature of China's industrial policy, and many of them mentioned the country's five-year plans and strategic goal to foster the competitiveness of its domestic firms (I-Audi-1,3, I-Porsche-1). Although few were able to name specific regulations, nearly all of them generally knew about Chinese measures for e-mobility promotion, especially so if these measures were relevant to their own field of work.

When asked what had had the greatest impact on their respective firms, interviewees often cited financial measures first. While subsidies for Chinese firms were perceived as a distortion of the competitive situation, financial measures on the demand side – including subsidies, the purchase and (in the case of Porsche) luxury tax exemption – were viewed more positively (I-VW-2, I-BMW-1, I-Porsche-1, I-Audi-2,3,4). In addition, the interviewees often mentioned the license plate restrictions and ban days introduced in various cities (I-Audi-1, I-BMW-2,3, I-Porsche-1,2, I-MB-1). Moreover, two interviewees stressed that EV models need to fulfil certain criteria to be eligible for these incentives; if a limit is tightened beyond what is technically possible for a certain model, the model is at risk of dropping out of the NEV incentive scheme (I-BMW-3, I-MB-1).

Another point on the supply side is that carmakers need to obtain NEV production licenses, which can take time, and produce the agreed volume before being allowed to apply again (I-BMW-3, I-Audi-3, I-Porsche-2). In addition, respondents spoke about localization requirements and about the obligation to send real-time data on battery performance, temperature, etc. to the Chinese government (I-Audi-1, I-BMW-1,2). Besides these obligations, the removal of the joint venture requirement and resulting opportunity to gain a majority stake were also addressed (I-Audi-4).

Regarding the introduction of new e-mobility regulations, some respondents reported a lack of transparency in China's policymaking (I-Audi-1,3) and observed that policies were often announced or amended on short notice (I-Audi-2,3, I-Porsche-1). As German carmakers have to comply with Chinese laws and regulations to avoid negative consequences, they have departments dedicated to compliance and government affairs. To anticipate future changes in formal institutions, they turn to various sources of information, ranging from business partners to think tanks (I-Audi-1, 2, I-VW-1,2, I-BMW-2,3, I-Porsche-2). In addition, some interviewees explained that their companies handle government affairs jointly with their joint venture partners, who are on good terms with the Chinese authorities. FAW, for instance, is closely related to the SASAC, and its top managers hold high positions in the Chinese Communist Party (I-Audi-1, I-BMW-3, I-MB-1). Besides the SASAC, respondents also cited the NDRC, MIIT, and provincial and city governments as key stakeholders (I-VW-2, I-BMW-2, I-Porsche-1,2).

To find out if the role of German carmakers in China goes beyond the mere adaptation to changing e-mobility regulations, the researcher asked to what extent German carmakers can influence China's formal institutions. The replies were mixed. Several interviewees stated that the opportunities for German carmakers to influence Chinese policymaking are non-existent or very limited compared with other parts of the world (I-Audi-2,3, I-Porsche-2). Others admitted that there has been an exchange with Chinese authorities and that German carmakers have sometimes been asked for advice when new regulations or policies were drafted, e.g., due to their expertise in certain areas (I-Porsche-1, I-BMW-2, I-VW-2). As one interviewee put it, *"of course, [we] [are] helping to shape this, just like any other OEM. In this very complex matter, it is important that the legislative institutions know what is feasible. And that is only possible through consultation with technicians and lobbyists"* (anonymous interviewee). Other interview data indicate that the advice provided by German firms is not always driven by technical considerations alone; I-VW-2, for instance, suggested that Volkswagen Group might have influenced the formulation of China's 'dual-credit policy' in a way that allowed the company to minimize financial losses and transition to e-mobility more smoothly.

The researcher also searched for differences between the five cases. While the interviewees generally agreed that German firms deal with China's formal e-mobility institutions in similar ways (I-MB-1, I-VW-2), I-VW-2 pointed out that there is *"a difference in location"*. For instance, before making new e-mobility investments, firms can negotiate tax reductions and subsidies with provincial and city governments and thereby find individual solutions (I-VW-2, I-Porsche-2). In addition, in the context of policymaking, *"if you are one of the bigger investors or the bigger tax* *payers, [these governments] will listen to you more"* (I-Porsche-1). The interviewees' statements thus imply that the extent to which carmakers may influence China's regional and local e-mobility policies depends on their location, level of FDI, and performance (I-VW-2, I-Porsche-1,2). According to I-VW-2, *"Volkswagen has established a very broad footprint in China […] [,] while Daimler and BMW have only selected a few preferred regions"*; hence, the three groups can be assumed to have different spheres of influence – generally, but also in relation to e-mobility policies.

6.3. Changes in the competitive environment

When asked about changes in the competitive environment, several respondents spoke about the size of the Chinese market. Referring to the rapid growth of China's EV market, some interviewees used words like 'exponential' and 'breathtaking' (I-BMW-3, I-VW-2, I-Audi-1). On the other side of the coin, it was mentioned that Chinese demand for ICEVs is declining but expected to persist longer than in other countries (I-Audi-1,2, I-MB-1). Moreover, in line with questions based on Porter's five forces, the respondents provided insights into how the industry structure has changed.

As reflected in several interviews, *"[electric] mobility has opened up the field for many newcomers to enter an ancient industry; it won't throw established players who are well prepared into the abyss, but certainly shakes up the field"* (I-BMW-3). Many respondents pointed out that e-mobility has lowered the barriers to entry into the automotive industry, as electric cars are relatively easy and less costly to develop and build (I-Porsche-2, I-BMW-2, I-Audi-1, I-VW-1,2). While many interviewees stressed the large number of the local players that recently joined the Chinese car market (I-VW-1, I-Audi-4, I-BMW-3), others noted that some of these start-ups already failed, and time will tell which ones will ultimately succeed (I-Audi-3). Start-ups[20] frequently mentioned include the Chinese players Nio, XPeng, Li Auto, and HiPhi – as well as the American firm Tesla (I-BMW-1, I-Audi-1,2,3, I-Porsche-1, I-MB-1).

In addition, some respondents pointed out that rivalry among established carmakers has also increased (I-Audi-2, I-BMW-3). Chinese players mentioned in this context include Geely, Great Wall Motors, and BYD (I-Porsche-1, I-VW-2, I-Audi-1,2,3); while I-Audi-1 highlighted BYD's history of vertically integrating the car industry, other interviewees mostly viewed the firm as an established carmaker. According to I-VW-2, the competitiveness of these established Chinese players at least partly stems from their early focus on e-mobility-related R&D. Moreover, the competition among German carmakers in China has become fiercer as well (I-Audi-2).

Besides BYD's forward integration (I-Audi-1), the interview data suggest further changes related to the power of automotive suppliers. On a preliminary note, I-BMW-2 said that, in the e-

[20] On a side note, when speaking about Chinese firms that recently entered the EV market, I-Audi-3 suggested that, in the Chinese case, *"'[start]-ups' might even be the wrong word because, effectively, they are supported by the state"*.

mobility transition, *"[the] powertrain changes, but not the entire vehicle"*. Components that can be used in both ICEVs and EVs thus continue to be provided by the same suppliers, and carmakers can retain their dominant position vis-à-vis these firms (I-BMW-2, I-VW-2). On the other hand, certain components are EV-specific, and German carmakers had to start sourcing (some of) these components from new suppliers (I-BMW-2). In this context, many interview partners spoke about the high competitiveness of Chinese battery makers like CATL and BYD (I-Porsche-2, I-Audi-1). Related to this, I-Audi-4 explained that *"you can't put as much pressure on these large battery manufacturers as on the long-established suppliers […]. The balance of power is different. You can't just switch to a different battery manufacturer; there aren't enough who can deliver in these quantities at this quality"*. Further comments were made in relation to displays and cameras; I-VW-1 suggested that Chinese suppliers have developed advanced technologies in these fields, but that their system integration capabilities cannot compete with those of German suppliers yet.

When asked about changes related to the power of buyers, I-Audi-2 noted that Audi AG's joint venture partner, which buys Audi-branded cars and distributes them in China, has become increasingly assertive in negotiations. Besides this business-to-business example, all the other interviewees exclusively referred to retail customers when speaking about buyers. Unsurprisingly, some respondents made the remark that Chinese consumer behavior was influenced through e-mobility incentives (I-BMW-2, I-Porsche-1). However, the topic most commonly raised was Chinese customers' increasingly demanding expectations (I-Audi-2, I-VW-1). According to I-Audi-1 and I-Audi-3, this development was at least partly induced by China's emerging NEV companies; in I-Audi-3's words, *"these new manufacturers are changing how customers look at a vehicle and what is important to them"*. Apart from strictly e-mobility-related criteria like battery range, Chinese customers attach particular importance to a vehicle's software-enabled features, infotainment, and connectivity; furthermore, in terms of interior design, they prefer large screens and comfortable seats – not only for the driver, but also for the passenger and rear seats (I-Audi-2,3,4, I-VW-1). In addition to heightened expectations, I-VW-1 suggests that Chinese customers have also developed a higher price sensitivity. Finally, another factor that several respondents believe has influenced Chinese customers' EV purchasing behaviors in favor of Chinese firms is a trend towards nationalism, propagated by Chinese media, which promote anti-Western sentiment and encourage Chinese national pride (I-Audi-2, I-VW-1, I-Porsche-1, I-BMW-3).

In addition to changes in competitive forces, another topic raised by interviewees from all five case study firms is industry segmentation. While Chinese competitors in the very cheaply-priced micro-car segment are not regarded as competitors by German firms (I-BMW-3), the same cannot be said about medium-sized and larger vehicles. In the volume segment, where the VW brand plays, the Chinese EV market is dominated by Chinese firms, including BYD, Great Wall

Motors, and many others (I-Audi-1, 3). What is special about this segment is that the barriers to entry are comparatively low (I-Porsche-2) and that national pride seems to play a stronger role here than in higher-priced segments (I-BMW-3). In the premium and luxury segments, where Audi, BMW, Mercedes-Benz, and Porsche play, mobility barriers are higher. As pointed out by I-MB-1, many competitors have tried to enter the premium segment in the past but failed. However, due to the electric transition, market dynamics are currently changing. (Aspiring) Chinese premium carmakers include Nio, HiPhi, and Li Auto, as well as XPeng, Geely, and BYD, which are pushing at least some of their models towards premium (I-BMW-3, I-Audi-1,3). Lastly, the interview data imply that the mobility barriers to the luxury segment, where Porsche and Mercedes-Benz position themselves, are especially high (I-Audi-2, I-Porsche-2). According to the two interviewees from Porsche AG, Nio is the only Chinese brand striving towards this segment (I-Porsche-1,2).

Besides the classification of the car industry into volume, premium, and luxury segments discussed above, two interview partners from Audi AG suggested that a differentiation has to be made between ICEV and EV markets. According to I-Audi-1, Chinese customers perceive EVs as a new category or even industry, and German firms need to work hard to enter it. Similarly, I-Audi-4 explained that *"[the] customer bases of ICEVs and EVs are not identical. […] Of course, both customer groups have an overlap, but they have their own requirements and attach importance to completely different things"*. Thus, the segmentation logic of the ICEV sector cannot be directly transferred to the EV sector, and supposedly non-premium brands that offer certain functionalities valued by EV customers can eat into the market share of traditional premium brands (I-Audi-4). A clear answer whether or in how far EVs substitute for ICEVs cannot be derived from the interviews.

As indicated throughout the present chapter, the interviews suggest that German carmakers are faced with an increasingly fierce competitive environment; according to I-Audi-2, the situation has become particularly severe over the past three years. As pointed out by I-BMW-3, *"very few […] foreign manufacturers have an adequate offering"* – for instance, because their price does not match that of Chinese competitors, because their new EV models have not been launched yet (I-BMW-3), or because they have already been launched but fail to appeal to Chinese customers (I-Porsche-1). These kinds of situation can seriously affect a company's bottom line (I-Porsche-1, I-Audi-2); I-BMW-3 remarked that *"a few of the incumbents may not make it, or at least not in the way we know them today"*. With regard to individual companies, the interview data suggest that VW and Audi have both been losing market share in China over the past two years, as neither the VW ID. series nor the electric Audi models sell as well as expected, and as the launches of many new models with advanced technologies are still pending (I-Audi-2, I-VW-2, I-Porsche-1). Meanwhile, I-Porsche-1 implied that Porsche has established itself in China's EV market more successfully, with its first BEV model selling well. Mercedes-Benz Group was brought up by several interviewees as a negative example; because its models EQE and EQS did not sell well in China, the company had to make a repositioning and lower the prices of both models by more than 10% (I-Audi-1, I-VW-1, I-Porsche-1). Finally, I-Audi-2 mentioned the success of BMW Group in China as compared to other German players; apart from this, no particularly positive or negative statements were made in relation to BMW Group's competitive situation in China's EV market.

6.4. Changes in German carmakers' value chains

The data generated for this study offer rich insights into the five case study firms' value chains and how they have changed. This sub-chapter addresses different parts of the value chain and related changes in competitive advantages, organizational arrangements, localization, and other aspects.

The part of the value chain that was mentioned by all interview partners and talked about the most is technology development; according to I-Audi-3, this field has seen greater changes than other parts of the value chain. As indicated in 6.1, the rapid development of the Chinese EV market has led German carmakers to electrify their product portfolios earlier than planned (I-Porsche-1). Moreover, Chinese EV firms develop new models twice as fast as traditional carmakers, which has put pressure on incumbents to increase their development speed (I-VW-1, I-Porsche-1, I-Audi-4). Audi, for instance, is struggling to defend its 'Vorsprung durch Technik' brand claim of technological advantage in China; as I-Audi-1 put it, *"above all, you have to be local and fast"*.

As pointed out by several respondents, German carmakers continue to have competitive advantages related to their R&D, systems engineering, and design capabilities, as well as the quality and safety of their products (I-BMW-1,2, I-Audi-1,3, I-MB-1). On the other hand, many sources of competitive advantage, e.g., ICE and transmission technologies, lost their importance due to the e-mobility transition (I-Audi-1,3, I-VW-1,2, I-Porsche-1, I-BMW-1). Interestingly, some companies like BMW Group decided not to set a 100% BEV goal but keep their options open and continue to benefit from their ICE competencies (I-BMW-2). Conversely, I-Porsche-1 regards this strategy as a source of competitive disadvantage, as German platforms serving both ICEVs and EVs might be outperformed by Chinese platforms that are completely geared towards e-mobility.

Regarding EV technologies in a stricter sense, the development focus of German companies is not so much on the electric motor but rather on battery and charging technologies (I-Audi-1, I-MB-1). In the battery technology field, carmakers are currently competing in terms of battery range and performance and in the development of ASSBs (I-Audi-1,3,4, I-VW-1, I-MB-1). EV batteries are no longer viewed as a commodity, and all three German carmakers are currently developing their own battery chemistries, cells, and packs to close the competitive gap with their Chinese rivals (I-VW-2, I-MB-1). To succeed in this, some of them collaborate with (Chinese) third parties; Volkswagen Group, for instance, is partnering with Gotion High-tech (I-VW-1,2, I-Audi-1,3).

In addition to the above, the interviewees spoke about changes in many other technological fields. Many interlocutors pointed out the high quality of the exterior and interior designs developed by Chinese carmakers (I-Audi-1,4, I-Porsche-1). For instance, Chinese EVs often have more comfortable seats, better cameras, and larger screens that are better integrated into the vehicle (I-Audi-1,2,4, I-BMW-2). To catch up in such fields, Volkswagen Group, for instance, is seeking to increase its cooperation with Chinese partners that have the required capabilities (I-VW-1).

Besides design and hardware, more than half of the respondents highlighted software-related aspects. I-MB-1 explained that traditional carmakers are facing the challenge of navigating dozens of sub-systems, and that they are now solving this issue by developing their own operating systems. Volkswagen Group, for instance, develops software in-house through its subsidiary CARIAD (I-VW-2, I-Porsche-1). Many respondents indicated that Chinese rivals are currently ahead of their companies in terms of software, connectivity, and OTA updates, but that their companies are determined to compete (I-Audi-1,2,3,4, I-Porsche-1). Another software-related field mentioned by several interviewees is automated driving. Interlocutors noted that, to advance its automated driving capabilities, Volkswagen Group is cooperating with a Chinese province and recently founded a joint venture with Horizon Robotics (I-VW-1,2, I-Audi-1); furthermore, Audi AG is already considered to have developed a competitive advantage in the ADAS field (I-VW-2).

As implied in some of the above paragraphs, many German carmakers have perceived the need to do more R&D locally – not just due to formal requirements but also in order to be faster and better able to meet Chinese needs (I-VW-1, I-Audi-1,4, I-Porsche-1,2, I-BMW-3). Accordingly, BMW Group and Audi AG focus more and more on developing vehicles with China-specific features (I-Audi-1,2, I-BMW-3), and Volkswagen Group recently set up a CARIAD division in Beijing to develop a China-specific software architecture (I-Audi-2, I-Porsche-1). As pointed out by I-VW-1, it will be interesting to see if German firms' R&D activities will be duplicated in Germany and China – or if some of the activities will eventually be conducted 'in China for global'.

The previous paragraphs discussed German carmakers' technology development. Another part of the value chain that each interview partner had something to say about is procurement. Due to the e-mobility transition, *"a lot of complex components are no longer needed"* (I-Audi-4). Still, German carmakers have continued to cooperate with traditional suppliers – also with respect to new components that are EV-specific (I-Audi-2). However, as indicated in 6.3, some EV-specific components – such as batteries – are now sourced from new suppliers (I-Porsche-2, I-BMW-2). As a large part of an EV's value is focused on the battery (I-Porsche-1, I-Audi-3, I-VW-1) and as Chinese battery suppliers have joined the world's leading players, at least for some of the case study firms, the share of a car's value that is added in China has increased (I-Porsche-2, I-VW-1).

As pointed out by several interviewees, many German carmakers are at a competitive disadvantage in procurement. Chinese competitors often have lower costs because they are highly vertically integrated or work with Chinese suppliers who have already broken even, so that they can offer cheaper cars (I-BMW-3, I-Audi-1,4, I-VW-1,2, I-Porsche-1). Regarding the question of how VW has been affected by this, two interviewees contradicted each other. While I-VW-1 said that the Chinese rivals' pricing has put VW under pressure, I-VW-2 argued that VW, with its highly localized value chain, benefits from the early break-even of its Chinese suppliers.

In addition, several respondents expressed their general concern regarding a single-source, just-in-time strategy and an overreliance on Chinese suppliers (I-VW-1, I-BMW-3, I-Audi-2, I-Porsche-1). To decrease supplier risk and gain more control, Volkswagen, BMW, and Mercedes-Benz Group are currently in the process of *"switching from outsourcing to in-house production"* (anonymous interviewee), especially when it comes to EV batteries. This increase in the degree of vertical integration was also stressed by I-Porsche-2, who highlighted the three Groups' *"investments in battery manufacturers or raw material suppliers"*. Besides an increase in vertical integration, the interview partners mentioned two more strategies for coping with supplier risk: German firms can adopt a more diversified sourcing approach, i.e., develop a network of suppliers across multiple countries (I-Audi-2), or engage in decoupling, i.e., *"do more business with suppliers in the markets where the vehicles are to be sold and where they are produced"* (anonymous interviewee). However, as suggested by I-Audi-3, German carmakers have not completed their e-mobility transition yet, so greater changes in their procurement approaches might only become visible at a later point in time.

When asked about logistics, the interlocutors in some cases raised similar points to the ones about procurement. Apart from this, some respondents stated that there were only a few minor changes (I-Audi-3, I-MB-1), e.g., due to the e-mobility transition, fewer parts need to be delivered (I-Audi-4), and Audi's BEVs started to flow through the existing logistics network (I-Audi-3).

In terms of EV production, some interlocutors stressed that their companies continue to profit from their experience, techniques, and high standards in manufacturing (I-BMW-1,2, I-VW-2). What changes in the era of e-mobility is that less ICE and more electric motor and battery plants are needed; furthermore, certain parts of the assembly line become obsolete (I-BMW-1, I-Audi-3). In China, existing joint venture plants are already producing Audi-branded EVs and ICEVs in parallel; furthermore, the new Audi FAW NEV Company will produce EVs only (I-Audi-1,4). The other respondents did not provide any concrete examples – except for I-BMW-3, who pointed out that BMW Group plans to produce electric MINIs in a Chinese joint venture as well (I-BMW-3).

Although the researcher only inquired about sales activities, the respondents provided information not just related to sales but also to marketing. Many interviewees stressed that their companies continue to have a competitive advantage related to their brand (I-VW-2, I-Audi-1, I-BMW-3, I-MB-1, I-Porsche-1,2) but that this advantage was slightly weakened due to the e-mobility transition and resulting changes in Chinese customers' expectations (I-VW-1, I-Audi-2,4, I-Porsche-1,2; see 6.3). I-Audi-1 suggested that the Chinese also developed new expectations regarding the purchasing process. As Chinese EV start-ups usually have direct sales models in place, Audi AG is striving to sell its EVs through a similar model in China but will continue to sell its ICEVs through its traditional dealership model (I-Audi-1). The interview data suggest several reasons why German carmakers may prefer to stick, at least in part, to their traditional sales models. For instance, it may be costly to replace the existing model with a new one (I-Porsche-1); moreover, the dealership model has the advantage of allowing carmakers *"to push the vehicles into the market using discounts and sales promotions"* (I-Audi-1). In addition, several interviewees complemented I-Audi-1's statements by indicating that the shift towards direct sales was not only triggered by the e-mobility transition but also by China's strict lockdowns and the tech savviness of Chinese consumers (I-BMW-3, I-Audi-1,3). Finally, I-VW-1 observed that German carmakers are localizing more and more marketing capabilities in China; as a case in point, Volkswagen Group recently assigned its global chief marketing officer, Jochen Sengpiehl, to this country (I-VW-1).

Related to services, I-BMW-2 emphasized that BMW Group has a competitive advantage over local EV start-ups in China due to its established customer service infrastructure. Moreover, respondents from Volkswagen Group and its subsidiaries reported that their companies' service activities underwent several changes due to the e-mobility transition. I-Audi-2 explained that the e-mobility transition has made the automotive business less profitable, which is why *"[attempts] are now being made to tap into new sources of revenue"*. To expand the charging infrastructure in China, Volkswagen Group is cooperating with other parties and has co-founded CAMS; Audi and Porsche AG also benefit from these efforts (I-VW-1, I-Audi-3, and I-Porsche-2). In addition, Audi and Porsche AG – similar to other premium-segment players – are building their own exclusive charging networks in China (I-Audi-1, I-Porsche-1,2). I-Audi-2 remarked that, despite these efforts, Volkswagen Group and its subsidiaries are still at a competitive disadvantage vis-à-vis local rivals – not only in terms of charging capacities, but also regarding fast-charging and battery-swapping stations (I-Audi-2). Besides charging, the interviewees also spoke about valet services, on-demand functions, and third-party services (I-Audi-2, I-Porsche-2).

6.5. Internationalization of Chinese e-mobility players

Many of the above findings are either related to the Chinese market or the overall situation. In some cases, however, respondents specifically spoke about changes occurring outside China, particularly when referring to Chinese firms' internationalization. In I-Audi-3's view, *"the Chinese automotive industry […] now see[s] an opportunity to […] break the dominance of Western manufacturers – not only in China but […] also in the rest of the world"* (I-Audi-3). Some respondents mentioned that Chinese suppliers are currently building battery plants in Europe (I-BMW-1, I-MB-1). Moreover, half of the interlocutors spoke about the rising number of Chinese carmakers starting to export their EVs to Europe. Brands mentioned in this context include BYD, Nio, XPeng, and Zeekr (I-BMW-1,3, I-Audi-2,4). Many interviewees were intrigued about future developments in Europe – and Germany, in particular – *"as Chinese manufacturers are entering the market […] with products that meet or […] exceed Western standards for the first time"* (I-BMW-3) and with new business models like battery swapping (I-Audi-2, I-VW-1). Additionally, I-BMW-3 noted that Nio, XPeng, and BYD offer EVs at similar prices as German premium brands, so it will be interesting to see to what extent German consumers will be willing to buy Chinese cars at this price level.

Furthermore, some interviewees observed a distortion of competition: Chinese carmakers receive more subsidies from the Chinese government than their European counterparts receive in China and the EU combined (I-Audi-2,3); in addition, European firms are subject to relatively strict regulations in China, while their Chinese counterparts benefit from Europe's free market economy (I-Audi-3). Thus, as a result of industrial policies, European firms have a competitive disadvantage vis-à-vis their Chinese rivals (I-Audi-2,3). As many EU jobs depend on the success of European carmakers, it will be interesting to see in how far the EU will make competition fairer (I-Audi-3).

7. Discussion

7.1. Discussion of findings through the lens of new institutional economics

Chapter 7 discusses the findings presented in chapter 6 with reference to NIE (7.1) and strategic management literature (7.2). Concerning changes in China's formal institutions (Ménard & Shirley, 2022, p. 5), the interview data provided relatively little macro-level information (Murrell, 2005, p. 668), except that some interviewees highlighted the role of five-year plans in advancing China's e-mobility transition (I-Porsche-1, I-VW-2). Richer insights emerged at the meso level (Ménard, 2018, p. 8). Interviewees stressed and confirmed the importance of government bodies such as the SASAC, NDRC, MIIT, and provincial and city governments (I-VW-2, I-BMW-2, I-Porsche-1,2), which Ménard (2018) would classify as 'devices' (p. 8). Regarding meso-level 'mechanisms' (Ménard, 2018, p. 8), an unexpectedly small number of respondents were able to name specific e-mobility-related regulations; however, all of them were informed and willing to talk about the resulting measures that affected their companies. These ranged from financial and non-financial incentives on the demand side, influencing Chinese consumers' purchasing behaviors (I-VW-2, I-BMW-1,2,3, I-Porsche-1,2, I-Audi-1,2,3,4, I-MB-1), to a variety of supply-side measures "delineating the domain of transactions that are possible and allowed" (Ménard, 2018, p. 8), including NEV criteria, production licenses, localization, real-time data, and joint venture requirements, as well as the dual-credit policy (I-BMW-1,2,3, I-Audi-1,3, I-Porsche-2, I-VW-2, I-MB-1). While most of the measures presented in 3.2.2 were brought up by the interviewees as expected, the issue of public procurement (Altenburg et al., 2022, p. 3) was not even raised once. Besides this, another surprising observation is that only two respondents expressed the view that the dual-credit policy had had an impact on their firms (I-Audi-3, I-VW-2).

At the meso level, Ménard (2018) speaks not only about devices and mechanisms but also about "the modalities of their enforcement" (p. 8), which correspond to North's (2005) "enforcement characteristics" (p. 22). Interestingly, the interviews hardly suggest any peculiarities related to the enforcement of China's e-mobility policies. Many interviewees indicated that regulatory enforcement in China is similar to that in other countries and applies equally to all firms; furthermore, they emphasized that their companies work hard to ensure compliance (I-Audi-2, I-VW-2, I-BMW-3, I-MB-1). However, one difference noted by several respondents is that Chinese policies tend to be enforced comparatively soon after being announced (I-Audi-2,3, I-Porsche-1).

In addition to the above points, the interviews provided further insights into the processes behind macro- and meso-level institutional change in China. As mentioned in 2.2.3, Nill et al. (2001, p. 83) and Nee and Swedberg (2005, p. 801) propose a dynamic perspective according to which various kinds of organizations can play an active role in (collectively) shaping institutional environments. As pointed out in 6.2, several interview partners observed that there are relatively few opportunities for German carmakers to influence policymaking in China (I-Audi-2,3, I-Porsche-2), thus implying that they play a rather passive role. On the other hand, the findings also suggest that the case study firms handle their government affairs together with their joint venture partners (I-Audi-1, I-BMW-3, I-MB-1), that they have, in some instances, advised Chinese authorities on the formulation of regulations or policies (I-Porsche-1, I-BMW-2, I-VW-2, I-MB-1), and tend to have more influence in the geographies where they are invested and pay taxes (I-VW-2, I-Porsche-1,2). Thus, while official ways of shaping China's formal institutions seem sparse, German carmakers might be more active in influencing China's formal institutions in indirect ways.

Although the interviewees mostly provided information regarding formal institutions in China, some also referred to formal macro or meso institutions in Europe. As mentioned in 6.1, some respondents voiced the view that, for a long time, the players in the German automotive industry did not act collectively and that German policymakers hesitated to promote e-mobility (I-Porsche-1, I-BMW-1). In other words, there were coordination failures, and a coordinated policy push was brought about relatively late (Altenburg et al., 2012, pp. 70–71). At the meso level, the respondents mainly made comments about differences in China's and Europe's industrial policies, which put German carmakers at a disadvantage vis-à-vis their Chinese rivals (I-Audi-2,3; see 6.5).

At the micro level, as explained in 2.2.4, firms select organizational arrangements, thus determining their degree of vertical integration (Ménard & Shirley, 2022, pp. 26, 79). The findings imply that China's e-mobility development has led to changes in the micro-level institutions of German carmakers. In some instances, case study firms increased their level of vertical integration. Reasons include regulatory changes like the removal of the joint venture requirement[21] (I-Audi-4), the realization that highly vertically integrated Chinese rivals can achieve better cost structures (I-Audi-1, I-Porsche-1), and the understanding that vertical integration allows firms to exert more control over their value chains and reduce complexity (I-Porsche-1, I-MB-1). An increase in vertical integration is particularly evident in battery R&D, battery production, and software development[22] (I-Porsche-1,2, I-VW-2, I-MB-1). In addition, new hybrid arrangements like long-term contracts and strategic alliances (Klein, 2005, p. 445; Ménard, 2018, p. 6) were created in the areas of EV charging and procurement of cameras and screens (I-VW-1,2). Furthermore, the fact that Audi-branded EVs will soon be sold through a direct sales model while ICEVs will continue to be sold through dealers (I-Audi-1) is an example of plural forms (Ménard & Shirley, 2022, p. 89).

According to NIE, the changes in organizational arrangements mentioned above can be explained by changes in underlying transaction costs (Ménard & Shirley, 2022, pp. 26, 79). For example, intensified supplier risk (I-VW-1, I-BMW-3, I-Audi-2, I-Porsche-1) and the high value of batteries (I-Porsche-1, I-Audi-3, I-VW-1) may have made arrangements with a higher degree of vertical integration more attractive for German carmakers (Ménard & Shirley, 2022, p. 79).

Although the researcher only inquired about formal institutions, the interviewees' answers also provided insights into the importance of and changes in informal institutions. At the firm level, guanxi relationships, which are considered a China-specific informal institution (Liu et al., 2012, p. 212), appear to play a role in the e-mobility transition. For example, the interview data indicate that connections with Chinese authorities have helped carmakers to learn about and express their views on upcoming regulations (I-VW-2, I-Porsche-1, I-Audi-1, I-BMW-2,3, I-MB-1). The data suggest that informal institutions are also highly relevant when it comes to customers; e.g., several respondents suggested that Chinese consumers' growing patriotism and increasing expectations have an important impact on the automotive business in China (I-Audi-1,2,3,4, I-VW-1, I-Porsche-1, I-BMW-3). In addition, I-BMW-3 discussed German consumers' perception of Chinese cars as good value for money and the question of whether they will ever be willing to pay a high price for

[21] The elimination of the joint venture requirement allowed foreign firms to select new forms of organizational arrangements, illustrating Klein's (2005) point that formal institutions delimit the set of available options (p. 455).

[22] As indicated in 6.4, in order to vertically integrate into the battery field, Volkswagen Group, for instance, has increased its cooperation with Chinese partners (I-VW-1,2, I-Audi-1,3).

Chinese EVs. Given the above, the researcher's assumption that changes in China's formal institutions affect German carmakers more than informal ones (see 2.2.2) needs to be reconsidered.

7.2. Discussion of findings through the lens of strategic management literature

Following the above discussion of findings in the context of NIE, sub-chapter 7.2 takes a strategic management perspective, covering both external and internal aspects. In terms of external analysis, the emphasis was on the competitive environment (Porter, 2008, pp. 88). As described in 6.3 and 6.5, interview questions related to Porter's five forces (Porter, 2008, p. 80) enabled insights into the changing structure of the automotive industry.

Generally, touching upon the forces 'threat of new entrants' and 'rivalry among existing competitors' (Porter, 2008, p. 80), the interview data indicate that Chinese carmakers have made considerable progress and, in some cases, leapfrogged ahead of their German rivals (I-Audi-2, I-Porsche-1, I-BMW-3), leading to fiercer competition both at home and abroad. The following two paragraphs will examine the two forces individually. However, it should be noted that a distinction between new entrants and existing competitors is not always easy to make. BYD, for instance, is considered an established company in China but a new entrant in Europe (I-BMW-3).

The interviews confirm the idea that entry barriers to the automotive industry have become lower in the era of e-mobility. As mentioned in 2.3.2, entry barriers can stem from economies of scale, switching costs, capital requirements, government policy, and access to distribution channels, among others (Porter, 2008, pp. 81–82). Apart from switching costs, all of these factors were mentioned in the interviews. Firstly, as Chinese carmakers focus on development speed, incumbents from other countries need to do likewise, compromising on the economies of scale they enjoyed in the past (I-Audi-1,4, I-VW-1, I-Porsche-1). Secondly, due to the reduced complexity of EVs relative to ICEVs (Altenburg, 2014, p. 14; Altenburg et al., 2016, p. 466), the capital requirements of entering the car industry have sunk (I-Porsche-2, I-BMW-2, I-Audi-1, I-VW-1,2). Thirdly, government policies have also played a role in decreasing entry barriers, e.g., through financial measures like subsidies (I-VW-2, I-BMW-1, I-Porsche-1, I-Audi-2,3,4). Lastly, nothing in the interview data suggests that existing distribution channels have become more accessible; however, as I-Audi-1 explained, Chinese EV start-ups tend to favor direct sales over dealership models, so one may assume that they find this type of channel cheaper to build. Due to the lowered entry barriers, many local players have emerged in China (I-VW-1, I-Audi-4, I-BMW-3).

Rivalry among existing competitors depends, among other things, on the speed of industry growth, number of rivals, height of exit barriers, rivals' commitment to the business, and likelihood of price competition (Porter, 2008, pp. 81–85). While the ICEV market is shrinking, the EV market is rapidly growing (I-BMW-3, I-VW-2, I-Audi-1). Nevertheless, rivalry has intensified not only in the ICEV sector but also in the EV sector, as the number of EV manufacturers has increased (I-VW-1, I-Audi-4, I-BMW-3). Exit barriers, according to Porter (2008), “arise because of such things as highly specialized assets” (p. 85). Since automotive R&D and production require large and specific investments, it can be assumed that exit barriers are high and that the firms that have invested in this business are deeply committed; however, the data do not reveal any e-mobility-induced changes in this regard. Finally, the interlocutors implied that the volume segment is more prone to price competition than other segments. However, competition in all segments also occurs along other, non-price dimensions, especially in terms of technology-enabled features, which have gained importance in the era of e-mobility (I-VW-1,2, I-Audi-1,2,3,4, I-BMW-2, I-Porsche-1, I-MB-1). As a result, interviewees perceived that the competition among (German and Chinese) incumbents has increased (I-Audi-1,2,3, I-VW-2, I-Porsche-1, I-BMW-3). Furthermore, the data partly confirm Rothaermel’s (2015) point that rivalry is mostly segment-specific (p. 83); they indicate that the premium and luxury segments are protected by mobility barriers but also point out that Chinese players are now taking the e-mobility-related chance to overcome these barriers and push their EVs towards the premium segment (I-Porsche-2, I-MB-1, I-BMW-3, I-Audi-1,2,3,4).

Porter’s (2008) force ‘bargaining power of suppliers’ depends on several factors, including the concentration of a group of suppliers relative to the industry that purchases their products, the uniqueness of the products offered by the suppliers, and the risk of forward integration of suppliers into the industry (pp. 82-83). The interview data imply that forward integration of suppliers is not perceived as a serious risk, but that the other two factors have indeed increased competition. The first one is linked to the fact that, due to the e-mobility transition, carmakers now need to purchase new kinds of components such as EV batteries. Although Chinese battery manufacturers have joined the world’s leaders, the number of suppliers that can deliver the desired quantities remains limited (I-Audi-4, I-BMW-1,2, I-VW-1,2, I-MB-1, I-Porsche-2). Meanwhile, these suppliers can choose from a growing number of carmakers willing to buy their products (I-VW-1, I-Audi-4, I-BMW-3). The concentration of battery suppliers in relation to carmakers has thus developed to the detriment of the incumbent carmakers. Regarding the second factor, several respondents stressed the importance of finding battery manufacturers that can offer products of the desired quality and performance (I-Audi-4, I-MB-1), thus referring to the uniqueness of EV-specific components.

Regarding the ‘bargaining power of buyers’ (Porter, 2008, p. 80), only I-Audi-2 spoke about business-to-business situations, noting that Audi AG’s Chinese joint venture partner has become increasingly assertive. In Porter’s (2008) words, this reflects a rise in the ‘negotiating leverage’ of an ‘intermediate customer’ (pp. 83-84). The other interlocutors only referred to retail customers. For instance, some respondents noted that Chinese consumers have been influenced by e-mobility incentives (I-BMW-2, I-Porsche-1) and the competitiveness of Chinese EVs, which has led consumers to increase their expectations and price sensitivity (I-Audi-1,2,3, I-VW-1). These points illustrate Porter's (2008) ideas that policies can influence competitive forces (p. 86) and that customers can exert power by "forcing down prices [and] demanding better quality or more service" (p. 83). Price sensitivity was also mentioned in the context of Chinese firms entering Europe, e.g., regarding the willingness of German consumers to pay high prices for Chinese EVs (I-BMW-3).

The interview data offered relatively little information regarding the fifth competitive force, 'threat of substitutes' (Porter, 2008, p. 84); none of the respondents identified a substitute that could truly replace the car as a means of individual transportation. The interviews did, however, raise the question if EVs are a substitute for ICEVs. While some people view the e-mobility transition merely as a shift in drive technologies, others argue that EVs are entirely new products that substitute for ICEVs (Hove et al., 2021, p. 27; Schwabe, 2020b, p. 1). It appears that I-Audi-1 and 4 favor the latter perspective; their statements imply that Chinese customers perceive EVs as a new category and that the segmentation logic of the ICEV market cannot be applied to the EV market. However, as mentioned in 6.3, the data do not provide a satisfactory answer to the question raised.

Based on the above analysis, one can conclude that, in the context of China's e-mobility development, at least four of Porter's forces have fueled competition in the car industry, making the business less profitable (Porter, 2008, p. 80). However, as illustrated in 6.3, the exact impact on individual firms depends on their respective positioning. The remainder of this chapter covers the topic of internal analysis. As explained in 2.3.3 and 2.3.4, the researcher based a part of the interview guide on Porter's (1998a) value-chain model (p. 37) to explore the impact of China's e-mobility transition on the case study firms' activities and competitive advantages. Related findings have been presented in 6.4; the below paragraphs link these findings to relevant theoretical aspects.

Primary activities, according to Porter (1998a), include logistics, operations[23], marketing, sales, and services (p. 37). Except for logistics, the interviews indicate that major changes have occurred in all of these areas. According to the respondents, the case study firms continue to benefit from their experience, techniques, standards, brands, and customer service infrastructure (I-VW-2, I-Audi-1, IBMW-1,2,3, I-MB-1, I-Porsche-1,2). This suggests that the case study firms have so far been successful at sustaining competitive advantages in these fields (Barney, 2014, p. 141). On the other hand, it appears that some of these advantages – e.g., those related to the brand – have slightly weakened as a result of China's e-mobility transition (I-VW-1, I-Audi-2,4, I-Porsche-1,2). Looking at concrete activities, the interviews indicate that (some) firms are gearing their production towards e-mobility (I-BMW-1,3, I-Audi-1,3,4), partially changing their sales models (I-Audi-1), increasing their China-specific marketing capabilities (I-VW-1), and diversifying their service portfolios (I-

[23] In terms of operations, this study focuses on production.

VW-1, I-Audi-2,3, I-Porsche-2). Presumably, the purpose of these changes is to create new competitive advantages or to avoid or offset competitive disadvantages (Barney, 2014, p. 127).

Regarding secondary activities of German carmakers, this study only focused on two of the four types proposed by Porter (1998a, p. 37), namely, procurement and technology development. The interviews suggest that both fields have seen significant changes in the wake of China's e-mobility transition. In terms of procurement, as noted in 6.4, some interviewees indicated that the share of certain German carmakers' value creation that happens in China has increased, e.g., because these carmakers have started to buy components like EV batteries from Chinese suppliers (I-Porsche-2, I-VW-1). In this context, some respondents also spoke about changes in cost structures; by sourcing EV-specific components from Chinese suppliers that have already broken even, carmakers can gain a competitive advantage over rivals whose supply chains are not localized in China (I-VW-2). This aspect may be particularly relevant for volume brands that strive for 'cost leadership' (Porter, 1998b, p. 35). In contrast to the increasing localization of value chains in China, some respondents also discussed corporate-level strategies of geographic diversification (Barney, 2014, p. 283). To reduce their reliance on Chinese suppliers, the case study firms (consider to) spread their suppliers across several countries, engage in decoupling, or increase their degree of vertical integration[24] (I-VW-1, I-BMW-3, I-Audi-2, I-Porsche-1,2, I-MB-1).

Judging from the interview data, the field of technology development has seen important changes as well. For instance, very concretely, competitive advantages in ICE and transmission technologies have turned out to be temporary (Barney, 2014, pp. 16, 141) and are losing their value as the industry transitions towards e-mobility[25] (I-Audi-1,3, I-VW-1,2, I-Porsche-1, I-BMW-1). Incumbent carmakers thus need to find new ways of transferring their past success to the world of e-mobility (I-Audi-3) – or, as Barney (2014) put it, they need to "leverage [their] resource base […] to gain and sustain competitive advantage in a […] changing environment" (p. 113). Another development is that the rise of Chinese EV start-ups has led to shorter product life cycles (Nill et al., 2001, p. 88) and put pressure on incumbents to speed up their development (I-VW-1, I-Porsche-1, I-Audi-4), thus causing some of the case study firms to localize more of their R&D in China (I-VW-1, I-Audi-4). Furthermore, as described in 6.4, the findings show that changes have not only occurred with regard to the development of 'hard' technologies, but also and especially with regard

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[24] The latter option has already been discussed in 7.1.

[25] This may explain why some German firms continue to use platforms that support various drive technologies; it seems that they are trying to profit from their ICE technologies as long as possible, regardless of the risk that a lack of commitment to electric-only platforms could turn into a source of competitive disadvantage (I-BMW-2, I-Porsche-1).

to software. The case study companies compete with their (Chinese) rivals in terms of battery and charging technologies, exterior and interior designs, integrated cameras and displays, operating systems, connectivity, OTA updates, ADASs, etc. (I-Audi-1,2,3,4, I-Porsche-1, I-BMW-2, I-VW-1,2, I-MB-1). Regarding these aspects, most respondents, with a few exceptions, reported that the technologies used in their companies' current models are still at a disadvantage compared with those offered by certain Chinese competitors. However, many of the technologies being developed today will only become visible in the future when new EVs are launched (I-Audi-2,3); thus, only time can tell whether the case study firms' ongoing R&D efforts, globally as well as locally in China, will ultimately lead to competitive advantage, parity, or disadvantage (Barney, 2014, p. 16).

8. Conclusion

The final chapter of this paper concludes by answering the research questions, pointing out the contribution of this study to existing research, and proposing future avenues of inquiry. To explore the impact of China's e-mobility development on German motor vehicle manufacturers, the researcher used a holistic multiple-case design to analyze five German case study firms from a NIE and strategic management perspective. As mentioned in the introduction, the first research question was: *in the context of the automotive industry's transition towards e-mobility, how have German motor vehicle manufacturers been affected by changes in China's formal institutions?* To begin with, it should be noted that some interviewees viewed the e-mobility transition in a narrower sense, while others viewed it more broadly and stressed the interrelation of e-mobility with connectivity, automated driving, digitalization, and sustainability. In China, the electric transformation has been shaped by changes in formal institutions at various levels. Macro-level institutions, like five-year plans and other long-term industrial policy instruments, have played a role in driving the transition of China's automotive industry and fostering the competitiveness of Chinese firms. However, a direct impact of China's macro-level institutions on German carmakers is difficult to trace.

The situation is clearer at the meso level. Respondents identified meso-level devices like the SASAC, NDRC, MIIT, and local governments as key stakeholders. In terms of meso-level mechanisms and their impact on German carmakers, the interviews provided few insights related to specific e-mobility policies but many related to resulting measures. When asked what measures had impacted their companies the most, interlocutors often cited financial measures first but also referred to other supply- and demand-side measures. Some of these measures benefited their firms, while others were detrimental: demand-side subsidies, tax exemptions, and the removal of the joint venture requirement were viewed positively; meanwhile, measures that were viewed negatively include supply-side subsidies for Chinese firms, demanding criteria for NEV incentive eligibility, the need to obtain production licenses, and localization requirements. The fact that few respondents spoke about the dual-credit policy may imply that this policy has had a neutral impact on most of the case study firms. Furthermore, regardless of the exact nature of the meso-level mechanisms, interviewees reported that Chinese e-mobility policies tend to be enforced on short notice. To anticipate future changes, (some of) the firms studied have dedicated departments, turn to various sources of information, and handle their government affairs jointly with their joint venture partners.

Interestingly, the case study firms were not just affected by changes in China's formal institutions but also by disparities between institutions in China and the EU. Since China managed to implement a coordinated policy push earlier and faster than Germany, German car manufacturers are now under pressure to speed up their electrification. Furthermore, differences between Chinese and EU industrial policies have put German carmakers at a disadvantage relative to Chinese rivals.

Going slightly beyond the scope of the first question, the study suggests that German carmakers do not merely adapt to China's changing e-mobility institutions; instead, they can play a more active role, e.g., by advising Chinese authorities on the formulation of regulations at the meso level, with the scope of their influence depending on their location, level of FDI, and amount of taxes paid. In addition, they have changed and created formal institutions at the micro level: for instance, some case study firms have increased their degree of vertical integration in battery R&D, battery production, and software development and formed new contracts and strategic alliances with Chinese partners in areas such as EV charging and the procurement of cameras and displays.

Finally, the study unexpectedly pointed out the importance of informal institutions in the context of the e-mobility transition. For instance, the interview data suggest that German carmakers have relied on guanxi with Chinese authorities to learn about and express their views on upcoming e-mobility regulations. Another example is related to customer preferences: in China, an increase in patriotism and customer expectations has made the business more difficult for German carmakers; in Germany, on the other hand, carmakers are still waiting for possible changes in the preferences of German consumers as Chinese EV models enter the German market.

The second research question was: *against the backdrop of China's e-mobility development, how have German motor vehicle manufacturers' competitive environment and positions changed (in China and globally)?* To answer this question, one can look at the two parts of the question – the competitive environment and the competitive positions – individually.

The data suggest that German carmakers' competitive environment has changed due to the Chinese e-mobility transition – not just in China but also generally. In China, the EV market is growing, while the ICEV market is shrinking but expected to persist longer than in some other countries. Respondents indicated that at least four of Porter's five forces have changed over the past few years, fueling competition in the car industry and making the business less profitable for their firms. Firstly, e-mobility has generally lowered the industry's entry barriers, e.g., because

EVs are less complex than ICEVs and governments have supported firms through subsidies; as a result, new carmakers have emerged, many of them in China. Secondly, rivalry has intensified among the case study firms as well as between them and other established automakers – including Chinese ones, many of which started to invest into EV-related R&D relatively early. Thirdly, some Chinese battery suppliers have emerged as leading players and entered automotive value chains with strong bargaining power since high-quality EV batteries are scarce. Fourth, Chinese buyers have become more demanding and price sensitive, so their bargaining power has increased.

Outside of China, the competitive environment is also changing. For example, a growing number of new and established Chinese carmakers are starting to export their EVs (and, along with this, new business models such as battery swapping) to Europe. Whether the expectations and price sensitivity of German buyers will change through the influence of Chinese firms remains to be seen.

Besides changes in the competitive environment, the data also point to changes related to the case study firms' competitive positions, i.e., their industry positions, resources, and capabilities, all of which can be sources of competitive (dis)advantage. How strongly changes in the competitive environment have affected the case study firms seems to depend on the industry segments in which they are positioned. For instance, the volume brand VW is facing fiercer competition from Chinese rivals than the other German brands, which are positioned in the premium and luxury segments and thus protected by higher mobility barriers. While some interlocutors stressed their confidence in these barriers, others suggested that the e-mobility transition has blurred the lines between the traditional segments of the car industry (allowing some Chinese players that were not originally considered premium manufacturers to push their EVs towards higher-end segments) and that EVs could even be considered a new product category that has a segmentation logic of its own.

The interview data reveal no evidence that any of the German car brands have substantially changed their positioning in response to China's e-mobility transition; however, they do imply that some of the case study firms currently do not have an adequate offering for the Chinese market, e.g., because their EVs are overpriced as compared to Chinese competitors, because their development speed is so slow that they are still waiting for their new EV models to be launched, or because the design of their EVs does not appeal to Chinese customers. As a result, some of the case study firms have lost market share, and one of them had to significantly lower the prices of its EVs in China; the latter is the only case that can be considered an example of a (moderate) repositioning. Regarding other geographies, the respondents did not mention any major changes in their companies' positioning, but it cannot be ruled out that such changes may occur in the future as more and more Chinese carmakers continue their expansion into other markets around the world.

Changes in the case study companies' resources and capabilities were identified through a value chain analysis. It appears that the automotive industry's transition towards e-mobility, both in general and specifically in China, has led to changes in the fields of production, sales, marketing, services, R&D, and procurement. The production activities of most case study firms experienced similar changes in China as in other parts of the world; for example, with more capacities and capabilities needed for electric motor and battery production, some plants have been reorganized or newly constructed. Regarding sales and marketing, China's e-mobility transition does not seem to have affected the case study firms' activities outside of China. Within China, on the other hand, the rise of Chinese EV makers may have slightly weakened some of the German firms' brand advantages, inspired at least one firm to consider selling its EVs through a direct sales model, and factored into at least one firm's decision to localize more marketing capabilities in China. In terms of services, the e-mobility transition has triggered some general changes in the global activities of German carmakers and, in the same vein, required them to find local solutions for China. Notably, some of the case study firms formed strategic alliances and shared resources with other parties to provide customers with better charging services and offset disadvantages relative to Chinese rivals. Whether the entry of Chinese players into other markets around the world will lead to changes in the services offered by German carmakers is yet to be seen.

The changes most evident in the interviews were those in R&D and procurement. The rapid development of the Chinese EV market and the shortening of product life cycles put some German carmakers under pressure to accelerate their electrification and localize more of their R&D in China. Since ICEV-specific technologies are losing value, the case study firms must rely on their dynamic capabilities to remain competitive. At the time of the interviews, many of the EV models offered by the case study firms were still inferior to Chinese models in terms of battery technology, design, camera and display integration, operating systems, OTA updates, or ADASs; to catch up, some of the firms were pursuing R&D collaborations with (Chinese) partners. However, since the results of current R&D efforts will not be visible until new models are launched, only time will tell whether these efforts will lead to competitive advantage, parity, or disadvantage. Concerning procurement, respondents reported that certain EV-specific parts of high value are sourced from new, in some cases Chinese, suppliers. A possible overreliance on the capabilities of Chinese suppliers appears to be a concern for several case study firms; coping mechanisms include vertical integration, diversified sourcing across multiple countries, and decoupling. As with R&D, greater changes in the firms' procurement strategies and possible effects may only become visible at a later stage.

This study has expanded on existing research by applying elements of NIE and strategic management literature to an e-mobility-related issue. Besides proposing answers to the research questions, from a NIE perspective, this study has explored the impact of formal institutional changes on organizational arrangements and pointed to the importance of informal institutions in the automotive industry. From a strategic management standpoint, this paper has confirmed the usefulness of Porter's five-forces and value-chain models to shed light on current developments in the car industry but also touched upon these models' limits; for instance, it may be useful to add 'software development' to Porter's 'technology development' activities. Furthermore, this paper has pointed to areas of overlap between the two research strands, e.g., by observing that disparities between formal institutions in different regions can cause firm-level competitive (dis)advantages and by illustrating how policies can influence the power of buyers and the threat of new entrants.

Future research could head in several directions. In the context of the Chinese e-mobility transition, quantitative methods may be used to analyze the transaction costs underlying German carmakers' decision to increase their vertical integration; qualitatively, it would be of interest to examine in more detail how German carmakers have been affected by changes in China's *informal* institutions. Moreover, since this study focused on German passenger car manufacturers, further research could include truck and bus manufacturers in the analysis and draw a comparison between the three types of companies. In addition, the entry of Chinese carmakers into the German market provides further avenues of inquiry; for instance, future research may attempt to gain insights into the market entry strategies of these firms and how they change the competitive environment.

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Appendices

Appendix 1. Short version of the interview guide using the example of Porsche AG

1. Was sind Ihrer Meinung nach die wichtigsten Entwicklungen in China im Bereich der E-Mobilität für deutsche Automobilhersteller wie die Porsche AG – und warum?

2. In Bezug auf formelle Institutionen mit besonderer Relevanz für die Porsche AG: Welche formellen Institutionen im Bereich der E-Mobilität haben sich in China verändert oder sind neu dazugekommen – auf nationaler, regionaler oder auch lokaler Ebene?

3. Welche Besonderheiten gab es bei der Umsetzung?

4. Wie haben sich die institutionellen Veränderungen in China im Bereich der E-Mobilität auf die Porsche AG ausgewirkt – kurzfristig und langfristig, vor Ort in China und global?

5. Inwiefern hat die Porsche AG formelle Institutionen in China im Bereich der E-Mobilität selbst aktiv (mit-)gestaltet?

6. Im Hinblick auf die Transformation der Automobilindustrie in Richtung E-Mobilität: Wie hat sich das Wettbewerbsumfeld der Porsche AG – oder anders gesagt die Branchenstruktur – durch chinesische Einflüsse verändert?

7. Inwiefern hat die Porsche AG angesichts des sich verändernden Wettbewerbsumfelds ihr Geschäftsmodell beziehungsweise ihre strategische Positionierung verändert?

8. Wie haben sich aufgrund des Wandels in Richtung E-Mobilität Teile der Wertschöpfungskette der Porsche AG verändert, vor allem in Bezug auf China?

9. In welchen Bereichen der E-Mobilität und angrenzenden Themenfeldern arbeitet die Porsche AG eng mit strategischen Partnern aus China zusammen?

10. Angesichts der chinesischen Konkurrenz im Bereich der E-Mobilität: Inwiefern haben sich die Wettbewerbsvorteile der Porsche AG verändert?

Appendix 2. Long version of the interview guide using the example of Porsche AG

Introductory remarks

Hallo, Herr/Frau [Name].

Vielen Dank, dass Sie heute an diesem Interview teilnehmen und mich dadurch bei meiner Masterarbeit unterstützen.

Bevor das Interview startet, würde ich mit Ihnen gerne kurz die Eckdaten klären. Wieviel Zeit haben Sie heute mitgebracht? Haben Sie direkt danach einen Anschlusstermin?

Dann noch ein paar Infos zum Datenschutz und zur Vorgehensweise: Ihr Name wird in der Arbeit anonymisiert werden, er wird also nirgendwo auftauchen. Wenn Sie eine Frage nicht beantworten können oder möchten, geben Sie mir gerne einfach Bescheid.

Zusätzlich habe ich noch einen Wunsch. Ich würde unser Interview gerne aufzeichnen. Das würde mir bei der Analyse extrem helfen. Die Tonaufnahme werde ich vertraulich behandeln, mit niemandem teilen, ausschließlich zur Transkription nutzen und nach Abgabe der Masterarbeit löschen. Sind Sie damit einverstanden, dass ich das Gespräch aufzeichne?

Haben Sie sonst noch Fragen, bevor es losgeht?

Introductory questions

1. *Was sind Ihrer Meinung nach die wichtigsten Entwicklungen in China im Bereich der E-Mobilität für deutsche Automobilhersteller wie die Porsche AG – und warum?*

    1.a. Welche Chancen und Herausforderungen haben sich durch diese Entwicklungen für die deutschen Automobilhersteller und konkret für die Porsche AG ergeben?

Main questions (part 1)

Als nächstes möchte ich Ihnen Fragen zum Thema der formellen Institutionen stellen. Kurz als Erklärung: Formelle Institutionen sind beispielsweise Gesetze, Regulierungen, schriftlich festgehaltene Regeln und Verträge – also sozusagen die „Spielregeln“, die von verschiedenen Akteuren festgelegt werden und nach denen dann gehandelt wird. Denken wir jetzt konkret an die formellen Institutionen im Bereich der E-Mobilität in China, die für die Porsche AG besonders relevant waren oder sind.

2. *Welche formellen Institutionen im Bereich der E-Mobilität haben sich in China verändert oder sind neu dazugekommen – auf nationaler, regionaler oder auch lokaler Ebene?*

2.a. Welche formellen Institutionen haben sich im Bereich der E-Mobilität durch China auch auf internationaler Ebene geändert? Z.B. im Bereich der Standardisierungen?

3. *Welche Besonderheiten gab es bei der Umsetzung dieser „neuen Spielregeln"?*

4. *Wie haben sich die institutionellen Veränderungen in China im Bereich der E-Mobilität auf die Porsche AG ausgewirkt – kurzfristig und langfristig, vor Ort in China und global?*

4.a. Inwiefern haben diese institutionellen Veränderungen Porsches Elektrifizierungsstrategie beeinflusst?

4.b. Welchen Einfluss hatten die Veränderungen auf Porsches finanzielle Situation?

4.c. Inwiefern hat sich Porsche – ausgelöst durch die veränderten formellen Institutionen in China – international neu ausgerichtet?

5. *Inwiefern hat die Porsche AG formelle Institutionen in China im Bereich der E-Mobilität selbst aktiv mitgestaltet – und ist dabei ihren ganz eigenen Weg gegangen?*

5.a. Welche formellen Institutionen (Verträge, Vereinbarungen) hat die Porsche AG in China im Rahmen ihrer Elektrifizierungs-Strategie gekündigt, verändert oder neu ins Leben gerufen?

5.b. Inwieweit ist die Porsche AG in Bezug auf die formellen Institutionen in China im Bereich der E-Mobilität einen anderen Weg gegangen als ihre (deutsche) Konkurrenz?

<u>Main questions (part 2)</u>

Machen wir nun einen Sprung vom Thema „formelle Institutionen" zum Themenfeld „Wettbewerb und Strategie".

6. *Im Hinblick auf die Transformation der Automobilindustrie in Richtung E-Mobilität: Wie hat sich das Wettbewerbsumfeld der Porsche AG – oder anders gesagt die Branchenstruktur – durch chinesische Einflüsse verändert?*

6.a. Wie hat sich die Rivalität der Porsche AG mit anderen etablierten Automobilherstellern entwickelt – in China und global?

6.b. Im Rahmen des Wandels in Richtung E-Mobilität sind neue Anbieter in China mit dazugekommen. Wie stark machen diese neuen Anbieter der Porsche AG Konkurrenz?

6.c. Wie hat sich durch den Wandel in Richtung E-Mobilität vor allem in China die Zusammensetzung und Verhandlungsstärke von Porsches Lieferanten und Abnehmern verändert?

6.d. Welche Ersatzprodukte von chinesischen Anbietern machen Porsches klassischen Produkten Konkurrenz – auf dem chinesischen Markt sowie auf Drittmärkten?

7. *Inwiefern hat die Porsche AG angesichts des sich verändernden Wettbewerbsumfelds ihr Geschäftsmodell beziehungsweise ihre strategische Positionierung verändert?*

8. *Wie haben sich aufgrund des Wandels in Richtung E-Mobilität Teile der Wertschöpfungskette der Porsche AG verändert, vor allem in Bezug auf China?*

8.a. Inwiefern haben sich als Antwort auf chinesische Markt-Einflüsse im Kontext der E-Mobilität Porsches Beschaffung, Produktion und Logistik verändert?

8.b. Inwiefern haben sich als Antwort auf chinesische Markt-Einflüsse im Kontext der E-Mobilität Porsches Vertriebs- und Service-Aktivitäten verändert?

8.c. Welchen Einfluss hatte die Wettbewerbssituation im Bereich der E-Mobilität in China bislang auf Porsches Technologieentwicklung?

8.d. In welchen Bereichen ist der Technologiewettbewerb im Bereich der E-Mobilität zwischen deutschen und chinesischen Firmen aktuell besonders intensiv?

9. *In welchen Bereichen der E-Mobilität (und angrenzenden Themenfeldern) arbeitet die Porsche AG eng mit strategischen Partnern aus China zusammen – und in welchen gerade nicht? Warum?*

9.a. Denken Sie zum Beispiel an verschiedene Abschnitte der Wertschöpfungskette (siehe 8.a., 8.b, 8.c.).

9.b. Denken Sie zum Beispiel an die Eröffnung neuer Fabriken oder Forschungszentren, beispielsweise in China im Rahmen von Joint Ventures.

9.c. Denken Sie zum Beispiel an die Zusammenarbeit mit Partnern aus anderen Wirtschaftsbranchen oder dem öffentlichen Sektor, beispielsweise in Sachen Lade-Infrastruktur, Batteriewechselstationen, bidirektionales Laden, Standardisierung usw.

10. *Angesichts der chinesischen Konkurrenz im Bereich der E-Mobilität: Inwiefern haben sich die Wettbewerbsvorteile der Porsche AG verändert?*

10.a. Welche Wettbewerbsvorteile der Porsche AG sind verschwunden, gleichgeblieben, haben sich verwandelt oder sind neu entwickelt worden?

Wrap-up questions

Gibt es etwas, worüber wir zu wenig gesprochen haben? Möchten Sie einen Punkt noch näher ausführen? Oder sonst noch etwas hinzufügen?

Gibt es eine Person, mit der Sie mir empfehlen, im Anschluss noch ein weiteres Interview zu führen?

Gibt es etwas, das Sie gesagt haben und das Sie gerne zurücknehmen möchten, sodass ich es von der Transkription ausschließe?

Final remarks

Hiermit ist das Interview beendet, die Aufnahme ist gestoppt.

Vielen Dank, dass Sie sich die Zeit genommen haben, mich bei meiner Forschung zu unterstützen.

Ich wünsche Ihnen einen schönen Tag!

Appendix 3. List of direct quotations and their translations

The following quotations are listed in the order of their appearance in chapter 6. The word order of the original sentences sometimes had to be modified as the sentences were translated into English; this is why some of the below quotations are slightly longer than those used in the thesis.

German quotation (original)	English quotation (translation)
„E-Mobilität heißt in der Zukunft nicht nur Batterie-Fahrzeuge, sondern E-Mobilität heißt auch vernetztes und intelligentes und auch autonomes Fahren in China“ (I-VW-2)	“in the future, e-mobility does not only mean battery-electric vehicles; e-mobility also means connected and intelligent and autonomous driving in China” (I-VW-2)
„die haben massiv aufgeholt, auch uns eingeholt, wenn nicht sogar in einigen Sachen auch überholt“ (I-Audi-2)	“they have made massive progress, even caught up with us, perhaps even overtaken us in some regards” (I-Audi-2)
„natürlich gestalte[n] [wir] das mit, genauso wie jeder andere OEM. Es ist in dieser sehr komplexen Materie wichtig, dass die gesetzgebenden Institutionen wissen, was überhaupt geht. Und das geht nur im Dialog mit den Technikern und letztlich den Lobbyisten“ (anonymous interviewee)	“of course, [we] [are] helping to shape this, just like any other OEM. In this very complex matter, it is important that the legislative institutions know what is feasible. And that is only possible through consultation with technicians and lobbyists” (anonymous interviewee)
„die drei deutschen Hersteller in China haben ähnliche Vorgehensweisen mit den Behörden, um mit den ganzen formellen Institutionen umzugehen. Nur halt unterschiedlich ist der Standort-Unterschied“ (I-VW-2)	“the three German manufacturers have similar procedures with the authorities in dealing with formal institutions in China. It’s just that there is a difference in location” (I-VW-2)
„wenn man einer der größeren Investoren oder der größeren Steuerzahler ist, dann wird auch mehr auf einen gehört“ (I-Porsche-1)	“if you are one of the bigger investors or the bigger tax payers, they will listen to you more” (I-Porsche-1)
„Volkswagen hat einen sehr breiten Footprint in China aufgesetzt […] [,] während Daimler und BMW ja nur einige, sehr bevorzugte Regionen ausgewählt haben“ (I-VW-2)	“Volkswagen has established a very broad footprint in China […] [,] while Daimler and BMW have only selected a few preferred regions” (I-VW-2)
„Die Elektromobilität hat vielen Newcomern das Feld eröffnet, einzusteigen in eine uralte Industrie. Das wird etablierte Player, die richtig darauf vorbereitet sind, jetzt nicht in den Abgrund stürzen, aber es mischt das Feld natürlich neu auf“ (I-BMW-3)	“Electric mobility has opened up the field for many newcomers to enter an ancient industry; it won’t throw established players who are well prepared into the abyss, but certainly shakes up the field” (I-BMW-3)
„‘Start-ups’ ist vielleicht sogar das falsche Wort, weil sie im Endeffekt schon staatlich unterstützt sind“ (I-Audi-3)	“‘Start-ups’ might even be the wrong word because, effectively, they are supported by the state” (I-Audi-3)
„Der Antriebsstrang ändert sich, aber nicht das ganze Fahrzeug“ (I-BMW-2)	“The powertrain changes, but not the entire vehicle” (I-BMW-2)

„Und was wir merken, ist, dass man diesen großen Batterie-Herstellern nicht so Druck machen kann wie den alteingesessenen Lieferanten […]. Da ist das Machtverhältnis ein anderes. Man kann nicht einfach den Batterie-Hersteller wechseln, dafür gibt es nicht viele genug und die in diesen Stückzahlen zu der Qualität etc. liefern können“ (I-Audi-4)	“And what we notice is that you can't put as much pressure on these large battery manufacturers as on the long-established suppliers […]. The balance of power is different. You can't just switch to a different battery manufacturer; there aren't enough who can deliver in these quantities at this quality etc.” (I-Audi-4)
„in China wird durch diese neuen Hersteller verändert, wie die Kunden auf das Fahrzeug blicken und was ihnen wichtig ist“ (I-Audi-3)	“in China, these new manufacturers are changing how customers look at a vehicle and what is important to them” (I-Audi-3)
„Der Kundenkreis von Verbrenner-Fahrzeugen und der Kundenkreis von Elektrofahrzeugen sind nicht identisch. […] Beide Kundengruppen haben natürlich eine Überschneidung. Aber sie haben doch auch eigene Anforderungen und legen wiederum auch auf ganz andere Dinge Wert“ (I-Audi-4)	“The customer bases of ICEVs and EVs are not identical. […] Of course, both customer groups have an overlap, but they have their own requirements and attach importance to completely different things” (I-Audi-4)
„sehr wenige andere ausländische Hersteller haben ein adäquates Angebot“ (I-BMW-3)	“very few other foreign manufacturers have an adequate offering” (I-BMW-3)
„Ein paar von den Etablierten werden es vielleicht nicht so schaffen oder nicht in der Form, wie wir es heute kennen“ (I-BMW-3)	“a few of the incumbents may not make it, or at least not in the way we know them today” (I-BMW-3)
„Was zunehmend schwerer wird ist, wie gesagt, die Thematik des technologischen Vorsprungs. Wir haben ja "Vorsprung durch Technik" als Marken-Claim. Den in China zu verteidigen, das ist ein gewaltiger Kampf. Und man muss vor allem lokal und schnell sein“ (I-Audi-1)	“What is becoming increasingly difficult is, as I said, the issue of technological advantage. We have ‘Vorsprung durch Technik’ as our brand claim. Defending that in China is a huge battle. And above all, you have to be local and fast” (I-Audi-1)
„Für ein E-Auto fallen sehr viele komplexe Bauteile weg“ (I-Audi-4)	“For an electric car, a lot of complex components are no longer needed” (I-Audi-4)
„indem man von Fremd-Fertigung auf Selbst-Fertigung umschaltet“ (anonymous interviewee)	“by switching from outsourcing to in-house production” (anonymous interviewee)
„Investitionen in Batterie-Hersteller oder Rohstoff-Lieferanten“ (I-Porsche-2)	“investments in battery manufacturers or raw material suppliers” (I-Porsche-2)
„einfach stärker in den Märkten, in denen die Fahrzeuge verkauft werden sollen, in den Märkten, in denen sie produziert werden, auch das ganze Lieferanten-Geschäft zu machen“ (anonymous interviewee)	“simply do more business with suppliers in the markets where the vehicles are to be sold and where they are produced” (anonymous interviewee)

„weil man dann nicht die Möglichkeit hat, dort mit Discounts und Verkaufshilfen die Fahrzeuge so in den Markt rein zu drücken“ (I-Audi-1)	“because then you don't have the possibility to push the vehicles into the market using discounts and sales promotions” (I-Audi-1)
„Man versucht jetzt neue Geldquellen zu erschließen“ (I-Audi-2)	“Attempts are now being made to tap into new sources of revenue” (I-Audi-2)
„viele chinesische Hersteller - und ich würde sogar sagen, die chinesische Automobilindustrie in Summe - sehen da jetzt die Chance, diesen offenen Wettbewerb für sich zu nutzen und diese Vormachtstellung, die die westlichen Hersteller hatten, zu brechen - und zwar nicht nur für China, sondern mittelfristig, so auch der Plan, im Rest der Welt“ (I-Audi-3)	“many Chinese manufacturers – and I would even say the Chinese automotive industry as a whole – now see an opportunity to use this open competition and break the dominance of Western manufacturers – not only in China but, in the medium term, according to the plan, also in the rest of the world” (I-Audi-3)
„Ich glaube, der größte Einschnitt kam jetzt oder kommt jetzt erst, wo wirklich die chinesischen Anbieter mit Produkten auf den Markt kommen, und zwar jetzt schon langsam global, die vielleicht erstmalig auch westliche Standards treffen oder teilweise übertreffen“ (I-BMW-3)	“I think the most significant break has come or is coming now, as Chinese manufacturers are entering the market – and gradually going global – with products that meet or, in some cases, even exceed Western standards for the first time” (I-BMW-3)

Appendix 4. Interview transcripts

To view the interview transcripts, please refer to the separate file that was submitted along with this thesis.