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Master thesis

From infant industry to global champion

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The importance of China's Innovation System for the domestic electric vehicle battery industry

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Abstract

This is a qualitative case study on the Chinese electric vehicle battery (EVB) industry. We have researched the relationship between the Chinese innovation system and the EVB industry. The research design is of exploratory and explanatory nature and tries to grasp how the Chinese innovation system is related and affects the emerging EVB industry. This was done in light of innovation theory, narrowed down to National Innovation System (NIS) and Regional Innovation System (RIS), to gather a comprehensive frame and solid foundation for understanding the details in this relation. Through semi-structured interviews followed by comprehensive coding processes, we integrated out empirics with our chosen academic literature to elaborate the relation between the Chinese innovation system and the EVB industry. We discovered that three actors stood central within both theories and findings: academia, businesses, and government. From a national perspective, it became apparent that the central government with their utilized measures in the form of plans, initiatives and policies guides the nation in a strategic desired direction. We also discovered the promotion of interregional coordination, with a focus on clustering different industries within specific regions, overall framed as the "urban planning policy". Upstream-downstream connections, firms interacting with it's environment and interactive learning process are found to be a guiding motive for the move towards clusters, and are seen to apparent for players of the EVB industry. Furthermore, Nelson's (1993) indicators for effective innovative performance are also seen to be fulfilled to a high degree.

We, therefore, conclude for the governmental measures being responsible for interactive movement and forming of the EVB industry. From a regional perspective, further evidence was made on clustering and interactions, structurally formed as a regionalized national innovation system. This was in coherence with the national perspective built between academia and businesses with the government orchestrating the innovation process. We, therefore, conclude from a regional perspective that the Chinese innovation system is related to the emerging EVB industry. This is seen through the encouragement of indigenous innovation via governmental measures, creating systems surrounding businesses, academia and government, which further helps strengthen the development of the regional EVB industry. All in all, we conclude that the analyzed Chinese innovation systems, built up and structured around governmental measures act like an enhancing infrastructure and environment for the EVB industry development.

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List of abbreviations

AI	Artificial Intelligence
BEV	Battery Electric vehicles
CE	Consumer Electronics
CPC	Communist Party of China
DIIS	Danish Institute for International Studies
EV	Electric Vehicles
EVB	Electric Vehicle Battery
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GWh	Gigawatt-hours
IFDI	Inwards Foreign Direct Investment
JV	Joint Venture
kwh	Kilowatt Hour
MIC2025	Made in China 2025
MLP	The National Medium- and Long-Term Science and Technology Development Plan (2006-2020)
NEV	New Energy vehicles
NKP	National Key R&D Programs
NIS	National Innovation System
OBOR	One Belt One Road
OFDI	Outward direct investment
PRC	People's Republic of China
RIS	Regional Innovation System
RMB	Renminbi
RNIS	Regional networked innovation systems
RNIS2	Regionalized national innovation system
R&D	Research & Development
SEZ	Special Economic Zones

SOE	State-owned enterprises
STI	The science technology innovation
S&T	Science & Technology
TERI	Territorially embedded regional innovation
USD	United States Dollar ($)
VC	Venture Capital

1. Introduction

"China is a sleeping giant.
Let her sleep, for when she wakes she will move the world."

(Napoleon Bonaparte)

One can only speculate about Napoleon's reasoning. According to historians, Napoleon argued for this due to the long tradition of literacy in China, their respect for learning and their huge size in population. But can this be true? In this thesis, we will reveal the underlying mechanisms for the economic rise of the People's Republic of China and the future growth prospects.

Observers around the globe are impressed by the rapid growth of China's economy over the past three decades. In 2006, a time when China was known to be the "world's factory" of cheap products, the Chinese central government released the "National Medium- and Long-Term Program for Scientific and Technological Development" (MLP) (2006 – 2020). The plan lays out China's ambition to become an "innovation-oriented society" by 2020 and the "global leader in science and technology" by 2049 - exactly one hundred years after the founding of the People's Republic of China (PRC). Hence, future growth of the Chinese economy heavily depends on contributions from innovation and high-tech technologies, rather than the continuous production of low-value added products.

In this paper, we look into the innovation system literature, to analyze how China's innovation system supports the country's transition towards an innovation-based economy. Therefore, we will analyse China's approach to innovation: "zizhu chuangxin", which translates to "self-determined" and "innovation". Scholars refer to China's innovation approach as "indigenous innovation" or "endogenous innovation". The promotion of indigenous innovation is at the core of the future Chinese economic reforms and has therefore great influence on the country's economic development.

The world is increasingly becoming electrified. Climate change and environmental concerns fueled the search for new technologies and more sustainable mobility concepts. Surprisingly, China emerged as the world's largest producer of Electric vehicles' (EV's) and the Chinese market accounted for roughly 55 percent of the global demand. The critical component or "the bottleneck" in the supply chain of an EV is without a doubt its battery! Therefore, we will conduct a case study in the paper revealing the relatedness between China's Innovation system and the emerging domestic industry of electric vehicle batteries (EVB). Since every EV requires a battery, it becomes apparent that the EV market and the EVB industry are inseparably connected. Therefore, we also need to understand the development and dynamics of the Chinese EV market to be able to understand the dynamics of the emerging Chinese battery industry.

1.1. Research question

The research question for this paper is formulated as followed:

How does the Chinese innovation system relate to the emerging domestic electric vehicle battery industry?

As scholars stated, innovation systems are complex. There is an abundance of literature available on both "Innovation" and "Systems". When the level of the "context" is added (the context in which "innovation systems" are applied), the theory is becoming even more complex. The basis of our research question is quite extensive as we are looking into how the Chinese innovation system is related to the innovative scene of both China in a national context, but also regionally. This will particularly have focus on the EVB industry. Therefore, we decided to draft two sub-questions of lower complexity. The answer or findings to both questions will ultimately help us to conclude on the research question.

Sub question 1:

How do governmental measures shape China's National Innovation System and relate to the domestic electric vehicle battery industry?

The first question will be covering the concept of National Innovation Systems (NIS) and how this influences the Chinese innovative scene. This will cover theoretical aspects answering how measures by the government in a national context can contribute to enhancing, encouraging and promoting the Chinese innovation system. Therefore, we look into policies, plans and initiatives and determine the effects this has on the actors that are involved in the innovation process. To get closer to the actual process of innovation, we will be looking into how those measures on a national level influence the actors to interact and cooperate.

In order to portray a representative picture, we include a brief historical review on how the Chinese NIS emerged and therefore evolved into what we see today. An analysis of this timeline with a selection of specific checkpoints are chosen and explained. We believe that this historical context contributes to our holistic understanding and therefore strengthens the foundation for answering our research question.

Sub Question 2:

How does the governmental measures contribute to shaping the Regional Innovation System, and which implication does this have for the domestic electric vehicle battery industry?

To make sure that a foundational structure is constructed correctly, the second question will dive deeper into a deeper context by decrypting the concept of Regional Innovation System (RIS). This will mainly be covering theoretical aspects on how regional interactions, networks, and clusters contributes to the regional setting. An example of the battery industry will be sat in focus to illustrate how an industry in light of the theoretical aspects has been affected, and how this is connected to the measures set by the government. This will be done in order to further create the depth required for our building blocks to give a more detailed and theoretically founded foundation to answer our research question.

1.2. Our motivation

We are fascinated by the fast economic development of China and the current transition of the economy towards innovation. We regard the Chinese economy as a large puzzle! Every action that is being taken, may have effects that were unforeseen. Our driving motive is to gain a holistic understanding on (1) how ”Innovation in China” works, (2) how the Chinese government pursues their goals, (3) to understand the causal relationships in the Chinese economy and (4) to understand the effects this has on other nations in a globalized world.

Also, we saw that the majority of innovation systems literature is western-centric, and that China-centric innovation systems literature is still relatively new and evolving. Therefore, we felt challenged to analyze the Chinese innovative dynamics in the light of this theory. The EVB industry caught our early attention, as it is connected to sustainability in a broad sense and as we believe represents a critical case as the industry emerged quickly, is seen to highly competitive and therefore showcases the power of China’s innovation system.

Furthermore, we believe that when we understand China’s innovation strategy in the EVB industry, we will be able to draw generalizations that are applicable to other similar high-tech industries. This will help us in the future to analyze, understand and place global macroeconomic developments in the context of China.

1.3. Delimitation

As our paper will be trying to tackle the relationship between the Chinese innovation system and their emerging EVB industry, several delimitations had to be considered. Firstly, within the field of innovation system, a broad display of theoretical concepts is available. However, due to the scope of our paper being limited, we have followingly decided to use theoretical concepts of NIS and RIS as we argue for these to be of the most beneficial use in our analysis. Moving into further detail, we are also aware that there are several theories within these two presented theoretical concepts. However, we chose theories we believed coherently will be able to illustrate the relationship between the Chinese innovation system and the EVB industry in a detailed manner. This is because our thesis will be approaching a macro to macro-meso perspective, excluding the micro perspective included in theory such as Sectoral Innovation System and

Technological Innovation System. Furthermore, we decided to analyze in a more macro to macro-meso approach as we believe that the paper will concludingly result with a stronger foundation covering this aspect in order to answer our research question, rather than attempting on also diving into the micro perspectives.

Furthermore, as an analysis of the **emerging** EVB industry can be interpreted to go many directions, we want to stress that we solely want to look into how the industry is built accordingly to the innovation system. We will not be focusing upon frameworks within competitiveness (like Porter's diamond framework or Porter's five forces) or go in-depth regarding further development despite our usage of the word "emerging".

Lastly, this thesis will not be covering other state supported strategic industries, except for the EV industry as it is strongly correlated and a driving force for the EVB industry. However, it is important to add that we will not be analyzing the EV industry itself, but only how it interacts with the EVB industry. Other industries are excluded as we believe that including too many industries would make our in-depth analysis to thin.

1.4. Structure of the thesis

The second chapter of this paper outlines our methodological approach and illustrates our research design chosen to answer the research question. Chapter three will then deep-dive and introduce literature on both National Innovation Systems theory, as well as Regional Innovation System theory. We decided to have this separation to have a clear structure in order to answer both sub questions from our problem statement. Chapter four is our background chapter, where we set the scene for the following analysis. In "setting the scene" we will illustrate China's economic development, give market insights into the EV and EVB industry, highlight the development of both R&D and China's higher education sector and finally explain important concepts contributing to a holistic understanding of China's economics. Following this, we will present and highlight our findings from the interviews in chapter five. Finally, in chapter six, we will be conducting our analysis. This chapter will be separated into two parts. The first part focuses on the national innovation system and the second part on the regional innovation system. The last chapter concludes on the thesis by answering both sub-question and thus the research question.

2. Methodology

This chapter seeks to lay out how we are going to answer our research question, why this particular approach is chosen, as well as possible shortcomings. To develop a coherent research process, we follow Saunders, Lewis & Thornhill's (2016) concept of the "research onion" (see figure 01). The onion illustrates the consecutive stages to consider when developing a research strategy. Viewed from the outside, each layer of the onion describes a more detailed stage:

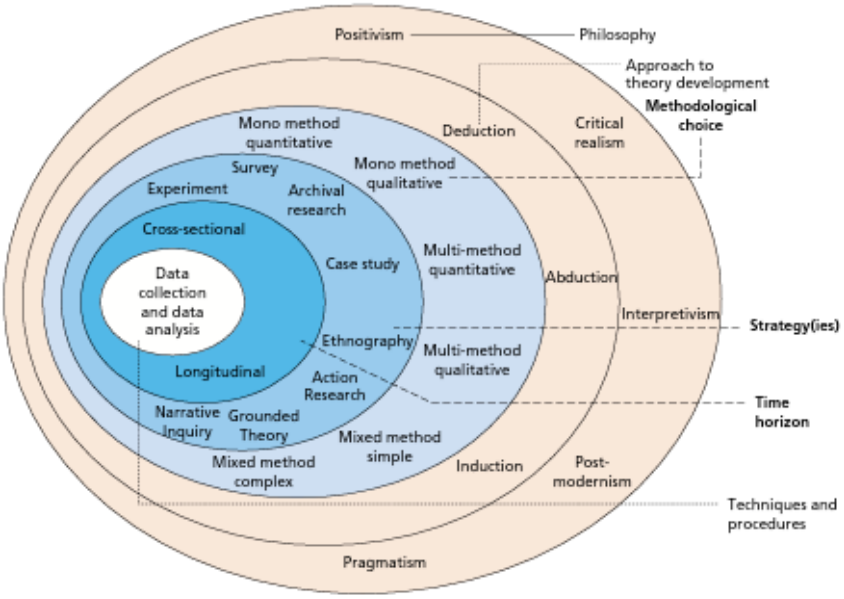

Figure 1: The Research Onion, taken from (Saunders et al., 2016)

In the process of developing a research proposal, it can be suggested to question what we need to consider. Crotty (1998) states firstly, what methodologies and methods should be employed in the research? Secondly, how will the choices and usage of these methods be justified?

First and foremost, we decided to start our research question with a "How?". In this paper, we seek to understand underlying structures and to gain knowledge on why something is the way it is, how it developed throughout time and what implications can be drawn for the future.

According to Saunders et al., (2016), research can have various purposes. It can be of exploratory, descriptive, explanatory and evaluative nature. In **exploratory studies**, researchers "aim to seek new

insights into a phenomenon, to ask questions, and to assess the phenomena in a new light". On the other hand, in **explanatory studies,** researchers' study "a situation or a problem in order to explain the relationships between variables" (Saunders et al., 2016).

The problem field of this thesis is explanatory and exploratory in the sense that it tries to explain the emerging competitiveness of the Chinese EVB industry using innovation system theories. We also want to understand the importance of the interplay between government, academia and industry and the effect it has on the countries innovation system. Since the powerful Communist Party of China (CPC) is often seen to interfere in processes by steering the action of players into favored strategic directions, the government's role will have our special attention throughout the thesis.

2.1. Epistemology & Ontology

Firstly, Crotty (1998) addresses *Ontology* as "the study of being". It argues for "What is" with the nature of existence as well as with the structure of reality. In other words, it can be perceived as a system of belief that reflects how an individual interprets what constitutes a fact. What is reality?

Epistemology defined by Crotty (1998) concerns a philosophical grounding which contributes to deciding: *"what kinds of knowledge are possible and how we can prove that they are sufficient and legitimate"*. This further opens up for the perspective of the theory of knowledge being embedded in the theoretical perspective and thereby in the methodology. is why it is necessary to identify, explain and justify the epistemological stance that has been adopted.

Crotty (1998) mainly touches three perspectives in epistemology:

(1) Objectivism: **"**Argues for meaning and therefore meaning reality exists as such apart from the operation of any consciousness." Put in context with the research conducted, it is important to keep in mind to try to avoid ethnographic [1]approaches as information available should be approached objectively. We, therefore, had to identify what we already knew and enlighten it with the findings and the gathered data in an attempt to approach the research in an objective matter.

[1] relating to the scientific description of peoples and cultures with their customs, habits, and mutual differences.

(2) Constructionism: Constructionism on the other hand "rejects this view of human knowledge" (Crotty, 1998). Unlike objectivism, it claims that there is no objective truth waiting for us to discover it. The truth materializes through our engagement with realities in our world. From this perspective, it is important to take into account that different people could construct meaning in different ways depending on experience and how the situations are perceived. This is arguably highly relevant in situations involving a third party e.g. interviews, where the discussion with authors would decrease the likelihood of misunderstandings as mentioned earlier, hence, increase the reliability.

(3) Subjectivism: Last one touched by Crotty (1998) is subjectivism which is described as something that: "Does not come out of an interplay between subject and object but is imposed on the object by the subject." The object does in other words not have any distinct meaning but relies more on the subject it is in context with. The importance of this perspective lies within the awareness one would have in context between the subject and object. We argue for that it points out to see things from a holistic view as information might lie as a factor that is not directly related to the matter.

All in all, there is a quite big range of epistemologies, and these are arguably the ones that had key points we decided to show attention to. Into our methodological section, ontology is presented hand in hand with epistemology as they together contribute for the set up for a holistic view and understanding on how we should structure the theoretical foundation of this paper based on our relation to related knowledge. Arguably, the awareness of these perspectives allows for the paper to reach a higher degree of quality, objectiveness and generalizability as it can contribute for more perspectives as well as creativity.

2.2. Research philosophy

Research philosophies refer to "systems of beliefs and assumptions about the development of knowledge" (Saunders et al., 2016). Therefore, our research philosophy contains important assumptions about how we view the world. The resulting attitude has a major impact on this paper. We need to distinguish between five major research philosophies in business and management: positivism, critical realism, interpretivism, postmodernism and pragmatism (Saunders et al., 2016).

Based on the key elements, as well as further elaboration of Saunders et al (2016), the research philosophy suiting best to our research question, our approach, as well as the phenomena under investigation is **critical realism**.
Other philosophies also might contain elements that suit our approach, e.g "Positivism" that typically follows a deductive reasoning approach. However, the fundamental aim of the other four research philosophies do not match our research question and how we plan on answering it.
Due to the scope of this paper, we only elaborate on why we believe to be critical realists and do not further elaborate on why we are not positivists, interpretivists, postmodernist or pragmatists. A list of the characterics of all 5 major Research philosophies can be found in Appendix I.

On critical realism, Bhaskar (1989) argues that we will only be able to "understand what is going on in the world if we understand the social structures itself that gave rise to the phenomena that we are observing and trying to understand". Critical realist research therefore focuses on "providing an explanation for observable organizational events by looking for the underlying causes and mechanisms through which deep social structures shape everyday organizational life" (Saunders et al., 2016). Due to this focus, the research of critical realist often takes the form of in-depth historical analysis of social structures, with a special interest on the emergence in the historical context (Reed 2005).
This sums up very well our beliefs on how to structure the process in answering the research question.

2.3. Reasoning - Approach

According to Saunders et al. (2016), we need to distinguish between three major approaches to theory development. Figure (02) displays the relationship between the deductive and inductive approach.
Deduction is concerned with testing existing theories and hypothesis by observations. Deductive reasoning is used when a conclusion is logically derived by a set of premises. If the premises hold, it follows that the conclusion is also true (Ketokivi and Mantere, 2010). On the contrary, *Induction* begins by making observations and identifying patterns, which will serve as basis for making hypotheses and finally building or advancing existing theory.

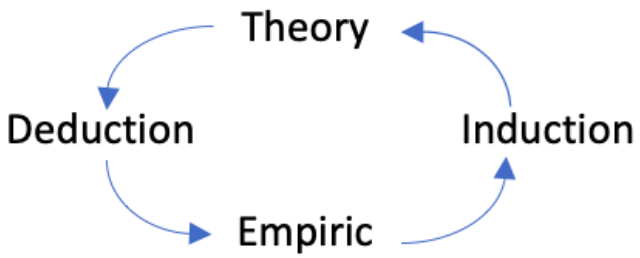

Figure 2: Relation between Theory and Empiric, own illustration

The *abductive* approach moves back and forth between deduction and induction, hence being a combination of both approaches (Suddaby, 2006).

Table (01) displays the major differences between the two different approaches (Saunders et al., 2016):

Deductive reasoning	Inductive reasoning
- Theory presents the basis of explanation - Origins: Research in natural science - Cause-effect link - Highly structured approach - Operationalization of concept - Reduces problems to the simplest element - Generalization of findings - Independence of researcher on what is researched	- From observations to theory building - Origins: Emerged through social science - Flexible structure allowing for changes as the research progresses - Generalization of findings is of less interest - Researcher is part of the research process

The research approach we use is **deductive** reasoning. In chapter three, we are reviewing the innovation system literature. Based on reviewed theories we will derive premises, that in case they hold, lead to a

certain conclusion. As we gather data related to our research question and theory, we will test if the theory is a plausible explanation for the phenomena under investigation.
The choice of using deductive reasoning naturally derives from our theory testing perspective: if the development of China's Innovation System is the explanation for the country's emerging EVB industry.

2.4. Research Design

The research design is concerned with the general plan of how to go about answering the research question. It is the "overall plan" for the research project (Saunders et al., 2016). Yin (2014) describes the research design as a plan to get "from here to there" - "here" being an initial set of questions to be answered, "there" being some sort of conclusions or answers to those questions. Between here and there, the research must conduct a coherent set of major steps, including the collection of data and analysis. Nachmias & Nachmias (1992) define research design as a plan that "guides the investigator in the process of collecting, analyzing, and interpreting observations. It is a logical model of proof that allows the researcher to draw inferences concerning casual relations among the variables under investigation."
Therefore, when designing the research process, it is crucial to pay attention to the coherence of the whole approach. In following sub-chapters, we will elaborate on the research strategy and the data collection methods.

2.4.1. Research strategy

Denzin and Lincoln (2011) describe research strategy as the "methodological link between your philosophy and subsequent choice of methods to collect and analyze data".
Yin (2014) states and justifies the need of case study research due to the researchers "desire to understand complex social phenomena." This method enables researchers to focus on a "case" while maintaining a "holistic" and "real world perspective". Case studies are especially useful when the overall research question starts with a "how" or "why", since these question "deals with operational links needing to be traced over time, rather than mere frequencies or incidents" (Yin, 2014). Therefore, it is most important for case studies to explain the "presumed causal links in real-world interventions that are too complex for surveys or experimental methods" (Yin, 2014). According to Yin (2014) "some qualitative research

strategies start with a deductive approach, to test an existing theory using qualitative procedures". Also, Dubois and Gadde (2002) argue that, "the interaction between a phenomenon and its context is best understood through in-depth case studies". An in-depth inquiry can be designed to identify what is happening and why, and perhaps to understand the effects of the situation and implications for action. To fully understand the dynamics of the case, case study designs often use quantitative or qualitative research and frequently uses a mixed methods approach.

Yin (2014) comes up with a two-folded definition of Case study research.

The first part of the definition is aimed towards the scope of the case. The case "investigates a contemporary phenomenon in depth and within its real-world context, especially when the boundaries between phenomena and context may not be clearly evident." Hence, case study research is done because the researcher desires to understand a real-world phenomenon assuming "that such an understanding is likely to involve important contextual conditions pertinent to the case" (Yin & David, 2007).

The second part of the definition deals with the features of case studies. Cases cope with distinctive situations where many more variables than data points are available, and as a result relies on "multiple sources of evidence, with data needing to converge in a triangulating fashion" (Yin, 2014). Furthermore, cases benefit from the prior development of theoretical propositions that guides the researcher's data collection and subsequent analysis.

Yin (2014) recognizes that case studies may be used for exploratory, descriptive and explanatory purposes. An explanatory case study is likely to use a deductive approach, using theoretical propositions to test their applicability in the case study, to build and verify an explanation.

Furthermore Yin's *(2014)* distinguishes between four case study strategies based on two common dimensions:

Single vs. multiple case study designs

A single case is often used where it represents **a critical** case or, alternatively, an extreme or unique case. A single case may be selected because it is typical or because it provides an opportunity to observe and analyze a phenomenon that few have considered before.

A case study strategy can also incorporate multiple cases. In this scenario, the research focuses on whether findings can be replicated across different areas.

We chose to do a single case study. The rationale for doing a single case study is that we regard the phenomenon under investigation as critical to the theory we have developed in the literature review. The single case can then be used whether the developed theory or propositions are correct or whether some alternative set of explanation might be more relevant. Therefore, the single case can "represent a significant contribution to knowledge and theory building by confirming, challenging or extending the theory.

Holistic vs. embedded

This second dimension refers to the unit of analysis. It is possible to analyze the phenomenon under investigation as a whole (holistic) or as a unit and its sub units (embedded). An example of an embedded case study would therefore be a public program that involves large numbers of funded projects - which would then be embedded units.

Hence, as we seek to gain an in-depth understanding of how the Chinese innovation system relates the EVB industry, our case study strategy is not only single but also embedded. Using case studies to develop insights, a qualitative research design may use a single data collection technique, such as semi-structured interviews, and corresponding qualitative analytical procedure. This is known as a **mono method qualitative case study** (Saunders et al., 2016). A qualitative research design may also use more than one qualitative data collection technique and corresponding analytical procedure. This is accordingly known as a **multi-method qualitative case study** (Saunders et al, 2016).

In this paper we conduct a multi-method qualitative case study as we use primary data obtained through semi-structured interviews and worked with other primary data taken from Chinese Statistical Yearbook, as well as secondary sources in the form of studies, reports, industry analysis and articles from the trade press. Therefore, this paper's research design is a multi-method qualitative case study (single and embedded).

2.4.2. Data collection: primary data

In this multi-method approach we have mainly collected primary data. First and to the major part we collected data via semi-structured interviews and second via the Chinese Statistical Yearbook which displays uninterpreted Chinese economic data. As the Chinese Statistical Yearbook displays economic data in a time series, we used those quantitative data to support and validate qualitative findings from the interviews.

Interviewees were either native Danish, English or German speakers. In order to compare findings and being consistent, all interviews were conducted in English. Interview partners were chosen based on their experience related to innovation in the context of Chinese high-tech industries, especially the EVB industry. Since the theoretical background of this paper draws on the importance of interaction between the government, academia and industry, we payed attention that interviewees have a background in at least one of those areas. A list of all interviewees can be found in Appendix II. Therefore, we believe to have a representative sample of primary data, as the sum of all interviewees cover the three major dimensions of government, academia and industry. Having a well-balanced set of interviewees is important due to two reasons. First, getting a holistic understanding and second, to not be biased as representatives of each dimension pay attention to different details.

We conducted phone-based, individual and semi-structured (also referred to as 'focused') interviews. Semi-structured interviews can lead to more flexibility and the possibility to make adaptations; they can also create a freer and more open atmosphere for the interviewer as well as the respondent (Yin, 2014). "Semi-structured" means that the questions are fairly open, but with guidance throughout the interview. This allows the subject to freely share knowledge even on topics the interviewer had not considered. This interview design supports creating a broad, detailed and holistic perspective of the industry and supports according to Saunders et al. (2016) our explanatory and exploratory purpose of the paper.

	Exploratory	Descriptive	Explanatory	Evaluative
Structured		++	+	+
Semi-Structured	+		++	++
Unstructured	++			+

Table 02: Interview Style and Nature of Research (own table, taken from Saunders et al., 2016)

In the process of conducting the interviews, we remembered the five P's "prior planning prevents poor performance" (Saunders et al., 2016). Therefore, we considered three different steps:

(1) Our knowledge: we did not start conducting interviews before we had an in-depth understanding about the complexity of the topic. This knowledge helped us to steer the interviews in the direction we needed it to go, as we demonstrated our competence and credibility and thus obtained confidence of the interviewee. (2) Developing an interview guide: We sent a comprehensive interview guide to all interviewees at least one week prior to the interview. The interview guide grouped interview themes we would like to gain an in-depth understanding of. Therefore, the interviewees had enough time to gather their thoughts to be well prepared for the interview. See Appendix III for the interview guide.
(3) The right location: Since our interview partners are located in Denmark, Germany, and England we conducted the interviews via telephone calls. We paid attention to be in a quiet setting to ensure good quality of recording and professionalism.

The second primary source we used is the Chinese Statistical Yearbook (2018), hereafter referred to as "the yearbook"). The yearbook is annually released by the National Bureau of Statistics on China (NBS, 2018). The Yearbook reflects on the Chinese economic and social development. It covers data especially for 2018 but also displays key statistical data in recent years and some historically important years at the national level and the local levels of province, autonomous region and municipality directly under the central government.

Yin (2014) argues that the individual approach to sources of evidence is not recommended when doing case study research, as the opportunity of using multiple sources of evidence is a major strength of case studies. Using multiple source helps in the development of *converging lines of inquiry* (Yin, 2014).

2.5. The Research Case

Choosing a case format as well as determining the boundaries of the study is a key factor in defining a case study (Flyvbjerg, 2011). According to Yin (2014), it is crucial to define a "unit of analysis". This can either be an individual, a group, an organization, a countries economy, an industry in the world, a marketplace, an economic policy, the trade or capital flow between countries, etc. If we have issues favoring a unit of analysis over another, our research question might be too vague. In our case, we limit ourselves to the Chinese system of innovation, also referred to as "indigenous innovation". As China's innovation system is a large apparatus, and the MIC2025 defines many industries that the country seeks to reach technological leadership in. We furthermore tried to narrow down the unit of analysis from the country's innovation system, to the relationship between the country's innovation system with the EVB industry.

Thus, in order to fully grasp the context of the subject matter, a description of the Chinese innovation process of EVB will present the case study at hand.

A battery for an electric vehicle is considered to be a high-tech product. The EVB needs to fulfill an array of complex features: the amount of loading cycles should match the life expectancy of the vehicle, it should work in hot and cold climates, the reach of one load should be sufficiently high, the charging time and the weight of the battery needs to be reduced to a minimum.

According to Merics (2018), Chinese companies have a global market share of 53% in this strongly to the booming EV market correlated industry. China's biggest ten battery manufacturers together hold a domestic market share of about 87% (Merics, 2018). As China's battery industry is bringing up "leading companies of international competitiveness" – the industry is in line with the MIC2025 goals.

China is a global leader in "mid-tech" industries like washing machines, manufacturing of cell phones, optical instruments, etc. (BCG, 2018), while at the same time making great strides in high-tech industries. BCG (2018) states that in a number of industries, China is beginning to transition to a similar stage like South Korea, Japan, and the US where "innovation increasingly defines competitive advantage". The government's industrial development plans and initiatives, like MLP (2006 - 2020) and MIC2025, aim towards dramatically increasing the countries strength in such high-tech sectors and ultimately becoming a "tech superpower" by 2049.

Therefore, we want to investigate the relationship of the Chinese EVB industry in the light of innovation theory. What is the structure of the country's innovation system? Who are the actors involved in the process? How do these interact with each other? How did the system change to move from low-tech over mid-tech to high-tech? How does innovation in this industry occur?

2.6. Interpretation and Analysis

We chose to use coding as a way of analyzing a variety of qualitative content to create an overview and deeper understanding of the qualitative data in our interviews. Content analysis is described by Schwandt (2007) as "a generic name for a variety of means of textual analysis that involves comparing, contrasting, and categorizing a corpus of data in order to test hypotheses." This definition of content analysis is in line with coding and present content analysis as a valid, systematic, and replicable means of analyzing qualitative text (Breuning, 2011). The core idea is that the qualitative data can be classified into broader and fewer subject categories.

In our interviews, we have coded the data and given the categories labels or phrasal descriptions. Codes are tags or labels to assign "units of meaning to the descriptive or inferential information compiled during a study", therefore it is of symbolic meaning (Miles & Huberman, 1994). Codes are usually attached to varying sizes of "chunks" like "words, phrases, sentences or whole paragraphs connected or unconnected to a specific setting" (Miles & Hubermann, 1994). It is not the words that matter, but their meaning. Codes therefore help the researcher to organize the "chunks" in a systematic manner and to quickly find, pull out, and cluster relating data. Clustering and the display of condensed chunks sets the stage for

further analysis and conclusions (Miles & Hubermann, 1994). Thus, codes are heuristic and a method for discovery where the researcher codes chunks of data by reading and reflecting on the data and from there decides on its core content or meaning (Miles & Hubermann, 1994).

We read all our interview transcriptions while highlighting the parts in accordance with our coding system via the software NVivo. We made different layers of codes as the qualitative responses flesh out themes and subthemes associated with our subject in matter. We mainly used deductive coding and provisional coding, where we used elements from the literature and theory to make our codes. A descriptive code assigns labels to data in order to summarize the topic of a passage of qualitative data, and it is argued that these codes are highly appropriate for social environments (Miles et al., 2014, p. 74).

The 1st-order analysis is a way to initially summarize segments of data (Miles et al., 2014). At this stage, the researcher shall not be concerned with the number of categories as this is an initial stage. As the research progresses, similarities and differences will surface among the categories, which will reduce the number of categories to a more manageable number. The categories are given labels, phrasal descriptors (Gioia, Corley, & Hamilton 2013) or nouns (Miles et al., 2014), so the researcher can consider the array and contemplate if there is some deeper structure.

Gioia et al., (2013) argue that apart from the basic assumption that the organizational world is socially constructed, we as researchers employ yet another assumption: "That the members constructing their reality around the organization are knowledgeable agents". In other words, the members of the organizations know what they are trying to do and are able to explain their intentions, thoughts, and actions (Gioia et al., 2013). This is a profound assumption in the conduct of research because for one thing "it foregrounds the informants' interpretations and initially casts us as researchers in the role of 'glorified reporters' whose main role is to give an adequate account of the informants' experience" (Gioia et al., 2013).

2.7. Generalization

"How can you generalize from a single case" is a frequently asked question. According to Kennedy (1976) the answer is not simple. Yin (2014) argues that generalization in science are rarely based on a single experiment or case study, he argues that generalizations are usually based on multiple experiments or case studies that used different conditions to replicate the same phenomenon.
Yin (2014) continues that case studies are "generalizable to theoretical propositions and not to populations or universes."

2.8. Reliability

To start off, we decided to approach this paper as mentioned earlier in a case study research approach. This is because the theory argued for that this would allow us to fulfill our "desires to understand complex social phenomena" as well as to maintain a real-world perspective. This was would then further allow us to get the most fulfilling explanation on how the interaction between a phenomenon and its context is based off of.
As the chosen case was specified within the EVB industry, we argue initially from this concept alone that the reliability can be considered high as data from both primary and secondary sources showed cases of redundancy in their perceptions and findings. The results were also somewhat aligned to our in-depth understanding of the topic. We thereby argue for that since several scholars, researchers and relevant actors tried to get a perception of the Chinese phenomenon to a similar degree of our research and derived to somewhat the same findings, the argument for reliability remaining as relatively high holds. However, it is important to keep in mind that the reliability of our thesis is narrowed down, as we used a single case approach, meaning that it might not result to the same findings if performed on other industries.

Saunders et al., (2016) further makes a distinction between internal reliability and external reliability:
Internal reliability addresses the ensurement of consistency during a research project. This can be done through using more than one researcher within a research project to conduct interviews or observations, as well as to analyze data to evaluate the degree of agreement in regard to the data and analysis (Saunders et al., 2016). As mentioned previously, our interview questions and selection of individuals was based

off of qualities we believed would contribute to answering our research question. This was done in an approach we believe helped us achieve a deeper understanding of the Chinese innovation system and its relation to the EVB industry, covering aspects like social, business and technological environment. In the perspective of internal reliability, a consistency in regard to consensus among several of the questions among the interviewees was reached. Furthermore, the interview process was conducted by both authors to reduce likelihood of misunderstandings or misinterpretations to occur.

External reliability on the other hand addresses whether your data collection techniques and analytic procedures would give consistent findings, regardless of replicated tries or research conductor.
The strength of the external reliability is arguably able to hold its ground as the qualitative analyses conducted were of semi-structured format. We argue for that semi-structured formats provides us the freedom to explore within a given frame allowing for the data to be consistent but also exploratory. In other words, the aspect of the questions provides a sense of higher flexibility, but the degree of the scope remained narrow and specific. This is all in an attempt to minimize errors and biases in the study (Ying, 2014). Additionally, we added multiple backgrounds in form of academic, industrial and government experts, who arguably are a part of the Chinese innovation system. This was done in order to reduce possible subjective opinions and sights that could be characterized within certain fields. Another intention behind this was to single out coherence among three perspectives in order to strengthen the reliability of the selected results. Furthermore, the nature of the procedures used with this qualitative analysis structure does not complicate nor include any specific interviewer qualifications. In other words, other researchers should therefore be able replicate or acquire the same findings

Lastly, we tried to mitigate several errors or biases to occur in order to increase the reliability (see Appendix IV). (1) Participant error as explained by Saunders (2016) was attempted to be avoided by assuring that the interview would occur in the most suitable time phrase for the interviewee, in aim of eliminating performance altering risks. (2) Participant bias is believed to not be of risk as the interviewees was interviewed in their respective working places and was all regarding topics within their respective specialties. (3) Researcher errors was mitigated through only conducting one interviewee per day of only 30 - 45 minutes, with preparation of interview guide a week beforehand in order to assure for clearness

and understanding. (4) Lastly, researcher bias was attempted to be eliminated by structuring questions in a way that was not predisposed to the interviewees.

2.9. Validity

Validity refers to the suitability of the measures applied, accuracy of the analysis of the results and to what extent the findings can be generalized. Saunders et al, (2016) further explains this in a breakup of three aspects:

"(1) Are the measures used in the research to assess the phenomenon being studied actually measuring what they are intended to do - are they suitable for their intended purpose?"
As the research conducted revolves around our research question, the utilized measures within the process was structured towards this matter. Our semi-structured interviews for instance was tailored as: (1) Direct, but with relatively open questions related as highly relevant for supplying substance for arguments in order to answer our research question. This was not tailored towards the background of our interviewees alone. The interviews served as a fundamental force for the conducted research gathered in the secondary data which together arguably builds a solid theoretical foundation. (2) We limited the interview time towards 30 - 45 minutes to increase the likelihood of the interviewee providing and maintaining highly detailed, specified and accurate answers from their respective perspective.
All in all, we would therefore argue that the employed measures in our research was able to provide us with what we intended to use it for.

"(2) Are the analysis of the results and the relationship being advanced accurate?" This is normally established when the conducted research is able to accurately showcase a causal relation between two variables".
As mentioned previously, the fundament of our research is built upon information formed by gathered primary data as well as secondary data. In light of this, the conducted research has been able to clearly show relations between certain variables. This was observed through arguments and insights provided through the primary data and then further strengthened by the gathered secondary data. To ensure the quality of the interviews and increase the perspective but also reduce the ambiguity involved, we involved

individuals from different fields: academic, industry and governmental. With this taken into consideration and the coherence and relations between their answers, seen with the gathered secondary data, we believe that the research manifests a strong level of accuracy.

"(3) What does the research findings represent? Does the claim about how generalizable they are stand up?"

The findings are fundamentally structured by the interviews which stands as the foundation of the illustrated insights. Furthermore, the secondary data provides further insights in already perceived status-quo of the innovative scene in China and the Chinese EVB industry. The conducted research therefore stands as a representation on how the results may supplement the already existing knowledge foundation built, in order to assess the research question. The understanding of the findings throughout the paper is represented as generalizable to a certain degree, as our findings were highly narrowed towards the EVB industry. It would therefore be limited to which industries would actually provide the same findings, given that they could have different circumstances.

All in all, we argue for that the validity of the paper can be understood as high as the measures applied were able to provide us with accurate findings and with a reasonable level of generalizability. Findings in coherence among not only the interviews but also together with the gathered data was also discovered.

3. Theoretical concept

3.1. Introduction Theory Innovation Systems

The context of how China has emerged into what they are today cannot be singled out to one factor alone as the joint effect of the different policies and actions taken by Chinese actors has affected several parts of the nation. In this paper, we will therefore put the majority of the theoretical weight on theory of the "innovation system". This will be done by showcasing the development processes in light of the theory as the approach of the innovation system is not characterized of "isolation" principles, but in unique context of social, political, economic, organizational and institutional. All in all, the theory will be able to showcase how the interactions has influenced China's development with a special interest to the process of innovation.

To begin with, "Innovation systems" is a combination of the words: "Innovation" and "System". Both terms are complex in itself, requiring further elaboration, as well as the context in which "Innovation systems" are useful to be applied. We are interested in a definition of innovation systems that includes the actors and elements that interact in shaping the innovation process. We also want to elaborate on how the innovation process link to a country's development and economic performance.

Therefore, we clarify in the beginning the concept of innovation, the context of innovation systems, as well as the "system" aspect, before we deep-dive into the literature review on National Innovations Systems (NIS), as well as Regional Innovation Systems (RIS).

3.1.1. The "Concept"

"Innovation" is a significant source of growth for many developed and developing countries (Metha, 2018). Therefore, the concept of innovation has experienced major attention by different scholars all around the world.

The concept of "innovation" goes back to Joseph Schumpeter (1939) who founded the term "creative destruction". He defined Innovation as the commercial or industrial application of something new - may it be a product, a process, organizational structure or a new source of supply. Other definitions of innovation include Fagerberg (2005): "attempt to carry an idea into practice" or the introduction of new

knowledge or new combinations of existing knowledge (Edquist 1997, Edquist & Johnsen 1997, Nelson 1993). According to Schumpeter, innovation includes the formation of new firms or the transformation of existing firms, financial systems or markets.

It is important to differentiate between "invention" and "innovation". An invention is the "first occurrence of an idea for a new product or process". The concept of innovation applies when this idea is put into commercial use. According to Rogers (1995) considerable time lag between invention and innovation can occur - a lag of several decades or more is not uncommon.

3.1.2. The "Context"

Literature on the context of innovation systems has evolved in four major dimensions: national, regional, super-national, sectoral and technological.

The further increase in globalization and internationalization open nation's borders for the flow of capital, goods and knowledge, giving surge and justifying a global analysis of innovation systems. However, to understand a nation's level of competitiveness, convergence and catching up, it is crucial to analyze the context of the NIS. The analysis of the NIS indicates the results of policy initiative undertaken on a national level. This also supports the re-steering of national policies to take into account changes in the dynamic environment. A huge literature body on the innovation system at the national body exist. Major contributors are Freeman (1987), Lundvall (1992) and Nelson (1993).

Furthermore, the literature used for NIS has inspired the argumentation for RIS. An analysis on the RIS contributes to pinpointing the regional dimensions of production and degree of exploitation of new knowledge. Followingly, the analysis helps explain regional differences in innovation capacity and economic strength.

3.1.3. The "System"

The "system" of innovation is the framework that rolls out the rules and forms processes of interactive learning that lead to knowledge generation and thus finally innovations. "Innovation systems" stresses the aspect of 'systemic' interactions between the various components of inventions, research, technical change, learning and innovation (Soete, Verspagen and ter Weel, 2010).

According to Edquist (1997), it requires iterative feedback loops and interactive relations among the actors, for the generation and diffusion of new knowledge to occur. As innovations are of economic significance for a nation, so is then the study of the "system". Lundvall (2007) is also contributing to the definition of the "system" aspect while highlighting the dynamics. According to him the innovation process is an interplay between "micro and macro phenomena where macro-structures condition micro-dynamics and vice versa new macro-structures are shaped by micro-processes". Therefore, in a dynamic context we need to understand "systems" as being complex and characterized by co-evolution and self-organization.

According to Etzkowitz (2003) and Metha (2018), the NIS consists of three main actors with inter-linkages among them: Government, academia and the industry. The roles of the players differ: The industry is concerned with product and process innovation for competitiveness, whereas academia's focus is on basic research and knowledge dissemination. The government is enforcing policies "aiming to make the national systems of innovation progressive, dynamic and sustainable" (Metha, 2018).

According to Soete et al. (2010) the NSI defines as central role for the state to be the "coordinating agent" in the innovation process. For policy makers the need for complementary policies, drawing attention to weaknesses in the system, while highlighting the national setting of most of those institutions.

The persuasion of this development is often characterized by the interactive relations and mechanisms of factors like science, technology, learning, production, policy and demand that are collectively shaped by institutions like laws, regulations, social, cultural norms and technical standards (Metha, 2018). Through these interactions in the economy, different pieces of knowledge become new ways or new knowledge that can result to new processes or products. This does not only take place in the R&D segment, but also in activities like procurement, production and marketing (ibid).

This whole process of continuous development can be illustrated as a system of innovation, where the theory includes how different sectors within the innovation system can be influenced and shaped depending on external factors, mainly consisting of the structure of institutions, organizations and social factors (Edquist & Johnson, 1997). The natural complexity on how to address the influence of the different factors must therefore be taken into consideration before putting into action.

3.2. Our innovation system focus

Within the innovation system, we distinguish between two contexts of the innovation system: The "National system of Innovation" and the "Regional System of innovation". As the goals, dynamics and structures differ in both systems, we will first seek to lay a theoretical foundation. The goal is to unfold the differences between both systems but also how they relate and support one another. This review on existing theory on the NIS and the RIS will give us a framework to systematically analyze the relationship of the innovation system with the Chinese EVB industry.

As this paper seeks to explore and explain the relationship between the Chinese innovation system and the emergence of the domestic EVB industry, we need to pay special attention to the role of the industry.

3.3. Literature Review - National Innovation System

3.3.1. Why focus on national level?

According to Lundvall (2007), national economic policies and standard economics - focused on national level - are an essential part in the analysis in a country's' innovation system. Also, since globalization is becoming a major theme in the academic discourse, it is important to understand how the historical role of national system is transformed. According to Soete (2010), the NSI brings to the forefront the central role of the state as a coordinating agent in the systematic process of innovation. It's particular attractiveness to policy makers lays in the explicit recognition of the need for complementary policies, drawing attention to weaknesses in the system, while highlighting the national setting of most of those institutions.

However, Lundvall (2007) also points out limits of the national level of analysis as it may not be the most adequate for "understanding the process of innovation". Therefore, the stand-alone analysis of the "national" context of innovation systems has relevance, but only shows a complete picture when analysis on the actual innovation process is added. Therefore, we will provide a theoretical understanding of the RIS in Chapter 3.5.

3.3.2. Development of the concept

Freeman (1995) argues that the first person to use the expression "National system of innovation" was Lundvall (1992) in his same called book "National Systems of Innovation: Towards a Theory of Innovation and Interactive learning". However, the idea goes back to 1841 to Friedrich List's book with the title "The National System of Political Economy".

The problem that List looked at was how Germany could economically overtake a, by then higher industrialized England. List would be a promoter of the protection of home market infant industries, but also a broad range of national policies designed to support industrialization and accelerate economic growth. The main focus of his policy recommendations was on learning and the application of new technologies. List also pointed out the importance of the industry - academia (formal institutions of science and education) link for innovation: "There scarcely exists a manufacturing business which has no relation to physics, mechanics, chemistry, mathematics, (...). In the manufacturing state, therefore sciences and arts must necessarily become popular."

List also recognized the importance of the interdependence of foreign technology import and domestic technical development. He recommended that nations should acquire the achievements of higher developed nations and to improve them by their own efforts.

Therefore Freeman (1995) acknowledges that List analyzed many aspects of the NIS that are subject to contemporary studies ("education and training institutions, science, technical institutes, user-producer interactive learning, knowledge accumulation, adapting imported technology, promotion of strategic industries, etc."), and recognized the importance of the state on the role of "coordinating and carrying through long-term policies for industry and economy".

The concept of National Systems of Innovation gained increasing interest in the late 1980s again and were mainly developed by three authors: Freeman (1987), Lundvall (1992) and Nelson (1993). Compared to the more neoclassical market failure approach (Soete et al., 2010), the NIS provided a new approach to innovation and its governance and stimulation.

The NIS adopts a holistic view on innovation rather than the sole focus on isolated elements of the innovation process. The NSI concept emphasizes the aspect of interaction and linkages between the key actors involved in innovation and analyzes how these interactions are shaped by social, institutional and political factors (Fagerberg and Verspagen, 2009). The approach was remarkably successful in a short period of time and is now being used in academia and policy contexts (Teixeira, 2013).

Contribution of Chris Freeman

Freeman (1987) employed the NIS concept to describe and explain Japan's innovation performance[2]. He defines the NIS as "the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies". In his research, Freeman specifically highlights the interaction between technology, social embeddedness, economic growth and system-enforcing feedback loops (Soete et al., 2010). His research focuses on four elements of the Japanese NSI:

(1) the role of national policies - Freeman states that Japanese policymakers had a significant influence in the rapid catch-up of the country by choosing particular strategic industries and supporting them in achieving comparative advantages. Finally, this would support the countries strong growth performance.

(2) the role of corporate research and development (R&D) in accumulating knowledge and developing advantages from it - The emphasis here is on how R&D was used to assimilate knowledge[3] and then used to create a set of own technological advantages. This is very similar to List's finding to source knowledge from higher industrialized nations and to improve it.

(3) The role of the workforce - Freeman stresses the role of human capital but also the way how work in firms is organized. The implementation of new technologies requires the right knowledge, skills and capabilities of people. Thus, the education system has a crucial contribution.

[2] Why Japan? Japan experienced a record period of economic growth between the post-World War II and the end of the Cold War. This period is also referred to as "Japanese economic miracle". Therefore, Japan represents an extraordinary case and a great opportunity for Freeman to analyse Japan's NIS.

[3] knowledge or technologies that are sources from abroad.

Finally, the role of industrial conglomerates in being able to profit from innovations emerging from developments along the entire industrial value chain.

Contribution of Bengt-Åke Lundvall

Similar to Freeman, Lundvall (1992) emphasizes the role of interaction for the production and the dissemination of new and valuable knowledge, shifting towards a broader view of the national institutional environment: "all parts and aspects of the economic structure and the institutional set-up affecting learning as well as searching and exploring." The institutional framework is crucial for the speed, the extent and success of commercialization's, as well as the diffusion in the economy. Emphasizing the role of the state, Lundvall outlines three major building blocks of an NSI:

1. The first building block deals with the sources of innovation and the actions of agents which lead to innovation. Lundvall (1992) differentiates between "learning" and "search & exploration". Learning is associated with routine activities like, production, logistics, supply chains that provide insights, finally triggering new knowledge and innovation (also known as learning by doing). The second form of innovation comes from Corporate R&D ("search") and academic R&D ("exploration").
2. The second building block distinguishes between the nature of innovation, namely radical[4] and incremental[5] innovation.
3. Finally, non-market institutions form the third building block. For these, Lundvall distinguishes between user-producer interaction (as an important form of knowledge exchange) and institutions. User-feedback integrates wishes or changing markets into the firm and leads to firms adapting their products. Institutions are understood as 'regularities of behavior' reducing uncertainty and volatility and thus, providing stability to the actors in the system.

[4] Radical innovations ("major breakthrough") arise from the creation of new knowledge and the commercialization of completely novel ideas or products.

[5] The series of small improvements to an existing product that helps maintaining or improving its competitive position over time.

Contribution of Richard Nelson

The third main author in the field of National Innovation Systems is Richard Nelson (1993) with his book: "National Innovation System: A comparative analysis". The book contains studies of 15 countries that are subdivided into three groups: large market oriented industrialized countries[6], smaller high-income countries[7] as well as newly industrializing states[8]. Nelson's objective was to describe, to compare and understand differences and similarities across countries innovation systems. He saw the need for a comparative analysis as previous scholars had only focused on "one country", leaving comparisons with other countries "mostly implicit". Nelson defines the innovation system as "a set of institutions whose interactions determine the innovative performance of national firms" and adds that the most important institutions are those supporting R&D efforts. Nelson focuses on the set-up of actors and how and why they collaborate. He is mostly interested in the institutions working in the science and technology sector or supporting it, especially universities conducting R&D.

He finds the "basic similarity" between the countries striking and notes that this would not have been the case if the Soviet Union or China were part of the sample (because central planning and control in those two cases are strong, whereas it was considered to be weak in the sample). Important findings differences between the three sample groups include:

- Industrialized countries have a larger fraction of their economies in R&D intensive industries
- Availability of natural resources or farming land shaped the innovation system: Countries that lack them must import resources and farm products which drives their economies to export-led manufacturing and an innovation system that supports this
- National security concerns had been important in shaping the innovation system

[6] US, Japan, Germany, Britain, France, Italy

[7] Denmark, Sweden, Canada, Australia

[8] Korea, Taiwan, Brazil, Argentina, Israel

Furthermore, Nelson (1993) finds factors for effective innovative performance:

- The bulk of the inputs and direction for innovative activity were coming from the firms itself.
- In all cases “becoming strong” involved being “exposed to strong competition and being forced to compete.”
- Nelson verifies Porter (1990) and Lundvall (1988) proposition that “firms in industries where a country is strong tend to have strong interactive linkages with their upstream suppliers who are also national firms.” (Upstream - Downstream connection)
- Similar observation is the importance of demanding set of home market customers.
- Availability of education and training system that provides people with the right knowledge and skills (university-trained or external training systems linked to firms)
- The package of fiscal, monetary and trade policies: where the combined set makes exporting attractive for firms, they are drawn to innovate and compete (in some cases companies were abroad while working in a rather protected home market)
- Role of government: educating the workforce and the macroeconomic climate
- R&D of universities or public laboratories are helping firms only if there are direct interactions via research projects, consulting arrangements or mechanisms that tie university or public laboratory programs to firms or group of firms.
- Infant industry protection programs, subsidies, government guidance may work if two factors hold: First, education and training system provides the right knowledge and skills to the firm and second, the extent to which economic conditions (government policies included) push the firms to compete on global markets.

Based on these three major contributions from Freeman (1987), Lundvall (1992) and Nelson (1993), the NSI concept has been developed further and is now considered "one of the most important concepts to emerge in the field of innovation studies" (Martin and Bell, 2011). In the following we will present five key findings that the NIS is trying to shape.

3.3.3. Sources of innovation

The sources of innovation are of great importance for the NSI. Classical analysis on innovation had relied mostly on R&D efforts. However, it is not only R&D that is crucial in innovation process - Producer-consumer relations (Lundvall, 1992) or upstream-downstream connections (Nelson, 1993) provide a source of innovation, too.

The systemic approach to innovation received its major impulse with the systematic collection of innovation data by statistical agencies (Freeman and Soete, 2009). Freeman and Soete (2009) state that "the science–technology–innovation (STI) system is one that is continuously and rapidly evolving." They believe that in the past ten years a major portion of global growth is associated with the accelerated diffusion of "technological change and worldwide access to codified knowledge[9]."

These successive innovation surveys revealed that a large part of innovative firms relied majorly on non-R&D sources (training of workers, learning, interacting with external environment, etc.) than on classical R&D. The innovation systems view provides a concept for studying the systemic interactions between, both R&D and non-R&D in explaining firms' successes and failures in innovation (Soete et al, 2010).

3.3.4. Institutions

Institutions and how they shape the interactions between actors within the system are of central importance to the NSI concept. Market and non-market institutions constitute the national innovation system providing the framework for governments to implement policies in order to influence the process of innovation (Metcalfe, 1995). Institutions in the broad sense are the habits and practices, or routines (Nelson and Winter, 1982) that shape the way things are done, how government, academia, industry act and interact, and how innovation comes about. For Edquist (1997), organizations (which should not be confused with institutions) are the tangible and legally identifiable, physical parts of the system that facilitate the innovation process through bringing actors together. Therefore, institutions are deeply

[9] also named "explicit knowledge". It is knowledge that can be articulated, codified, stored and accessed. It can be easily transmitted to others. The rise of information and communication technology enabled fast diffusion.

rooted within each society and describes the way of acting between government, academia and industry. It is these institutions which are trying to be targeted by policy interventions at the national level.

3.3.5. Interactive Learning

In Lundvall's words, the innovation system is a "system constituted by elements and relationships which interact in the production, diffusion and use of new and economically useful knowledge (...)." (Lundvall, 2010). Not only knowledge but also everyday learning (learning by interacting) is important for the innovation process. As knowledge introduced to the system is fundamental, learning of individuals as well as organizations is now also necessary within the innovation process (Soete et al, 2010). Learning processes include: new knowledge, new combinations thereof or the introduction of knowledge to a new organization or person. This shows the link between the NIS concepts and human resource management, the higher educational sector, labor market institutions and learning capacities of firms (Arundel, Lorenz, Lundvall and Valeyre, 2007), as the interactive learning process is a process between people.

3.3.6. Interactions

Firms rarely innovate only by themselves, they rather innovate by interacting with its external environment. Scholars point out the need for a constant interaction and cooperation between the innovating firm and its external environment, which in the "optimal" case leads to a virtuous circle of a better exploitation of available knowledge.

As Nelson (1993) noted in the context of successful R&D: "one needs detailed knowledge of its strengths and weaknesses and areas where improvements would yield big payoffs and this type of knowledge tends to reside with those who use the technology, generally firms and their customers and suppliers. In addition, over time firms in an industry tend to develop capabilities … largely based on practice."

It is this interactive nature of innovation and the according institutions that govern the interactions that raise the possibility a low innovation performance. Here it becomes clear that the coordination between the parts of the system is essential for an efficient innovation process. This is the main ingredient in the concept of NSI that leads to policy prescriptions.

3.3.7. Social Capital

Also, social capital[10] stimulates innovation. In literature, social capital has been identified as an important determinant in explaining differences in income - meaning a higher level of trust leading to more wealth. Therefore, for China to become a wealthy and prosperous nation, government should seek measures to increase the countries social capital. Innovation is an important channel that improves income growth. The idea is that more advanced historical institutions have established a higher stock of social capital. Social capital positively influences the decision for risky financing decisions and therefore also the innovation process because capital providers and researchers trust each other.

When they do so, more successful projects are carried out, which improves innovation outcomes by means of more patents. As shown by Grossman and Helpman (1991) and Aghion and Howitt (1992), higher innovation output yields higher income per capita. The knowledge base grows because of R&D efforts and the rate by which new discoveries are made increases. Therefore, it's necessary for China to target an increase in social capital on the national level, because this will support the pursue of their vision (this will be further explained in the Chapter "Setting the scene").

The NIS approach has found acceptance amongst policy-makers, as it provides a comprehensive approach with many opportunities for input.

3.3.8. Criticism

However, the NIS approach has a few major shortcomings. In the following we will give a glimpse into the weaknesses of this approach: (1) Since the NIS approach (like all SI approaches) is not a formal one, there is no agreement on what has to be taken into account and what needs to be analyzed when looking at a countries NIS. (2) Even though the NIS has been majorly developed by scholars for more than three decades, the theory still remains 'under-theorized' in terms of lacking common definitions and

[10] By the OECD defined as: "networks together with shared norms, values and understandings that facilitate co-operation within or among groups" or "the links, shared values and understandings in society that enable individuals and groups to trust each other and so work together."

terminologies. (3) Since the concept evolved around empirical studies of well-developed systems (e.g. Japan by Freeman (1987) and Nelson's comparative analysis (1993)), critics argue that the NIS approach is mainly an ex-post analysis framework, which means that developments have already taken place and are later analyzed. (4) This approach lacks the possibility of ex-ante system building (Johnson, Edquist, and Lundvall, 2003). Thus, if a good system exists, the NIS can draw attention to it and explain the causal links and why this is good. As such, if one country has developed a good framework, others may be able to learn from it. However, as existing institutions and social practices across different nations are apparent, effects might still vary. (5) A further challenge for the NIS approach can be seen in the increasing innovation activities, which do not require research (Cowan and van de Paal, 2000).

3.3.9. Conclusion

The more comprehensive nature of the NSI approach has two positive consequences for policy intervention. The use of policy instruments can be justified more broadly, for instance in the case of stimulating university-industry collaborations. In a market-failure approach, this would be justified by the need for public investment when the market fails (e.g. universities), whereas in the NSI approach influencing the distribution of knowledge and increasing the capabilities of firms could serve as an obvious justification. Secondly, as policies are part of the complex, interactive system, policy-makers cannot design the system top-down as was the case with the market failure concept. Unforeseen repercussions of the top-down approach need to be avoided through more evenly based interactions and communications (Soete et al., 2010). In this regard, the NSI approach is more democratic than the traditional approach.

3.4. NIS in the Chinese context

The majority of literature on NIS is western centric. Nelson (1993) points out that his findings, that were of basic similarity in the sample groups, would have looked a lot different if the Soviet Union or China were part of the analysis. As the Chinese economic development is unique and not comparable to the

development of highly industrialized nations like the US, Japan, Germany, Britain, etc. it is almost necessary to add a Chinese-centric view into the Western-centric scholarly view.

3.4.1. China's Indigenous innovation approach

Since Deng Xiaoping's market reforms in 1978, China has in the past three decades transformed itself from a planning to a more market-oriented economy and has in the same period sustained rapid economic growth (Vinig and Bossink, 2015). As wages grow and the competitive advantage of the manufacturing strategy fades, future development of the Chinese economy heavily depends on contributions from innovation that are based on developments in S&T. China's new "indigenous innovation strategy" aims at transforming its business systems and to leapfrog[11] to a leading position in a science-based and technology-oriented industry (Cao, Suttmeier, and Simon 2006; Wildson, 2007). The Chinese approach of "science-based and technology-driven innovation" is commonly referred to by Chinese scholars, government officials and business people as "indigenous innovation".
China's indigenous innovation ambition aims at:

1. Economic upgrade by the transition from manufacturing of low-value added products to high-value added products.
2. Reducing the PRC's dependence on foreign innovation and technology.
3. Mitigation of the risks from their export reliance.

China's ambition to move beyond the 'catch-up' phase in its innovation trajectory is driven by its desire to self-sufficiently pave its way to economic prosperity and develop an indigenous innovation approach that is at the core of China's economic development strategy (Tang and Hussler 2011). The approach aims at moving China's scientific and technological development to self-sufficiency with regard to an innovation-based economy. It can be proposed that China is facing the challenge of developing a Chinese indigenous innovation approach, and not a Western-centric innovation approach, or a Chinese approach

[11] leapfrogging is a term used in business and economics, that was developed in the research areas of industrial organization and economic growth. The central idea of leapfrogging is that small and incremental innovations enable leading firms and nations to stay ahead. However, sometimes radical innovations permit new firms or less industrialized nations to "leapfrog" or pass by superior competition or higher industrialised countries.

that is derived from a Western approach. A range of national and regional policies and programs facilitates this development and is fueled by heavy government funding. Hence, China's innovation approach is driven by its desire to overcome it's catch-up phase and to self-sufficiently pave its way to economic prosperity and technological leadership. The indigenous innovation approach is therefore at the core of China's economic development strategy (Tang and Hussler 2011).

On a macro level, the indigenous innovation program creates a web of policies, industries (both private as well as state-owned), in a political, economic and social context to lead China towards an innovation-based economy and become one of the countries that leads the world in ideation, invention and renewal. Vinig and Bossink (2015) note that China, "the world's factory", is not often studied in an innovative context and when studied, then "from an imitative innovation point of view". Since China is transforming to an "innovation based economy" by building indigenous innovation capabilities, Vinig and Bossink (2015) propose the development of a "Chinese theory of innovation"

3.5. Literature review - Regional Innovation System

The purpose of the regional innovation system is to further enhance the depth of knowledge in order to answer the research question by diving into a more macro and macro-meso perspective while showcasing details that have been neglected, excluded or works accordingly with the NIS.

3.5.1. Literature review on Regional Innovation System theory

Regional innovation system which is to a large extent inspired by the same literature as NIS touches upon how systems of innovation operate and interact with each other. This also covers how innovation remains a crucial factor for generating economic growth, development and competitive advantage (D'Allura, Galvagno & Li Destri, 2012; Acs, 2000). RIS differentiates itself from NIS in more elaborate focus on the regional aspect, rather than national. This implies firstly that, seen from a macro perspective, the regional systems of innovation in different areas in a country can differ significantly. One can therefore through RIS theory map the differences in a more organized matter. Secondly, the internal national

organization of firms, relationships between firms, roles of the public sector and public policy can be researched to a more detailed context through a regional analysis (Schrempf, Kaplan & Schroeder, 2013). This showcases how the macro-meso approach of RIS is able to provide a more detailed encryption of interactions between different parties.

This is mainly led by the concept of relationship between *technology*, *industrial location* and *innovation*. Furthermore, RIS is characterized as a system where firms and other organizations are systematically engaged in interactive learning via an institution milieu characterized by embeddedness (Cooke, Heidenreich & Braczyk, 2004; Asheim, Coenen & Svensson-Henning, 2003). Embeddedness is then described as the importance of personal relations and networks ingrained in the local, social and cultural context.

The surge of interest in regard to which factors and dynamics affect regional competitiveness has also led to a wider perception and understanding of the concept of RIS. Amongst the most argued ones, as described by research done by D'Allura et al., (2012) and Asheim et al., (2003), among others, we can see concepts as: Learning regions, innovative milieu, industrial district, local productive system, cluster, technopole, endogenous innovative network, exogenous innovative network and regional innovation system. Central within among these concepts is that interactions among the actors as well as innovational development is seen in context with competition.

Through these methods of research, a regional analysis contributes to highlighting how a region is exploiting new knowledge and production related processes, as well as how different actors contributes to the regional innovation scene. Together, it contributes to illustrating differences within each region in regard to innovation capacity and economic strength. All in all, in result of these aspects, researchers and scholars within the field of innovation systems has therefore defined the approach towards regionally based innovation system as geographical areas within a country (Schrempf et al., 2013).

Furthermore, the perspectives regarding the theory argues for regional innovation system as regional clusters surrounded by *'supporting'* organizations, where if further broken down consists of:

1. Companies in the main industrial clusters in a region together with the supporting actors (customers, suppliers).
2. Actors who backs up the innovative performance of the previously mentioned actors. This includes educational institutions, technology transfer agencies, business associates and more. (Asheim et al., 2003)

This coherence is then further backed up by contributors within this field of study who agrees upon that there is an underlying thought of territorial agglomeration providing the best context for an innovation-based globalizing economy. One argument for this case is that localized interactive learning processes and "sticky" knowledge grounded in social interaction (D'Allura et al., 2012; Asheim & Isaksen, 2002). In other words, close proximity between organizations creates a strong foundation for creation, acquisition, accumulation and utilization of knowledge integrated in their social interactions (Asheim et al., 2002).

It is therefore important to understand that the formation of RIS is in context of creating a policy framework that aims to systematically promote localized learning processes in order to secure factors like innovativeness and competitive advantage of regional economies. This is done in a matter as mentioned previously through cooperation in innovation activity between firms and knowledge creating organizations as academic institutions as well as businesses (Asheim et al, 2003).

With this underlying thought in mind, it is important to not neglect that there is widespread evidence of uneven spatial distribution of innovative behavior between geographical areas and, in particular, between different regions in the world (D'Allura., 2012). This has led to increased attention in regard to if regions of high density of innovation in a globalized economy is caused by a significant interrelationship between technology, innovation and industrial location (Florida 1995; Cooke, Uranga, Etxebarria, 1997).

Lastly, is important to keep in mind that the RIS theory covers a broad amount of aspects that could be analyzed in order to answer our given questions. However, the chosen theories within RIS in this analysis has been selected due to the believed ability to concretely and accurately measure the factors that we believed was important in order to come to a conclusion. The theories related to the RIS is followingly

therefore used to adjust and address the complexity of interactions between actors within the systems in a region. Its purpose will serve as to embrace the matter in a systematic manner and correlate the relevant number of the other concepts considered as mentioned previously (ibit).

3.5.2. Innovation network

Asheim et al., (2003) points out how RIS implicates a strategic institutionalization of innovation between private and public sectors in a systematic matter, forming an institutional infrastructure to the production structure of a region. Regions are therefore perceived as important bases of economic coordination at a meso-perspective. Further discussed by Lundvall (2010), the RIS can be perceived as a set of relationships between entities or points involved in innovation processes. Lundvall (2010) explains it as nodes being industrial firms and their innovative partners in the form of suppliers, customers, private and public consultancies as well as competitors. Further backed up by papers presented by Schrempf et al., (2003), explains how interaction takes place in various forms, but most crucially in the form of organization-to-organization interaction within a network. This is argued for to give innovation its systematic dimension.

Asheim et al., (2003), however, argues for it to be more than this as he points out that in order for the relationships to be systematic, they must involve some degree of interdependence. This is argued through the thought of not all relationships necessarily being equally strong all time, but some may. This also goes for systematic relations, where not all necessarily are regional, but many are (Asheim et al., 2003). Asheim et al., (2003), therefore derives to an answer of it being mainly two types of innovation networks.

3.5.2.1. Endogenous innovative network

The endogenous innovative network is built upon an already-existing regionally or locally delineated cluster of small and medium enterprises (Asheim et al., 2003). This is founded by history of interactions

and learning from each other, constructive and effective competition, and cooperative innovation practices.

3.5.2.2. Exogenous innovative network

Exogenous innovative network is characterized by the form of technopoles or science parks. Asheim et al. (2003) points out that they tend to emerge in two kinds of circumstances:

1. Situations where firms situate their production structure and R&D activities in functionally specialized zones where it is expected for synergies to arise from the environmental influence of the location.
2. Planned exploitation of established innovative environment to promote collaboration between universities and SMEs

3.5.3. Different type of innovation systems

The distinction between endogenous and exogenous innovation strategies serves as an indication on the classification type of regional innovation system. This is important to highlight as it both in analytical and political light is important to distinguish the different systems, especially in the cases related to interplay with NIS (Asheim & Isaksen 2002; Asheim et al., 2003).

3.5.3.1. Territorially embedded regional innovation

Territorially embedded regional innovation system (TERI) is mainly based off localized learning processes stimulated by social, cultural and geographical proximity without significant interaction with knowledge organizations (Asheim et al., 2003). This is often seen with networking SMEs in industrial districts. These districts tend be to be characterized as innovation systems that are territorially embedded in spatial structures of social relations within a certain region. The purpose of these territorially embedded systems is to create a bottom-up, network-based support (Asheim et al., 2003).

3.5.3.2. Regional networked innovation systems

Stemming from territorially embedded regional innovation, *Regional networked innovation systems (RNIS)* is furtherly developed. This still emphasizes on firms and organizations still being embedded in a specific region as well has being characterized by localized and interactive learning. On the other hand, it differs through how the systems have a more planned character via deliberate focus on strengthening of the region's institutional infrastructure. This can be illustrated through a stronger and further developed role for regional based R&D institution and other local organizations involved in the firms' innovation process. This is often perceived as an ideal RIS structure as it is built up as a cluster of firms surrounded by a local 'supporting' institutional infrastructure (Asheim et al., 2003).

This particular system represents an endogenous development model as it tries to enlarge the innovation capacity and collaboration through public policy instruments. This is further explained by Asheim et al., (2003), as they point out that in the long run, especially for SME's, firms cannot solely rely on exclusively localized learning, but must also be open for wider pools of knowledge on a national and global basis. He further addresses the creation of *regional networked innovation systems* through increased cooperation with entities like local universities, R&D institutes and technology transfer agencies to be a crucial supplementary factor as they it can contribute to increasing their information and competency of the already existing locally derived knowledge.

3.5.3.3. Regionalized national innovation system

The *Regionalized national innovation system (RNIS2)* separates itself from the previously mentioned theories in multiple ways. This is mainly categorized through, firstly: the interactions between industry and the institutional infrastructure. The interaction between these actors are more functionally integrated in the national or international innovation systems. Further explained, its innovation activity primarily takes place in cooperation with actors outside the region, hence, a more exogenous development model.

Cooke et al., (2004) adds that it can be defined as an innovation system incorporating the R&D functions of other actors such as academic and research institutions as well as corporations.

Secondly, the shape of this collaboration takes a more linear shape, unlike the previous systems. This is due to specialized and specific innovation projects aiming to build and develop more radical innovations. This is done through formal scientific knowledge typical in industries possessing an analytical knowledge base (Asheim et al., 2003). Consequently, cooperation is most like to arise among individuals with the same educational background, enhancing further development. This system is often observed in the clusters of R&D laboratories of large firms and governmental research institutes in focused science parks. However, Asheim et al., (2003) points out that although they may be located in close proximity to universities and technical colleges, they tend to have a *weak local cooperative environment*. This results to difficulties in developing inter-firm networking and interactive learning in the parks.

All in all, it implies a lack of territorial embeddedness and creates uncertainties in regard to capability of promoting innovativeness and competitiveness on a broad scale in local industries in particular regions (Asheim et al., 2003). On the other hand, the networking between the R&D institutions, firms and local state tends to be better in regionalized national innovation systems compared to national ones.

3.5.4. Cluster theory

3.5.4.1. Industrial Clusters

As highlighted previously, as there are unique underlying connections and dynamics in fields like political science, economic geography and business economics, different explanations on concepts regarding these interactions has arised (D'allura et al., 2012; Porter 1998; Asheim, Cooke & Martin, 2006). Clusters are one of the many folded concepts and is defined by Porter (1998) as "*critical masses: in one place - unusual of competitive success in particular fields*". I.e. Clusters is composed with a range of linked industries and entities important to foster and maintain enhancing competition (Asheim et al., 2006). Porter further explain how these clusters are a striking feature of virtually every national, regional and state economy, especially advanced ones. Additionally, Asheim et al., (2006) in agreement of Porters

(1998) research points out how clusters lies in a paradox stating how enduring competitive advantages in a global economy increasingly lies within local resources: knowledge, relationships, motivation - Something foreign competitors might have trouble competing against. One key perspective within this theory is how competition in today's economy is correlated with innovational development. This is further argued for by Cooke (2004) as he explains how systematic innovation also looks into aspects on how regional or national assets can contribute for development in form of collaboration or influence. These can take in form of laboratories, firms, governments agencies, business associations and other intermediaries leverages. Porter (1998) further points out how continual innovation is required in order to maintain competitive as it helps make more productive use of inputs. Put into a different perspective, Steiner (2006) argues for how the most successful regions are perceived to be those whose firms are capable of showcasing high innovative capacity as well as being able to adjust the changes in environment and staying a step ahead.

Another key aspect pointed out by Porter, which has been pointed out previously as well within this paper is how the environment plays a vital role in innovational development. Porter (1998) dives more deeply into the idea of how institutions such as universities can contribute to competitive success as well as how governments can promote economic development and prosperity. This remains as a core competency within enterprises, as Porter argues for productivity rising on how companies compete, and not necessarily on the particular fields they compete in. Furtherly explained, companies will have difficulties in competition at a high level if problems are encountered within local environmental weaknesses like bad transportation infrastructure and lack of qualified employees to mention some.

3.5.4.2. Clusters

Pointed out by Asheim et al., (2006) and Porter (1998), the success of a nation's export firms depends on a favorable national 'competitive diamond' (figure 03). The more developed and intense the interactions are, the greater will the productivity, hence, the competitiveness be. They then proceed to argue for the competitive diamond to be a central theme on cluster literature, as it comprehensively also covers the significant roles of partners within the 'local context' such as: local business, social, institutional, and political environment (Asheim et al., 2006; Porter, 1998). All in all, the competitive

diamond's purpose is to sustain a driving force for further cluster development, in light of competition, cluster effects can be divided into three categories.

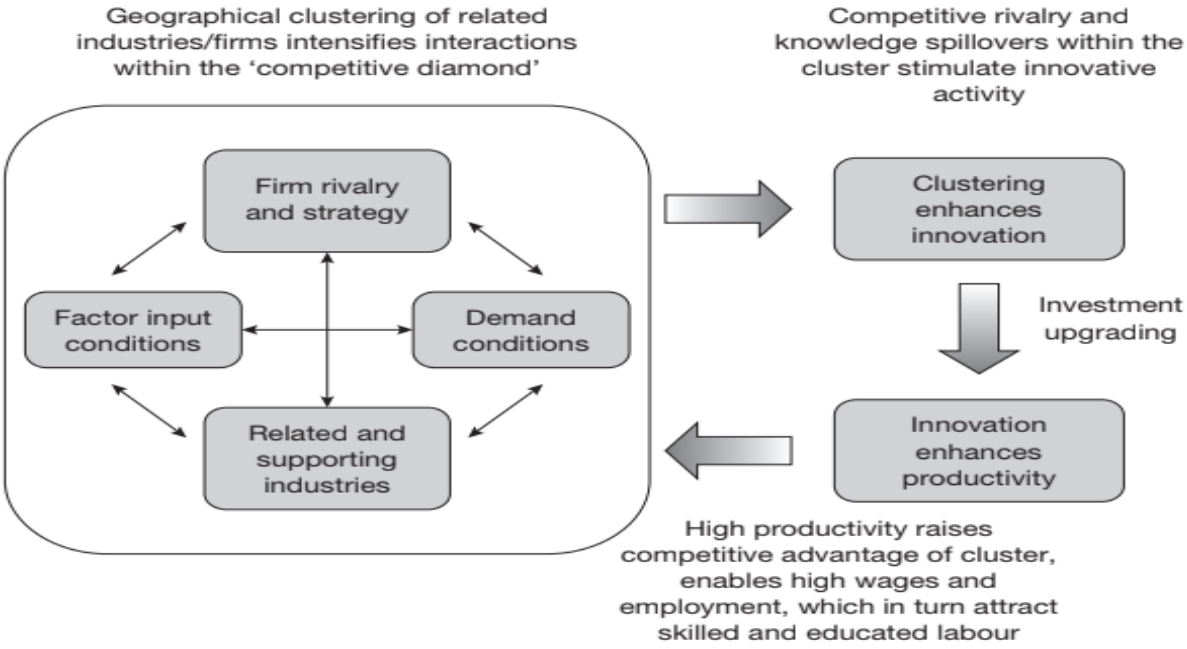

Figure 3: Competitive diamond (Porter 1998)

Clusters and productivity

Clusters and productivity are correlated in the sense of being part of a cluster gives companies the opportunity to operate more productively in sourcing inputs, as well as accessing information, technology, needed institutions and coordination with related companies (Porter, 1998). He then points out benefits to be gain in form of: (1) Better access to employees and suppliers, (2) Access to specialized information, (3) Complementarities, (4) Access to institutions and public goods, (5) Better motivation and measurement.

Clusters and innovation

Porters research paper (1998) also points out that clusters enhances company's ability to innovate, where one of the reasons can be observed within the window in the market, as companies within clusters usually

has a better window than isolated ones. Secondly, seizing of local opportunities are made easier as knowledge and processing of different activities are densely located within one area, compared to if isolated.

Clusters and new business formation

Clusters in relation to business formations provides advantages in different types of forms: barriers entry are lower than elsewhere, easier access to assets, skills, inputs and staff, local financial institutions and investors more developed and knowledgeable about fields within the already existing and perhaps developed cluster, hence, contributing to building a positive feedback loop (Porter, 1998).

3.5.5. Limitation to cluster theory

As there are several important aspects within the cluster theory that has to be taken into consideration, the range of what can be defined as a cluster remains as central in this paper. Asheim et al., (2006), points out an important argument made by Porter saying: "The geographic scope of a cluster can range from a single city or state to a country, or even a network of neighboring countries" (ibid, p 199 - Porter 1990). One could therefore question where the border goes causing for uncertainties in regard to the accuracy of the theory as it can be argued to be static. Porter has also received criticism on lack of proof on whether the case studies he conducted actually are clusters or not. This further leads to question in regard to if the cluster theory can be considered as a universal theory of cluster formation or if it differs depending on dynamics and context (Asheim et al, 2006).

4. Setting the scene

The purpose of this chapter is to supply important background information that will supplement our findings and therefore provide valuable insights we will also refer to in our analysis. By setting the scene, we will be able to illustrate the status-quo of several aspects within China, further strengthening the core foundation needed to answer our research question.

4.1. China's economic past and vision

We often mentioned the tremendous growth China experienced since their reforms in 1978. Speaking in numbers, the graph shows that that the GDP increased from RMB 3.678 million to RMB 827.121[12] million (225x). Huge growth was seen in the secondary sector, which contribution to GDP increased from 1.755 million to 334.622 million (191x) - highlighting China's role as the world's factory.
The GDP growth rate is seen to steadily declining in the recent past, indicating that the Chinese economy needs to search for new sources of growth.

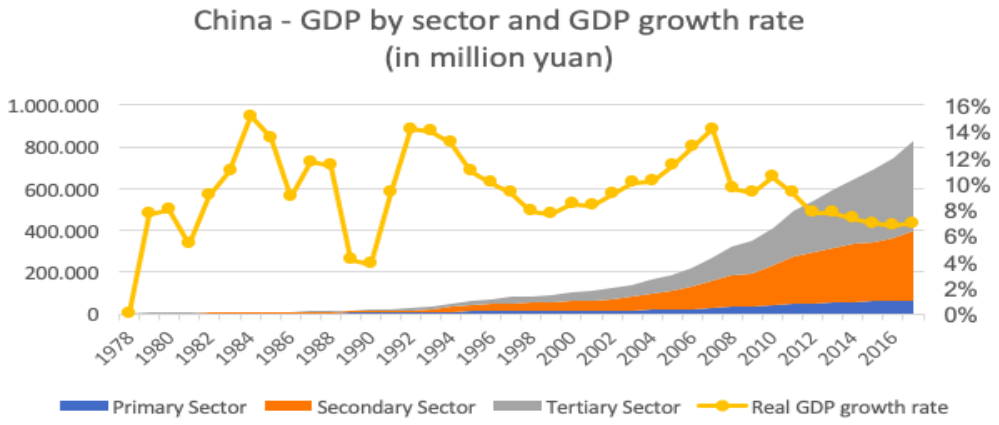

Figure 4 - Own graph on Chinese GDP by sector and GDP growth rate based on China Statistical Yearbook 2018

[12] USD 11,7 trillion in the current exchange rate (1 RMB = 0,14 USD)

The practical solution put in action by the Chinese government was then to attempt to rebalance its economy by achieving a **new normal**. The purpose of the new normal would be to build a slower but more sustainable economic development (Zhang & Chen, 2017; BBC, 2015). As pointed out by Xi Jinping in the B20 summit in Hangzhou, innovation has time and time again been seen as the way to further develop any economy, including the Chinese one. This is arguably strongly correlated with the visions mentioned previously in this paper, as they jointly would contribute to the Chinese economic, technological and structural evolution (Chinadaily, 2017).

Economic development situations hold a phenomenon referred to as "middle income trap". The core of this phenomena is that a nation loses its competitive edge in the export of goods due to rising wages. At the same time, the nation cannot keep up with other more developed nations in the high value-added markets. As a consequence, per capita GDP remains constant over time while investments in fixed assets are low and the industrial economic scene is poorly diversified. As China's vison entail being a wealthy, prosperous and an innovation leader in the future, it becomes apparent that the middle-income trap needs to be overcome.

4.2. Economic development plans and initiatives

As already illustrated in the economic history of China, initiatives and plans has for long played crucial roles in China's development. As we can see from China for the last decade, a more sustainable and innovative future has been the core of their new plans. Figure 5 will display the connection of time, innovative capacities, and the indigenous innovation approach

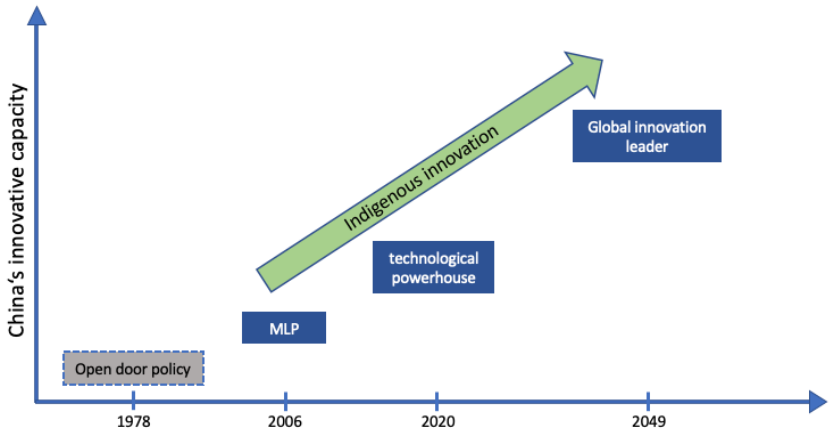

Figure 5: China's Economic transition (own graph)

The introduction of these policies will therefore have to be assessed in order to analyze certain actions that can and has been seen within the innovative scene, especially the EVB industry in China later in the paper.

4.2.1. China's MLP

China's MLP on S&T (2006 - 2020) was published in February 2006 by the State council. The plan articulates two very important milestones that are shifting the focus of Chinese economic and industrial policies:

(1) 2020: China is a technology powerhouse

(2) 2049: China is a global innovation leader

The MLP defines a series of investments and industrial policies designed to enhance the role of innovation in the PRC. Since the MLP sets the proportion of government funded R&D expenditure to 2.5% (of the country's GDP), China has enough financial resources to fulfill on their investments. According to Berger (2013), China's double-digit economic growth in the past decades was heavily depending on its national manufacturing strategy and its leading position in low-cost and good quality manufacturing ("low value added" goods). However, China's future economic development depend to a higher degree on innovation - a competency that is intended be built with this plan.

4.2.2. Made in China 2025

Made in China 2025 (MIC2025), is an initiative which aims to secure China a global powerhouse position within the high-tech industries (isdp, 2018). The initiative mainly consists of a 10-year comprehensive government strategy with an ultimate goal of reducing China's dependence on foreign technology and promote Chinese high-tech manufacturers in the global marketplace (Mcbride & Chatzky, 2019). The initiative also targets the problems in regard to the middle-income trap, which contributes to illustrating how comprehensive the initiative is.

Arguably, through such a transition, China would move from being a low value-added manufacturer that they have been characterized with to a direct- added-value competitor. The initiative covers a range of aspects China wants to improve such as: (1) Improving manufacturing innovation, (2) Integrating technology and industry, (3) Strengthening the industrial base. (4) Fostering Chinese brands, (5) Enforcing green manufacturing, (6) Promoting breakthroughs in ten key sectors, (7) Advancing restructuring of the manufacturing sector, (8) Promoting service oriented manufacturing and manufacturing-related service industries, (9) Internationalizing manufacturing (Merics, 2016; english.gov, 2015).

Furthermore, the strategy covers ten strategic sectors that it wants to improve, covering: (1) New advanced information technology, (2) Automated machine tools & robotics, (3) Aerospace and aeronautical equipment, (4) Maritime equipment and high-tech shipping, (5) Modern rail transport equipment, (6) **New energy vehicles and equipment**, (7) Power equipment, (8) Agricultural equipment, (9) New materials, (10) Biopharma and advanced medical products (Kennedy, 2015).

The intended approach for achieving this goal is set by specific tactics such as: (1) setting explicit targets - China's leadership encourages private and public entities to form their **decision-making around the plan's priorities**, (2) Providing direct subsidies - The government will be playing an increasingly more important role as they intend to increase direct support for MIC2025 industries through state funding, low interest loans, tax breaks and other subsidies, (3) Foreign investment and acquisitions - This entails Chinese companies, both private and state-backed to invest more in foreign companies in order to gain

accessibility to advanced technology, (4) Mobilizing state-backed companies - Most of these investments are from SOE's or companies backed by the Chinese government. Regardless of certain companies being characterized as privately run, they are still supported by the government, (5) Forced transfer agreements - As complained by foreign companies previously, in order for them to access the Chinese market, joint ventures has become a requirement, hence, sharing of sensitive intellectual property and advanced know-how (Mcbride & Chatzky, 2019).

There are many aspects one can take into consideration when looking at this initiative, however, the indication of where China is heading with this initiative alone is clear: A movement from low-value manufacturing to a high-tech global leader is what they aim for, and what is clearly shown within this plan.

4.2.3. Limitations

It is important to highlight that there are several other initiatives that has been initiated by China that we were unable to cover due to natural limitations of the paper. Critical reflection in form of degree of reliability and how realistic it is for these initiatives are also not addressed as the presentation of these initiatives only served as a tool to illustrate the ambitions China are heading towards within the high-tech industry.

4.3. The electric vehicle market

As reported by Demand institute (2016), China is the world's largest automotive market, with the China Association of Automobile Manufacturers reporting more than 21 million cars being sold in China per 2015. In light of China's ambition on improving their innovation sector as well as addressing their sustainability weaknesses, drastic development has been observed within new energy vehicles (NEV).

China has now more than 100 EV manufacturers, most prominent being SAIC, FAW, Dongfeng, BAIC, Chery, BYD and Geely. Global sales of EV's increased 73% in 2018 to 1.26 million units, after already jumping 86% the year before. The Chinese home market demand amounted for roughly 0.7 million units,

meaning that roughly 55% of the global demand is based in China. In the past, China has built massive production capacities for EV's. According to a report by Sanderson (2019), the EV industry has seen themselves being subsidized of an estimate of $ 58.8bn by Beijing, showing the support of China's central government for this industry.

However, China's domestic EV manufacturers have yet to fully engage in the export of their products. EV industry analyst Jose Pontes says there are three reasons for their reluctance: (1) the Chinese market, its size and growth rates, is big enough to absorb the current production capacity (2) many car companies in China are almost unknown in the West, so customers would be reluctant from buying those brands. (3) Chinese cars do not yet comply with strict safety regulations in the U.S. and Europe (Barkenbus, 2019).

4.4. The battery industry

When referring to the battery industry we always mean the EVB industry. The underlying technology is not based around "lead-acid", but on "lithium-ion". What is so special about lithium-ion batteries and what determines the applicability for the EV industry? The answer is that "lithium is one of the lightest elements, and it has the strongest electrochemical potential of any element" (Rapier, 2019). Therefore, the lithium-ion battery pack holds a lot of energy by being relatively small and light. Therefore, this is not only the preferred technology to power cell phones, but also EV's.

China is the largest producer of car batteries on the planet. According to an analysis by Rapier (2019) in early 2019 there were 316 gigawatt-hours (GWh) of global lithium cell manufacturing capacity. China is home to an astonishing 73% of this capacity, followed by the U.S., far behind in second place with 12% of global capacity. CATL has developed partnerships with notable partners like BMW and Volkswagen AG as of recently (Reuter, 2019; catlbattery, 2017). Reports issued by Preisinger & Bryan (2018) for instance explains that one of the main reasons for BMWs cooperation with CATL lies within Europe's lack of own production capabilities of lithium-ion batteries. CATL has followingly declared this as the first step as they aim towards supplying all manufacturers in Europe (Preisinger & Bryan, 2018). CATL's reporting shows that the revenue of CATL's has quintupled since 2015.

Audi - the premium car brand of Volkswagen, is said to be in negotiations with BYD about the supply of EVB's for their EV's according to Bloomberg (2019). Hence, Chinese EVB manufacturers are successfully competing with their products on the global stage, landing premium, well-established German car manufacturers as customers.

According to the Financial Times (2019) China's dominance in the electric car supply chain raises growing concerns in Europe and the US that they could be squeezed out of the next generation of personal vehicles.

The Chinese government restricted domestic EV companies from buying batteries from foreign producers, which naturally enhances the competition and value chain of the domestic EVB production in China (Sanderson, 2019; Merics, 2018). In 2016, the last time the list was updated, it included a total of 57 companies where none of them were foreign (Huang, 2019). This is referred to as the certification scheme. One can also see this in line with MIC2025, where it is stated that China wants to cut on foreign influence and boost the concept of indigenous innovation.

China's undeniable growth within the battery industry is therefore not to be underestimated. However, moving forward, China has planned to phase out subsidies for EV's next year. This will have multiple implications, as EV companies might find themselves in bigger financial struggles in the future. For the EVB industry on the other hand, this also means the end of a related policy that effectively shut out foreign battery makers, which created the domestic monopoly we see today (Huang, 2019). Furthermore, China's ministry of Industry and Information Technology announced that they will be dropping their practice of publishing lists of EVB makers that met technical standards. One could therefore argue that the removal of the list could invite for more foreign technological influence, something the Chinese innovation scene is in need of, putting question to how big degree they will rely on foreign influence given their ambition of boosting domestic indigenous innovation.

4.5. Government R&D spending

China's R&D spending has for decades fluctuated in accordance to the development they have experienced. Dating back to 1991, the R&D spending accounted for just 0.72% of its GDP whereas per 2015, it accounts for 2.07% of its GDP (chinapower, 2016). One can see this in line with the plans and

initiatives mentioned previously, highlighting the renewed support for R&D and its correlation with their innovation goals. R&D expenditure has therefore in the last decade been experiencing a significant amount of growth, making China a global R&D player. However, China still sees themselves lagging in R&D intensity, especially in high-technology industries (Schaaper, 2009). Shed in the light of arguments made previously in the paper, R&D with innovation jointly promotes further economic growth which argued by Porter (1998) as well as by Asheim et al., (2006) leads to higher degree of competitiveness.

4.6. China's higher education sector

The role of the higher education sector within a innovation system consists of supplying human resources which is a key contribution in long as well as short terms perspective in terms of R&D development. This is strongly related to innovation driven activities where co-operations are developed between academic institutions and other key parties in need of highly educated labor. For instance, this can be showcased in how the higher education sector can be linked towards the business sector.

One of the major contributors to this resource is the C9 league, which is an alliance of nine universities in mainland China. This alliance was initiated by the Chinese Central Government through "Project 985" and is deliberately promoting for the benefit of further development and reputation of higher education in China. This come to fruition as universities in the C9 League has been observed to account for 3 percent of the country's researchers and receive 10 percent of national research expenditures, showcasing the importance of government backed research institutes (timeshighereducation, 2018).

Furthermore, according to Schaaper (2009), the business sector outsourced an increasing share of R&D to the higher education sector. Additionally, per 2006, the number was RMB 10.1bn, accounting for a total of 36.6% of total R&D expenditure in the higher education sector. Simultaneously, the higher education institutions has jointly with industrial enterprises participated in a wide range of national S&T programmes, supported by the government such as programmes like: 863 & 973, the "Star and Fire" programme and others (Schaaper, 2009).

Furthermore, published by NBS (2018), basic statistics for higher education related to S&T activities has seen a steady increase in both number of institutions as well as R&D expenditure. The number of S&T R&D institutions increased from 9.800 in 2013 to roughly 15.000 in 2017, while the number of R&D personnel increased from 70.000 to 90.000 simultaneously.
At this point we wanted to include numbers of S&T graduates; however, the yearbook does not display these. Whatsoever, as we can see a strong increase in the number of Science & Technology Research institutions and personnel, it seems highly likely that the number of S&T graduates increased in a similar fashion.

All in all, the higher education sector has been gaining increased support not only privately but also governmentally as they aim to promote the advancement of specific Chinese universities, especially with relatively strong research capacity in a few key subjects. From a business perspective, this helps them prosper and utilize untouched upon resources in form of labor pool that can help reduce cost but also broaden the perspective of their R&D department. Whereas from a governmental perspective: creating a world-class research environment and performance that will contribute to making the national economy prosper in general (ibid).

5. Findings

This section will present our findings. The findings were derived from the four semi-structured interviews we conducted. As described in the methodology, we analyzed the qualitative data using the analysis software **NVivo**. Using NVivo, we categorized our findings in four main sections, which will be presented in the subsequent chapters. Hence, the findings will display non-interpreted data we obtained through our interviews. All transcribed interviews can be found in Appendix VI.I – VI.IV . the findings will be presented in great detail using quotes from our Interviewees.

As our key findings regarding the "Role of the government", were seen to be highly complex, we display a simplified illustration in Appendix VII.

5.1. Role of the government

All interviewers stressed the central role of the Chinese government for the innovation process in the high-tech industry. Mrs. Holzmann from The Mercator Institute for China Studies stated it very clearly:

"In general, the central government releases long-term plans that lay out the priorities where the state wants Academia, the Industry but also local governments to focus their research on. The central government is defining strategic industries, but also nominates specific technologies where it wants to see breakthroughs over the next couple of years."

Going further into detail, on how this is done, or how these long-term plans are defined, she continues:

"Yes, in my opinion this (MIC2025) is a good plan to look at, because it lists ten core industries where it wants to see major breakthroughs, to eventually become the global leader within those industries. The MIC2025 strategy comes with a roadmap that focuses on the underlying technologies. It goes for each of the ten industries into detail which technologies should be targeted and developed over the next couple of years."

This is supported by Mr. König, International Markets Head of Unit East Asia (China, Japan, Korea) at

the German Chamber of Commerce and Industry. On the question, how the interplay of government – academia – industry works, he stresses the central aspect of the Chinese government:

"So, first of all: All of those three aspects are guided by the government. Neither academia, nor the industry is completely independent of the government. It you look into the market of NEV or at the major policy shifts in terms of the structure of the Chinese transportation system – what is "hip or going to work" is shockingly often dictated by the state, (...)."

In practice, this leads according to Mr. König to an accumulation of industrial segments:

"This is why there are so many electric vehicle start-ups in China or start-ups for transportation solutions. It is not because everybody is super passionate about transportation, etc. We know that this is the case because it is the priority of the Chinese state."

Ultimately, he concludes:

"Whatever academia does, whatever R&D is being conducted, it is all tailored towards a certain goal, that is defined not by markets, but by the state. This is something that has worked for China! (...). Ultimately, the goal is, or all those things serve particular needs of the government. (...). The creativity process in the country is ultimately guided by the state apparatus."

This finding is very broad in the sense that it is valid not only for the EVB industry, but for all major high-tech industries. It displays how the Chinese innovation system is orchestrated by the central government and that it ultimately serves its own needs.

The government has different measures to steer the indigenous innovation process and to support the emergence of domestic high-tech industries.

5.1.1. Indirect government support - Subsidies for NEV

Since every electric vehicle has a battery, the market for electric vehicles and the battery industry are strongly correlated. China has subsidies in place that boost the EVB industry and thus ultimately as well

the supplying industries.

However, in 2019 the government shortened the subsidies for EV's with a minimum range of 400 kilometers by half to 25.000RMB ($3.700) as the market for EV matures and cost have fallen (Bloomberg, 2019). Also, to qualify for any subsidy, the minimum range increases from 125 to 250 kilometers. This should encourage domestic EV manufacturers to rely on innovation rather than government assistance.

Mrs. Holzmann from MERICS states:

"Within the NEV industry we see lots of subsidy programs. Those subsidies also benefit indirectly the supplier industries (in this case the battery industry) as those policies boost the domestic demand for NEV and therefore also batteries."

and continues:

"it is one of the goals of the Chinese government to increase the quality of the batteries. They want batteries to be: Secure, of high quality, long range and to increase the length of the lifecycle. With their subsidy policy, the government certainly want to push and promote innovation in the battery industry."

Mr. König points out the benefits of domestic subsidy programs, paired with a large domestic market:

"(...). This also includes promoting (here: subsidies) certain industries and of course they also use the benefit of having 1,4 billion domestic consumers. If they do that, a large part of the world is already embracing it, without them having to try too hard. There is a huge benefit there."

Mrs. Jiang, from the Danish Institute for international studies (DIIS) is further referring to the general system of subsidies, that are in most cases tailored towards SOE's and big private companies. This finding is non-battery industry specific but shows how the general Chinese subsidy system is tailored:

"There are different kinds of subsidies, and they mainly go to state owned enterprises and the big private companies that can be called national champions. "

Also Mr. König says in the context of the competitive landscape in the Chinese high-tech industry:

"The dominance of SOE's is unfair competition."

Next to subsidies for EV's, the government is indirectly supporting the EVB industry by exempting EV's from license plate lotteries. Mrs. Holzmann says:

"NEV are sometimes exempt from "license play lotteries". People with such a license plate can drive on certain roads during certain times of a day for example."

Dr. Rathi, a senior fellow of the global energy center at Quartz adds:

"However, we can also see license control. In big cities, the number of licenses given for gasoline driven cars versus electric cars are limited. This is arguably because the government wants to control the market conditions. (...) With electric cars however, there is a higher chance of acquiring a license, therefore, more people are purchasing electric cars."

5.1.2. Direct government support – Certification scheme

Next to the indirect support of subsidies for NEV and license lottery exemptions for electric vehicles the government supports the EVB industry directly via a so-called certification scheme. Mrs. Holzmann from Merics explains:

"The Chinese Ministry of Industry and Information Technology has a list of certified battery manufacturers for the Chinese market. Companies who made it onto the list were seen as the "best" of the "best" in terms of producing high quality products. Highly surprisingly, it was mainly Chinese manufacturer who made it onto this certification list. This is another example who the Chinese government supports the domestic industry. "

The certification scheme is an example of how the Chinese state protects domestic EVB against non-domestic competition. This is part of a larger Chinese strategy and is also seen in other industries. Mrs. Jiang from the DIIS states that China had a policy in place that:

"encouraged government projects to buy products that were designed and made in China. (...) This was discriminating against foreign investment."

Thus, indirect and direct government support really promote and support domestic manufacturers, while boosting domestic, home market demand for EV car batteries. Domestic companies are clearly favored over international competition. Forthcoming, we will refer to this phenomenon as "artificial home market demand".

5.1.3. Location factors

For innovation to occur the setting must be right. In the interviews, we found out that China is constantly trying to increase relevant factors to support a competitive business environment. Mr. König stated:

"If you think about the location factors in China that make it a favorable location for investment, it is probably the low taxes and easy administrative processes to get a business license. Also, the general "market speed" (general time to market) of new technologies and new ideas. (...). In total, the favorable conditions are a set of securities combined with a sense of adventure. China wants to position themselves as a country where it is easy to conduct business."

But the location factors include more than just taxes and easy administration processes. It is also crucial to have the right people, intellectual property rights, as well as infrastructure. Mr. König continues:

"But it is also some very basic aspects of modern life that make great Chinese location factors – like high speed internet for example. In terms of overall attractiveness China still has some way to go but it is constantly progressing."

5.1.4. Availability of financing

Coming up with innovation is widely regarded as a costly process. Therefore, it is important to have capital available to finance new ideas and the innovation process. Mr. König who lived for several years in Shanghai experienced the local financing scene:

„There is the tendency to take risk and try out new things, because it is often backed by the government. Financing is in most cases secured and quite easy to get. (…). Like I mentioned capital is largely available. There are several ways of doing it.

First,

"let's assume we are a start-up in the Shanghai area, there are hundreds of Venture Capitalists (VC) who are waiting to throw money at you. There are also incubators or accelerators that would put you in touch with the right VC-funds to get your funding. They are also the ones that are going to set-up a pitch meeting with the VC within let's say a week or so. It goes really fast."

Second,

"you can go the regular way of getting a bank or a business loan. That is the most cumbersome and outdated way of doing things."

Third,

"Also, there is microfinancing, crowdsourcing available. We do not see it this much in Germany, but in China those forms of financing are tried out on a large scale. You can get microfinancing/ crowdsourcing for a project or office space. Anything is possible really."

Forth,

"There is also the opportunity of going to the big state-owned enterprises (SOE) and asking for infrastructure, etc. or can we sell our idea to you. It is shockingly easy to get meeting with state-owned enterprises or the SEO representatives. The SOE usually have a small to medium size enterprise section which screen the market for new ideas and to throw money at you, because if there is no shortage of anything the capital would otherwise only sit around."

Mr. König then concludes:

"So, if you have the right connection and the right idea, getting financing is no issue."

5.1.5. Central R&D Initiatives

As mentioned previously, in order for a country to stay competitive, the innovative scene has to be able to continuously develop their product and services. In order to do this, variables like R&D and S&T in light of plans and initiatives set by the government becomes of importance. Mrs. Jiang touches upon this as she states:

"China also has a number of initiatives to support domestic Science and Development as well as Research & Development. One of the programs, directly translated is also known as "Star and Fire" or maybe also "sparkling". The intention behind this is that the Chinese government wishes to "sparkle" innovation through the seed money for Research & development. These programs have been going on for decades, and the money of the funds mainly goes to research institutions (...) as well as programs like 973[13] and 863[14]"

Both programs (973 and 863) together are referred to as China's National Key R&D Programs (NKPs).

5.1.6. Interregional coordination

One key issue we identified is the competition of local governments to attract industry. Here the central government is intervening with a process named "interregional coordination". Mrs. Holzmann explains the phenomena:

"Last year, we went to China and spoke to people there and they confirmed what we found out during our desk research. That this competition between local governments is really strong and that all the regions want to excel in all ten of those defined core industries of the MIC2025 plan. From a macro-

[13] On June 4, 1997, the State Science and Education Steering Group decided to formulate "The National Plan on Key Basic Research and Development" and organize the implementation of the "National Program on Key Basic Research Project (973 Program)". The purpose of these two initiatives was to strengthen basic research in line with national strategic targets. (taken from: Consulate Generale of the People's Republic of China in New York)

[14] State High-Tech Development Plan is a program funded by the central government of China. The program intends to encourage the development of high-tech industries for the purpose of rendering China independent of financial obligations for foreign technologies.

perspective, this does not make any sense, because you do not want every region to specialize in ten core industries. Therefore, central government is steering its policies to avoid overcapacities and redundancies, which is highly inefficient and therefore also wasting resources. This competition of local governments is what the central government is increasingly trying to tackle by getting involved in interregional coordination."

Mr. König shares this finding and believes that China is headed towards clusters for two main reasons:

The trend is the following: The cities are going to be huge hubs that are clustered anyway and within those "Cluster hubs" there is going to be more of a specialization. China is really pushing to promote the following: "City X is the car city and City Y is about aerospace". This makes a huge country like China more manageable and also diversifies where the wealth goes."

Yet again, the urban development is not following market signals but is centrally assigned by the government.

5.2. Government – Measures affecting the regional level

As assessed in the theoretical chapter, the regional level covers a more macro to macro-meso perspective in comparison to the NIS. The findings on this section will therefore be able to provide us a different perspective. Followingly, we will once again see the importance of the government as they are stressed by the interviewees, even on the regional level.

This was for instance clearly pointed out by Mrs. Holzmann from a holistic perspective at first as she stated:

"In general, the central government releases long-term plans that lay out the priorities where the state wants Academia, the Industry but also local governments to focus their research on."

Mrs. Holzmann further elaborates on the industry stating the following:

"In a broad sense, it is in the interest of the Chinese government to foster national champions and then also global champions in a later stage. Government really want to have a thriving domestic industry, but not based on many small companies. They really want to have a small number of leading companies. An example of this is CATL and BYD really emerged as national champion in the battery industry."

This is precedingly backed up in a point highlighted by Mrs. Jiang as she states:

"China support the big national, state owned and private companies, because China wants a team of global champions. They think it's part of national power. The United States has Apple, Coca Cola, etc. But what does China have now? China believes that it should also have these as part of national strength."

On an even more macro-meso, Mr. König points out the degree of the government involvement for SOEs stating:

"This is a clear benefit of a guided SOE system where the government is dictating what is happening right now. This also helps you as an entrepreneur because you know what works and what not. The creativity process in the country is ultimately guided again by the state apparatus"

5.2.1. Governmental measures on a regional level

Moving on, the methods of support and involvement the Chinese government can use for the Chinese EVB industry, especially seen from a regional level, is of many options. However, some of the methods sticks out more than others.

Firstly, the most common way of governmental support was through economic measures. Mrs. Jiang pointed out the following:

"There are a number of funds, like the R&D funds. These days, recently, there are some government guidance funds for industry, for small and medium enterprise innovation, and there is venture capital investment. The Chinese government also through their own state, have banks that offer loans with low interest and some tax breaks for high tech development."

This was followed by another point by Mrs. Jiang as she proceeds to explain:

"China is, through government subsidies and support trying to encourage innovation. We can see some progress in some sectors, like in biotechnology, electric cars, and batteries, and IT and even aviation."

Mrs. Jiang however follows this up by explaining that it is important to keep in mind that:

"There are different kinds of subsidies, and they mainly go to state owned enterprises and the big private companies that can be called national champions"

Keeping this in mind, Mrs. Holzmann provided another perspective when it came to the governmental support as she stated:

"Another aspect is that also the Chinese government has limited amounts of financial resources, even though the NEV is a strategic industry for the Chinese government they cannot keep on subsidizing the industry forever."

Moving on, it became apparent that other measures also would have to exist, other than economic ones., Dr. Rathi points out an important factor as he explains that involvement from the Chinese government could also be observed in the form of the following:

"When the Chinese government started with the subsidies, it covered almost ⅓ of the price of the car. This year however, they have started reducing it by claiming they will be cutting off direct subsidies. There are, however, indirect support remaining where we can see local governments giving pieces of land to companies to build manufacturing points at building up the local scene. This illustrates that the

government does not necessarily resort to subsidies or economic incentives. In other words, we can still see a lot of collaborations between governments and companies.“

However, with these actions, the local governments within the regions may potentially cause implications on a national level. This was highlighted by Mrs. Holzmann, going back to the argument that illustrated under “interregional coordination”, stating:

“All the regions want to excel in all ten of those defined core industries of the MIC2025 plan. From a macro-perspective, this does not make any sense, because you do not want every region to specialize in ten core industries.”

Conclusively, Mrs. Jiang and Mr. König has their final say on the governmental influence, whereas the first mentioned believes:

“I think from the beginning, the government has a strategy or a blueprint about what's the major sector that are fine, for instance, IT sector down in Shenzhen. And the government build infrastructure, like roads and highways and provide cheap land, and maybe tax incentives.”

Whereas Mr. König enhances the thought of the governmental plan with his explanation:

“In general, I would say: “whatever Academia does, whatever R&D is being conducted, it is all tailored towards a certain goal, that is defined not by markets, but by the state.”

5.2.2. Clusters

Another important aspect that was discovered as a key point within regional level was the term Clusters. Clusters was argued for to be formed for different purposes.
First and foremost, Dr. Rathi points out importantly, taking CATL as an example that:

"They manifest cities with huge manufacturing sites, where CATL for e.g. has over 15.000 employees. Most of the manufacturing is automated. One area for instance lies between Hangzhou and Shanghai, where we met with 3-4 manufacturing companies."

One could therefore firstly question the reasoning behind clusters and who the promoters are. Keenly observed by Mrs. Holtzman, she explains:

"They want to promote manufacturing clusters. They try to create platforms or ecosystems that allow for innovative business activities to happen. For instance, they have campuses with innovation and research centers, manufacturing companies and start-ups to bring them all together to allow for collaboration and to promote alliances. Geographically they want basic research and applied research to happen at the same place and to bridge the gap to business applications."

Followingly, a question on if "they" was the government and if she could further elaborate on this was set to light in order to clear for misunderstandings. Mrs. Holtzman further explained:

"Yes. This is definitely a focus of the industrial policy in China right now, but it is not the most important aspect. In general, MIC2025 is like a catalyst for those industries while also putting an emphasis on:
- High quality manufacturing
- Advanced manufacturing
- Smart manufacturing
- Increase efficiencies in the industrial set-up in China."

The purpose of the clusters was set to a more bright light. However, Mrs. Holtzman touched upon the aspect of "Geography". This was later discovered to be something the interviewees would share an interest in. For instance, when Mrs. Jiang was asked for her perception of this, she replied:

"Yes, maybe on a smaller scale, like in Beijing. That's where the Beijing University Tsinghua university and many IT companies are. China is trying to build China' Silicon Valley with it's universities and IT

companies. Then down south in Shenzhen, Guangzhou, we have the greater Bay Area initiative. which is aimed at exactly the high-tech sectors and service sectors. They have companies like Huawei and some other modern IT manufacturers. Yes, there are a number of clusters that China is trying to build. Lastly around Shanghai, more directed towards finance and modern logistics and trading."

This observation is shared by Mr. König as he explains:

"The clustering model is something we really see in the south of China – Guangdong province for example. There it is all about clustering. The driving force here is China's Urban planning – this is promoting clustering. Having industrial parks, having eco parks, that are serving particular industrial branches. The trend is the following: The cities are going to be huge hubs that are clustered anyway and within those "Cluster hubs" there is going to be more of a specialization. China is really pushing to promote the following: "City X is the car city and City Y is about aerospace."

Conclusively, Mrs. Jiang and Mr. König narrows it down pointing back to the government where Mrs. Jiang firstly explains:

"In the clusters in China. Still, there is a lot of government operation there. And the competition from outside is not so strong. Yeah, it's not so open. It's more like a zone. So that players can collaborate with each other and that, that could limit the development of these clusters."

Whereas Mr. König backs this up with his opinion, stating:

"My personal opinion is that we are headed to clusters steered by the government. If you think of Beijing: the government has the plan to combine 5 cities in one province to become this gigantic 150 million people city. In Shenzhen, there is also this clustering activity where it will be more than 65 people. That is also one expression of this clustering plan."

5.2.3. Collaboration and Innovation network

As findings from governmental influence, to regional clusters has been discovered, the last subcategory will be covering findings related to how exactly these clusters are beneficial for each other. Dr. Rathi starts off by providing an interesting aspect, explaining:

"Collaborations do exists, however, this is not between the battery companies themselves but rather the battery industries and the car maker. This is more due to technical reasons like ensuring that the compatibility between the battery and the car."

However, he further elaborates on this collaboration as we questioned this. Reflectively, he explains:

"There are also universities collaborating with battery companies. There are instances observed where universities aim towards working within the specified fields that are focused on by the government. I.e on universities are Tsinghua university in Beijing and Tongji University in Shanghai, and there must be more."

Interestingly enough, Mrs. Jiang provides an interesting detail to this, opening up for thought on why collaboration is emphasized. This was explained as:

"In the past China used to force foreign investors to make joint ventures and transfer technology, but now, because of the tradewar and WTO, China is not formally allowed to do so."

Finally, Mrs. Jiang comes to a conclusion of:

"You can't continue some old ways of doing things and China realize that they have to try and improve domestic indigenous innovation."

5.3. New knowledge

As pointed out by Lundvall (2007) "knowledge" and "learning" are the basis for innovation and key to progress. Therefore, we emphasized these topics in the interviews and found out that China has two ways of generating new knowledge. First, internally through their innovation system and second through FDI, mostly oversea M&A.

5.3.1. Internal creation

Opening questions regarding how businesses within the EVB industry creates new knowledge internally was set to light. Dr. Rathi points out the importance of linkages as he explains:

"So linkages between these institutions are being strengthened, as well as there being knowledge spillovers from universities to companies."

This goes in line with what has been revealed previously. Furthermore, Mr. König also touches upon how the policies focuses on creating dense areas to promote acquisition of new knowledge. Mr. König explained it as:

"The policies that are in place are the urban planning policies, with the pronounced goal of concentrating certain knowledge to certain parts of the country. This is the clearest expression as of now – this shows the trend China is currently headed.

Mrs. Holzmann supports the perceived movement Mr. König presented by the following statement:

"Chinese industrial policy is really focused on increasing the likelihood of successful technology transfers from the research to the business / industry."

5.3.2. Oversea M&A

Another aspect that was touched upon by several of the interviewees was the role M&A and the government has played for acquisition of knowledge for the Chinese innovative scene. This was explained by Mrs. Jiang as:

"Yes, and as you probably know, China has also tried to obtain overseas assets through investment and acquisitions. These are the major ways on how the Chinese government are trying to achieve high-tech growth."

On the question on whether foreign involvement for realizing MIC25 goals is of decreasing importance, Mrs. Jiang points out and stresses:

"That's right. Whether overseas investment or high investment into China, they're still relying on foreign technology and foreign patents."

This is supported by an report of the U.S.-China Economic and Security Review Commission. In the report "How Chinese Companies Facilitate Technology Transfer from the United States", O'Connor (2019) states: "Chinese FDI in the United States remains an important tool for acquiring U.S. technology, (...)" and continues: "The Chinese government encourages state-owned and private firms to acquire U.S. technology companies in line with the government's strategic interests in industries." O'Connor notes that "Chinese firms' attempts to directly acquire and invest in foreign firms focus on companies that have or are developing technology, IP, facilities, and talent in high-tech industries." The deal value reached a peak with more than 100 deals and an estimated deal value of USD 45 billion.

The semiconductor industry, an industry where China is lagging behind (South China Morning Post, 2018)[15], is illustration the strategy quite nicely: "In the semiconductor industry, for example, the Chinese central and local governments have established at least $107 billion of national and regional integrated circuit investment funds to finance increases in domestic capacity and Chinese firms' acquisitions

[15] Article: "China must face its weakness in semiconductors squarely, says head of state-backed fund."

abroad. Between 2013 and 2016 alone, China-based firms leveraged this state funding to attempt to acquire or invest in at least 27 U.S. semiconductor firms totaling more than $37 billion."

Hence, regarding new knowledge and technology China tries to follow the approach to primarily acquire this via their innovation system. In core technologies, where China is lagging too far behind and thus shows signs of great vulnerability in the supply chains of downstream industries, FDI is used to close the gaps.

5.4. Other notable challenges of China's innovation process

5.4.1. Lack of commercialization

In the aspect of challenges, commercialization was believed to stand as roadblocks for the Chinese innovative scene. Despite Mrs. Holzmann explaining:

"Geographically they want basic research and applied research to happen at the same place and to bridge the gap to business applications."

Mrs. Jiang points out that they still have a lot to learn and develop. Mrs. Jiang explained it as followingly:

"So, it seems still there's a lot of missing links, and often when we say that maybe in western countries, lots of venture capital, like angel investors would combine manufacturers and scientists. But in China, the money comes mainly from government ministries and from banks, and they seem to be not so good at making this marriage and identify commercialized innovations."

Mrs. Jiang further explains some research that has been conducted and how the role of commercialization is missing. Mrs. Jiang explains it as:

"Some have argued that it's not the problem of money. This money is for research and development. But to what extent they commercialized is the missing link."

Mrs. Jiang moves on with explaining her perception on the Chinese innovative scene its missing links. Another point Mrs. Jiang touches upon is the technological aspect. Mrs. Jiang explains it as:

"And so, it seems it's still China is good at making small innovations that adapt to specific, consumer needs, and some medium level of technology and online platforms, but they still lack the most, you know, cutting edge technology."

Mrs. Jiang then adds her last perceived issues to be:

"limits of private capital and private companies is another. Thirdly, they also say that China is quite behind in the highest level of technology, but better in medium and lower levels and that China has the most patents."

Through these perceptions, questions on whether the lack of cutting-edge technology arises, and perhaps stands out as a reason for the lack of commercialization. The arguments for the lack of highest level of technology is further supported by Mrs. Holzmann, even though she also adds another perspective to it. This was explained as:

"My perception is that the level of technology is sufficiently good, and it has increased a lot. My understanding is that it is not in particular top-notch but it is also not the aim of China because they have 1. decent quality 2. high capacity 3. the ability to scale up the production quickly and to finally take that abroad. They have highly competitive products not only in the Chinese market, but also in the global market."

5.4.2. Lack of openness

Once again, the influence of the government is centrally focused upon. Mrs. Jiang explains how the central government contributes to the degree of openness the Chinese innovative scene:

"But one major difference from Silicon Valley (vs. Greater Bay Area) is making the flexibility of markets. Still, there is a lot of government operation there (here: Greater Bay Area). And the competition from outside is not so strong, it's more like a zone. So that players can collaborate with each other, but still as it is not that "open" it could limit the development of these clusters."

Another interesting aspect included by Mrs. Jiang reflects supports the intervening role the government can play for the Chinese innovative scene that Mr. König touched upon. Mrs. Jiang explains it as:

"(...) foreign competition could be an incentive for better productivity. But in China, it's more like an infant industry, and we give money and you try to make up, make something out of it. And, some analysts believe that, market mechanisms in these areas with less government intervention would be better for them."

6. Analysis

In this section of the paper will we will bring together elements from "setting the scene", our findings, and how this responds to the theoretical concepts presented earlier in the paper. Therefore, our analysis will produce insights on the applicability of the theory to the Chinese EVB industry.

6.1. **Analysis case I: Chinese national innovation system** –

In this part of the analysis, we will analyse China's NIS, how the governmental measures shape it and how it relates to the domestic EVB industry. Since we believe that the historical development of China's NIS contributes to answering the first sub question, we will start off our analysis with a short historical review showing how the Chinese NIS evolved since 1978.

After this, we will analyse how China's policies, plans and initiatives on a national level contribute to an efficient innovation environment in China. Therefore, we will look into the effects on Sources of innovation, Interactive learning and social capital.

"Interactions" and "Institutions" won't have seperate sub-chapters, as they are to a large degree already embedded in (1) - (3). After this we will analyse how Nelson's (1993) findings for effective innovate performance apply to the Chinese EVB industry.

6.1.1. China's NIS in a historical context

In the paper "China's innovation system and the move towards harmonious growth and endogenous innovation" Gu and Lundvall (2016) attempt to capture the current characteristics of China's production and innovation system.

Analyzing China, it is according to Gu and Lundvall (2016) crucial to distinguish between two periods in the 20th century. The turning point is 1978 when Deng Xiaoping took over the political leadership and initiated economic reforms like the "open door policy[16]". Therefore, Xiaoping started China's economic

[16] Open Door Policy refers to the new policy announced by Deng Xiaoping in December 1978 to open the "doors" to foreign businesses that want to set up in China. Chinese economic policy then shifted to encouraging and supporting foreign trade & investment.

transition from a centrally planned economic regime to a market-oriented economy (Gu and Lundvall, 2016). The policies that supported this transformation may be seen as two parallel and mutually reinforcing lines of action, aimed at "decentralization" and "privatization" (Wu, 2003).

Decentralization was concerned with increasing the "autonomy of firms in decision-making on production planning, investment and acquisition of technology, marketing, pricing and personnel and with more autonomy to local governments in financial, budgetary and administrative issues" (Gu & Lundvall, 2016). Privatization was mainly concerned with the creation of "Special Economic Zones[17]" (SEZ) for FDI-related investment. Throughout the 80s, the SEZ setup attracted partners from the Greater China area – Hong Kong and Singapore and from the second half of the '90s also multinational companies from North America and West Europe (Gu & Lundvall, 2016).

Gu and Lundvall (2016) point out that producer-driven industries like computer and IT products exports are mainly manufactured and exported in factories owned by Western and Taiwanese investors. They calculated that in 2003, 61.9% of high-tech exports was produced by fully foreign-owned and 21.4% by partly foreign-owned firms. This is quite important as it shows China's ability to easily access foreign technology.

However, Gu and Lundvall (2016) describe a set of issues in the Chinese economy that indicate weaknesses in their NIS:

- Massive penetration into global markets and trade disputes.
- Jobless growth, inequality in wealth distribution and redistribution, entails social instability.
- Slow pace in competence and competitiveness upgrading, China is still specialized in low value-added products with profit margins ranging from 2% - 5%.
- widening income gaps and negative environmental externalities.

The reform of the Chinese R&D system in 1995 was highly "systemic", but as it turns out, the problems remaining after the reform are also highly systematic. Gu and Lundvall (2016) state that the key issue of the system that negatively affects "absorption of foreign technology" and "domestic innovation" is that in organized markets the "economic structure does **not support learning by interaction**".

[17] According to the World Bank, SEZs have significantly contributed to China's development. SEZ has given the government a tool to experiment with market-oriented reforms, while attracting international capital, technology, as well as technical and managerial expertise.

In the following, the central theme for reforms was to rearrangement of relationships between the knowledge producing body and users and their relationships with the government.
The goal of this is to overcome the organizational separation between innovation and production that impeded the system of vital and intimate interactions between producers and users, which is among scholars regarded as essential element for innovation in sophisticated producer goods technology (von Hippel, 1994; Lundvall, 1988).

6.1.2. China's NIS from a western-centric perspective

In the context of NIS, scholars pointed out the importance of the government to be the "coordinating agent" of actors involved in the innovation process. Therefore, the government has the role to release policies that coordinate academia and industry in a way that promotes interactions and interactive learning and therefore an efficient innovation process.

Our findings stress the central role of China's government for the innovation process. China's central government gives guidance to academic institutions and industries by releasing long-term national policies and by communicating coherent long-term national goals. The key policies on the national level are the MLP, as well as the MIC2025 initiative. As noted in our findings the central government releases *"long-term plans that lay out the priorities where the state wants academia, the industry but also local governments to focus their research on."* This suggests that China's economy is not really driven by market forces, but that it is more guided by the government. Therefore, we found that neither academia, nor the industry are "*completely independent of the government "*. So, the Chinese government takes the role of coordination by coherently defining long-term policies and initiatives that put priorities on innovation in particular high-tech industries and therefore guides academia and industry into those favoured directions.
MIC2025 targets virtually all high-tech industries that strongly contribute to economic growth in advanced economies (Merics, 2016). As layed out this also includes the EV industries with its most critical upstream supplier - the EVB industry. The support of EV manufacturing in China is as much about helping China upgrading it's manufacturing value chain as they are for reducing pollution. This is

in line with Gu and Lundvall (2016) that identified "environmental degradation and negative externalities[18]" being central issues in the Chinese innovation system and that requires action on national policy level.

Hence, by defining the EV industry as strategic industry (and therefore also the upstream EVB suppliers) and including it into the MIC2025 plan, it shows the dynamic aspect of China's innovation system as macro structures condition micro-dynamics (Lundvall, 2007). This is a great example how the policy on national level battles the weaknesses that China's old NSI revealed in 6.1.1.

6.1.2.1. Sources of innovation

Looking into the contribution from R&D to innovation, Lundvall (1992) stressed the importance of non-R&D sources for innovation. Lundvall regards non-R&D sources as some that are based around "learning by doing", but also includes "user-producer" relationships and Nelson (1993) adds "upstream-downstream connections".

The findings show that EVB companies are collaborating with EV manufacturers. Looking into the value-chain, this represents a downstream connection[19] as the EVB companies act as suppliers to the EV manufacturer. The collaboration is said be due to "technical reasons" to ensure "compatibility" between the EV and the battery.

This collaboration is also due to the subsidies in the EV market of importance. As pointed out, the market for EV's matures and the government has not only shortened subsides but also raised the bar for subsidies even higher (in terms of minimum reach of the EV). In the pursuit of producing EV's that are eligible for subsidies, the EV manufacturer will request higher advanced batteries, ultimately leading to the exchange of ideas and knowledge with their upstream suppliers. Putting this in light of theory, it confirms Nelson's proposition that *"firms in industries where a country is strong tend to have strong interactive linkages with their upstream suppliers who are also national firms."* The decrease in subsidies also leads to effective innovative performance according to Nelson (1993) as the home market is becoming more

[18] Negative externalities also include environmental degradation such as pollution of air and water and exploitation and wasteful use of other non-renewable resources.

[19] From the point of view of the battery manufacturer

demanding. Since strong collaborations between EVB- and EV manufacturers exists, it seems that the organizational separation between producers and users fades.

But China's innovation system is not purely depending on non-R&D sources. China has also classical R&D sources in place. One example would be China's MLP and the coherent commitment to spend 2,5% of GDP on R&D. As pointed out in our findings, China has a number of initiatives to support domestic S&T as well as R&D.

The program translates to "Star and fire" or "sparkling" and the money goes mainly to research institutions (academia) to "spark" innovations. Other R&D programs includes "973" and "863", with 973 focusing on funding basic research and 863 focuses on encouraging high-tech industries.

6.1.2.2. Interactive learning

Scholars, most prominently Lundvall (1992) pointed out that not only knowledge but also everyday learning ("learning by interacting") is important for the innovation process.

In Lundvall's words, the innovation system is a "*system constituted by elements and relationships which interact in the production, diffusion and use of new and economically useful knowledge*" (ibid). Learning processes includes: new knowledge, new combinations thereof or the introduction of knowledge to a new person. We discovered that there is strong competition between local governments to attract high-tech industries. This is an issue because on a macro-perspective it is regarded as inefficient when multiple regions all specialize in the same industries.

On a national level the central government responded with a so called "urban planning policy". The basic idea of the urban planning policy (or the interregional coordination) is that high-tech industries get assigned to different regions. This has a few favourable effects: (1) concentrating certain knowledge to certain parts of the country, (2) overcapacities and redundancies are avoided and (3) it makes the country more manageable and diversifies where the wealth goes. The idea of having concentrated knowledge of different actors in geographical proximity is to allow for cooperation, coordination and alliances to occur. It increases the likelihood for successful knowledge spill overs as well as the successful recombination of knowledge. Lastly, this should also "bridge the gap to business applications" – a process China is not regarded to be particularly strong in.

Regarding "Knowledge", Nelson (1993) states that it is crucial for innovative performance to have the people with the right knowledge and skills. Therefore, it is of fundamental importance to have specific university programs and external training systems linked to the firms. With programs like "985", Chinese central government promotes the reputation and development of higher education in China and drive towards academic excellence, also in S&T areas. Also, as in setting the scene displayed the higher educational sector grew in terms of graduates drastically. Also, the number of R&D institutes and R&D personnel increased strongly. Therefore, we believe that the Chinese academic sector is producing people with the right skills and knowledge that can contribute to the innovation process of the firms.

6.1.2.3. Social capital

Also, social capital is found to have a positive impact and stimulate innovation. As found out, the higher the innovation output of a nation, the higher the income per capita. Social capital is concerned with shared norms, values and understandings that facilitate cooperation. Ultimately, the concept of social capital can be narrowed down to the degree of trust within groups or societies. Higher social capital facilitates an increase in groups working together, but also for example VC's funding riskier projects. We believe that the Chinese central government with its coherent communication of long-term plans, in connection with the long-term support of strategic industries supports an increase in the nation's social capital.

In the findings, it was stated that the guided system helps the entrepreneur because "you know what works and what not[20]" and it was formulated even stricter: "what is hip or going to work if shockingly often dictated by the state". The findings illustrate this aspect by pointing out the high number of EV start-ups in China: "It is not because people are passionate about mobility or logistics, it is because they know that the EV industry will be supported."

Another aspect of this is the positive impact it has on financing and funding. We found out that that there is the tendency to take risk and try out new things because the involved parties know that it is "backed by the government". It was pointed out a couple of times that when you have "the right idea" getting financing in various forms is no issue. In this context, it is important to note that "the right idea" or

[20] Quote by Mr. König where he refers to the guided system and the benefit for entrepreneurs to know which industries will be likely to be supported (in terms of R&D funding, financing, incubators, etc.) and which not.

“trying out new things” is concerned with entrepreneurship that has an impact on the defined strategic industries by the states.

6.1.2.4. China in Nelson’s context

As pointed out in the literature review, Nelson (1993) defined factors for effective innovative performance. In the following we will be looking into three factors and link it to the Chinese EV and EVB industry.

(1) Nelson found that “becoming strong” (in the sense of competitiveness) involved being “exposed to strong competition and being forced to compete.” As China’s urban planning policy drives knowledge and industries to particular regions, ultimately leading to the formation of clusters and hubs, we do believe that the Chinese firms are exposed to compete. Also, News about CATL being supplier to BMW and rumours about supply negotiations between BYD and Audi support this aspect that the firms are competing. However, in the Chinese EVB industry this competition is too the largest extend only with other domestic producers, due to the certification scheme. As the findings show, this lack of openness to foreign competition could limit the developments of the clusters. Hence, the EVB industry is not seen to be exposed to competition to the fullest extent.

(2) Since Chinese EVB producers are seen to be exporting their products, the set of fiscal, monetary and trade policies are assumed to create favourable conditions for that. Therefore, this factor is seen to be fulfilled.

(3) Nelson justifies infant industry protection programs, subsidies and government guidance if two conditions hold: First, firms have access to the right knowledge and second firms are pushed to compete in global markets.

We found that infant industry protection, subsidies and government guidance occurs to a large degree in the Chinese EVB industry. (1) The industry is protected by certification scheme, (2) in the downstream supply chain (EV market) subsidies promote demand and therefore also demand upstream and (3) the government heavily guides the industry in a specific direction and supports with funding and infrastructure. More importantly, we also found that both conditions hold with limits though. We said that the EV and EVB industry in China are to a large degree correlated. The EVB industry is seen to be

exporting their products, as supply deals with German premium manufacturer point out. However, the EV industry is not seen to be pushed to be competing on global markets.
Since both conditions hold to a high degree, infant industry protection program like the certification scheme, the subsidies and government guidance have a positive effect on the industries innovative performance.

6.2. Analysis case II: Chinese regional innovation system

In this part of the analysis, China's RIS will be analyzed in order to get a perspective and understanding of the regional innovation structure with focus on what implications the government measures has on the regional innovation structure as well as the domestic EVB market. This will be done by firstly looking into: Regional innovation theory, Innovation networks, Clusters.

6.2.1. Regional innovation system theory

Proceedingly, the RIS displays a more detailed and narrow illustration than the NIS. Looking into the theory itself, the RIS as mentioned previously covers *"how systems of innovation operate and interact with each other"* (ibid). This is important to take into consideration as studies have shown the importance of innovation for generating economic growth, domestic development, and global competitive advantage through perspectives of regional focus (ibid). In terms of parties operating with each other, the findings already pointed out the significant contribution and influence of the Chinese government, but also the influence of academia and businesses.

A subtraction one could make out of this in light of the theory and the findings is that the actors within the EVB industry are not acting independently, but in coherence with its surroundings. This was accordingly to circumstances such as business environment, accessibility to information, proximity, cooperation possibilities, relevant actors and set policies (ibid). By having the central government tailoring policies towards certain directions, this plays as a contributing role to creating an environment that could naturally encourage interactive learning and collaborations. An example of this can be seen

through the indirectly embedded collaborations that was discovered between the EV industry and the EVB industry as they coherently move forward together. By having governmental subsidies provided for the EV industry, the EVB industry indirectly gains from this as demand increases. One has to take into consideration the complete supply chain, availability of information and prices into consideration, as every small detail would be of importance when looking for a business partner. Hence, if EV industries are located in one specific region, it would be of more benefit to take use of a geographically and technologically closer EVB manufacturer to cooperate with as this would provide for more efficient and valuable value chains. This example can be observed to be a clear example on how collaborations through government measures causes for interactions and regional clustering to develop.

Moving on, the findings also revealed that the approaches used by the government to encourage and enhance the development of the innovative scene was of high variety. We discovered for instance measures of both IFDI's and OFDI's as well as joint ventures and partnerships to play significant roles. These were all shown to be structured by the issued policies from the government.
The one argued for to be the most beneficial one for the innovative scenes was joint ventures and partnerships in the catching up phase. This was revealed in the findings as it was indicated that foreign influence of cutting edge technology remains crucial for China's innovative scene today. Systematically broken down, the government through their policies tries to structure how the flow of information, influences and cooperation goes. As the new policies encourages for indigenous innovation, we can simultaneously see the Chinese government's ambition on decreasing their dependency on foreign influences through changes in policies, goals in initiatives and through their plans. We argue for that this is to improve domestic development but that it also could cause for weaker competition compared to a case where foreign entities would be involved. This could arguably lead to a lower degree of innovative development, depending on the complexity of the involved businesses in the EVB industry.

Another important aspect is observed in the findings where it points out how the different industries, as well as the EV and EVB industry, has been given a "blueprint" on how they should develop and what segments of the market to target in order to receive the advantages provided the government. An example on this was observed within the EV market, whereas mentioned earlier, subsidies was being provided given that the companies were to follow ideal procedures presented by the government (ibit). Through

the economic relief the subsidies provide for the EV and EVB industry, this allows companies granted these incentives to have the liberty to direct more financial assets towards R&D and eventual other corporations and needs. However, one could also argue for that the degree of subsidies also could act as a contra-developing factor as it could lower the degree of competition.

Followingly, academic institutions were revealed to play key roles in developing and cooperating with these businesses, covering R&D. The resources invested in higher education is of high density, creating a special strong academic foundation for the innovative scene. This implicates for highly educated labour pool to get involved. As the EV industry witnesses themselves to be in a beneficial spotlight by the government, this provides for a bigger market for partnering businesses, the EVB industry, hence also creating a larger opportunity for the EVB industry to scale. This all goes back to the initiatives set by the government which has led for industries to search for ideal settings that can provide the most beneficial foundation for their development. These examples contribute to explaining how the government influences the different industries, encouraging and promoting cooperation among them, in addition to involvement of knowledge capital through academic institutions. A relationship between government, private businesses and academic institutions is apparent.

Broken down even further, it was drawn out that the governmental influence was not only from the central government nor of economic measures. An example pointed out in the findings was the local government, as they were observed to be giving pieces of land to build manufacturing points, along with other incentives. Seen on the regional macro-meso level, the RIS highlights the importance of *"territorial agglomeration providing the best context for an innovation-based globalizing economy."(ibid).* The findings showcase that the government supports the idea of this theory by having each region having local government promoting the "national champions" within their region. This is because, as these national champions grow within their region, it would naturally nurture the infrastructure, social variables and other factors in the region. However, an important aspect to keep in mind is that this has to be done in context with what is available, hence creating different kinds of clusters.

On the contrary, the existing clusters was however also pointed out to be problematic in some cases, as the aim of national policies are to increase the development on a macro level, but instead created

imbalances and uneven development on a macro-meso level within specific regions. The findings revealed that competition between the local governments occurred, opening up for redundancies, especially among different regions. Furthermore, an argument on whether this is the case for the EVB industry can be drawn to question as it can be seen through the visualization illustrated by Merics (see Appendix V) that there is a significant amount of EVB manufacturers in the provinces of Guangzhou and Jiangsu, compared to other regions. This implicates the presence of the statement pointed out in the literature stating, *"regional systems of innovation in different areas in a country can differ significantly"* along with *"the importance to not neglect that there is widespread evidence between different regions in the world " (ibid).* The central government has however tried to address the issue by promoting for inter-regional coordination. The counter argument for whether this is a negative case or not for the EVB industry is found in the ambitions of the national government of China as it indicates that it wants different regions to solely focus on specific industries in order to maximize the development. One could therefore argue that, given the clustering formation shown in the south, one can make the assumption of inefficient redundancies to be of lower likelihood. However, one can question whether the coordination among regions has been organized properly. We however argue for that despite the redundancies that was discovered, the battery industry remains strong, mainly as the EV industry along with the EVB industry are perceived to be organized properly.

With this in mind, it is also important to make a distinguishment between central and local governments. The main difference between the central and the local government lies in the scope of the effects. The central government stands for measures like policies and initiatives like MLP and MIC2025 to direct for industrial development towards a certain goal. On the other hand, the local government is mainly focused on the local development and how they can specifically give the regional industries advantages. However, it is also important to keep in mind that the findings argued for that local government contribution resulted into regional development.

The second thing which is important to keep in mind is that it comes out clear that cooperation among these parties is present, but also that there are several other variables involved. The interaction and cooperation that emerges is mainly built around the foundation made by the set plans of both central and local governments. From the perspective of regions, local governments are presented as a central factor

in the development of the infrastructure of innovation and innovative systems. Furthermore, it is clear that the industry is indirectly dictated by the government through certain incentives and advantages given by following the "blueprints". Consequently, as each region are to have different advantages in form of resources, location, academic institutions and researchers, the formation of clusters with different specializations is inevitable.

Thirdly, the effect regional focus on cooperation, systematic engagement and interactive learning encouragement has on the Chinese EVB industry directly can be measured by the development of the companies involved. As the theory coherently with the findings states that the establishment of these previously mentioned factors contributes to helping the innovative scene develop and become more competitive, it is already clear that the battery giants of China has taken advantage of this. Given that the circumstances for this industry, related to business partners, academia and environment is tailored towards their needs by the help of not only central but also local government, it is undeniable that the national champions of the EVB industry are flourishing at a remarkable pace. One could argue that it is steered by a multi-level governance as the focus narrows down from national to regional. With CATL and BYD being among the top 5 battery manufacturers in the world, one can with the observed infrastructure argue for that the cooperation between the involved parties, especially the government along with environment has played a key role in their development.

6.2.2. Innovation network

As the theory of innovation network tries to point *"how strategic institutionalization of innovation between private and public sectors is formed in a systematic manner"* and how *"this results to a formation of an institutional infrastructure to the production structure of a region (ibid)"*. In the position of the EVB industry, as previously discussed, the formation of an institutional infrastructure within a region has already been witnessed, as government measures has been acting as a strategic institutionalization tool for innovation between private and public sectors, resulting to institutional infrastructure. This was basically broken down further by Lundvall (2010) as a set of relationship between nodes being institutional forms and their partnerships and involvement with parties involved in

the network such as suppliers, customers, competitors and similar (ibid). The battery industry of China can therefore be categorized to be within a innovation network.

Pre-emptively, an assessment on how the Chinese battery industry innovation network is structured has to be further defined. This will portray an image on how the private and public sectors but also parties like suppliers, customers and alike coherently operate and orbits around national policies and government initiatives.

Endogenous vs Exogenous innovative network

Endogenous innovative network as presented earlier is characterized by their *"foundation being built upon already existing regionally or locally delineated cluster of small and medium enterprises"*. On the other hand, "*Exogenous innovative networks come from firms situating their production structure and R&D in functionally specialized zones and with planned exploitation of established innovative environment due to partners like universities and SMEs"*.

In the case of the Chinese EVB industry, several arguments can already be established on where they fall and why. Firstly, the Chinese EVB industry is not something that has been developed over a longer period of time. As already presented previously as a key point, we already witnessed the development of the fairly newly established giants within CATL which was founded in 2011 and with BYD being founded in 1995. The establishment and significant development if to be compared to counterparts like Panasonic and Samsung which has been around since 1918 and 1938, is of different level. The considerable trait that has to be observed here is that CATL and BYD are perceived to be among the top 5 biggest battery manufacturers already. With the given functionality specialized zones with innovative environment provides, it comes out that the Chinese EVB industry in the case of BYD's and CATL's has benefitted majorly from this. This contributes to showcasing the strength of how proper environment for innovative development is crucial.

Accordingly, to theory of the exogenous innovative networks, industries that falls within this category also have their production structure and R&D around specialized zones. According to BYD and CATLs respective websites, BYD has headquarters and several manufacturing and researching sites located

around the province of Guangdong, close to Shenzhen. CATL on the other hand have their headquarters located in the neighbouring province of Fujian but also has manufacturing sites in Shenzhen (BYD, 2019; CATL, 2019). Regarding the policies and intentions set by the Chinese government which was mentioned previously, together with the Chinese vision of bolstering indigenous innovation, one could argue that the defined locations are set to enhance and promote knowledge spill over, regional cooperation and development. This falls back once again on the theory of benefits of RIS as it is supposed to promote innovative development. The arguments therefore support the two circumstances given within the exogenous category and therefore conclude for the EVB industry to be of exogenous category.
Moreover, this can however be broken down even further as to whether the industry is of endogenous or exogenous nature only serve as an indication of the classification type within the theory of regional innovation system.

TERI - RNIS - RNIS2

The Chinese EVB industry as described previously mainly have their manufacturing sites within close proximity of other regions that could be considered as *industrial clusters*. However, it was also pointed out that the industry itself has had governmental and positional influences by promoted cooperation and spill overs by not only companies and private entities but also academic institutions. As the findings pointed out, there are several industries that have tried to station their R&D and S&T faculties in a location with academic cooperation possibilities. Beijing, for instance, has Tsinghua, where it was discovered that IT services specifically tried to aim for. Once again, a further argument for an industrial setting, together with available resources for further development such as academic involvement is something the Chinese industries and government is keeping in focus. In other words, the structure of the government policies together with locations and partnering possibilities once again leads to the formation of clusters. Conclusively, taking the characteristics of the *TERI* into account (ibid), it is therefore argued that the EVB industry **cannot** be considered under this category.

Moving on, one could say that the *TERI* is a premature structure of the Chinese EVB industry. With the characteristics of the RNIS and RNIS2 taken into consideration in light of gathered data and findings, we argue for that the Chinese EVB industry is witnessing itself to be evolving. Firstly, as RNIS argue for localized and interactive learning as well as strengthened regional institution infrastructure, this is

what the findings has been showcasing the Chinese EVB industry to be currently doing. However, a development of these environments has been observed as change is occurring domestically. This stems from the involvement and change of policies set by the government. As the findings and gathered data highlights, China was primarily dependent on foreign influence and attempted to integrate international innovation systems in order to boost their own industries. This has been in the form of joint ventures and trade of market entrance for technology transfer. In light of theory, we argue for that this approach of interaction pursues a more international innovation system integration of functional degree, which is of RNIS2 nature. In light of this discovery, we argue for that they are evolving. This evolution can be seen as the Chinese government has set itself goals of boosting their indigenous innovation, factors like proximity, linkages between firms, R&D bodies, and support organizations becomes of much more importance, as these play central roles in solely developing domestically. In line with the theory and findings, we can see the Chinese governmental action of deliberately focusing on strengthening regional institutional infrastructure, creating specialized regions. This arguably goes hand in hand with the initiatives of MIC2025 and also contributes to coming closer to realizing MLP. However, it is important to keep in mind that China has yet to be able to see themselves as completely independent, as they know that their innovative sides still lack on the high cut edges. We therefore still see partnerships and cooperation between the EVB industries and international actors, but the focus of the government lies within increasing the independence of the Chinese national champions.

Conclusively, even though RNIS tends to be of endogenous nature, due to the influence and capabilities in the Chinese government's disposal, an exogenous network was characterized. Conclusively, we argue for that the EVB industry is witnessing a transition from integrating international innovation (RNIS2) to bolstering indigenous innovation (RNIS).

6.2.3. Clusters

In accordance with the previously conducted analysis, clusters, in the form of industrial clusters specifically, stand out as one of the essential building blocks in the Chinese innovative scene, including the EVB industry. One of the main reasons that have been repeatedly showing up for why clusters are being formed is due to its enhancing abilities on creating indigenous China for development and on

bolstering competitiveness. As the theory of industrial clustering highlights, *"the importance of continual innovation is required in order to maintain competitiveness"*. This is what is arguably being observed in the Chinese EVB industry today. The shift of being dependent on foreign influence to focus on developing indigenous development is a clear indication of where their ambitions are headed towards, as this contributes to boosting the domestic market, development and potentially the competitiveness. Furthermore, the Chinese EVB industry will be aiming to see itself in one of the global steering positions and the formation of the clusters in this position will be proven to be playing a crucial role in the future.

Additionally, how these clusters are bolstering the competitiveness of the Chinese EVB industry is in correlation with the theory of competitive diamond. As the previously conducted analyses covered which partners and institutions that have an influential role in the EVB industry, the competitive diamonds also covers how this clustered structure also provides for stronger competitiveness. This is as illustrated in the literature mainly divided into three sections.

Firstly, the correlation between clusters and productivity is apparent, as through structural setups with academic institutions, fellow operating entities as well as governmental support has shown to allow for access to institutions and public goods to be high. Additionally, beneficial policies like subsidies also provides companies more room to play with in terms of financial freedom. The question on the relationship between clusters and productivity rates is therefore argued to be high.
Furthermore, according to Schaaper (2009), we also see that the role of the higher education sector has increased in accordance with the development of the innovative scene as the data shows that the business sector has been increasing R&D share to higher education sectors. This provides for the business sector to be more flexible with production and research in-house but also to make use of the highly educated human resources, hence, better access to employees and specialized information.

Secondly, we argue that the presence of knowledge spill overs and competitive rivalry is present. This was clear in the findings as we saw clear cluster formations within the southern parts of China specifically. Additionally, BYD and CATL has also reported themselves to be in-going several partnerships with different EV manufacturers in accordance to bolster their innovative development. This

evidently shows the presence of how knowledge spill over could contribute to enhancing the innovative scene of the EVB industry.

However, clusters forming within a region does not necessarily indicate that all businesses and industries within this cluster cooperate with each other. As different alliances and agreements between businesses can be formed and given the vast amount of producers and knowledge circulating through the clusters, each business has to assure that they are among the best ones.

This means, despite the currently formed partnerships, BYD and CATL will continue to compete on being most attractive for foreign and domestic EV car manufacturers to cooperate with, hence, increasing the competition on making the most cutting-edge EVB in the market. The EV industry and the EVB industry will continuously pressure each other to innovate in order to compete with other partnerships but also other producers. We therefore argue that the clustering formation provides for competitive rivalry, especially as the EVB industry has to make sure to live up to the EV industry qualifications.

Thirdly, we questioned whether the observed clusters within the Chinese EVB industry in relation with business formations provided advantages, and what other implications it could have. With the gathered findings and data, we argue for that, as the business formation is shaped by the implications from the policies set by the government, it is not the business formation itself that provides for advantages but rather the government policies. This is because the Chinese central government already has national champions and industries that they want to invest in, like mentioned in the MIC2025. Therefore, being located within the cluster itself will not necessarily give you the same advantages as the other companies within the same location. This is highly dependent on the government's opinion on your business. This does not mean that the cluster itself does not promote innovation, as we believe, through the previously analysed factors, that there are businesses within a cluster that cooperates. However, we argue for that the underlying driving factor for the innovation is not the market window formed by the cluster, but rather the policies set by the government.

7. Conclusion

7.1. Concluding on research question

In this thesis, we have investigated how the Chinese innovation system relates to the emerging electric vehicle battery industry. We have researched how "innovation in China" works in the context of the emerging EVB industry. Therefore, we are now able to answer if the Innovation System literature holds to explain this phenomena.

Sub Question 1:

How do governmental measures shape Chinas National Innovation System and relate to the domestic electric vehicle battery industry?

China's NIS is strongly influenced by the country's vison to be a global leader of innovation in the S&T field and therefore also a prosperous and wealthy nation. We found out that the Chinese government is taking a central role in coordinating and guiding academia & industry into favoured strategic directions. The guiding measures is a web of plans, initiative, and policies that is designed to enhance the country's innovation process. The market for EV's is defined as a key strategic industry that should contribute to China's economic growth in the future. Accordingly, the upstream supply chain, most prominently the EVB industry, is being developed in a robust fashion that the country's future reliance on foreign technologies decreases – it goes even further than this, it seems that China is emerging into the position to set future standards. Therefore, the central governmental measures also apply to the EVB industry. The web of polices is promoting the efficiency of innovation within the EVB industry. Governmental measures target to an array of elements that are found to have a positive influence on innovation: R&D and non-R&D based sources of innovation, interactive learning, interaction with the environment, institutions and social capital. It applies to the EVB industry as follows:

(1) There is no organizational separation between EV – and EVB manufacturers apparent. Governments supports this by their urban planning and interregional coordination policies. Therefore, powerful non-R&D based sources as "learning by doing" are enabled. (2) China's central government improves the

countries higher educational sector by continuous funding. Paired with and industrial push towards clusters this increases the likelihood of knowledge diffusion, recombination's and knowledge spill overs of EVB manufacturers, universities and other government funded institutions. China follows a build or buy strategy: necessary technologies that cannot be built internally are acquired via oversea M&A activities. (3) The consistent communication of visions, long-term plans and the policies by the government are seen to have a positive impact on the level of trust, increasing the social capital and therefore also the innovative efficiency.

Also, we found that Nelson's (1993) factors for efficient innovative performance are to a high degree fulfilled by the EVB industry. However, lacking openness for foreign competition due to the certification scheme, may limit the development of EVB clusters. Also, the lacking competition of the strongly correlated domestic EV industry on the global markets stands out. Here it becomes apparent, that the innovation potential is not to the fullest extent exhausted.

We found that the "system" is dynamically reacting to changing micro-behaviour. Reached production scale of EV and EVB manufacturers gave rise for shortening the subsidies and increasing the hurdle rate. Hence, central government takes the role of creating a more demanding domestic market, forcing the EVB industry to focus on the innovation process even more. The Chinese innovation process on national level is seen to be of increasing efficiency, highly systematic, but also dynamic as macro structures influence micro dynamics and vice versa.

Sub Question 2:

How does the governmental measures contribute to shaping the regional innovation system, and which implication does this have for the domestic electric vehicle battery industry?

In light of the analysis conducted on RIS, it is clear that the companies within the Chinese innovative scene never flourished independently but coherently through relationship with relevant actors. A clear example on this was illustrated through the EV and EVB industry. Furthermore, cooperation between the industry, government and academia was stressed repeatedly. This further highlights how the Chinese innovative scene steps towards further developing is alined with the characteristics showcased in the RIS theory. We also conclude that the Chinese RIS promotes clustering formation through governmental

measures, encourages for interactions and specialized zones, paving the way for the national champions to flourish in not only the domestic market but also internationally.
All in all, we argue for that through the concepts presented by the RIS, it is apparent that this ideal set up of regional clustering environment together with the influence of the involved partners, especially the government, has a positive effect on the EVB industry. The Chinese innovative scene will not only keep developing but eventually have their national champions take the leading seat in the international scene, as a sub-effect of the structured environment.

The analysis clarified that the Chinese EVB industry is within a innovation network. We broke this further down, and discovered that it is clear that the Chinese EVB industry from a regional aspect shows to be of the exogenous category. This was mainly argued for because Chinese EVB businesses was witnessed to place their production structures within specialized zones with planned exploitation of innovative environment as well as promoted collaboration with universities being present. The gathered data concluded that this was mainly formed due to governmental measures. It further became evident that the formation of these functionally specialized zones has benefitted the EVB industry. Furthermore, the regional innovation network in the case of the Chinese EVB industry can be concluded to initially be off RNIS2. However, due to the highlighted factors, we can see the trend of the industry moving towards RNIS. Once again, the central government illustrates how their measures, such as initiatives and plans, directly contributes to shaping regional structures and industries as well as their market approach.

Lastly, the analysis in light of the theory of clusters indicates that (1) – the relationship between innovation and productivity is evidently concluded as positive mainly due to the structural setups visible in the clusters allowing for increased access to institutions, public goods and a highly educated labor pool. In other words, the relationship allows for higher productivity. (2) – The presence of knowledge spillover and competitive rivalry is also evidently to be positive as the EV industry is highly interacted with the EVB industry in dense areas, resulting for opportunities and availability to be considered as present. This explains for the presence of knowledge spillover as it was argued for that companies within the respective industries in a cooperative setting could be providing each other with assistance. However, it was also pointed out to not neglect that entities within these industries are shown to be on constant pursuit for innovative development also due to the availability of substitutes due to these clusters, hence,

explaining the presence of competitive rivalry. (3) – Promotion of innovation and unique business formations was however more questioned. As the analysis stated, it was not the business formation itself that necessarily gave the innovative scene advantages but rather the governmental measures put in action. However, the business formation itself was observed to be an implication of these governmental measures, hence, in the end also supporting the innovative scene.

How does the Chinese innovation system relate to the emerging domestic electric vehicle battery industry?

The analysis conducted on the relationship between the Chinese innovation system and the domestic electric vehicle battery industry in light of NIS and RIS theory is evident. Both theories in context with the analysis argue that the Chinese innovation system is mainly structured through the measures issued by the Chinese central government. This was evidently to be seen in the form of initiatives and plans, where key performers - government, academia, and businesses were present in light with indigenous innovation. These initiatives and plans further resulted in the evidently argued for domestic infrastructure that has been built and tailored towards enhancing the innovative scene, including the EV and the EVB industry. This was witnessed through China's smart approach of protecting their home market for domestic infant industries while fuelling their development with policies and subsidies. This creates a strong foundation for these industries to use as a start point and will only contribute to further enhancing their position in not only the domestic market but also the international market in the future. It is also evident that China is in possession of special characteristics as the market is artificially created by the central government, through their policies and initiatives. All in all, we conclude that the analyzed Chinese innovation systems, built up and structured around governmental measures act like an enhancing infrastructure and environment for the EVB industry's development.

Coming back to Napoleon: his reasoning can be seen as correct to some degree. As presented the process of learning and a huge domestic market are important elements in China's economic rise. However, both are worth little if not supplemented with the right governmental measures that increase the interactions between government, academia, industry and supports an efficient innovation and commercialization process. By having the innovative infrastructure that supports the emergence of Chinese technological giants, we might witness a shift of power towards the east.

7.2. Further research

As the thesis only covers a selection of aspect of the relationship between the Chinese innovation system and the emerging EVB industry, other topics for further research could be of interest to research in order to deepen the theoretical depth and strength of our thesis.

Firstly, as the thesis studies on the innovative interactions and infrastructure, mainly in context with the EVB industry with a small segment including the EV industry, an analysis on another industry could complement our theory as it could provide as an example for comparison. By gaining perspective on the infrastructure within another industry, we argue for that it could further elaborate the strengths and weaknesses of each industry, but also gain further insight on what could be improved.

Secondly, we argue for that a deeper dive into the degree of competitiveness the emerging EVB industry has is of highly relevance. An analysis on this aspect could contribute to showcasing how well organized the EVB industry currently is and give a more detailed projection on how the EVB industry could shape not only the domestic EVB market but the global one in the next years. The degree of competitiveness could also be correlated to the efficiency of the innovation system, (e.g. in light of governmental measures). By looking deeper into the relationship of competitiveness and innovation system, rather than the development and infrastructure and the innovation system, we argue for that a combination of both these perspectives would provide a more detailed and stronger research paper.

Lastly, the last aspect we would like to mention would be the perspective of going deeper into the innovation system theory. As our thesis mainly covers a macro to macro-meso perspective, a view on the micro level was excluded. We believe that an extensive analysis covering the micro level could further reveal details that were excluded from a meso perspective, revealing detailed explanations on regional interactions as well as local and technological ones.

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Appendix

Appendix I: Research philosophy

Philosophy	Ontology	Epistemology	Axiology	Typical Methods
Positivism	– Real – external – independent – One true reality (universalism)	– Scientific method – Observable and measurable facts – Law-like generalisations Numbers	– Value-free research – Researcher is detached, neutral and independent of what is researched	– Typically deductive – highly structured – large samples measurement – typically quantitative methods of analysis
Critical realism	– **Stratified/layered (the empirical, the actual and the real)** – **External, independent Intransient Objective structures Causal mechanisms**	– **Knowledge historically situated and transient** – **Facts are social constructions** – **Historical causal explanation as contribution**	– **Value-laden research** – **Bias by world views, cultural experience and upbringing** – **Researcher tries to minimise bias and errors and stays objective**	– **Retroductive, in-depth historically situated analysis of pre-existing structures and emerging agency** – **Range of methods and data types**
Interpretivism	– Complex – rich Socially constructed through culture and language – Multiple meanings, interpretations, realities	– Theories and concepts too simplistic – Focus on narratives, stories, perceptions and interpretations – New understandings and worldviews as contribution	– Value-bound research – Researchers are part of what is researched, subjective – Researcher interpretations key to contribution	– Typically inductive – Small samples, – indepth investigations, – qualitative methods of analysis
Postmodernism	– Nominal – Complex rich – Socially constructed through power relations – Some meanings, interpretations, realities are dominated and silenced by others	– Focus on absences, silences and oppressed/ repressed meanings, interpretations and voices – Exposure of power relations and challenge of dominant views as contribution	– Value-constituted research – Researcher and research embedded in power relations – Some research narratives are repressed and silenced at the expense of others	– Typically deconstructive – reading texts and realities against themselves – In-depth investigations of anomalies, silences and absences – Range of data types, typically qualitative methods of analysis
Pragmatism	- Complex, rich, external - 'Reality' is the practical consequences of ideas	– Practical meaning of knowledge in specific contexts – 'True' theories and knowledge are those that enable successful action – Focus on problems, practices and relevance	– Value-driven research – Research initiated and sustained by researcher's doubts and beliefs	– Following research problem and research question – Range of methods: mixed, multiple, qualitative, quantitative, action research – Emphasis on practical solutions and outcomes

Taken from Saunders et al., (2016); own table

Appendix II: List of interviewees

Mr. Thomas König - International Markets Head of Unit East Asia (China, Japan, Korea)
German Chamber of Commerce and Industry

Mr. König is the Head of the East Asia Unit (Greater China, Japan, Korea) at the German Chamber of Commerce and Industry (DIHK). In his position, he is also concerned with the organization of the Asia-Pacific Conference of German Businesses. This represents one of the main events of the Asia-Pacific Committee of German Business (APA)
About APA: The APA pools the economic concerns of German businesses active in the Asia-Pacific region and is an agenda-setter for crucial economic issues regarding the future of the cooperation with the Asia-Pacific region. The APA supports high-level economic talks during visits of Asian government representatives to Germany and during visits of the German Federal Government to Asia.

Mrs. Anna Holzmann - Junior Research Associate
Mercator Institute for China Studies – Merics

Mrs. Holzmann's primary research area focusses on China's industrial policy, with special attention to new technologies. Prior to joining MERICS, she worked as a research assistant at the Vienna University of Economics and Business and gained professional experience in Austria's information & communications technology (ICT) industry. Anna Holzmann studied International Business Administration (BSc), Chinese Studies (BA) and East Asian Economy & Society (MA) in Austria, Australia and China. In the course of her studies, she completed a one-year intensive Chinese language and culture program at Zhejiang University in Hangzhou.

Mrs. Yang Jiang - Senior Researcher, Global Transformations
Danish Institute for International Studies

Yang Jiang is a Senior Researcher at the Danish Institute for International Studies. She does research on the contemporary political economy of China, including domestic politics of economic reform, policymaking of foreign economic policy, economic diplomacy, aid, and outward investment. Her current research projects include China's overseas investment in infrastructure, the role of Chinese actors in conflict zones, and China's role in global economic governance.

Dr. Akshat Rathi - Senior Reporter, Senior Fellow, Global Energy Center, Atlantic Council
Quartz

Mr. Rathi is a senior reporter for Quartz, where he covers science, energy, and environment. He has a Ph.D. in organic chemistry from the University of Oxford, and a BTech in chemical engineering from the Institute of Chemical Technology in Mumbai.

Previously, he was The Conversation's science editor and has worked at The Economist and the Royal Society of Chemistry

Appendix III: Interview guide

Interview guide

Interviewee:
Date:
Interview setting:

The frame of interview:

- Semi-structured interviews with both interviewers present in order to gain comparable and quantifiable responses, as well as to reduce the likelihood of misunderstandings.
- The semi-structured interview also opens up for fairly open but guiding questions within the topic. This allowed participants to freely share knowledge. The interview does not necessarily follow the chronological order illustrated below as the semi-structured interview allows for flexibility when answering, but the core of the questions are all believed to be within the interview.
- Each interview will last for approximately 30 - 45 minutes.
- The interviews will be recorded for accuracy purposes.
- Interviews are conducted in English to increase consistency when comparing and analyzing results.

Information provided pre-interview:

- Research question: How does the Chinese innovation system relate to the emerging domestic electric vehicle battery industry?
- The interviewee will be informed that the interview will be recorded.
- The interviewee will be informed of what the intention behind the interview is and what and how the information will be used.
- We will ask the interviewees to answer the questions as fully and detailed as possible in order to make the answers clear when transcribing.

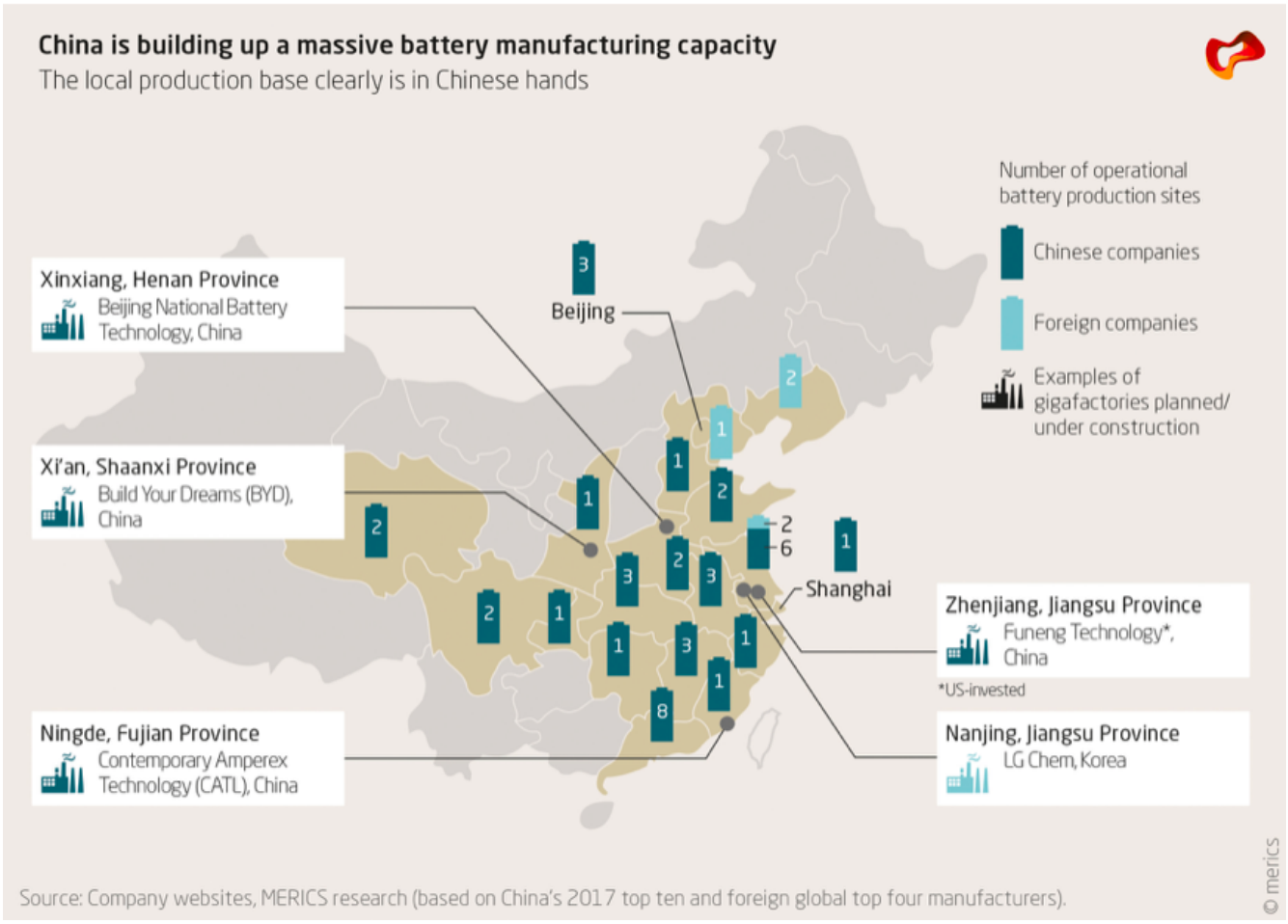
Topic of discussion	Interview Question
Key factors for the Chinese electric verhicle battery industry in context with innovation theory.	<u>Chinese government and policies - academia - businesses</u> What are the government's policies to support high-tech industries - especially the battery industry? • How did these policies change over time? • What would you argue for are the most important policies?
	Do academic institutions play a significant role in the Chinese innovative scene? • How do they contribute to knowledge? • How do they interact? • Are they active in lcusters?
	Does the government run any initiatives to support collaboration between different high-tech related institutions? • Some specifically for the battery industry? (Inter-firm, universities, independent research institutions?) • If yes, in what way do they collaborate? • How are interactions supported?
	Which other indirect policies are in place?
	Does the Chinese government actively encourage for innovation and upgrading in the high tech industry - especially the battery industry? • If yes, how?
	Are we witnessing a shift from partnerships and joint ventures with foreign companies to the encouragement of indigenous innovation • if yes, how is it done?
	What are other major economic policies to catalyze and challenge the high-tech industry?
Initiatives	Which effect has "Made in China 2025" had on the mentioned high-tech industries?
	Which role has "One Belt, One Road" had for the Chinese innovative scene?

Factor conditions	Large investments in fixed assets, as well as R&D, are needed to boost the EV and battery industry. • Who finances this? • Are there state-run financing programs?
	Are subsidies provided for electric vehicles an indirect subsidy or catalyst for the Chinese battery industry? • If yes, how? Why? • How has this changed over time?
Clusters	Have you observed any form of clustering activities happening in China regarding the innovative scene, especially within the EV and battery industry? • If yes, where? • If yes, how have you perceived the competition? • How are ineractions shaped in the cluster?
	Why and how do you believe these clusters are formed? • Do you think these clusters are of benefit to the battery industry? • If yes, in what way?
	Do you think knowledge exchange, spillovers or cooperation among the companies in the given industries occur in these clusters?
	What kind of implications do you think can occur through these clusters?
Open questions	Which strategy do Chinese battery companies pursue in your point of view?

Appendix IV: Reliability errors and biases

Threat	Definition and explanation
Participant error	Any factor which adversely alters the way in which a participant performs. For example, asking a participant to complete a questionnaire just before a lunch break may affect the way they respond compared to choosing a less sensitive time (i.e. they may not take care and hurry to complete it)
Participant bias	Any factor which induces a false response. For example, conducting an interview in an open space may lead participants to provide falsely positive answers where they fear they are being overheard, rather than retaining their anonymity
Researcher error	Any factor which alters the researcher's interpretation. For example, a researcher may be tired or not sufficiently prepared and misunderstand some of the more subtle meanings of his or her interviewees
Researcher bias	Any factor which induces bias in the researcher's recording of responses. For example, a researcher may allow her or his own subjective view or disposition to get in the way of fairly and accurately recording and interpreting participants' responses

Appendix V: Merics battery cluster illustration



Appendix VI: Transcribed interviews

Appendix VI.I: Interview with Mr. König

Interviewee:	Mr. Thomas König *International Markets Head of Unit East Asia (China, Japan, Korea)* German Chamber of Commerce and Industry
Date	24th of April 2019
Interview Setting	Telephone call

The following is a summary of the content we received during the interview with Mr. Thomas König. The summary shows the content of his answer – it is not a word by word description. Irrelevant information is left out of the summary.

Question:
You attended a panel discussion of the SWR in February, you mentioned that the German government should invest more in German "location factors" like digitalization or lower taxes to stay competitive with China. Now speaking about China: which location factors do they have in place that favor the development and competitiveness of the Chinese high-tech industries?

Answer:
If you think about the location factors in China that make it a favorable location for investment it is probably the low taxes and easy administrative processes to get a business license. Also, the general "market speed" (general time to market) of new technologies and new ideas.
There is the tendency to take risk and try out new things, because it is often backed by the government, financing is in most cases secured and quite easy to get.
In total, the favorable conditions are a set of securities combined with a sense of adventure. China wants to position themselves as a country where it is easy to conduct business. They are not quite there yet, they try to shorten the negative list which industries are investable in and which not.
But it is also some very basic aspects of modern life that make great Chinese location factors – like high speed internet for example. I have the feeling that the future is now in china, while we still work towards the future in Germany.
In terms of overall attractiveness China still has some way to go but it is constantly progressing.

Question:
You touched upon the case that capital is largely available and that there is a fast time to market speed. This implies that the role of the government is quite significant. Let's say we are a Chinese battery company and we would like to invest on our production facilities. How easy is it for us to get access to capital for this expansion?

Answer:
Yes, like I mentioned capital is largely available. There are several ways of doing it:

First, let's assume we are a start-up: in the Shanghai area, there are hundreds of **Venture Capitalists** (VC) who are waiting to throw money at you. There are also incubators or accelerators that would put you in touch with the right VC-funds to get your funding. They are also the ones that are going to set-up a pitch meeting with the VC within let's say a week or so. It goes really fast.

Second, you can go the regular way of getting a **bank or a business loan**. That is the most cumbersome and outdated way of doing things.

Also, there is **microfinancing**, **crowdsourcing** available. We do not see it this much in Germany, but in China those forms of financing are tried out on a large scale. You can get microfinancing/ crowdsourcing for a project or office space. Anything is possible really.

There is also the opportunity of going to the big State-owned enterprises (SOE) and asking for infrastructure, etc. or can we sell our idea to you. It is **shockingly easy to get meeting with State-owned enterprises** or the SEO representatives. The SOE usually have a small to medium size enterprise section which screen the market for new ideas and to throw money at you, because if there is no shortage of anything the capital would otherwise only sit around. So if you have the right connection and the right idea, getting financing is no issue.

Question:
In the panel discussion, you also talked about the situation of Joint Ventures (JV). We see the following situation: Back in the days it was the trade-off technology transfer vs. market access. This deal is becoming increasingly unattractive for the Chinese as they do not rely on technology transfer that much anymore. For us this implies that the Chinese economy is better now to come up with innovations themselves. The reliance on foreign knowledge is getting weaker. During your 4 years in Shanghai: have you experienced how the whole process of coming up with innovations developed over the years considering the entities: Government, Industry, Academia. Do you know how the interaction work?

Answer:
So, first of all: All of those three aspects are guided by the government. Neither Academia, nor the industry is completely independent of the government. It you look into the market of NEV or at the major policy shifts in terms of the structure of the Chinese transportation system – what is "hip or going to work" is shockingly often dictated by the state, which is not exactly how we would define a start-up culture in Germany.
This is why there are so many electric vehicle start-ups in china or start-ups for transportation solutions. It is not because everybody is super passionate about transportation, etc. We know that this is the case because it is the priority of the Chinese state. So, we want to feed into that.
This is a clear benefit of a guided SOE system where the government is dictating what is happening right now. This also helps you as an entrepreneur because you know what works and what not. The creativity process in the country is ultimately guided again by the state apparatus.
In general, I would say: "**whatever Academia does, whatever R&D is being conducted, it is all tailored towards a certain goal, that is defined not by markets, but by the state**."

This is something that has worked for China! They wanted domestic firms in the NEV industry – now they have them. They wanted different mobility solutions – now they have them. They wanted Artificial Intelligence (AI) technology – now they have them or they are working on it.
NEV are of course eco-friendly and address environmental problems, AI and facial recognition are important to control the population. Ultimately, the goad is or all those things serve particular needs of the government. This is something that is often ignored or overlooked by people how look at "Why is China so good in what it does".
Democratic processes are more complicated and cumbersome. In China, they cut the middle man. They are creating an innovative scene that would have never naturally grown or that would have grown into a "different sphere", it is not about the individuals that are passionate about something, it is about what the government wants.

Question / Follow-up:
The interplay of Government – Academia – industry is not really an independent interplay. It is more like a orchestra that is directed by the government? Because the government decides which direction to go. Market forces are of less importance.

Answer:
Yes, market forces are not the main driving factor.

Question:
Earlier when talking about start-ups you mentioned incubators, accelerators and that it is super easy to get meetings and that the speed of development is quite high. Do we see in different industry sectors cluster activities? That different players or entities are close to each other in terms of geographic distance?

Answer:
I think this is the idea towards which China is headed. But for now, it is too early to say that this is the case. The clustering model is something we really see in the south of China – Guangdong province for example. There it is all about clustering.
The driving force here is Chinas Urban planning – this is promoting clustering. Having industrial parks, having eco parks, that are serving particular industrial branches. The trend is the following: The cities are going to be huge hubs that are clustered anyway and within those "Cluster hubs" there is going to be more of a specialization. China is really pushing to promote the following: "City X is the car city and City Y is about aerospace". This makes a huge country like China more manageable and also diversifies where the wealth goes. The government is not to keen on centralizing the power in one particular city – it is more about diversification.
However, this process is not done yet, it is still ongoing.
My personal opinion is that we are headed to clusters steered by the government. If you think of Beijing: the government has the plan to combine 5 cities in one province to become this gigantic 150 million people city. In Shenzhen, there is also this clustering activity where it will be more than 65 people. That is also one expression of this clustering plan.

Question:
This comes close to what Mrs Holzmann told us from Merics: that there is a huge competition between local government to perform well in all industries defined by the MIC2025. The central government is now intervening and steering the process of which provinces shall focus on which industries to avoid inefficiencies.
You mentioned that we are driving towards clusters and that market forces do not play the most important role. I would assume now that this whole clustering does not really occur naturally but is also steered by the government. Are there policies in that guarantee that clustering is becoming an increasing factor now?

Answer:
There is not really a policy in place. The policies that are in place are the urban planning policies, with the pronounced goal of concentrating certain knowledge to certain parts of the country.
This is the clearest expression as of now – this shows the trend China is currently headed. **This is not framed as an industrial policy but as an urban development/planning policy.** But as ultimate result, this policy will serve the industry.

Question:
When it comes to interaction between Government – Academia – industry: Would you say that there is something that Germany could learn from China?

Answer:
First, Germany and China are very different from each other – so I need to be careful here.
In general, I would say that the German business community could have a bigger tendency towards taking risks and towards trying things out. The German mentality is too much staying safe as long as possible and do not leave the comfort zone too much.
Also, I believe that the German government should invest more in like infrastructure. There are so many factors to consider. The money is there to invest in Germanys future and to make sure that Germany stays attractive but this is not being down (think of Schools, universities, infrastructure, roads, Wifi, less taxes etc.). There are so many ways to push the attractiveness of Germany as a location. So, I would wish for a German government that would steer more into the direction of improving those location factors.
Whereas China is throwing lots of money at all of those factors – this should be inspirational to the German government.

Question:
I have the impression that there are in China often markets with artificially created demand (consumer subsidies for example). How do you see it that government is artificially promoting this home market demand for particular industries?

Answer:
Yes, that is exactly what there are doing. Ultimately, to serve their own purpose and not the greater good of humanity. This is for the greater good of the Chinese idea and the Chinese economy. I think this is a good observation you made there. This is a way how they promote their own interests, they are not bothered by being the world police or to make the world a safer, better place. China is very pragmatic, they are not bothered about bringing peace to the world, "**their relationship with Africa is ultimately**

also about securing resources". We see a lot of pragmatism of China being active on a global stage. This also includes promoting certain industries and of course they also use the benefit of having 1,4 billion domestic consumers. If they do that a large part of the world is already embracing it, without them having to try too hard. There is a huge benefit there.
The dominance of the SOE is unfair competition. There are still things to do in the future. The way to future in opinion is to corporate more and fight less (in a global economic context).

Appendix VI.II: Interview with Mrs. Jiang

Interviewee: Mrs. Yang Jiang
Senior Researcher, Global Transformations
Danish Institute for International Studies (DIIS)
Research areas include: China, development in practice, emerging economies, politics of great and emerging powers

Date 3rd of May 2019

Interview Setting Telephone call

The following is a summary of the content we received during the interview with Mrs. Yang Jiang. The summary shows the content of her answers – it is not a word by word description. Irrelevant information is left out of the summary.

Question:
Let's start off broadly with high-tech manufacturing. We have identified it as a very important aspect of the Chinese development, especially looking into the Made in China 2025 plan. How would you in general describe Chinas industrial policies? How do they support the emergence of those high-tech industries?

Answer:
Made in China2025 is, of course not the only industrial policy that supports high technologies in China. You may know that China's role in global manufacturing used to be **low-value added** exports. So, the value added within China is very limited. **China gets the high-tech parts from Japan, The United States and sometimes Taiwan**, they then assemble it, and add some other parts. Finally, they export the final product again or sell it domestically.

But China also has a number of initiatives to support domestic Science and Development as well as Research & Development. One of the programs, directly translated is also known as "Star and Fire" or maybe also "sparkling". The intention behind this is that the Chinese government wishes to "sparkle" innovation through the seed money for Research & development. These programs have been going on for decades, and the money of the funds mainly goes to research institutions. **The traditional problem is that there is a gap between commercialization, industrial sectors and research institutions.** And traditionally China has also focused more on heavy industries, but with the emergence of the new initiatives, China has narrowed down their focus into ten industries that was highlighted in MIC2025. China has become more future-oriented, not only in order to catch up with western countries, but also to lead the global industry.

Question:
So, it's also an aspect of Made in China 2025 to shift the economy from manufacturing of low value added to high value added?

Answer:
Yes. They have been working on this for two decades but the progress is still limited as innovation takes a long time to develop. It's to bring the problem of education that could be the most innovative sector, some economists argue would be in the private sector. But now they have more restrained access to financing. This is mainly because state commercial banks prefer to loan to state-owned enterprises, and they use these private companies used to borrow from shadow banking, but China has been become stricter on this side and has cut down on shadow banking.

So, there are several ways that China tried to achieve high-tech growth which was mainly through some policies. Mentionable one is the **"five-year" plans**, as well as programs like **973** and **863**. Within these plans, there is a leading small group coordinating different ministries and agencies headed by Vice Premier, who is the economic sir of the current China.

A second way is through funding. There are a number of funds, like the R&D funds. These days, recently, there are some government guidance funds for industry, for small and medium enterprise innovation, and there are kind of venture capital investment.
And Chinese government also funds through their own state, have banks that offer loans with low interest and some tax breaks for high-tech development.

They try to mobilize SOE's. In the past China used to force foreign investors to make joint ventures and transfer technology, but now, because of the trade war and WTO,
China is not formally allowed to do so. However, it could still happen but in reality, that does not include that anymore.

Question:
So it is now due to trade war and WTO, there is also this shift that China is moving away from the trade-off: Joint venture and technology transfer versus market access. This is mainly a picture we've seen in back in the days and not so much more currently.

Answer:
Yes, and as you probably know, China has also tried to obtain overseas assets through investment and acquisitions. These are the major ways on how the Chinese government are trying to achieve high-tech growth.

Question:
In the past, we have seen tendencies of foreign investors coming to China. But with these policies, do you think that promotes Chinese companies to go outwards instead?

Answer:
China has been encouraging companies to go out since at least 2004. There were some government policy papers, which encouraged companies to go out in order to obtain, one of the four major aims that was

listed to obtain strategic assets, including high technology. We could then see that Chinese companies were more successful in developing countries, but when they have gained experience and confidence, they are now more approaching developed countries.

At the moment, there seems to be a shift when it comes to foreign investment into China.
That China used to think: Okay, we are the leaders of the market and foreign investors want to come? Yeah, but this, this context is changing with the rising costs in China. And many companies feel that due to the difficult playing field in, in China, some of them are moving out. Furthermore, China used to think: okay, we are flowing with cash, and we are not necessarily in need of foreign capital. **But I think the government is also realizing that China still does need foreign investment**. Because of capital, because of the whole industrial lines and that it has made change in China. And also, the technology that it has benefited through the decades. So, you can also see the recent statements made by Chinese top leaders, more open to showing investors and also to create a more even playing field within China.

Question:
We thought it was interesting, because in the past, China has been more dependent on foreign investment and from technology spill over, in order for them to develop in this pace. But in meeting Made in China 2025, if I'm not mistaken, one of the aspects was that they wanted to rely less on foreign involvement, which we thought was interesting, because that's sort of been playing a key role in their development so far.

Answer:
That's right. Whether overseas investment or high investment into China, they're still relying on foreign technology and foreign patents. And when they try to obtain it, you face backlashes: Is China stealing technology or forcing transfer? You can't continue some old ways of doing things and China realize that they have to try and **improve domestic indigenous innovation**. In the past, China had some policy that, for instance, encouraged government projects to buy products that are designed and made in China. So, because of that, investors lost a lot of market share within China. Because then a lot of these big projects and infrastructure, they are government projects, and this is discriminating against foreign investment. Now, that has been scrapped. It doesn't exist anymore. But China is, through these government subsidies and support trying to encourage innovation. We see some progress in some sectors, like I heard in biotechnology, electric cars, and batteries, IT and even aviation.

Of course, this also includes solar and wind power. So, we can see that it is catching up in these sectors, but also a bit slower in sectors like chips such as microchips for instance. But it is undeniable that China would like to encourage indigenous innovation design and to have Chinese patents.

Question:
Yang, you touched upon subsidies. Is that the case for most industries? Looking at the new energy vehicle markets, I recognize that there were quite high subsidies to artificially create a large home market demand. First of all, is my observation, right? And if yes, does this also apply to other industries?

Answer:
There are different kinds of subsidies, and they mainly go to state owned enterprises and the big private companies that can be called **national champions**. I haven't looked in detail at the electric car sector within China. But now I know that some cities used electric cars: BYD for their taxis. And then there are other kinds of subsidies **through cheap land, tax breaks, you know, easy access to financing from the state banks or low interest** from the banks in controlling interest rates. **But they mainly go to state owned enterprises and various levels for central and provincial level**. And that's what Western company's countries complain most, lots of private small private companies are left on their own to fight, they don't get much subsidy, but companies like Huawei could be called a private, I'm not sure, it's very complicated. Mainly private, and companies like maybe also Alibaba and Tencent. Maybe the subsidies are more hidden in terms of new forms of financing, or their access to, for instance, government services, you know, Tencent and Alibaba are picked to build some sort of IT platform for government. These are some of the subsidies for the big private companies.

Question:
Okay. So basically, the Chinese government is trying to create a situation where the factor conditions are highly favourable off doing business. So, they look into that the companies that are the growth market, that they have easy access to capital, that they have access to people on the labour market, there's a huge whole market demand, etc.

Answer:
Yes, they support SOE's, because maybe the leadership still believes that they should play a major role in the national economy. And they afraid the loss of jobs from these state-owned enterprises would be a major factor of social instability. And they support the big national, state owned and private companies, because China wants a team of global champions. They think it's part of national power. The United States has Apple, Coca Cola, etc. But what does China have now? China believes that it should also have these as part of national strength.

Question:
Regarding national champions: Because in terms of national champions and R&D in the US, they've like generated specific areas where they've created this environment to booster this, like Silicon Valley for example. Do you see or have observed any policies that have been promoting clustering or, or areas of like special economic zones or some of some sort in China, that's directed towards the development of all of these national champions?

Answer:
Yes, maybe on a smaller scale, like in Beijing. That's where the Beijing University Tsinghua university and many IT companies are. China is trying to build China's Silicon Valley with its universities and IT companies.

Then down south in Shenzhen, Guangzhou, we have the Greater Bay Area initiative. which is aimed at exactly the high-tech sectors and service sectors. They have companies like Huawei and some other modern IT manufacturers.

So yes, there are a number of clusters that China is trying to build. Lastly around Shanghai, more directed towards finance and modern logistics and trading.

But one major difference from Silicon Valley (vs. Greater Bay Area) is making the flexibility of markets. **Still, there is a lot of government operation there (here: Greater Bay Area).** And the competition from outside is not so strong, it's more like a zone. **So that players can collaborate with each other, but still as it is not that "open" it could limit the development of these clusters.**

Question:
Because as we touched upon earlier, like foreign interference has always played a huge role and by only playing amongst each other, could be limiting further development.

Answer:
Yes, because foreign competition could be an incentive for better productivity. But in China, it's more like an infant industry, and we give money and you try to make up, make something out of it. And, some analysts believe that, market mechanisms in these areas and, and less government intervention would be better for them.

Question:
Yang, you mentioned that the government is playing a huge role in the clusters, but what is this role exactly about? Is it about steering this cluster activity into favoured strategic industries? Or what is the involvement exactly about what why are they so involved?

Answer:
I think from the beginning, the government has a strategy or a blueprint about what's the major sector that are fine, for instance, IT sector down in Shenzhen. And the government builds infrastructure, like roads and highways and provide cheap land, and maybe tax incentives. But I think that maybe they also help to pick who gets to move into it, and into the zones.

In China, bankruptcy is a big question. When it comes to important companies, there is no proper bankruptcy process. The government simply keeps bailing them out. And one should question, to what extent invite competitors into the cluster instead of just you're just a famous company, or just one company or just your friends or families company then. And, these companies in Beijing have their connections within the government. Or, it's an open process for venture capitals and private companies to move in if they see opportunities in these, and it is during these situations that the government intervention is strong.

Question:
In the beginning, you mentioned something very interesting, about this "Star and Fire" or this "sparkling". Which is basically looking into increasing the interactions between different players. And I think that you mentioned, R&D institutions and, and industries.
Can you maybe give us an overview of how this interaction has been in the past? And how this interaction between different players has now developed recently, and maybe also this in a cluster context?

Answer:
Okay, you can have look into these programs, for instance, one is called “973” and “863”. They are huge programs with a lot of funding over the years. Some have argued that it's not the problem of money. This money is for research and development. But to what extent they **commercialized is the missing link**. Some state that from the late 2000s, China is only after US in the portion share of R&D money to GDP. **And so, it seems it's still China is good at making small innovations that adapt to specific, consumer needs, and some medium level of technology and online platforms, but they still lack the most, you know, cutting edge technology**. I read news that they just made a chip, I don't know how good it is. It seemed very advanced and micro manufacturing, but still China imports a lot of these high-tech parts, though. So, it seems still there's a lot of missing links, and often when we say that maybe in western countries, lots of venture capital, like angel investors would combine manufacturers and scientists.

But in China, the money comes mainly from government ministries and from banks, and they seem to be not so good at making this marriage and identify commercialize innovations.

Question:
So, you're saying, the whole process of finding a market solution for a new technology is not that that strongly developed in China? So, there is maybe a bit of an innovation culture lacking?

Answer:
Yes. That is one, also the limits of private capital and private companies is another. Thirdly, they also say that China is quite behind in the highest level of technology, but better in medium and lower levels and that China has the most patents.

Question:
Can we say that we can observe trends of China catching up in these high-tech areas?

Answer:
Yes, I believe so. You can see Huawei phones, super computers, air space technology, China making their own chip and lastly battery and new energy vehicles. There are definitely some goods signs out there.

Appendix VI.III: Interview with Mrs Holzmann

Interviewee: Mrs. Anna Holzmann
Junior Research Associate
MERICS – Mercator Institute for China Studies

Date 17th of April 2019

Interview Setting Telephone call

The following is a summary of the content we received during the interview with Mrs. Anna Holzmann. The summary shows the content of her answer – it is not a word by word description. Irrelevant information are left out of the summary.

Question:
Based on your article *China's battery industry is powering up for global competition*: "The industries strong performance results from state support of local manufacturers".
In your opinion: What are the most important elements of this state support in terms of regulations and policies?

Answer:
First, the Chinese battery industry is closely tied to the New Energy vehicle industry (NEV).

1. Form of state support: Subsidy of NEV industry

Within the NEV industry we see lots of subsidy programs. Those subsidies also benefit indirectly the supplier industries (in this case the battery industry) as those policies boost the domestic demand for NEV and therefore also batteries.

2. Form of state support: "Certification scheme"

The Chinese Ministry of Industry and Information Technology (MIIT) has a list of certified battery manufacturers for the Chinese market. Companies who made it onto the list were seen as the "best" of the "best" in terms of producing high quality products. Highly surprisingly, it was mainly Chinese manufacturer who made it onto this certification list. This is another example who the Chinese government supports the domestic industry.

In a broad sense, it is in the interest of the Chinese government to foster national champions and then also global champions in a later stage. Government really want to have a thriving domestic industry, but not based on many small companies. They really want to have a small number of leading companies. An example of this is CATL and BYD really emerged as national champion in the battery industry.

Question:
We have seen a developing battery cluster activity in the Shenzhen area. Have you experienced what is going on in those clusters?

Answer:
In general, this is the goal of the broader Chinese industrial strategy. They want to promote manufacturing clusters. They try to create platforms or ecosystems that allow for **innovative** business activities to happen. For instance, they have campuses with innovation and research centers, manufacturing companies and start-ups to bring them all together to allow for collaboration and to promote alliances. Geographically they want basic research and applied research to happen at the same place and to bridge the gap to business applications.
Chinese industrial policy is really focused on increasing the likelihood of successful **technology transfers** from the research to the business / industry.

Questions:
The technology transfer is an interesting point you are touching upon (From research (Academia) to industry who puts the knowledge in commercial use). How would you describe the Chinese national innovation system?

Answer:
In general, the central government releases long-term plans that lay out the priorities where the state wants Academia, the Industry but also local governments to focus their research on. The central government is defining strategic industries, but also nominates specific technologies where it wants to see breakthroughs over the next couple of years.

Questions:
The definition of those industries and technologies – is that for example the "Made in China 2025" plan?

Answer:
Yes, in my opinion this is a good plan to look at, because it lists 10 core industries where it wants to see major breakthroughs, to eventually become the global leader within those industries. The MIC2025 strategy comes with a roadmap that focusses on the underlying technologies. It goes for each of the ten industries into detail which technologies should be targeted and developed over the next couple of years.
If we look for example at the roadmap of the NEV industry (which is one of the core industries), we see that batteries are obviously also mentioned there. But I need to say that batteries are not featured powerfully in the MIC2025, but it is definitely a part of it as it is closely related to NEV.

Questions:
So, the government is supporting the industry indirectly through subsidies of the NEV industry. We have seen a development / change in those subsidies based on increased reach of the cars. Do we see that the government challenges/forces the battery industry to innovate and upgrade?

Answer:
It is one of the goals of the Chinese government to increase the quality of the batteries. They want batteries to be: secure, of high quality, long range and to increase the length of the lifecycle.
With their subsidy policy, the government certainly want to push and promote innovation in the battery industry. Another aspect is that also the Chinese government has limited amounts of financial resources, even though the NEV is a strategic industry for the Chinese government they cannot keep on subsidizing the industry forever.

In the future, we will see a cut in subsidies. In general, the direct NEV subsidy will face out in 2020. Those subsidies went directly to the consumers. The government want to reduce/decrease the NEV's industries dependence on subsidies.

Question:
Do other regulations next to the subsidy of NEV exist?

Answer:
Yes, NEV are sometimes exempt from "**license play lotteries"**. People with such a license plate can drive on certain road during certain times of a day for example.
Those regulations are governed on a local level (city level). You want to keep the following in mind: there are central government policies and regulations, but then there also policies/ regulations at the local level.
Local governments have quite some substantial authority over these topics. In regard to high-tech industries there are is an intense competition between local governments. Every local government has the goal to outperform one another!

Question:
We have seen this issue in your article *Evolving Made in China 2025*. It says: "the MIIT re- leased guidelines for local Made in China 2025 adaptations. These guidelines tackle the issue of overambitious local governments and inefficiencies resulting from a lack in inter-regional coordination by defining which province and municipality are to focus on which industries." Is this showing the dilemma you just pointed out?

Answer:
Yes, exactly. Last year we went to China and spoke to people there and they confirmed what we found out during our desk research that this competition between local governments is really strong and that all the regions want to excel in all ten of those defined core industries of the MIC2025 plan. From a macro-perspective, this does not make any sense, because you do not want every region to specialise in ten core industries. Therefore, central government is steering its policies to avoid overcapacities and redundancies, which is highly inefficient and therefore also wasting resources. This competition of local governments is what the central government is increasingly trying to tackle by getting involved in **inter-regional coordination**. We have a study coming out June that will further elaborate on this inter-regional coordination aspect.

Questions:
Do you mean that those policies of the central government promote clustering of industries in particular regions? Inter-regional coordination means to us that government is pointing out which region focusses on which industry. Is that correct? Can we interpret it like that?

Answer:
Yes, you can.
This is definitely a focus of the industrial policy in China right now, but it is not the most important aspect.
In general, MIC2025 is like a catalyst for those industries while also putting an emphasis on:

- High quality manufacturing
- Advanced manufacturing
- Smart manufacturing
- Increase efficiencies in the industrial set-up in China.

Question:
Globally, China already has the largest market share in the battery industry for Elective vehicles. How do you see the state of technology? Is it in a catch-up phase or can we already say that China is setting the new standards (in terms of technology, not scale)?

Answer:
My perception is that the level of technology is sufficiently good and it has increased a lot. My understanding is that it is not in particular top-notch but it is also not the aim of China because they have 1. decent quality 2. high capacity 3. the ability to scale up the production quickly and to finally take that abroad. They have highly competitive products not only in the Chinese market, but also in the global market.

Appendix VI.IV: Interview with Dr. Rathi

Interviewee: Dr. Akshat Rathi
Reporter - Senior fellow, Global Energy Center, Atlantic Council
Quartz

Date: 10th of April, 2019

Interview Setting: Telephone call

The following is a summary of the content we received during the interview with Dr. Akshat Rathi. The summary shows the content of his answer - It is not described word-for-word as irrelevant content has been excluded.

Background:
Based of your article, regarding a Chinese company controlling most of the metals needed to make the worlds advanced battery.

Question:
"China was able to catch up because of its ability to manufacture the batteries at larger scales and sell them for cheaper" - This was followed by a diagram illustrating Korea, China and Japan with China taking a larger market share in the lithium-ion market. How would you evaluate the current technology of lithium-ion batteries produced by Chinese companies compared to Japan and Korea?

Answer:
As a reporter, I depend on other analysts. According to the analysts I have spoked with: In general, China is behind Korean and Japanese companies, but there are a few Chinese companies that are getting close. CATL in the Fujian province in China is an example. They are perhaps the leader in the Chinese market, and are just slightly behind companies like LG and Panasonic.

Question:
Would you therefore say that China still are in the period of catching up, they are not technology leaders yet, in yours or the analysts perspective?

Answer:
Yes. In the battery industry, I do not think that having the latest battery model is the most important aspect within the lithium-ion battery industry. I think a good battery at a good price is more important, and I believe in that aspect, China is leading. Mainly because China produces the highest amount of battery but also produces batteries for a cheap price. This leads to people buying batteries not only for China and Chinese cars but also for cars abroad. Accordingly, we therefore see CATL building factories in Germany as well as the U.S.

Question:

You mentioned CATL being able to catch up: Could you explain how, more detailed? Were they able to catch up because, back in the days, Made in China was not the biggest seal for quality but more directed towards low-value products. Did you during your reporting find out more specifically what made them catch up? Is it R&D, labor pool or government related?

Answer:
CATL's story is that it was created from a previous company which still exists, and is called ATL. It was founded in the late 1990s to be supplying lithium-ion batteries for portable devices: MP3 players, bluetooth earphones and eventually smartphones. This was mainly done by licensing technology from the U.S. They then proceeded to be bought up by a Japanese company called TDK corporation, who them brought their own processes and technology. In other words, it now had technology acquired from the U.S. and Japan. It followed the stereotypical Chinese approach of development. Furthermore, CATL isn't being sued by other companies, nor getting criticism around their patenting as it seems like they have their own idea. Additionally, they spend around 10-11% of their revenue on R&D which is a large amount for a Chinese company and is where they differentiate from other Chinese companies. I.e. Yes, the stereotype we have of China are still there, but there are also those sectors where China has gone ahead, through the use of connections and money they have acquired and been supported with.

Question:
When talking about battery, you said earlier that the price is very important. In your opinion, what makes a good battery? Is it energy density, range, longevity or price? What do you believe is the most important factors here?

Answer:
I believe it's all of those factors combined together in a optimized equation. You want it to be safe and last longer. We have previously seen batteries produced in a defect matter, later causing for companies to file for bankruptcy, i.e safety would be first. Afterwards, it would be cost, however, it also depends on the car manufacturer. It could either be cost or density. Companies like Tesla or luxury electric car markets, like Jaguar and Audi, they would value density more than price as it would provide for longer range. In China however, there are more companies that produce for lower range, but for a cheaper price which is more appealing for the Chinese market. It really depends on the segment that is being served: High-segment v.s. Low segment.

Question:
Could you think of any battery industry clusters in China? A specific area where many industries are located? Perhaps five or more?

Answer:
I think those exist, however organized in a different way than in Europe for instance. They manifest cities with huge manufacturing sites, where CATL for e.g. has over 15.000 employees. Most of the manufacturing is automated.
One area for instance lies between Hangzhou and Shanghai, where we met with 3-4 manufacturing companies. That is one I encountered, and there might be more outside of my knowledge.

Question:

This whole catching up period, with focus on R&D: Is it clear to you if there are collaborations between different battery industries, universities, government funded institutes? Did you perhaps see any situations where collaboration was incentivised, or was it more in silos?

Answer:
Collaborations do exists, however, this is not between the battery companies themselves but rather the battery industries and the car maker. This is more due to technical reasons like ensuring that the compatibility between the battery and the car. CATL for instance collaborates with BMW, with the production of customized batteries, which they claim contributed to making their batteries more sophisticated as well as more appealing for foreign buyers.

There are also universities collaborating with battery companies. There are instances observed where universities aim towards working within the specified fields that are focused on by the government. I.e on universities are Tsinghua university in Beijing and Tongji University in Shanghai, and there must be more.

So linkages between these institutions are being strengthened, as well as there being knowledge spillovers from universities to companies. However, the most important collaboration lies between the car industry and the battery industry.

Question:
When talking about China, the role of the government always stands out. Are there any cases apparent you where we can see the Chinese government pushing the local Chinese battery industries with policies like Made In China 2025?

Answer:
Yeah, the electric car industry has been heavily supported by the Chinese government, and through support for the this industry, it indirectly affects the battery industry as well.
When the Chinese government started with the subsidies, it covered almost ⅓ of the price of the car. This year however, they have started reducing it by claiming they will be cutting off direct subsidies. There are however, indirect support remaining where we can see local governments giving pieces of land to companies to build manufacturing points at building up the local scene. This illustrates that the government does not necessarily resort to subsidies or economic incentives. In other words, we can still see a lot of collaborations between governments and companies.

However, we can also see license control. In big cities, the number of licenses given for gasoline driven cars versus electric cars are limited. This is arguably because the government wants to control the market conditions. If you want to buy a gasoline car which has a high demand and has a limited number of licenses, you have to either pay more money or put your name in a lottery system and its not guaranteed that you will be getting a car. With electric cars however, as the demand is low, there is a higher chance of acquiring a license, therefore, more people are purchasing electric cars.

Question:
Speaking about lithium-ion batteries: What are the main drivers of the industry in your perspective? Is it electric vehicles, mobile phones or portable devices?

Answer:
Specifically for lithium-ion batteries, its electric cars as a electric car is usually powered by the equivalent of 1000 batteries of a smartphone. In the 1990s and the 2000s it was smartphones, but since the mid-2000s it has been the electric car industry.

Question:
Are you aware of if China is securing special resources in other parts of the worlds, related to the battery industry? Perhaps to make the supply chain more stable?

Answer:
It is also other countries. 60% of the world cobalt comes from democratic republic of Congo, and China has a significant control over the Cobalt supply. China also has interest in nickel in Indonesia. These are two of many that I am aware of.

Question:
Does the One belt One road affect the battery industry in your point of view?

Answer:
Not that I am aware of, as the one belt one road initiative is not so clearly defined, so it is hard to define the clarity regarding the coherence between the battery industry and the initiative.

Question:
Can we see any sort of prioritization of the battery industry compared to other industries in light of the Made in China 2025 vision?

Answer:
To some degree, as battery and electric vehicles is one of the major industries they want to support. It may not be the favorite, but is among the most favorites.

Appendix VII: Findings "Role of government"
Source: derived from NVivo