Public Procurement for Indigenous Innovation: A Case Study of the Chinese New Energy Vehicle Program

Author: Lanxing Lin (S122519)
Supervisor: Peter Gammeltoft

Master's Thesis, MSc in International Business and Politics
Copenhagen Business School
Date of submission: 15th January, 2021
Pages: 65 (17211words, 114022 characters)

Acknowledgement

Firstly, many thanks go to my supervisor, Peter. Sincerely thank you for all professional guidance and detailed advice during the entire process. What's more, I am also grateful for all the support from family and friends throughout the entire process of thesis writing. Thank you mom and dad, for always being supportive and understanding me. I also want to show my gratitude to my best friend, Pengfeng, for saving me from being homeless and cooking nice dinners for me.

Abstract

The purpose of this research is to explore the underlying mechanism for public procurement as a demand-side innovation policy to impact indigenous innovation in China, using a case in the New Energy Vehicles Program. With regard to approach, this study takes a critical realism perspective and adopts a qualitative case study approach. Government policies and political statements are collected from newspapers, annual reports and official websites of organizations. In addition, numeric figures used in this study are collected from mainstream databases and adapted from academic articles. Through a thorough analysis, this study finds out as a demand-side innovation policy instrument, public procurement can contribute to China's indigenous innovation blueprint in four major ways. Specifically, public procurement can create a new market for off-the-shelf products with its tremendous purchasing power; in addition, it transfers required resources (e.g. money, knowledge, talents) to innovation activities; in addition, it brings competition to the market and accelerates the diffusion of innovation into society. Going forward, we identified three key factors that affect the effectiveness of public procurement for indigenous innovation. Firstly, it is important for procurers to specify objectives of procurement. Although local and central governments may differ in specific goals that they pursue through procured products or solutions, they also have common targets. The ideal situation is that the goal of regional governments is consistent to that of the central government. Secondly, the author found, an efficient and transparent procurement system is a critical premise. Last but not least, cooperation is a key to generate indigenous innovation through procurement, which requires a close collaboration across sectors and regions to jointly contribute to the blueprint of indigenou innovation.

Contents

1. Introduction

1.1 Motivations & Objectives

In recent years, policymakers around the world show an increasing interest in public procurement. Statistics of the World Trade Organization (WTO) indicate that public procurement accounts for more than 10% of national economy in most countries (Arrowsmith, 2003); This figure is particularly high in some advanced countries such as Netherland and Finland, which is up to 20.2% and 18.5% respectively, almost twice as much as that in most developing countries (Simeon et al., 2016; WTO, 2020).

Apart from public procurement's direct contribution to economic growth, there is also a growing awareness among policymakers and researchers across the world that public procurement, as a part of demand-based innovation policy, is a powerful tool to spur innovation and accelerate diffusion of innovative products and services in society (Edler & Georghiou, 2007; Charles Edquist & Hommen, 1999; Charles Edquist & Zabala-Iturriagagoitia, 2012; Uyarra et al., 2020).

However, despite an increased recognition of public procurement's potential for reaching a multitude of goals, it still remains an understudied topic (Grandia, 2018). Little is known about how public procurement is conducted, how it leads to desired outcomes, and what factors and conditions determine its effectiveness (Grandia, 2018). In addition, knowledge on public procurement activities in developing countries is less than in the developed world as a whole (Lember et al., 2014; OECD, 2007, p. 20). In the meanwhile, in recent years, more and more developing countries worldwide show their interests in this policy instrument and consider introducing it into various sectors. Hence, in this setting, it is quite relevant to develop knowledge on the usage of public procurement, particularly in developing economies.

According to statistics of OECD (2007), in 2006 only 2% of GDP in China was generated through publicly procured projects, which was far less than the average level of developed countries; but OECD (2007) also contends that it is of strong potential for China to promote innovation via public demand with respect to its sizable market and purchasing power; more prominently, the important role played by central government as well as local government (OECD, 2007).

Public procurement first officially announced as an instrument to promote indigenous innovation in China can date back to 2006, when Chinese State Council together with a number of national departments jointly launched the National Medium- and Long-term Program for Science and Technology Development (2006-2020) (hereinafter also referred to as MLP (2006-2020)) (Y. Li et al., 2015). On the whole, this initiative not only represents Chinese state's recognition towards public procurement as an effective policy tool, it also signals a significant change in national policy direction. Since it is the first time that Chinese government claims to prioritize public demand as an important source to promote indigenous innovation; whereas previously it has long entirely relied upon supply-side policies to spur technology innovation and development (OECD, 2007).

MLP (2006 - 2020) has fully shown China's great ambition in developing indigenous innovation — to be a technology powerhouse by 2020, and take a lead in global innovation by 2050 (State Council, 2006; Vinig & Bossink, 2015, p. 622). Specifically, in the Development Goal, and Major Policies and Measure of MLP (2006 - 2020), it states that:

"The general objectives of the nation's S&T development over the next 15 years ... to noticeably enhance indigenous innovation capability and S&T level in promoting economic and social development and in maintaining national security ... ... implementing government procurement to favor indigenous innovation as well as

formulating regulations of the 'PRC Government Procurement Law' to protect indigenous innovation should be given a strategic priority" (State Council, 2006).

From the above documents, it is obvious to see that Chinese government has attached great importance to public procurement to enhance indigenous innovation since the very beginning, but how does public procurement contribute to China's indigenous innovation indeed?

Understanding the linkage between public procurement and innovation is of significant meanings, because more and more countries around the world are aware of the potential of public procurement and considering introducing it into a variety of sectors as an innovation policy tool (OECD, 2016). Therefore, regardless of the specific approach taken to analyze such relation, a closer look at this link is crucial to understanding the underlying mechanism; which in turn increases transparency and consistency of procurement decisions (OECD, 2016).

By reviewing the body of collected research, we find rich literature on topics namely the national innovation system of China, demand-based innovation policies and indigenous innovation respectively. However, systematic analysis of the underlying mechanism for public procurement to contribute to indigenous innovation China is far less common. Furthermore, existing quantitative and qualitative evidence is limited and most is confined to developed countries in Europe or North America.

To be specific, with regard to quantitative evidence, a report of (OECD, 2016, p. 6) compiled available data across a scope of member countries concerning the role of public procurement in innovation. This report indicates that between 2010 and 2012, about 14% to 36% of firms participating in public procurement also have conducted at least one innovation activity as part of procurement contracts. Statistical evidence in this report also suggests a positive relationship existing between the value of a procuring contract in a given year and the volume of a firm's R&D expenditures in the

following year (OECD, 2016, p. 6). In addition to empirical study on possible correlation, Dai et al. (2020) further disentangled and measured public procurement's effectiveness on innovation, using firm-level data. This study demonstrates the demand-pull effect of publicly procuring activities on innovation is dominant but indirect.

Besides quantitative research, qualitative evidence on this topic seems quite little except the work of Yanchao Li (2011; 2015; 2017; 2020). This author has conducted a series of studies on the topic of public procurement in the context of China. Specifically, Y. Li et al. (2015) believed that innovation catalogues and signalling catalogues are two important instruments that Chinese government uses to implement public procurement activities. What's more, Y. Li & Georghiou (2016) also found that those catalogues played an important role in introducing innovations to the market although the intended mechanism of those policy instruments might not work as planned. Besides, in a study about the use of public procurement in Brazil and China, the authors observed similar obstacles that they experienced when implementing public procurement for innovation (Y. Li et al., 2020). Those findings are very helpful for us to understand China's public procurement system and the role of government within the system.

Overall, both quantitative and qualitative studies on relations between public procurement and China's inidgenous innovation strategy are limited. Particularly, knowledge on the underlying mechanism for public procurement activities to impact on indigenous innovation remains underexplored. Therefore this study attempts to make a conceptual contribution to literature on public procurement for innovation in the Chinese context. In particular, we seek to shed light on how public procurement results in inidgenous innovation as a demand-side innovation policy. In doing so, we aim to provide policy implications for policymakers to enhance the transparency and consistency of procurement decisions in the future.

1.2 Research Questions Formulation

This paper studies the link between public procurement activities and China's endogenous innovation goal, by focusing on the underlying mechanism and dynamics in the procurement process at both central and local levels. Based on a review of existing theoretical concepts and literature in the fields of public procurement for innovation and indigenous innovation in China, combining with our motivations and research objectives stated previously, we formulate our research question as follows:

How does public procurement as a demand-side innovation policy contribute to China's indigenous innovation?

In order to answer this core research question, we need to address several sub-questions first. We present our sub-questions as below:

Sub-question 1: What are the main achievements since China's indigenous innovation strategy was launched in 2006 ?
Sub-question 2: How does the underlying mechanism look like and how do involved actors interact with each at all levels ?
Sub-question 3: What are the key factors enabling public procurement to generate inidgenous innovation ?

The number of sub-questions are organized in such a sequence on purpose so that once the three sub-questions are addressed, the main research question can be answered ultimately. Specifically, for the first sub-question, this paper aims to investigate how successful China's indigenous innovation is in general, since it was put forward as a top priority in 2006. Statistical data about the construction of fundamental infrastructure, patents and scientific publications are extracted from mass media, databases and government reports to give an overview about overall performance.

Based on knowledge of development of China's indigenous innovation, the second sub-question explores the specific mechanism underlying public procurement for indigenous innovation in the Chinese context. For this part, we construct a conceptual framework, with reference to academic research. To develop a thorough understanding of this established framework, a realised case — "Ten Cities, Thousand Vehicles" Demonstration Program in the New Energy Vehicle (NEV) sector — is used to illustrate the breadth of functions of the underlying mechanism. Particularly, solid evidence ranging from primary data (e.g. leader's speech transcript) to secondary data (e.g. newsletters, industrial annual reports, tendering reports, databases) are used for explicit interpretation. After addressing the first two sub-questions, this study attempts to identify patterns in the public procurement for innovation, focusing on key factors and conditions that enable public procurement to result in indigenous innovation.

Regarding approaches to understanding this function mechanism underlying surfaces, so far there are no unified indicators or methods among scholars yet. Considering the exploratory nature of research questions in this study, and the case study approach's advantages in analyzing how and why questions, we tend to take a qualitative case study approach for our research questions, grounding on critical realism and following an abductive reasoning logic. On the whole, by tackling the number of sub-questions sequentially, we expect to gain new insights on how public procurement contributes to Chinese government's ambition in home-grown innovation beyond existing research.

1.3 Thesis Structure

To gain an in-depth understanding of our chosen research question and fill the current research gap in the field of public procurement for innovation in the Chinese context, we structure our thesis writing in the following way. This paper first presents the methodology used in this study as a starting point, in which why we take critical realism as philosophy of science, how data are collected and verified, together with what the rationale behind case selection is, will be explained in detail.

Following that, we conduct literature review on the basis of previous research papers and collect official reports and newsletters. In doing so, we expect to have a better understanding of concepts and identify possible research gaps in the areas that we can contribute to fill.

In the next section, with reference to collected literature, this paper conducts a qualitative case study about public procurement for indigenous innovation in the new energy vehicle industry to shed light on how public procurement in China is implemented, how it contributes to China's indigenou innovation, and what key factors and conditions affect the effectiveness of public procurement for innovation (Edler & Yeow, 2016; Grandia, 2018).

In the last chapter, this paper summarizes findings that are observed in previous analysis; furthermore, implications for practice and policymaking targeting indigenous innovation will be discussed further (Edler & Yeow, 2016). In addition to that, limitations of this research as well as possible research areas for future exploring will be reflected.

2. Methodology

This section gives an introduction to research design and underlying research philosophy of this study. In accordance to philosophical position, detailed approaches to data collection and in-depth analysis will be stated. By doing so, we aim to reveal how the analysis is conducted and how results are generated in the following chapters.

2.1 Philosophy of Science

It is of particular relevance to map out the philosophical position of research prior to knowledge development. To be specific, in the process of developing knowledge (may be a new theory or certain problem), we are consciously or unconsciously making a range of assumptions for each step of our research. In turn, those presumptions will influence how we perceive research questions, which approach we choose and how we interpret results in the end (Burrell & Morgan, 2017; Crotty, 1998; Saunders et al., 2019).

In this research project, a critical realism perspective will be utilized to guide our research methodology, with a key assumption that "the world exists independently of our knowledge of it" (Sayer, 2000). Overall, critical realism is widely viewed as a coherent, solid and relatively new research philosophy that not only provides substantive groundings for case study being a research method, it is also quite useful in helping us to understand theoretical development as well as the research process (Easton, 2010, p. 120).

Critical realism originated in the work of Bhaskar in the 1970s and 1980s, aiming to challenge empiricism and positivism (Archer et al., 2013; Fletcher, 2017; Mingers, 2004). In Bhaskar's opinion, reality is both intransitive (existing independently of humans) and stratified (Archer et al., 2013; Mingers, 2004). Particularly, for critical realists, reality is external and independent, therefore it is impossible for human knowledge to

fully capture reality but only a small part of it. In this sense, ontology (the nature of reality or being) is not reducible to epistemology (our knowledge of the real world) (Fletcher, 2017; Saunders et al., 2019).

At the same time, this philosophical position also claims that although a real world is out there, it does not mean the reality is not accessible at all (Danermark et al., 2019; Fletcher, 2017; Saunders et al., 2019). Bhaskar (2014) argues:

"*we are only able to understand — and so change — the social world if we identify the structures at work that generate those events and discourses...These structures are not spontaneously apparent in the observable pattern of events; they can only be identified through the practical and theoretical work of social science" (Bhaskar, 2014, p. 2).*

Furthermore, Saunders et al. (2019) posit that we can follow two steps to understand reality: in the first place we experience sensations and events; then we *"reason backwards from experiences to underlying reality" (Reed, 2005).* Besides that, from the viewpoint of Fletcher (2017), some knowledge can be closer to the real world than others. In this regard, critical realist research can also be viewed as relativism, in which observing organizational events can be a possible approach to explore underlying causal structures and mechanisms.

With respect to typical methods of critical realism research, they are often considered essentially abductive. Specifically, in an abductive reasoning logic, collected data is used to investigate a phenomenon, and identify themes or patterns that are going to be further tested through additional data collection. Moreover, regarding the theoretical framework of critical realism, generating a new theory or modifying an existing theory is often employed (Saunders et al., 2019, p. 153).

To sum up, in the opinion of critical realists, although it is impossible for human beings to fully know the nature of reality, we are still able to develop knowledge so as

to get closer to the nature of reality by observing organizational events (Danermark et al., 2019; Fletcher, 2017; Saunders et al., 2019).

2.2 Theoretical Background of Case Study

Grounding on critical realism, we build our research upon a qualitative case study approach (R. K. Yin, 1991), considering the nature of the research question of this project necessitates an in-depth understanding of the context and dynamics of public procurement for innovation.

Many have attempted to define what case research is, but that is quite difficult since it is often associated with a variety of different research approaches (Easton, 2010, p. 119). According to Easton (2010, p. 119), "*a case is a single instance, a sample of one*". Thus, a key advantage of case study is that it allows us to understand a phenomenon in depth and comprehensively; but in the meanwhile it is of low representativeness due to small sample size (Easton, 2010, p. 119).

Studies indicate that case study approach suits to analyze how and why questions since it is exploratory in nature (Easton, 2010, p. 119). Relating to our research questions, our main interest lies in the underlying mechanism and interactions of the innovation process rather than statistics. From this perspective, in-depth case study suits qualitative research of this paper very well (R. K. Yin, 1991; Robert K. Yin, 2003).

2.3 Case Selection

In terms of case selection, we choose a realized case — "Ten Cities, Thousand Vehicle" of the new energy vehicle industry for this research. The first key reason for us to select this case is because it presents Chinese government's strong determination to enhance indigenous innovation in the traditional manufacturing sector. It is well-known that China's rapid economic growth in the past decades was largely attributed to manufacturing industries and domestic cheap labor costs. But behind such impressive economic performance, it is at the expenses of the environment and natural

resources. In the short term, it seems that China has gained a lot in this way; however, from the long-term perspective, if China sticks to this developing path, it is doomed to lose more.

However, the process to develop a new technology and ultimately manage to commercialize is full of challenges and uncertainty. In other words, massive inputs can never guarantee outputs. In this setting, Chinese government's decision to prioritize new energy vehicle innovation and development demonstrates its strong determination to pursue sustainable development.

Secondly, we select this case because we have observed unusual enthusiasm of the Chinese government with regard to new energy vehicles, and we are conscious about the rationale behind the government's strong support towards this industry. After a broad scan of Chinese public activities across sectors, we found that Chinese government has attached great importance to new energy vehicles compared to other emerging industries. For example, in a wide range of government policies and documents, new energy vehicles and related technologies have been given top priority. It is one of the 13 Engineering Megaprojects in China; in the meanwhile, it is also identified as one of the 8 Frontier Technology Program as well as key areas by the Ministry of Science and Technology. Thus, we believe an in-depth investigation of this case may help us understand why the state works hard to promote new energy related innovation and technology rather than invest on other projects. After all, there are also a number of urging issues that need to be addressed.

Besides two important reasons above, another motive for us to select new energy vehicles for case study is the existence of research gaps. In the process of case selection, we realize public procurement activities targeting indigenous innovation in the context of the new energy vehicle industry is still understudied. Although there are already a few articles that explored China's government procurement system and indigenous innovation across sectors etc.. However, there is not a systematic analysis

about how public procurement contributes to indigenous innovation in the Chinese context indeed yet. Therefore we aim to contribute to this research field through an in-depth analysis of public procurement for innovation situated in the new energy vehicle industry.

Of course, we are also aware of the possible limitations of undertaking case study in our research. As critical realists claim, reality is not reducible to our knowledge; likewise, through a single case study may not be able to capture the whole picture of this research area. In addition, our past experiences and socio-cultural background, alongside some undiscoverable factors, may always shape the means we perceive question, design research and interpret findings somehow. Consequently, biases are inevitable. But that does not mean our research is meaningless; in fact, all research is at the risks of being biased. We have to admit this fact; but more importantly, we should strive to minimise biases as much as possible; as a result, being objective at the very beginning seems a possible way to reduce impacts deriving from subjective biases (Saunders et al., 2019, p. 148).

2.4 Data Collection

Data for this study is mainly obtained from two sources. First of all, an extensive collection of government policies are collected from official websites of those agencies (e.g. local branches, central ministries) respectively. What's more, political statements, along with Chinese leaders' public speech transcripts are acquired from newspaper, government annual reports as well as the websites of party-related organizations.

The second important data source is mainstream databases around the world, including both publicly accessible databases and specialized commercial databases. Specifically, indicators such as industrial annual performance, R&D inputs and outputs, together with value and volume of public procurement, all are important indicators that we are interested in. Besides that, because this paper aims to investigate industrial

performance during a time period of 15 years, to do so, we also draw numerical figures from academic articles.

In terms of challenges in the process of data collection, one inevitable challenge is that some data, in particular those extracted from academic studies, are outdated or no update. Therefore as a complementary, we manually update and organize those figures with latest data. To ensure the validity and reliability as much as possible, regardless of data sources, input data in this study has been verified through data-triangulation (Băzăvan, 2019, pp. 2–3).

Additionally, another challenge we encounter is language. Since we are interested in the dynamic nature of innovation activity in the Chinese context, some policy announcements, reports and political statements are often in Chinese. However, the process of language translation may distort those data with subjectivity. To deal with this issue, firstly we tend to acquire English versions of required documents if it is available on websites. By doing so, we can avoid self-translation and the distortion on original statements. For those without English version, we turn to Google Translate and verify translation results with information obtained from multiple sources, using search engines (e.g. Google, Baidu).

Overall, combining with our research motivation and selected research questions, for this study we mainly rely upon secondary data collected from a range of sources. In order to gain insights on the latest trend of industry performance and procurement activities, we also complement some data with the latest information. To enhance the validity of cited data, we take a data-triangulation approach to verify input data. Furthermore, we are consciously aware that some data such as political statements, leaders' speeches and interviews relating to government policy are inherently influenced by subjectivity and censorship (Băzăvan, 2019). As a response, we will take this factor into consideration in findings. But from another perspective, those contents also give us some hints on the state's attitude or more accurately, policy

preferences. From this perspective, it is still of value to keep and examine those data rather than abandon them because of fear of limitations.

2.5 Validity and Reliability

2.5.1 Construct validity

Although multiple-case design is stated by Robert K. Yin (2011) as a typical way to provide stronger confidence to research, this study consciously designed a case study to increase construct validity. With reference to the framework developed by Robert K. Yin (2011), we design this research by using systematic procedures to strengthen its construct validity. In detail, prior to data collection, the author has browsed a bunch of theoretical studies and related government documents concerning developed research questions. By doing so, we anticipate to have a general understanding about how other scholars in this research field establish standards for case selection. In order to gain a deeper insight into selected questions, it has been decided that the case must reflect the state's strong determination towards indigenous innovation; thus industries or technologies that have been highlighted in the MLP (2006 - 2020) can help the researcher narrow down the scope. Aftering gathering a range of cases, the author decided to take a demonstration program — "Ten Cities, Thousand Vehicles" in the new energy vehicle sector for analysis. Specifically, this demonstration program has met all standards we set for case selection; in the meanwhile, it was a quite recent event and still not extensively studied yet.

Following case definition, this research specifies several sources for data collection. Because this demonstration was implemented between 2009 and 2012, to obtain first-hand from those pilot cities seems impossible. In this background, the author decided to mainly focus on secondary data from multiple sources. Moreover, data-triangulation has been employed in the process of collecting data. In order to avoid being distracted by irrelevant information, the core research question has been intentionally thought throughout the whole process. To summarize, those procedures

are particularly useful to keep this research staying on the right track and being prepared for possible challenges.

2.5.2 External validity

Compared to other research methods, a qualitative case study is inherently limited by the absence of external validity (Mariotto et al., 2014). However, because this research is mainly designed to explore the underlying mechanisms and identify key linkages within the system, this study is still able to construct a sound basis for the analytical generalization with certain external validity (Robert K. Yin, 2011).

2.5.3 Reliability

The reliability of a study can also be regarded as its consistency, which means if subsequent researchers can generate the same results if they replicate the research design and follow the same steps again (Mariotto et al., 2014). In the author's opinion, the reliability of this research has been achieved. Following Robert K. Yin (2011)'s framework, this research consciously designed the research steps and strictly stuck to designed systematic procedures during the entire process. More importantly, data used in this study were collected from diverse sources, ranging from newspapers, official government documents related to the research, to raw data extracted from both public and commercial databases worldwide. Furthermore, in order to present how we perceived and achieved conclusions, original texts have been incorporated in this research. To summarize, readers can arrive at the same insights if they replicate this research again (Mariotto et al., 2014).

3. Literature Review

3.1 Indigenous Innovation in China

3.1.1 What is Indigenous Innovation?

In general, innovation has long been widely used as a powerful tool to stimulate economy, society and technology development worldwide. Politicians frequently mention the word "innovation" in their speeches; entrepreneurs prioritize innovation as a key to gain competitive edge in markets; and agencies keep citing this term in mission and vision statements (Kahn, 2018). As discussion revolving around innovation is everywhere today, China's indigenous innovation (also referred as "Zi Zhu Chuang Xin" in Chinese) also attracts growing attention from researchers and policymakers across the world. Similar to ongoing debates on innovative activities, disputes on the topic, indigenous innovation, have never ceased.

Because the research focus of this paper is about the contribution of public procurement for endogenous innovation in the Chinese context, prior to further analysis, it is important to figure out some basic concepts (e.g. innovation, indigenous innovation); more prominently, when we talk about China's indigenous innovation, what do we really mean, like a strategy, policy plan or certain capability?

A lot of people show their concerns about the overuse of the term innovation as it may lead to misunderstanding of its true meaning, consequently resulting in irrational decisions of individuals, corporates or organizations (Kahn, 2018; Kuratko et al., 2014). Therefore, to develop a solid conceptual basis for further analysis in the following sections, we will delve into origins of those notions to get a comprehensive understanding. Moreover, this paper will clarify three common misunderstandings concerning indigenous innovation.

In the past decades, many scholars have attempted to define the term "innovation". Kline (1985, p. 36) broadly defined it from the perspective of economics; that is "*A set of actions that lead to actual adoption in practice of a device, machine, process, or system*". O'Sullivan & Dooley (2009) specified types and trajectory of innovation in given definition: *"Innovation is the process of making changes, large and small, radical and incremental, to products, processes and services that result in the introduction of something new for the organization that adds values to customers and contributes to the knowledge store of the organization" (O'Sullivan & Dooley, 2009; p. 3)* .

In addition to various definitions towards innovation, there are also a number of alternatives often interchangeably used to refer to innovation, ranging from "innovativeness", "innovative" to "novelty". However, as a matter of fact, obvious distinctions exist among those terms. As a result, interchangeable use of them may cause confusions from time to time.

On the whole, in this research we argue that interchangeable use of those words are not appropriate and decide to follow a broad definition given by Cambridge Dictionary. According to Cambridge Dictionary (2020), *"innovation"* literally refers to *"(1) a new idea, design, product, etc.; or (2) the development of new products, designs, or ideas"*. From this definition, it is evident to see that both outcomes and processes are two key aspects of innovation. This notion is also consistent with a view of Kahn (2018); in the author's opinion, innovation can be perceived from three dimensions — an outcome, a process and also a mindset. Besides that, Kahn (2018) also emphasized that so-called outcome, process as well as mindset are not mutually excluded but interrelated to one another.

In terms of misunderstanding towards indigenous innovation, the first common misperception is that "indigenous" specifies a certain type of innovation. However, a flood of research suggests that today when people talk about indigenous innovation,

most of the time they actually refer to a paradigm of state-encouraged innovation (Losacker & Liefner, 2020, p. 1125).

Secondly, a lot of people wrongly believe that indigenous innovation is a unique phenomenon only observed in China. Scholars like Vinig & Bossink (2015) contend that indigenous innovation is an approach put forward by Chinese government as an alternative to Western-centric innovation approach; while Peng (2010) offered a new insight from law perspective, positing that endogenous innovation is a national strategy initiated by China so as to take more control of core intellectual property (IP) rights. On the whole, both of them tend to view indigenous innovation as a China-specific phenomenon. But abundant evidence indicates that in fact developed countries already have a long history in using indigenous innovation to generate wealth (Lazonick, 2004).

For example, early in the 1820s, Boston Associates in the USA made determination to invest more on domestic machinery and equipment. By doing so, it strived to minimize dependence on imported British textile technology and enhance its own capability in self-innovation and technological creation (Jeremy, 1981; Lazonick, 2004). This marks a significant step taken by US business to pursue indigenous innovation (Jeremy, 1981; Lazonick, 2004). Somehow by coincidence, on another continent, a Japanese firm called Toyota Automatic Loom Company eventually managed to develop its own shuttle-changing automatic loom after years of experiments, while prior to that, Japan had to fully rely upon imported technologies from a British company Platt Brothers (Kazuo, 2004).

The third common fallacy is that indigenous innovation must be something radical and completely new to the world (Kahn, 2018). In fact, endogenous innovation is not equivalent to a new creation out of nothing; more importantly, incremental innovation should not be placed on each one's opposite side. Relating to indigenous innovation in

China, in the Guiding Principles of MLP (2006 - 2020), the Chinese State Council defines indigenous innovation as below:

"Indigenous innovation refers to enhancing original innovation, integrated innovation, and re-innovation based on assimilation and absorption of imported technology, in order to improve our national innovation capability" (State Council, 2006, p. 9).

From the description above we can conclude that in the Chinese context, indigenous innovation refers to *"new to the country"* instead of *"new to the world"* (Y. Li & Georghiou, 2016, p. 341). Overall, innovation can be understood from a range of various dimensions. On the one hand, it could mean an outcome — e.g. a totally new product or solution; while at the same time, it can also be viewed as a process that is very dynamic in nature. On the other hand, no matter if it is a minor incremental progress in functions or a significant breakthrough in theories, as long as it is new to the country through constant efforts such as state-encourage innovation policies, it can be considered as indigenous innovation (Kahn, 2018). What's more, it is worth noting that innovation should not be too ambitious, because the more radical creation requires more inputs and management; accordingly, risk of failure is greater than incremental innovation (Kahn, 2018). Therefore, when required resources are not available, starting with small, incremental changes may be a good choice to pave ways for radical innovations in the future.

3.1.2 Rationale to Pursue Indigenous Innovation

China has displayed its ambition in enhancing indigenous innovation capabilities a long time ago. But the first official document prioritizing indigenous innovation as a national strategy is The National Medium- and Long-term Science and Technology Development Plan (2006-2020) (Vinig & Bossink, 2015). With reference to prevailing research and government documents, we tend to categorize the rationale into two

types: internal and external reasons, which will be detailed in the following paragraphs.

Internal reasons, from our viewpoint, can also be perceived as domestic factors that drive the Chinese state to promote capabilities of self-innovation. The first and foremost motivation is that rising labor costs in China make it difficult for domestic manufacturing to maintain a competitive edge as previously (Guanhua Xu, 2006). Due to demographic dividend, China has experienced rapid economic growth and made significant achievements for decades since economic liberalisation. Nevertheless, this comparative advantage is diminishing as ageing accelerates. Hence, in order to sustain economic growth, it is quite necessary for Chinese government to foster indigenous innovation (OECD, 2007b, 2007a).

Secondly, indigenous innovation is a feasible way for China to move up value chains and specialise in high value added activities .(Grimes & Du, 2013; OECD, 2007; Vinig & Bossink, 2015). Because of lack of core technology, it is increasingly difficult for Chinese enterprises to profit by engaging in low value-added production of the global value chain. For instance, some manufacturing plants are forced to give up a large portion of selling prices to foreign patent holders, ranging from 20% for each phone, to 30% for every computer sold. Thus as a response, to move beyond the catching-up phase, developing an innovation-oriented and knowledge-based economy seems quite crucial and urgent (Vinig & Bossink, 2015, p. 622).

In addition to internal causes, there are also a variety of external factors, incentivizing China to pursue indigenous innovation. The first inevitable issue faced by Chinese enterprises is increasing restrictions on technology exports imposed by developed countries. On the whole, China's competence of generating innovation is lagged behind its economic growth rate as domestic industries strongly rely on imported technology from abroad and foreign direct investment (FDI) (X. Liu & Peng, 2015; OECD, 2007, p. 9). The degree of dependence is particularly high in certain industries,

namely airplanes, automobiles, chips and software. Therefore in this context, some measures must be taken to reduce reliance on imported technology.

Another important factor resulting in implementation of indigenous innovation in China is core obligations of WTO — GATT, GATS and TRIPs. It has been approximately 20 years since China joined WTO in 2001. However, as the volume of trade between China and other WTO members grows, tensions are also mounting. This is particularly acute when it comes to China's policy on technology transfer, which has aroused constant controversy and resulted in a range of WTO dispute settlement cases (Zuijdwijk, 2019). From this perspective, those ongoing international disputes under WTO regulations have become major obstacles for China to compete in global markets.

Thirdly, the global financial crisis is also an important external factor that pushes Chinese government to take more aggressive actions in enhancing indigenous innovation (X. Liu & Peng, 2015). This crisis not only struck the global economy in a hard way and led to Great Recession across the world subsequently, it also made countries to be more cautious and tighten up regulations. Statistics indicate that China has continuously increased R&D inputs even during the period of financial crisis (X. Liu & Peng, 2015). To some extent, this has revealed the state's confidence in using endogenous innovation to recover the economy in a short time, and to sustain long-term economic growth.

Overall, poor innovation capability inevitably places China in an awkward situation, where the domestic economy is mainly driven by low costs but at expenses of profit margins; on the other hand, science and technology development is trapped by intellectual property rights (IPR) and high license fee. What's more, pressures deriving from global competition, international treaties and regulations as well as global financial crisis all suggest a more sustainable and high value-added approach to an innovation-oriented and knowledge-based economy.

3.1.3 Definition and Origins

Concepts and definitions are crucial to identifying and understanding phenomena. Based on previous discussion pertaining to innovation and rationale, we define indigenous innovation in the Chinese context as follows:

"*Indigenous innovation refers to the capability of developing technology independently and owning core intellectual property rights through a range of state-encouraged innovation policies and strategies, targeting sustainability of economy, society and environment*".

In line with Circular 618 ("Circular on Carrying out the Work on Accreditation of National Indigenous Innovation Products"), we further define indigenous innovation products as "*items of which intellectual property rights owned by a Chinese company and a commercial trademark initially registered within China" (McGregor, 2010b).*

Specifically, in our opinion, depending on the specific phases of development and external environment, measures required to promote indigenous innovation also evolve accordingly. For example, 2008 global financial crisis demonstrated risks associated with import reliance; as a response, MLP (2006 - 2020) was repeatedly redeveloped (Vinig & Bossink, 2015, p. 622). To summarize, indigenous innovation is neither a country-specific phenomenon, nor a single initiative, but a kind of endogenous ability which can be cultivated and enhanced through knowledge accumulation and constant practice.

Regarding indigenous innovation's origin in China, the launch of MLP (2006 - 2020) was widely accepted as an official starting point. Early in 2005, the CPC Central Committee achieved a consensus to elevate indigenous innovation to a strategic level as significant as Deng Xiaoping's reform and opening policy (McGregor, 2010b). Additionally, in a public speech of Hu Jintao, he emphasized that science and technology development should be placed at the center of national strategy

(McGregor, 2010b). A few months later in the same year, MLP (2006-2020) was unveiled.

According to this science and technology plan (S&T plan), the key objective is to transform China to a technology powerhouse by 2020 and become a global leader by 2050 (McGregor, 2010a, p. 4). Furthermore, the potential of indigenous innovation as a means to enhance competence and to develop a knowledge-based economy was highly recognized in this national plan (OECD, 2007). In the following decade, the state subsequently redeveloped a variety of policies and programs to strengthen capability in innovation. For instance, in November 2009, Circular 618 was released.

In general, this new initiative has fully demonstrated China's ambition to develop an innovation-oriented and knowledge-based economy in the near future. This strategy has not been static since the very beginning. Instead, the state is constantly adjusting the direction and paces according to changing circumstances. Moreover, MLP (2006 - 2020) and other related innovation policies feature in both depth and breadth. On the one hand, the variety of government policies and programs targeting indigenous innovation is distinct from previous measures implemented by Chinese in depth. To be specific, it places more emphasis on long-term planning rather than a single technology or a specific field. On the other hand, this innovation is remarkably different in breadth compared to instruments in the past. From planning to implementation, the entire process gives full play to the role of innovation, involving a wide range of actors (e.g. organizations, government agents, business) at central, provincial and municipal levels (Wolff, 2007, p. 55).

3.2 Theories on Innovation

Today science-based innovation is everywhere. Apart from policymakers and politicians, more and more researchers show their interests and engage in academic studies of this emerging area. General speaking, a well-integrated bastion for discipline of innovation research has not formed yet (Smits, 2002). In the viewpoint of

Smits (2002), studies on innovation can be regarded as an evolving research field that lies at the crossroads of multiple disciplines — economic studies, sociology and policy studies, and historical as well as technological research.

Before looking into demand-oriented innovation policies in general, and public procurement activities for innovation in particular, we want to examine the role played by demand in promoting innovation first (Charles Edquist et al., 2012, p. 9). By this means, we expect to have a basic understanding of the relation between demand and innovation.

3.2.1 Linear-oriented View versus System-oriented View

By reviewing the body of existing literature, it is evident to see that in the past decades, knowledge of innovative activities has amassed at an unprecedented speed. According to Edquist & Hommen (1999, pp. 63–64), innovation process and innovation policies are closely related to each other. In general, literature on the innovation process can be categorized into two types: linear-oriented view and system-oriented view; likewise, innovation policies can be classified as demand-based policy and supply-based policy. To be specific, a linear-oriented process is associated with supply-side policies in innovation; while a system-oriented view favors a demand-driven perspective concerning innovation processes (Charles Edquist & Hommen, 1999, pp. 63–64).

Linear view of innovation is highly consistent with the notion of market failure in neoclassical economic theory. Neoclassical economics presumes development in science and technology is inherently freely accessible to all (Kattel & Lember, 2010, p. 9). Besides that, this theory posits that such development is somehow linear (Kattel & Lember, 2010, p. 9). In that sense, the state is supposed to invest more in industrial R&D directly (e.g. subsidies, tax reductions) and indirectly (e.g. funding for basic science) when market failure occurs (Arrow, 1962; Charles Edquist & Hommen, 1999, p. 64; Nelson, 1959).

Many have attempted to define what a linear innovation process is essentially. Kline (1985, p. 36) claims that innovation is an orderly process, starting with knowledge discovery, followed by developments, and ultimately being presented in a viable form. Gibbons et al. (1994) describes this process in a more detailed way. In the author's opinion, it is basic science that leads to technological innovation at the very beginning; subsequently technology generates required products so that market demand is met ultimately. As a whole, the essence of linear perspective is that the entire innovation process is smooth and irreversible (Charles Edquist & Hommen, 1999). As a result, investments on basic science can guarantee technology creation and plentify profits eventually (Charles Edquist & Hommen, 1999).

Based on the above discussion, it is not hard to find out that linear models are too ideal to be realistic in practice. Scholars like Kline & Rosenberg (2009, p. 286) pointed out that *"feedback and trials are essential to the innovation process"*, regardless of revolutionary or evolutionary innovation. The authors also highlighted that *"design is central to the innovation process rather than science" (Kline & Rosenberg, 2009, pp. 287–288)*. Thus, simply counting on large-scale investment to guarantee outputs is not feasible in reality.

By contrast, a system-oriented view fully recognizes the complexity within innovation systems and dynamics in the process (Charles Edquist & Hommen, 1999). In accordance to evolutionary theories, the system view of innovation contends that *"the process of generating innovation is anything but linear; similarly, technology is anything but freely accessible" (Kattel & Lember, 2010, p. 9).* Among the bunch of models and approaches deriving from the demand side, Systems of Innovation Approach is known as a powerful tool for examining relations between demand-oriented policies and innovation, which therefore enables us to explore the innovation process and underlying mechanism systematically (Charles Edquist & Hommen, 1999, p. 65; Gibbons et al., 1994). In the following paragraphs, we will give an explicit introduction to Systems of Innovation Approach.

3.2.2 Systems of Innovation Approach

Systems of innovation was first introduced in the late 1980s, as a policy concept in studies of science, technology and innovation (STI) in Europe. Afterwards, National Innovation Systems emerged and offered a new insight on innovation, focusing on how nations construct knowledge infrastructures for economic development (Freeman, 1987; Lundvall, 1992; Nelson, 1993). This framework later was applied to regions and sectors, where technological innovation systems (Carlsson, 1997), regional innovation systems (Cooke et al., 1997) and sectoral innovation systems share certain characteristics over time (Breschi & Malerba, 1997; Fischer & Fröhlich, 2001; Malerba, 2005).

The notion of innovation systems implies that innovations are not generated in isolation, but are created in a dynamic process in which multiple actors and agents constantly interact with each other (Fischer & Fröhlich, 2001). Innovation, knowledge generation and diffusion are all central to innovation system approach (Fischer & Fröhlich, 2001, p. 1). Additionally, different from network school research (Håkansson, 1987), innovation systems approach values the role of institutions in the innovation process (Charles Edquist, 1997; Fischer & Fröhlich, 2001).

However, it is worth noting that the systems of innovation approach is a conceptual framework rather than a formal theory (Fischer & Fröhlich, 2001, p. 1). Compared to earlier theoretical approaches, systems of innovation approach offers a new perspective for us to investigate factors that influence innovation processes from a demand-based perspective. In particular, Gregersen (1992) stresses the role of public sectors as a pacer in innovation.

3.3 Demand-side Innovation Policies

Since the 1990s, demand-side innovation policy instruments are widely used to design and analyze policies. Nevertheless, application of this instrument in practice is decreasing since it was introduced. Edquist et al.(2012) and Smits (2002) have offered

a compelling explanation for this phenomenon. They claim that if we want to transform theoretical innovation policies into practice successfully, more resources than expected are required (Charles Edquist et al., 2012, p. 11; Smits, 2002, p. 865). In other words, policy planning is more accessible than policy implementation in reality.

Demand-based innovation policy in general refers to "any innovation policy that aims to increase the demand for innovations, to improve the articulation of demand in order to spur innovations and to accelerate the diffusion of innovations" (Edler & Georghiou, 2007). According to Edler & Georghiou (2007), demand-side policies can be categorized into four groups: *"systemic policies, regulations, public procurement and support of private demand" (see in Figure 1).* Another OECD (2007) classifies demand-based innovation policies into three groups — public procurement of innovation, standardisation and regulation, lead-market and user-driven innovation initiatives.

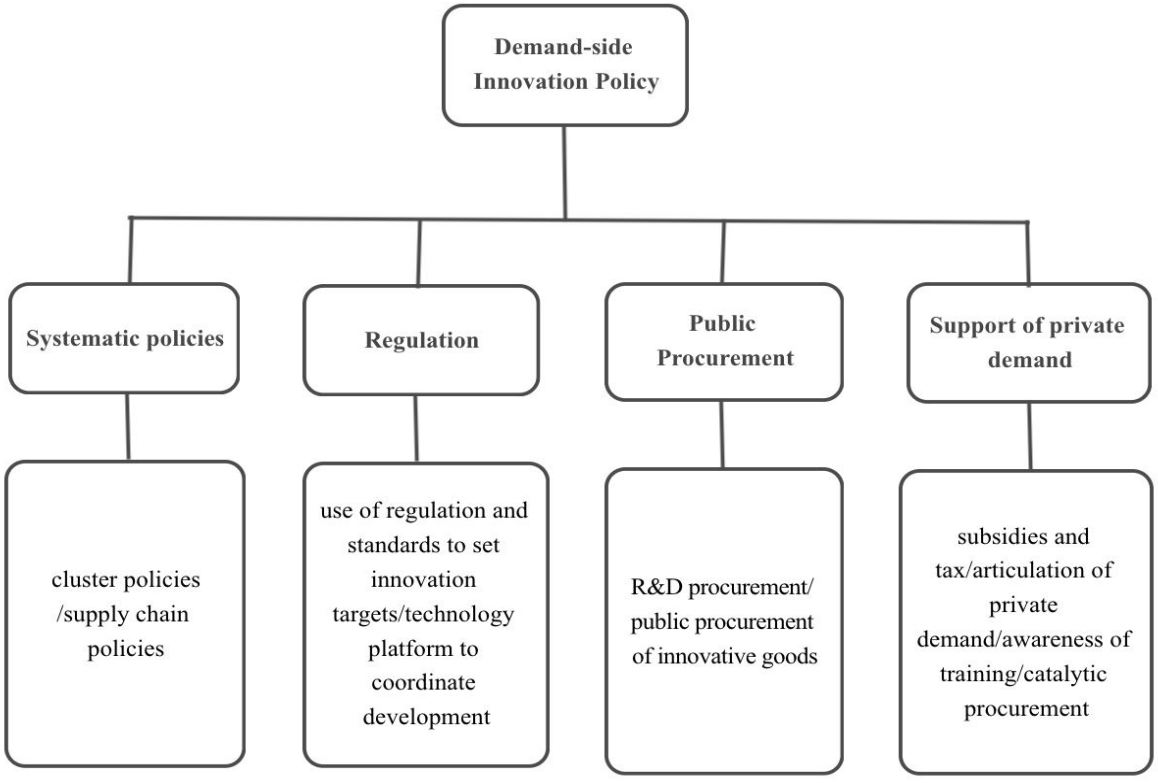

Figure 1. Demand-side Innovation Policy Instrument, draw from Public procurement and innovation—Resurrecting the demand side, by (Edler & Georghiou, 2007)

Regardless of differences in classification, from the above discussion we can conclude that public procurement is a crucial instrument to support innovation among a number of innovation policies deriving from the demand side. In fact, the work of Geroski (1990), Lember et al. (2011) and Rothwell & Zegveld (1981) provides evidence for a better performance of public procurement compared to R&D subsidies.

3.4 Public Procurement for Innovation

3.4.1 Origins and Forms

Public procurement for innovation, is also known as *"public technology procurement" (C. Edquist & Hommen, 2000) and "innovation-oriented procurement" (Rothwell, 1984)*. This term was first coined to describe an emerging phenomenon — *"public organizations place an order for a product or a system that does not exist at the time, but it could be delivered within a reasonable period. To fulfill the demands of the buyers, additional R&D work is required and thereby might influence the innovation capability of providers" (Lember et al., 2011, p. 1374)*. Afterwards, to further extend the scope of publicly procuring activities, the term "technology" is replaced by "innovation".

Due to differences in procured products, the degree of innovation and end users, public procurement can take many forms, namely, general procurement versus strategic procurement, development procurement versus adaptive procurement, and direct procurement, cooperative procurement as well as catalytic public procurement.

To be specific, general public procurement usually refers to a product, in particular an off-the-shelf product, which is purchased to simply fulfill the demand of buyers (Vonortas et al., 2011, p. 2). Unlike general public procurement, strategic public procurement is often more mission-oriented. For instance, this practice is often taken to drive a market by purchasing a product on the list of innovation catalogue (Edler et al., 2005, p. 15; Edler & Georghiou, 2007).

Furthermore, depending on the degree of innovation, public procurement can also be categorized into development procurement and adaptive procurement. Procurement is considered as development one only when it is developed from zero; while fundamental technologies required for an adaptive procurement usually are already there (C. Edquist & Hommen, 2000, pp. 21–22). But in order to meet buyers' specific needs, additional innovation is required for further adaptations (C. Edquist & Hommen, 2000, pp. 21–22).

Besides classification above, public procurement can also be understood from the side of end users. If government itself is the direct user of procurement, then this procurement can be called direct public procurement; on the contrary, if both public organizations and private buyers jointly pay for and consume procured products, then this practice can be considered as cooperative public procurement (Edler & Georghiou, 2007, p. 954). The third kind of public procurement, catalytic public procurement, refers to a procurement that is launched by a state agency, but the ultimate consumers are private users (C. Edquist & Hommen, 2000; Charles Edquist & Hommen, 1988; Vonortas et al., 2011).

As a whole, no matter which form of public procurement for innovation takes, placing an order for a technology or service is neither the beginning nor the end (Charles Edquist & Zabala-Iturriagagoitia, 2012). From the viewpoint of Charles Edquist (2012), public procurement for innovation is often carried out for two main purposes:

"(1) to satisfy human needs, and/or *(2) solve societal problems".*

However, Charles Edquist (2012) also pointed out human needs and so-called societal problems are often too broad. Therefore, when conducting in-depth analysis about public procurement for innovation, it is important to specify which product is

procured; what goal is expected; more importantly, how a tendering process is implemented.

3.4.2 Applications in Developing and Developed Economies

PPI has been incorporated into a number of international organizations' agendas (Kattel & Lember, 2010, p. 4). By 2020, 48 WTO members in total have committed to Government Procurement Agreement (GPA) (WTO, 2020). To further support innovation through public procurement activities. In recent years, a variety of initiatives such as Aho-Report (European Commission, 2006) and Barcelona Strategy (European Commission, 2003) were launched successively in Europe.

As a part of demand-oriented innovation policy mix, PPI is not only highly promoted within European Union (Doe, 2012; European Commission, 2005), but also recognized by OECD as an effective instrument for both developed and developing economies to stimulate innovation (OECD, 2009b). OECD further emphasizes that even in advanced economies, PPI related activities should be fully developed and accelerated as long as it is possible (OECD, 2009a).

In early 2004, prior to other European countries, France, Germany and UK showed their interests in using PPI to drive innovation and accelerate the diffusion of innovation; they urged European Council to promote this measure across Europe (Edler & Georghiou, 2007; Charles Edquist & Zabala-Iturriagagoitia, 2012). By contrast, evidence on the application of public procurement to incentivise innovation outside the military sector is little (Vonortas et al., 2011).

What's more, although strategic-oriented public procurement exists in the United States, it basically has no connection to innovation at all; since most of them are designed and conducted to pursue a social objective such as environmental protection, energy efficiency or welfare of disadvantaged populations (Edler et al., 2005;

Vonortas et al., 2011, p. 2). All in all, PPI is more frequently deployed to promote science and technology innovation in Europe than in the US.

Public procurement for innovation, as a powerful innovation policy instrument, is not only widely applied in developed countries to incentive innovation, its potential is also recognized by many developing countries (eg. Brazil, India, China). In 2013, the Federal government of Brazil spent more than R$ 68 billion on procurement to nurture industry innovation, corresponding to 1.7% the national GDP (Sorte Junior, 2016). In India, in order to enhance innovation and development of small-scale firms, national procurement law stipulates that certain goods and services must be exclusively procured from small businesses (Srivastava, 2001). In China, since MLP (2006 - 2020) was unveiled, the Chinese government at both central and local levels mobilize a lot of resources to promote indigenous innovation capability via a number of innovation policy tools, of which public procurement is a typical one.

Besides its high popularity across the world, public procurement is also revitalized and used in both public and private sectors (Aschhoff & Sofka, 2009, p. 1235). For example, industries such as GPS, semiconductor industry and passenger jets, often require tremendous resources and repeated experiments before commercialization. Additionally, the risk of failure in those sectors are also higher than others(Cabral et al., 2006; Lember et al., 2011; Ruttan, 2006). In this setting, the government as the first buyer, on the one hand, provides enterprises with required funds for subsequent innovation and development; on the other hand, because publicly procured equipment is usually an off-the-shelf product or solution, by placing a tendering order for certain item, the state also provides a testing ground for the business before mass production (Rothwell, 1984; Vonortas et al., 2011).

Overall, the successful application of public procurement for innovation in various economies and sectors has given us some new insights on feasible approaches to innovativeness besides supply-side innovation policies. But it is also of particular

relevance to explore the function mechanism underlying such phenomenon for both practical and theoretical considerations. In fact, there are already a number of scholars attempting to identify and measure how public procurement affects indigenous innovation, using various indicators and methods. Some of them believe that this practice creates a new market for unpopular technologies with signaling meaning for other potential buyers; others claim that the government provides a testing ground for products before mass production (Rothwell, 1984; Vonortas et al., 2011). Moreover, public procurement for innovation is a market activity essentially. Through exchange, both buyers and producers are allowed to obtain what they desire eventually. In this regard, one major objective of the state is to enhance the capability in indigenous innovation, therefore they will ask for at least one innovation activity in the procurement contract.

3.5 A General Evaluation of Achievements

By 2020, it has been 15 years since MLP (2006 - 2020) was unveiled in 2006. Over this period of time, China has made historic achievements in enhancing home-grown innovation capability. In this study, we use three indicators to illustrate China's overall performance in indigenous innovation. Specifically, the range of indicators consist of the number of high-tech science parks, patents registration and academic publication (Appelbaum et al., 2016, p. 150).

3.5.1 High-tech Science Parks Steadily Expand

The statistics of UNESCO (2020) show that by 2020, there are more than 400 science parks in total around the world and this figure still keeps growing. In particular, the US takes a lead with a total of over 150 science parks across the country. Second to the US, Japan has 111 high-tech science parks. China comes next with around 100 science parks domestically by now, among which 52 technology parks were constructed by the central government, while the rest were approved by governments at local level.

In general, science parks are of great importance in developing knowledge-based economies and fostering science and technology commercialization, by bringing together government, enterprises and scientific researchers at one physical place (UNESCO, 2006). China shows its enthusiasm in developing science and technology parks in the 1980s. In 1988, the first high-tech science park, Zhongguancun, was launched, which still remains as the largest technology park now in China. In light of science parks' clustering effects, Chinese government at both central and local levels consistently supports the development of science parks domestically. In 2006, as China officially announced its plan to pursue indigenous innovation, this process of constructing science parks has also been accelerated. Thus by observing the scale of Chinese high-tech science parks, we are allowed to gain some insights into China's past performance in developing innovation endogenously.

3.5.2 China's Patent Registration Reaches New High

Patent protects own inventions from imitation and block competitors (Blind et al., 2006, p. 657). By the same token, the number of a country's patent application and registration, more or less, shows its capability of self-innovation. According to a study of (WIPO, 2020), in 2019 over 3.2 million patent applications were received and filed globally. Particularly, the total amount of applications for patents received by the top 5 offices, together accounted for around 85.7% of global patent applications.

Among the top offices across the world, the National Intellectual Property Administration of the People's Republic of China (CNIPA) came top of the list. According to the statistics, in a single year of 2019, CNIPA processed over 1.4 million patent applications in total, which even exceeded the combined share of the United States Patent and Trademark Office (621453 applications), the Japan Patent Office (307969 applications), the South Korean Intellectual Property Office (218975 applications) and the European Patent Office (181479 applications) (WIPO, 2020, p. 12).

By and large, the growth of innovation in China is impressive. In 2009, China ranked the third position with respect to patent applications across the globe; nevertheless, only two years later, in 2011 China overtook the US and declared to the top spot (WIPO, 2020). Since then, it has led the list of global patent applications for 9 consecutive years in a row and seems to continue in the near future (WIPO, 2020).

In terms of specific applicants, in 2019, domestic applicants accounted for a total of 1.244 million patent applications, approximately 89% of the total size in China; while the remainder 11% was submitted by foreign applicants, close to 157000 totally (CNIPA, 2020). In addition to patent application, grant of patents in China also shows an interesting pattern. In 2019, the number of domestic invention patents amounted to 361000, of which 95.4% patents were granted to service inventions and 4.6% was for non-service inventions (CNIPA, 2020). Besides invention patents, around 1.58 million utility model patents and 557000 design patents were issued (CNIPA, 2020). It is obvious to see from those figures that in 2019 utility model patents accounted for most patents granted in China, followed by design patents, and the share of invention patents was the leasest.

3.5.3 The Largest Producer of Scientific Publications

Riggs & Hippel (1992, p. 11)posited that *"The number and quality of publications result from an innovation"*. From this perspective, how many academic publications a country produces, to a large extent, reflects its innovation capability and capacity as well. Thus, the third indicator we use to illustrate China's performance in indigenous innovation in general is the volume of scientific publications.

In 2018, the US National Science Foundation (NSF) released a report about global research articles. According to this report, China claimed the world's largest producer of academic articles and surpassed the United States for the first time (Tollefson, 2018). To be specific, data reveal that approximately 426000 research articles documented in the Elsevier's Scopus database were produced by Chinese scholars,

exceeding 409000 studies of the United States (Tollefson, 2018). It is worth noting that, although the global landscape is changing, this report also suggests that the US will still remain as a "global science powerhouse" in spite of growing competition worldwide (Tollefson, 2018).

3.6 Public Procurement System of China

Prior to a close examination on "how" questions, it is necessary to know "what". Relating to our research questions of this study, in this chapter we develop knowledge of China's PPI mechanism by searching answers for the following three questions: (1) What is the structure of Chinese public procurement system? (2) Who is involved in this procurement system? (3) What mission does such a system designed to fulfill?

3.6.1 Structure

According to the Public Procurement Law of the People's Republic of China (NPC, 2002), public procurement refers to:

"purchasing activities conducted with fiscal funds by government departments, institutions and public organizations at all levels, where the goods, construction and services concerned are in the centralized procurement catalogue complied in accordance with law or the value of the goods, construction or services exceeds the respective prescribed procurement thresholds" (NPC, 2002).

In particular, *"all levels"* indicates that public procurement activities are performed at three levels — national level, provincial level and municipal level. Consistent with such structure, Public Procurement Offices (PPO; also referred to Public Procurement Centers) are established at those levels respectively (See in Figure 2). In China, in order to ensure transparency and accountability of public procurement, the government with procurement needs usually does not participate in procuring activities directly. Instead, PPO will communicate the actual buyers' requirements with suppliers on behalf of the government with procuring demand.

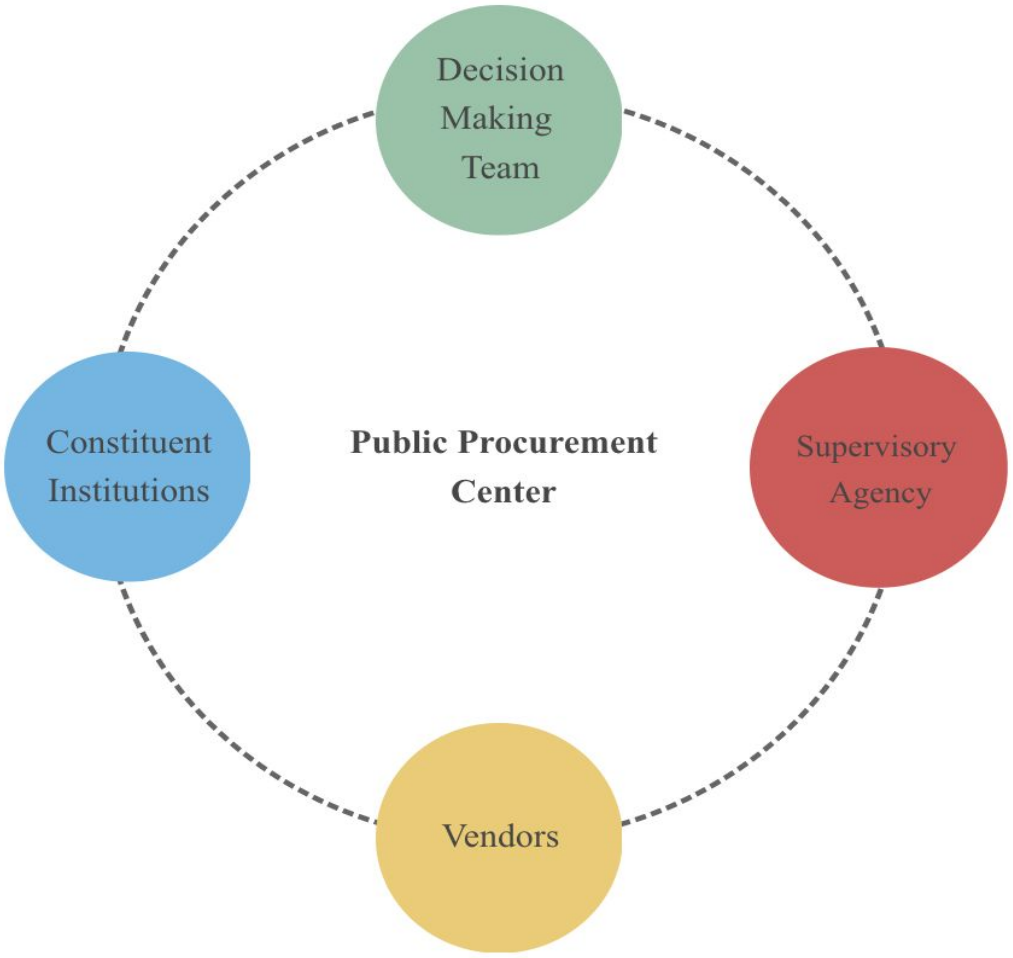

Figure 2. Public Procurement System of China, adapted from Integrating cleantech into innovative public procurement process – evidence and success factors, by Alhola & Nissinen (2018, p. 338).

As the major undertaker of public procurement activities at all levels, PPO is directly and indirectly influenced by four forces: The Decision Making Team, the supervisory agency, constituent institutions and vendors (Wang & Li, 2014, p. 911). To be specific, the Decision Making team is only responsible for making major decisions for PPO, including personnel, budgeting, organization structure and policy making (Wang & Li, 2014, p. 912). The duty of a supervisory agency is to oversee PPO's daily operation and activities, with a particular focus on supervising the practice of PPO, dealing with complaints and sometimes carrying out on-site supervisions on bidding

and tendering if it is necessary (Wang & Li, 2014, p. 912). What's more, constituent institutions can be understood as a customer of PPO and vendors are contracted to the public procurement center directly, responsible for supplying required products and services according to the procurement contract (Wang & Li, 2014, p. 914).

According to Lin et al. (2010), a government procurement center at municipal level is made up of three key departments: marketing office, procurement office and integrated office. Specifically, marketing office is in charge of commodity procurement; procurement office is responsible for procuring massive projects and integrated office undertakes a responsibility to coordinate activities between related departments (Lin et al., 2010, p. 299).

3.6.2 Involved Actors

As a whole, the public procurement system of China is structured in a concentrative way, where a variety of government agencies and organizations are involved in the process of government procurement for innovation. Specifically, the government and organizations at national level take charge of top-level design, while agencies at provincial and municipal levels undertake more responsibilities in implementation. This research also finds out that the national government and departments usually deploy two tools — legislation and regulation, and innovation and equipment catalogues — to impact on subordinate governments.

Relating innovation activities, Ministry of Science and Technology (MoST), Ministry of Finance (MOF), Ministry of Industry and Information Technology (MIIT), National Development and Reform Commission (NDRC) along with State Steering Group of Science, Technology and Education (SSGSTE), those national ministries and departments are often involved in publicly procuring practice in China.

Specifically, MOF is in charge of national budgets and complement PPI activities with financial funds and policies. MoST plays an important role in making innovation

policies, organizing experts to conduct certification for innovative products and compiling government procurement catalogues. In fact, most early innovation policies in China were formulated by MoST, since it has better performance in building ties to local governments than other national ministries (Appelbaum et al., 2016, p. 152; F. Liu et al., 2011). In addition, MIIT takes charge of designing industrial policy and implementing equipment catalogues (Yanchao Li, 2011).

By contrast, the role played by NDRC and SSGSTE in public procurement for innovation seems broader. In other words, they put more effort in agenda setting and management. In particular, as an agency at ministry level, NDRC is mainly responsible for planning and setting out agendas for national economy and the STI plan is a part of national agenda (Yanchao Li, 2011). SSGSTE is responsible for reviewing and approving STI policy as well as coordinating activities among different departments.

Within the public procurement system, local governments and related organizations play a more important role in implementing plans and policies made by government agencies at national level. In order to supervise the procuring process and secure the interests of the state, a number of sub-departments have also been set up.

To sum up, Chinese public procurement system is characterized with a centractive structure. Such a structure not only has inherent advantages in performing government amendments quickly and efficiently, but also enhances internal transparency and accountability by specifying positions and duty of departments, supervising the entire procuring process under a Governance-Operation Separation principle (Wang & Li, 2014, p. 918).

3.6.3 Legislation and Catalogues

National government ministries and related departments mainly rely on two tools to influence public procurement for innovation: Law and catalogues. At national levels,

government procurement legislation is promulgated by the State Council to promote fairness, transparency and integrity of government procurement activities (NPC, 2002). Government procurement in China is primarily regulated under two national laws: the Government Procurement Law and Tender Law (Library of Congress, 2020).

The first measure taken to implement PPI is "innovation catalogues". Innovation catalogues are made up of a variety of innovative solutions, which have been authorized by the Ministry of Science and Technology, for the Ministry of Finance (MOF) direct government procurers' practice as a reference (Y. Li et al., 2015, p. 179; Y. Li & Georghiou, 2016). The second instrument is called "signalling catalogues" or "equipment catalogues". In this catalogue, the central government lists all technologies that are urgently needed in China (Y. Li & Georghiou, 2016).

Specifically, innovation catalogues were developed in 2007 and MOST, MOF and NDRC are mainly responsible for the implementation of this instrument. In Particular, MOST and MOF are in charge of the technological and financial part respectively. MOST carry out a series of activities to encourage firms and regional governments to apply certificated technology in production; in addition to that, MOST is also responsible for organizing experts to do certification work. MOF's duty is to provide financial support for certificated innovation products at both national and local levels. The official claims that innovation catalogues are designed to be a guide book rather than a regulation for procurers; besides that, they are supposed to update regularly (Yanchao Li, 2011, p. 13).

Equipment catalogues were launched after innovation catalogues in 2009. In this catalogue government lists required technologies; and if providers (eg. companies, individuals or organizations) are capable of developing certain technology on the list, the government will give them various support such as subsidies and tax reduction and so on. Once a technology is successfully developed, it will be removed from signalling catalogues and added to innovation catalogues for references (MIIT, 2009). Overall,

innovation catalogues, along with signalling catalogues, are two important forces — push and pull forces — to stimulate innovation (Yanchao Li, 2011, p. 13).

By contrast, local government plays a more important role in implementation. For example, in order to update innovative products catalogues and equipment catalogues regularly, the national government will publish a notice or announcement to the sub-central government. Those documents often end up with a sentence: *"we hereby issued you, please follow and implement"*(MIIT, 2009).

On the other hand, although localized innovation catalogues exist, those innovative products on the list of localized innovation catalogues are often compiled according to the national innovation catalogues. Because the national government has a measuring system to estimate whether each sub-government has performed the required duty. What's more, in order to fulfill the demand of the central government, regional governments often carry out a series of localized implementation measures combined with regional resources and the special circumstances locally.

To summarize, China's public procurement system is top-down rather than bottom-up, in which the national government is responsible for top-designing and steering the direction of innovative activities; while local government takes more responsibility in implementing published policies targeting goals. But at the same time, the local government also enjoys autonomy to make its own implementation measures and further develop localized innovation catalogues on the basis of central catalogues.

3.7 A Conceptual Framework for Case Study

Public procurement can not only contribute to economic growth, it is also a useful tool to trigger innovation from the demand side. This study aims to research how public procurement, as a demand-side innovation policy, contributes to China's indigenous innovation blueprint, particularly concentrating on the specific means for procurement activities to impact on technology innovation and diffusion. Thus, grounding on

existing academic research on this topic, we construct a conceptual framework (see in Figure 3) to guide analysis in the following sections.

In this framework, we specify objectives of procurement activities in the first place. Following the sequence of procurement processes, we explore at each stage how public procurement can contribute to indigenous innovation in the industry, based on evidence from pilot cities in the demonstration program. Going forward, we identify key factors and conditions for public procurement to result in indigenous innovation successfully.

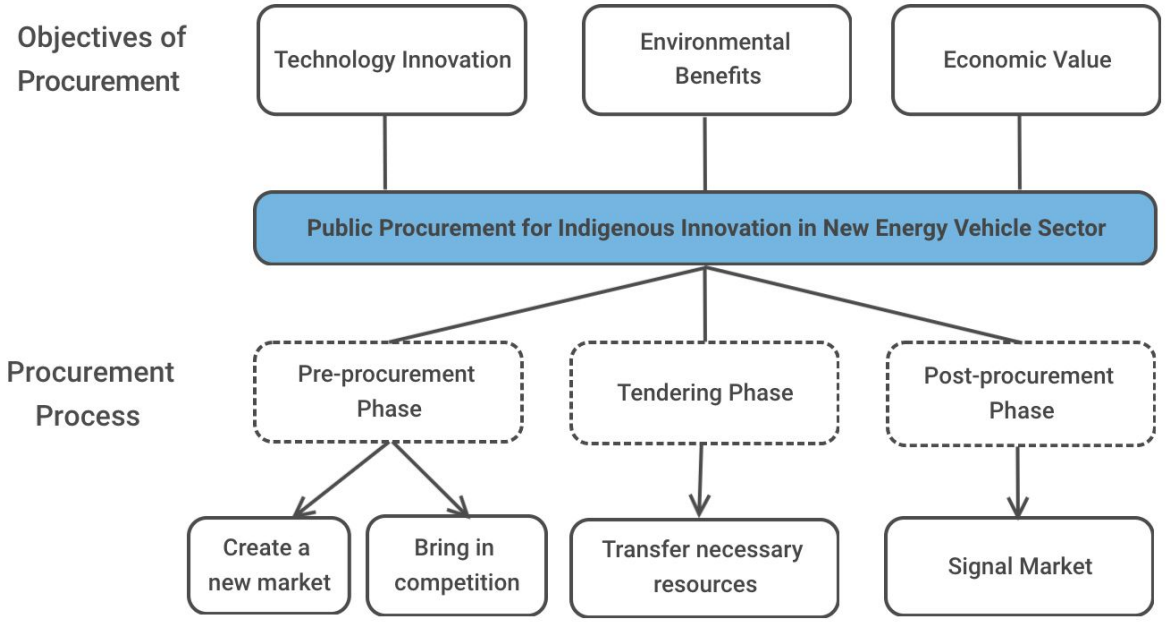

Figure 3, Conceptual framework of this study, adapted from Integrating cleantech into innovative public procurement process – evidence and success factors , by Alhola & Nissinen (2018, p. 338).

4. Analysis: Possible Means and Key Factors Enabling PPI

In this section, we explore the underlying mechanism for public procurement activities to generate indigenous innovation through an in-depth analysis of a realized case — New Energy Vehicle Program in China. Following an established conceptual framework (See in Figure 3), we structure the analyzing process in the following sequence. In the first place, we give an introduction to required technologies of NEVs and review its development history. Secondly, we take a close look at public procurement activities in the Chinese NEVs sector, aiming to identify the underlying mechanism for publicly procuring practice to promote indigenous innovation in the purchasing process. What's more, we are aware that indigenous innovation not only occurs in a tendering stage, as a matter of fact, government procurement has positive effects on indigenous innovation in both pre- and post-procurement phase as well. Thus, we mark three key stages for public procurement for innovation to take effects. At each stage, this study further identifies key factors and conditions.

4.1 Case Background

Between 2006 and 2020, a series of major policies was issued (see in Figure 4**)**. It is evident to see from those policies, Chinese government has made great efforts to promote the new energy vehicle sector.

Year	Policies
2006	Long-term Science and Technology Development Plan
2009	Notice on the Pilot of Demonstration and Promotion of Energy Saving and New Energy Vehicles
2010	Notice on the Pilot Subsidies for Private Purchase of New Energy Vehicles
2014	Notice on The Further Promotion and Application of New Energy Vehicles
2015	Notice on the 2016-2020 Financial Policy for the Promotion and Application of New Energy Vehicles
2020	Notice on Improving Fiscal Subsidy Policies for the Promotion and Application of New Energy Vehicles

Figure 4. Policies related to the NEV sector, adapted from Can new energy vehicles subsidy curb the urban air pollution? Empirical evidence from pilot cities in China, by Xie et al., 2021 (p. 2)

Toyota's Prius was the first NEV model introduced to Chinese market in 2005 (Y. Liu & Kokko, 2013). Since then, the technologies and production capacities of new energy cars have been massively improved and more than half new energy passenger car models were domestic brands. However, the scale of domestic NEV markets is still quite small, private customers were particularly discouraged by the high prices of electric and hybrid cars (Y. Liu & Kokko, 2013). According to statistics, in 2011, there were no more than 500 NEVs on streets of Shanghai, and the driving range of one-time full charge was under 100 kilometers on average(Andrew, n.d.; Kennedy, 2018).

Thus it is obvious to see that at the very beginning market demand was not the main force driving industry's growth. If so, what was the main force accounting for fast growth of new energy vehicles ? The answer is government intervention. In order to take a lead in the new energy industry, Chinese government has taken many measures to stimulate interactions between actors in the industry and promote innovation capabilities (Y. Liu & Kokko, 2013). One powerful instrument is public procurement. By reviewing the history of Chinese new energy industry, three stages of development can be distinguished.

4.1.1 The First Stage: 2001- 2009

The first stage is from 2001 to 2009, when the main focus of the new energy industry was on electric vehicles, fuel cell vehicles and hybrid models. In 2001, the continued implementation of 863 Program (also referred to National Technology Research and Development Program) was approved as a part of national S&T plans in the 10th Five-year Plan. In this strategic plan, the explicit objective is to boost overall high-tech innovation and R&D capabilities in key areas and NEV was top on the list (Y. Liu & Kokko, 2013).

According to statistics, the majority of automakers in China that excelled in electric vehicle markets, had been favored by the 863 Program. Similarly, a lot of component producers also benefited from this national program in various forms e.g. tax reduction and R&D subsidies (Y. Liu & Kokko, 2013). In addition to 863 Program, in 2006 the NEV industry was also prioritized as one of the priority topics to fully develop in the MLP plan in the following 15 years (The State Council of The People's Republic of China, 2006). Specifically, with respect to energy-efficient and new energy-based automobiles, The MLP plan states that:

"*Priorities will be assigned to research on and development of key technologies for design, integration, and manufacturing of hybrid, alternative fuel, and fuel cell automobiles, power system integration and control technologies, automobile computation platform technologies, and technologies for high-efficiency and low-emission internal combustion engines, fuel cell engines, accumulator batteries, driving motors, and other critical components, and technologies for developing experiment and test techniques and infrastructure for automobiles using new energy" (The State Council of The People's Republic of China, 2006).*

4.1.2 The Second Stage: 2009 - 2010

The second stage was from 2009 and 2010, when two milestone policy packages were introduced in 2009, primarily attempting to establish markets for the commercialization of NEVs. Besides direct favourable measures e.g. R&D subsidies, Chinese government also issued a range of policies to incentivise innovation within the new energy vehicle industry (Y. Liu & Kokko, 2013). At this stage, pure electric and hybrid electric vehicles were attached more importance than others, whereas fuel cell vehicles enjoyed relatively lower priority due to its slow progress in technology breakthrough (Y. Liu & Kokko, 2013).

One important policy was the "Automotive Industry Readjustment and Revitalization Plan" in 2009. In the same year, a "Notice on New Energy Vehicle Demonstration and

Extension Work" was announced to favor the "Ten Cities, Thousand Vehicles" Program in the public sector, ranging from buses, taxis to postal centers. (Huang, 2019).

The ultimate objective of " "Ten Cities, Thousand Vehicles" Demonstration Program was to increase the scale of national new energy vehicles to 10% of the domestic automobile market by 2012. This demonstration program was divided into three phases. In the first batch, 13 cities have been confirmed to participate in this project, including Beijing, Chongqing, Shanghai, Changchun, Dalian, Hangzhou, Shenzhen, Wuhan, Jinan, Hefei, Changsha, Kunming and Nanchang. Afterwards, cities such as Tianjin, Haikou and a variety of medium and small cities successively carried out this program locally and have made different achievements. Local governments in the first 13 cities also have autonomy to publish local policies to further adoption of NEVs in public areas and build fundamental infrasture (Y. Liu & Kokko, 2013). In this study, we will mainly focus on the public procurement activities in this national demonstration program and examine the specific means for government procurement to impact on indigenous innovation in the field of new energy vehicles.

4.1.3 The Third Stage: 2010

2010 marks the third stage of Chinese government's policy plan. In this year, MoF, MoST, MIIT together with NDRC decided to subsidize the private-car market for plug-in hybrids and electric vehicles. In the official notice — "Notice on Subsidies for Private Purchases of New Energy Vehicles", five cities were selected to be pilot cities for private consumer subsidies.

China's first own-brand hybrid cars were BYD's F3M and Chana's Jiexun, which appeared on the market around the end of 2008 (Y. Liu & Kokko, 2013). By 2010, Chinese auto companies namely Dongfeng, Chery, Chana, BYD, FAW and SAIC had established a relatively supply chain of own-brand NEVs (Yang et al., 2010).

Besides, along with their Chinese partners, foreign enterprises such as Toyota, Honda and GM also put lots of efforts in developing their own hybrid models in joint ventures (Y. Liu & Kokko, 2013). According to an action plan of the Ministry of Science in 2009, the production capacity was expected to exceed 500, 000 vehicles in 2011 (Y. Liu & Kokko, 2013). In this context, government intervention, e.g. in the form of public procurement and subsidies, is required to improve the efficiency of existing technologies and create new technologies (Choi & Oh, 2010; Diamond, 2009; Nakata, 2000).

4.2 "Ten Cities, Thousand Vehicles" Demonstration Program

4.2.1 Objectives of Procurement of NEVs

According to Charles Edquist (2012), a technology or solution is often developed to address certain societal problems or meet human demand. Nevertheless, those so-called societal problems or human needs are often too broad to explore. Thus, when it comes to in-depth analysis, it is important to specify what objectives are targeting for. In this research, we have observed three major goals that Chinese governments expected to achieve through this demonstration program: technology innovation, environmental benefits and added economic value in the long-term.

4.2.1.1 Technology Innovation

New energy vehicles (NEVs) refer to vehicles that use non-traditional fuels (ethanol, biogas, biodiesel), electric vehicles, fuel cell vehicles, and hybrids of these energies (Y. Liu & Kokko, 2013). In China, the term NEVs is used to specify plug-in electric vehicles, including battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs) and fuel cell electric vehicles (FCEV) (Wikipedia, 2020) (see in Figure 5). What's more, although those three core technologies are crucial to innovation and development of new energy vehicles, Chinese government has attached various importance to them; moreover, the progress of technology innovation in those three models varies a lot.

Models		2001-2005	2006-2010	2011-2015
HEV	Micro-hybird	yes	-	-
	Mild-hybrid	yes	-	-
	Full-hybrid	yes	yes	-
PHEV		yes	yes	yes
REEV		yes	yes	yes
BEV		yes	yes	yes
FCEV		yes	yes	yes

Figure 5. Technology Focus of NEV in China during different phases, adapted from Progress of Chinese electric vehicles industrialization in 2015: A review, by (Du & Ouyang, 2017, p. 534)

On the whole, past decades have witnessed a steady development in NEV related technologies **(**see in Figure 6**)**. However, in China key technologies for full hybrid electric vehicles are still lagged behind compared to the advanced level in developed economies, especially in battery technology, traction package technology etc,; in addition, some key components of electric vehicles are unable to produce domestically, which will continue to rely on imports (Du & Ouyang, 2013). Thus in order to enhance regional technology competence and align with national strategy, pilot cities actively participated in this demonstration program to develop NEV technologies.

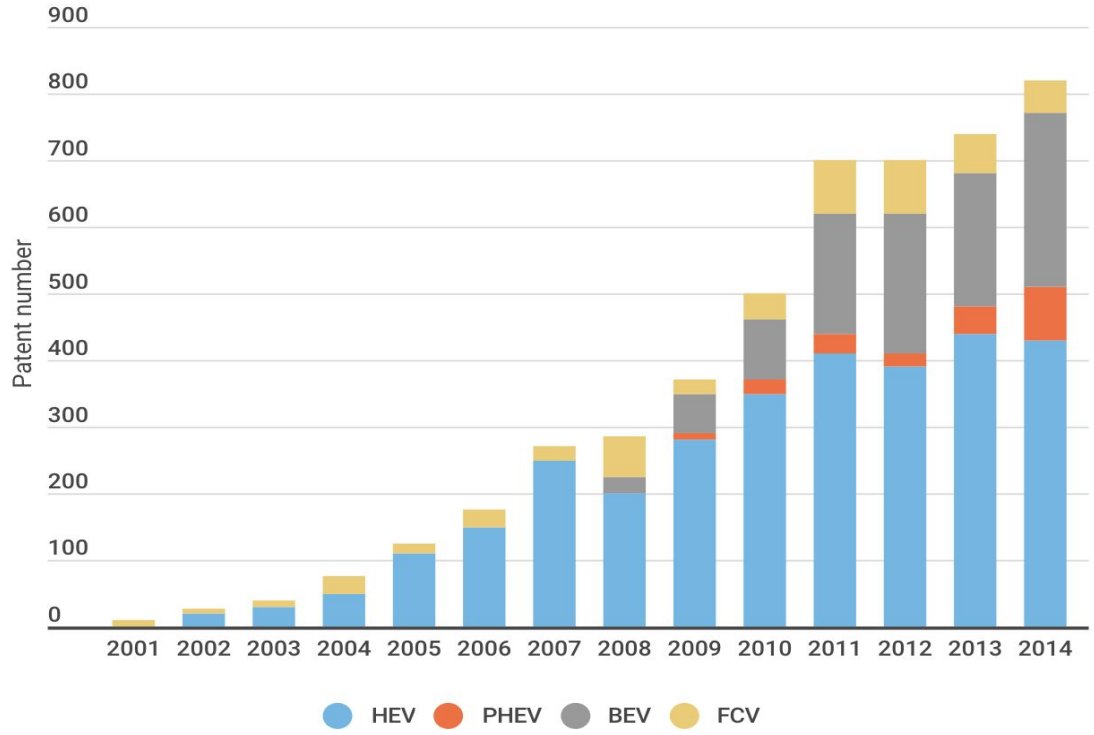

Figure 6. Patents of new energy vehicle related technologies (2001-2014), adapted from The Evolution of China's New Energy Vehicle Industry from the Perspective of a Technology–Market–Policy Framework, by Yu et al. (2019, p. 5)

4.2.1.2 Environmental Benefits

According to Chinese traffic management bureau of the MPS, automobile consumption in the Chinese market rose to number one worldwide in 2009; and by mid-2019, vehicle population had exceeded 340 million (Xinhua News, 2019). Particularly, 66 cities in China had more than 1 million cars, while 11 cities (e.g. Beijing, Chengdu) owned over 3 million cars on the streets (Xinhua News, 2019).

In 2009, the Chinese government launched the "Ten Cities, Thousand Vehicle Program" to enhance innovation and development in the electric vehicle industry, focusing on deployment of NEVs in public domains. There were 13 pilot cities **(**see in Figure 6**)** selected to participate in this demonstration project at the very beginning. Afterwards, this four-year demonstration program expanded to 25 cities, with a focus shifting targeting private consumers. In the first batch of pilot cities, eight out of ten

cities showed that as the vehicle population kept growing, they were experiencing unprecedented pressure as well (Zheng et al., 2012). Thus one important motive for those pilot cities to take part in this demonstration program as pioneers, is a strong desire to build "Green Cities" , towards energy-saving and pollution-reduction.

City Name	Number of AFVs (by year)	Vehicle Type	Service Fields
Beijing	1000 (2009); 5000 (2012)	HEV and PEV, considering FCV	Buses, and sanitation vehicles
Shanghai	4157 (2012)	N/A	N/A
Chongqing	2550 (2012)	HEV (Gasoline Electricity Hybrid Vehicle and Natural Gas Electricty Hybrid Vehicle)	Buses, taxis, official-duty vehicles and passenger cars
Changchun	1000 (2012)	HEVand PEV	Buses, official-duty vehicles
Dalian	1200 (2010); 2400 (2012)	HEV, PEV and FCV	Buses, taxis, official-duty vehicles, passenger cars
Hangzhou	3000 (2012)	N/A	N/A
Jinan	1600 (2012)	HEVand PEV	Buses, taxis, official-duty vehicles, sanitation vehicles, postal service vehicles, tourists buses
Wuhan	2500 (2012)	HEVand PEV	Buses, taxis, official-duty vehicles, passenger cars, business vehicles
Shenzhen	more than 800 buses (2010); 24000 AFVs (2012)	HEVand PEV	Buses, taxis, official-duty vehicles, passenger cars, business vehicles
Hefei	1400 (2012)	PEV	Buses, taxis, official-duty vehicles
Changshai	4570 (2012)	N/A	N/A
Kungming	1000 (2012)	HEV, considering PEV	Buses
Nanchang	1100 (2012)	HEVand PEV	Buses, taxis, official-duty vehicles, sanitation vehicles, postal service vehicles

Figure 7. AFV deployment plan of the 13 pilot cities (1st tier), drawn from Strategic policies and demonstration program of electric vehicle in China, by Zheng et al. (2012, p. 20).

Each pilot city committed to this demonstration program, also had a demonstration goal that needed to be achieved during the period of demonstration program (2009 - 2012). Among the range of pilot cities, Changchun already had successful experience in deploying AFV. The success of past experience enabled it to enjoy massive environmental benefits such as fresh air, less carbon emission and a comfortable living environment (Zheng et al., 2012). While as a tourism city, Kunming considered this demonstration program as a great opportunity to accelerate the development of local tourism, with an interest in improving its city image. Overall, those involved pilot cities may slightly differ in their specific goals, but it is undeniable that a favorable and sustainable environment is the basis for pursuing other objectives.

4.2.1.3 Economic Value

Public procurement, as a demand-based innovation policy tool, is an economic activity in essence (Jing Ranzhe et al., 2007). To implement this large-scale demonstration program, both national government and municipal government subsided NEVs procurement. In general, costs required for pilot cities to fulfill procurement and demonstration can be divided into four parts: procurement fees, construction of fundamental infrastructure (e.g. charging station), daily operation and maintenance and R&D research (indirect input) (Zheng et al., 2012, p. 20). However, subsidies from the national government were insufficient to cover all costs but procurement fees. Therefore, the local government had to fill this gap with regional budgets.

It is easy to understand the motivation of the national government to highly encourage such a demonstration program, but why are local governments enthusiastic about this demonstration program? That is because those pilot cities consider this program as a great opportunity to develop their local auto industry, which in turn boost the local economy and create more job opportunities in the long-term (Zheng et al., 2012, p. 19).

4.2.2 Understanding Underlying Mechanism

4.2.2.1 Create a New Market

The important role of demanding consumers in spurring innovation is widely acknowledged (Hakansson, 2015; Olson & Bakke, 2001; Riggs & Hippel, 1992; Wynstra et al., 1998). In this study, we found that the first important way for public procurement activities to enhance indigenous innovation in the emerging industry — NEVs actor — is through market formation.

China has shown its ambition in the new energy vehicle sector for quite a long time. In the past few decades, both central and local governments in China have issued a series of policies to promote the innovation and development in the new energy vehicle

sector. However, compared to those “hot policies”, new energy cars and passenger vehicles seem facing “a cold market” (W. Li et al., 2016, p. 34).

In this setting, Chinese government planned and implemented the “Ten Cities, Thousand Vehicles” Demonstration Program, aiming to incentivise industrial innovation by creating a new market for NEVs. in other words, this time governments became the first customer of this young business. In this demonstration program, 25 cities, located in 21 different provinces conducted large-scale procurement for HEVs, BEVs and FCVs for public areas, including buses, taxis, official-duty vehicles and specific purpose vehicles (Gong et al., 2013). The effect of this program is obvious (see in Figure 8).

Inspired by “Ten cities, Thousand Vehicles” Demonstration Program, the NEV production capacity grew steadily. Especially since 2009, the volume of production has exceeded 7000 units. As illustrated in Figure 8**,** the production of NEV passenger cars (HEV) in 2010 was only 2637 units; but by 2013, the production capacity had increased to 24331, almost ten times. What’s more, the market share of BEV and PHEV in China increased steadily between 2010 and 2013.

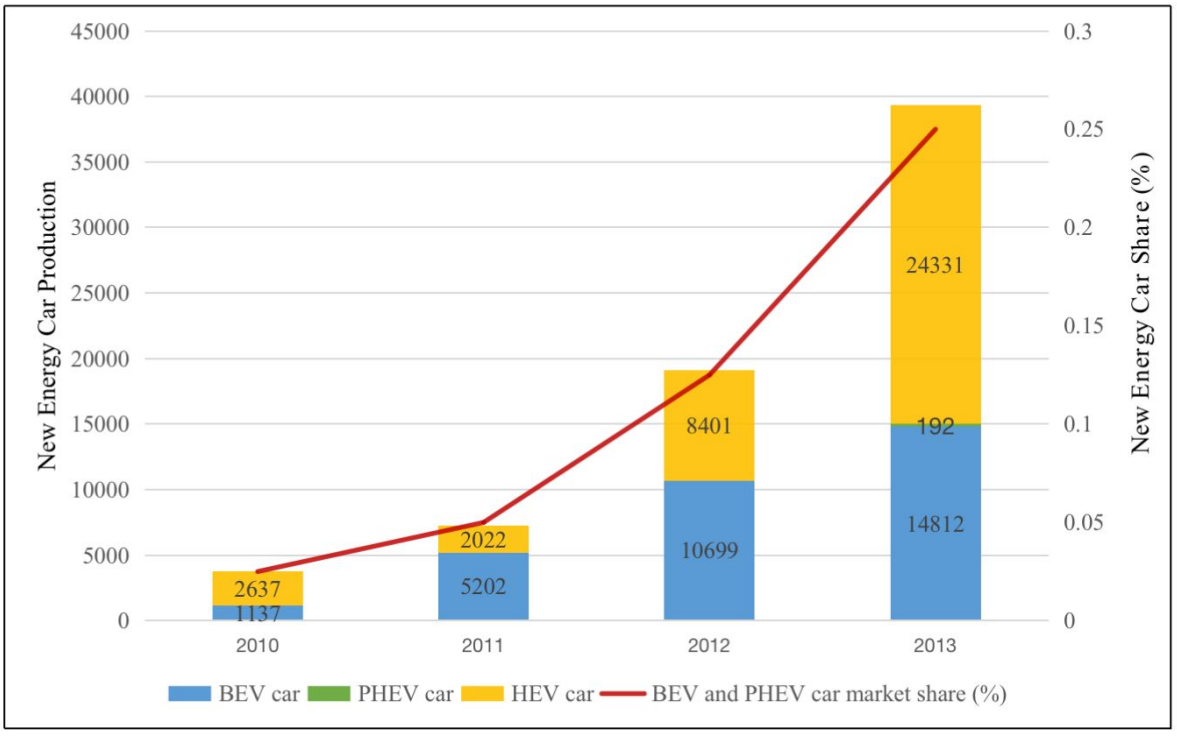

Figure 8. The production of NEV passenger car pand market share in China (2010-2013), drawn from Plug-in electric vehicle market penetration and incentives: a global review, by Zhou et al. (2015, p. 788)

Besides the fast growth of passenger cars, from Figure 8 , it is evident to see that NEV bus production also increased at a steady speed between 2007 and 2013. Particularly, in 2010, the market share of large NEV buses soared to 8% and continued to grow steadily since then. In addition, we can also find that the production of BEVs, PHEVs and HEVs varied in terms of their production capacity and speed respectively.

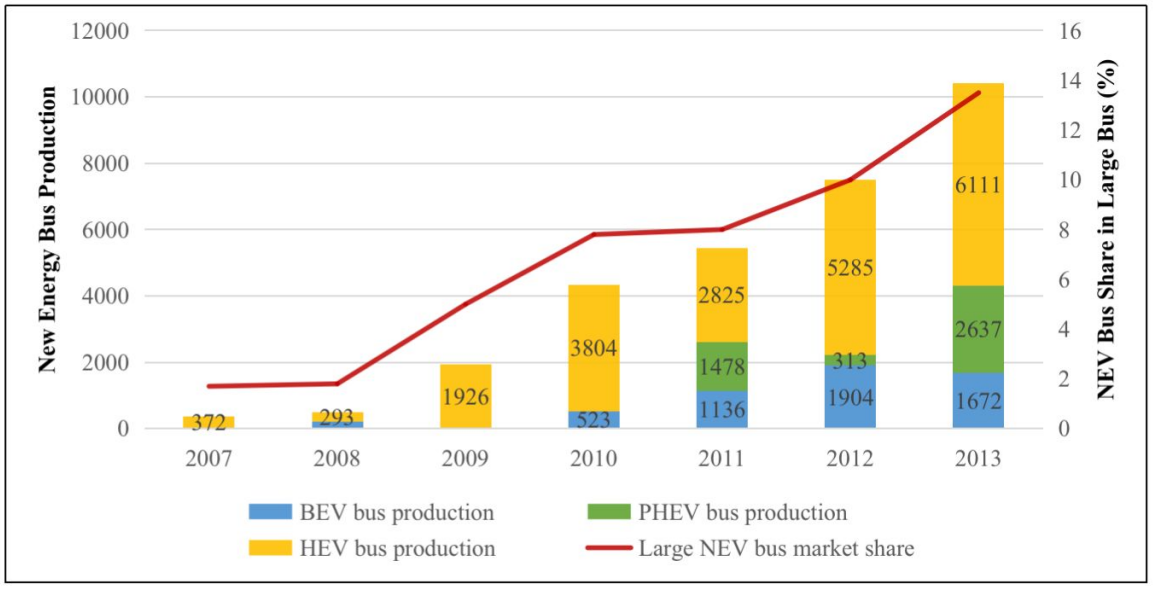

Figure 9. The production of NEV bus and market share in China (2007-2013), drawn from Plug-in electric vehicle market penetration and incentives: a global review, by Zhou et al., 2015 (p. 789)

To sum up, by mapping the trend of production in the NEV sector and the demonstration goal approved of each pilot city (see in Figure 7), it is not hard to discover that in the early stage, large order from municipal governments and public organizations (e.g. postal office, bus, taxis) was the major force that triggered innovation and development of new energy related technologies.

4.2.2.2 Bring in Competition to Market

Public procurement contributes to industrial innovation by bringing more competition to the market (Uyarra & Flanagan, 2010, p. 10). Under the National Procurement Law, municipal governments themselves do not sponsor R&D activities directly. Instead, when they have procurement demand, municipal public procurement centers will function as an agent to perform procurement through bidding (Zheng et al., 2012, p. 20).

In the viewpoint of George (2011), in the short term public procurement, particularly in the form of bidding, affects the participation level of a firm in the tendering process and the homogeneity of tendering products. Overall, by increasing competition in the bidding process, buyers are allowed to enjoy lower prices and have more options for high-quality products as well (George, 2011). From a long-term perspective, by bringing in more competition, governments are able to alter market structure (George, 2011).

In the case of "Ten Cities, Thousand Vehicles" Demonstration Program, in those pilot cities, local governments do not participate in the procurement process for NEVs directly; instead, they communicate their demands with municipal PPO and specify requirements regarding procured vehicles. Then the public procurement office will implement the procurement on behalf of those municipal governments and public organizations.

There are several advantages of increasing competition among bidders and within the entire process. First of all, this approach is effective in promoting transparency and combating corruption in tenders. Many regional governments have set up related departments to supervise the tendering process and even carry out on-site supervision when necessary. In addition, through public bidding, NEV manufacturers have stronger motives to enhance innovation in their products and services. Last but not least, small businesses are also granted the same opportunity to compete. In the long run, NEV related technologies and products can be more diverse and contribute to industrial innovation.

For those pilot cities, developing the local auto industry is one key objective to participate in the NEV demonstration program. We do have concerns that the possible local protectionism may exist in regional public procurement, which will be further discussed in the following sections.

4.2.2.3 TransferNecessary Resources

The research of Lindskog (2012, p. 6) indicates that if resourceful consumers are involved in the process of innovation and development, then the probability of success in innovation activities is higher correspondingly. Through a close examination of the selected case, we find that municipal governments tend to mobilize all resources to support innovation activities of suppliers.

Although municipal governments as the purchaser, do not negotiate with bidders or suppliers. They often give strong support to enable enterprises to incubate innovation. In fact, some of them will specify that at least one innovation must be generated as a part of procurement contracts. In the case of the NEV demonstration program, developing the local auto industry has well explained the unusual enthusiasm of local governments in those pilot cities, because as the ultimate purchaser, they often are considered to be in a position with more advantages.

When we investigated all 25 pilot cities (3 tiers in total) involved in this demonstration program of NEVs, we had an interesting finding; almost all pilot provinces of demonstration programs have their own local new energy automakers (Gong et al., 2013). To be specific, among the 21 provinces that participated in the demonstration program, only Inner Mongolia, Yunan and Hebei, three provinces do not have NEV manufacturers locally and earn certified models.

In this background, municipal governments not only view this program as procurement activities that are able to supply official cars for general use in the public domains, but an important opportunity to develop local auto industries. Thus, supporting R&D activities of local auto manufacturers seems more like a long-term investment rather than an one-shot deal.

Public procurement supports indigenous innovation of NEV enterprises in the following manners. First of all, as a market activity, it provides required funds for

production. From receiving procurement orders to successfully deliver required models, the entire process is quite long, usually taking months. Thus, to ensure normal production and operation, municipal governments are required to pay a deposit in advance.

In addition to that, local governments also support indigenous innovation within NEV sectors by providing a favorable environment. High-tech science parks are often constructed to form clustering effects and help companies to match required talents. Besides that, when necessary, local governments in those pilot cities transfer research and knowledge for technology innovation within the industry.

4.2.2.4 Accelerate Diffusion of Innovation into Society

As the first buyers of NEV products, pilot cities further contribute to endogenous innovation by accelerating diffusion of new technology into society. In general, consumers are acceptors of public policies (Krupa et al., 2014). Following those pilot cities of the 1st tier in the demonstration program, 5 cities subsequently implemented a series of policies to help new energy automakers to open up the market to private car users.

Evidence suggests that at the very beginning, NEV manufacturers had a hard time attracting private car consumers for several reasons. In the first place, customers are often discouraged by high prices of electric and hybrid cars (Y. Liu & Kokko, 2013). Compared to the cost of fossil fuel-based cars, the pricing of NEVs appears not attractive enough. In theory, in perfect markets, the creation and development of technologies is largely directed by the market, where scarce resources are often priced with a higher price, otherwise alternatives will be used to substitute the scarce resources or new technologies will be developed to enhance the utilization of scarce resources (Y. Liu & Kokko, 2013). However energy markets are imperfect (AFDC, 2007), where oil price does not really reflect the value of natural resources**.** Moreover, compared to fossil fuel cars, electric cars do not perform better in long-distance

travelling. Data indicate that the driving range of one-time full charge of electric cars, usually is under 100 kilometers (Andrew, n.d.; Kennedy, 2018).

What's more, as procured NEVs are put into use in public areas (e.g. bus, taxis, postal vehicles, sanitation vehicles), the public gradually changes their attitude to this emerging technology. In the past, private consumers tend to hold a skeptical attitude towards this new technology concerning its safety, reliability and efficiency. However, as those new energy vehicles appear on the street across the city, private consumers are aware of the advantages of electric cars and may consider purchasing pure or hybrid electric vehicles in the future. In addition, in order to make sure the normal operation, municipal governments also invested a lot on constructing charging stations and maintenance points, which allow private customers to discard concerns about charging problems.

To sum up, through national demonstration of new energy vehicles across 21 provinces, 25 pilot cities, municipal governments managed to increase the acceptance of private users towards electric cars. In addition, municipal governments spent a lot on constructing fundamental infrastructure such as charging stations and maintenance points, creating a favourable environment for consumers to purchase electric cars without worries.

4.3 Key Factors and Conditions

4.3.1 Clear Procurement Goals

On the basis of previous studies, we find that the first and foremost factor for public procurement activities to result in innovation is clear procurement goals. In the case of "Ten Cities, Thousand Vehicles" Demonstration Program, pilot cities at municipal level were mainly motivated by desires to develop technology innovation in the new technology of new energy vehicles, to reduce environmental pollution and build "Green Cities", and to boost local economy in

the long-term. For Chinese national government, the major objective is to enhance the competitiveness of new energy vehicle sectors in the world. Although pilot cities may slightly differ in the specific goals, on the whole, goals of local governments are generally aligned to the objective of national government.

Selected case of the new energy vehicle sector demonstrates that if local governments and national governments have similar goals when implementing public procurement activities, it is of higher possibility to generate indigenous innovation through procurement.

4.3.2 A Transparent and Efficient Procurement System

In this research, Chinese public procurement system is a concentrative system, in which the national government and local governments are responsible for different missions but also are able to perform tasks efficiently. For each level of system, there is a supervisory office in place to overview the procurement process and carry out onsite supervision when it is necessary. In addition, under the National Procurement Law, the tendering process must be transparent and open to the public. It is not hard to conclude that the design of procurement systems should target for transparency and efficiency.

4.3.3 Cooperation Across Sectors and Regions

Close cooperation between governments at different levels and across sectors are also crucial to indigenous innovation in industries. In the case of the demonstration program, some pilot cities attempted to protect local industries and set some barriers for non-local enterprises. In the short term, it seems that it saves the local automakers from competition. However, disturbance from governments will damage the innovation capabilities of local industries. In the

long term, they will be eliminated by the market. Thus, only closely collaborating with other companies across regions, the national blueprint can be realized.

5. Conclusion

This paper specifically investigated a demonstration program of the new energy vehicle industry — "Ten Cities, Thousand Vehicle" Demonstration Program, aiming to deepen the understanding of how public procurement, as a demand-side innovation policy tool, contributes to China's indigenous innovation blueprint. After a comprehensive examination of academic articles in related fields, this study discovered that different from supply-side instruments, public procurement is a powerful tool to enhance innovation. However, quantitative and qualitative evidence on the underlying mechanism for public procurement to generate innovation, particularly in the context of developing countries is limited. Therefore, in order to gain more knowledge of identified issues and the innovation process, this research conducted a case study about a demonstration program, in which public procurement activities were mainly employed to promote innovation in this emerging industry.

In this study, we take a qualitative case study approach to investigate chosen research questions. Through an in-depth analysis, we identify four main means for public procurement to affect indigenous innovation. Specifically, in the first place, public procurement contributes to innovation by creating a new market for new technology. For emerging technologies, at the very beginning, it is difficult for it to commercialize and gain profits to cover costs, especially for those high-tech sectors. Therefore, as a buyer with strong purchasing power, governments at all levels can support technology innovation by creating demand for such emerging technology. In addition, in China, government procurement is regulated under National Procurement Law. According to regulations of this national law, publicly procuring activities must be conducted by a third party, an agent. What's more, before making a procurement decision, all suppliers with required products or solutions are all encouraged to participate in bidding. Through public bidding, governments bring competition to the markets. As a result, private enterprises, regardless of scale, are all allowed to compete equally.

Besides that, because of increased competition, participants are also motivated to provide high-quality products with lower costs. More prominently, companies will keep investing in science and technology innovation so as to gain a competitive edge in markets. Thirdly, placing an order for off-shelf products or services is never the beginning or the end. In fact, governments, especially local governments at provincial and municipal levels, often are very favourable to all innovation activities because they expect the prosperity of local businesses can in turn boost the local economy and create more job opportunities for local citizens. Therefore, they often tend to mobilize all resources to support innovation and development of local enterprises. Lastly, we found procurement for public use can signal private users in markets. The tendering behavior not only alleviates the public's concerns about safety and reliability of emerging technologies, but also allows potential private customers to know them in reality when enjoying those products and services in public domains.

On the basis of previous analysis, this study identifies a set of key factors that determine the effectiveness of public procurement for indigenous innovation. The first and foremost condition is that buyers must have a clear procurement objective. Secondly, a transparent and efficient procurement system is also critical to the success of innovation. Thirdly, public procurement for innovation requires close cooperation across sectors and districts. This is particularly important for manufacturing industries, which usually need a lot of input in the early phase than other sectors.

In the process of analysis, the author is also aware of limitations of this study. Since this research takes a qualitative case study approach, that means case selection is quite critical to ultimate findings. Thus, patterns and mechanisms identified through the lens of the NEV sector may not apply to another industry. Additionally, when interpreting the selected case, the author's past experience will somehow affect how a phenomenon or issue is perceived. To summarize, for future search, selecting various cases from different sectors so as to identify similarities among them will provide a more solid

evidence. Moever, a combined research method can also be utilized to complement the drawbacks of qualitative studies.

6. References

AFDC. (2007). *Alternative Fuels Data Center: How Do Hybrid Electric Cars Work?* https://afdc.energy.gov/vehicles/how-do-hybrid-electric-cars-work

Alhola, K., & Nissinen, A. (2018). Integrating cleantech into innovative public procurement process – evidence and success factors. *Journal of Public Procurement*, *18*(4), 336–354. https://doi.org/10.1108/JOPP-11-2018-020

Andrew, B. (n.d.). *China's World: Why the Electric-Car Market Is Low Wattage; Shanghai's Failure to Popularize Electric Vehicles Highlights Challenges for Economic Reform | Bamboo Innovator*. Retrieved January 6, 2021, from https://bambooinnovator.com/2013/11/27/chinas-world-why-the-electric-car-market-is-low-wattage-shanghais-failure-to-popularize-electric-vehicles-highlights-challenges-for-economic-reform/

Appelbaum, R. P., Gebbie, M. A., Han, X., Stocking, G., & Kay, L. (2016). Will China's quest for indigenous innovation succeed? Some lessons from nanotechnology. *Technology in Society*, *46*, 149–163. https://doi.org/10.1016/j.techsoc.2016.03.004

Archer, M., Bhaskar, R., Collier, A., Lawson, T., & Norrie, A. (2013). *Critical realism: Essential readings*. Routledge.

Arrow, K. J. (1962). *Economic Welfare and the Allocation of Resources for Invention*. 19.

Arrowsmith, S. (2003). *Government Procurement in the WTO*. Springer.

Băzăvan, A. (2019). Chinese government's shifting role in the national innovation system. *Technological Forecasting and Social Change*, *148*, 119738. https://doi.org/10.1016/j.techfore.2019.119738

Bhaskar, R. (2014). *The possibility of naturalism: A philosophical critique of the contemporary human sciences*. Routledge.

Blind, K., Edler, J., Frietsch, R., & Schmoch, U. (2006). Motives to patent: Empirical evidence

from Germany. *Research Policy*, *35*(5), 655–672. https://doi.org/10.1016/j.respol.2006.03.002

Breschi, Stefano, & Malerba, F. (1997). Sectoral Innovation Systems: Technological Regimes, Schumpeterian Dynamics, and Spatial Boundaries. In Charles Edquist (Ed.), *Systems of innovation: Technologies, institutions, and organizations*. Pinter.

Burrell, G., & Morgan, G. (2017). *Sociological paradigms and organisational analysis: Elements of the sociology of corporate life*. Routledge.

Cambridge Dictionary. (2020). *INNOVATION | definition in the Cambridge English Dictionary*. https://dictionary.cambridge.org/us/dictionary/english/innovation

Carlsson, B. (Ed.). (1997). *Technological Systems and Industrial Dynamics* (Vol. 10). Springer US. https://doi.org/10.1007/978-1-4615-6133-0

Choi, H., & Oh, I. (2010). Analysis of product efficiency of hybrid vehicles and promotion policies. *Energy Policy*, *38*(5), 2262–2271. https://doi.org/10.1016/j.enpol.2009.12.014

CNIPA. (2020). *China National Intellectual Property Administration Annual Reports*. https://english.cnipa.gov.cn/col/col1336/index.html

Cooke, P., Gomez Uranga, M., & Etxebarria, G. (1997). Regional innovation systems: Institutional and organisational dimensions. *Research Policy*, *26*(4–5), 475–491. https://doi.org/10.1016/S0048-7333(97)00025-5

Crotty, M. (1998). *The foundations of social research: Meaning and perspective in the research process*. Sage.

Dai, X., Li, Y., & Chen, K. (2020). Direct demand-pull and indirect certification effects of public procurement for innovation. *Technovation*, 102198. https://doi.org/10.1016/j.technovation.2020.102198

Danermark, B., Ekström, M., & Karlsson, J. C. (2019). *Explaining society: Critical realism in the social sciences*. Routledge.

Diamond, D. (2009). The impact of government incentives for hybrid-electric vehicles:

Evidence from US states. *Energy Policy*, *37*(3), 972–983. https://doi.org/10.1016/j.enpol.2008.09.094

Doe, J. (2012, March 14). *EUROPE 2020 A strategy for smart, sustainable and inclusive growth* [Text]. EUROPEAN INNOVATION PARTNERSHIP - European Commission. https://ec.europa.eu/eip/ageing/library/europe-2020-strategy-smart-sustainable-and-inclusive-growth_en

Du, J., & Ouyang, D. (2017). Progress of Chinese electric vehicles industrialization in 2015: A review. *Applied Energy*, *188*, 529–546. https://doi.org/10.1016/j.apenergy.2016.11.129

Du, J., & Ouyang, M. (2013). *Review of Electric Vehicle Technologies Progress and Development Prospect in China*. *6*, 8.

Easton, G. (2010). Critical realism in case study research. *Industrial Marketing Management*, 11.

Edler, J., & Georghiou, L. (2007). Public procurement and innovation—Resurrecting the demand side. *Research Policy*, *36*(7), 949–963. https://doi.org/10.1016/j.respol.2007.03.003

Edler, J., Ruhland, S., Hafner, S., Rigby, J., Georghiou, L., Hommen, L., Rolfstam, M., Edquist, C., Tsipouri, L., & Papadakou, M. (2005). *Innovation and public procurement. Review of issues at stake*.

Edler, J., & Yeow, J. (2016). Connecting demand and supply: The role of intermediation in public procurement of innovation. *Research Policy*, *45*(2), 414–426. https://doi.org/10.1016/j.respol.2015.10.010

Edquist, C., & Hommen, L. (2000). Public Technology Procurement and Innovation Theory. *Public Technology Procurement and Innovation*, 5–70. https://doi.org/10.1007/978-1-4615-4611-5_2

Edquist, Charles (Ed.). (1997). *Systems of innovation: Technologies, institutions, and organizations*. Pinter.

Edquist, Charles, & Hommen, L. (1988). *Government Technology Procurement and Innovation Theory*. 148.

Edquist, Charles, & Hommen, L. (1999). Systems of innovation: Theory and policy for the demand side. *Technology In Society*, 17.

Edquist, Charles, Zabala, J. M., & Timmermans, B. (2012). *A Conceptual Framework for Analyzying the Relations between Demand and Public Innovative Procurement and between Knowledge Intensive Entrepreneurship and Innovation*. 45.

Edquist, Charles, & Zabala-Iturriagagoitia, J. M. (2012). Public Procurement for Innovation as mission-oriented innovation policy. *Research Policy*, *41*(10), 1757–1769. https://doi.org/10.1016/j.respol.2012.04.022

European Commission. (2003). *Report on Investing in research: An action plan for Europe—Committee on Industry, External Trade, Research and Energy—A5-0389/2003*. https://www.europarl.europa.eu/sides/getDoc.do?type=REPORT&reference=A5-2003-0389&language=EN

European Commission (Ed.). (2005). *Public procurement for research and innovation: Developing procurement practices favourable to R&D and innovation*. Office for Official Publications of the European Communities.

European Commission. (2006). *Creating an innovative Europe: Report of the Independent Expert Group on R&D and Innovation appointed following the Hampton Court Summit* (January 2006). Office for Official Publications of the European Communities.

Fischer, M. M., & Fröhlich, J. (Eds.). (2001). *Knowledge, Complexity and Innovation Systems*. Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-662-04546-6

Fletcher, A. J. (2017). *Applying critical realism in qualitative research: Methodology meets method*. 15.

Freeman, C. (1987). Technology Policy and Economic Performance: Lessons from Japan. *Frances Pinter Publishers*.

George, S. (2011). *Assessing the impact of public sector procurement on competition (September 2004)*.

Geroski, P. (1990). Innovation, Technological Opportunity, and Market Structure. *Oxford Economic Papers*, *42*(3), 586–602.

Gibbons, M., Camille, L., Nowotny, H., Schwartzman, S., Seot, P., & Trow, M. (Eds.). (1994). *The new production of knowledge: The dynamics of science and research in contemporary societies*. SAGE Publications.

Gong, H., Wang, M. Q., & Wang, H. (2013). New energy vehicles in China: Policies, demonstration, and progress. *Mitigation and Adaptation Strategies for Global Change*, *18*(2), 207–228. https://doi.org/10.1007/s11027-012-9358-6

Grandia, J. (2018). Public procurement in Europe. In *The Palgrave handbook of public administration and management in Europe* (pp. 363–380). Springer.

Gregersen, B. (1992). The public sector as a pacer in national systems of innovation. *The Public Sector as a Pacer in National Systems of Innovation*, 129–145.

Guanhua Xu. (2006). *徐冠华：关于自主创新的几个重大问题*. Ministry of Science and Technology of the People's Republic of China. http://www.most.gov.cn/kjbgz/200604/t20060406_30290.htm

Håkansson, H. (1987). *Industrial technological development: A network approach*. Croom Helm; /z-wcorg/.

Hakansson, H. (2015). *Industrial technological development (routledge revivals): A network approach*. Routledge.

Huang, E. (2019, January 19). *China is promoting the use of hydrogen-powered fuel-cell cars—Quartz*. https://qz.com/1535967/china-is-promoting-the-use-of-hydrogen-powered-fuel-cell-cars/

Jeremy, D. J. (1981). *Transatlantic industrial revolution: The diffusion of textile technologies between Britain and America, 1790-1830s*. Mit Press.

Jing Ranzhe, Qiu Ruchun, Zhao Xibin, & Gu Ming. (2007). A framework of management information system on government procurement in China. *2007 IEEE International Conference on Grey Systems and Intelligent Services*, 1558–1562. https://doi.org/10.1109/GSIS.2007.4443534

Kahn, K. B. (2018). Understanding innovation. *Business Horizons*, *61*(3), 453–460. https://doi.org/10.1016/j.bushor.2018.01.011

Kattel, R., & Lember, V. (2010). Public procurement as an industrial policy tool: An option for developing countries? *Journal of Public Procurement*, *10*(3), 368–404. https://doi.org/10.1108/JOPP-10-03-2010-B003

Kazuo, W. (2004). *Kiichiro Toyoda and the Birth of the Japanese Automobile Industry: Reconsideration of Toyoda-Platt Agreement.*

Kennedy, S. (2018). *China's Risky Drive into New-Energy Vehicles*. 58.

Kline, S. J. (1985). Innovation Is Not a Linear Process. *Research Management*, *28*(4), 36–45. https://doi.org/10.1080/00345334.1985.11756910

Kline, S. J., & Rosenberg, N. (2009). An Overview of Innovation. In N. Rosenberg, *Studies on Science and the Innovation Process* (pp. 173–203). WORLD SCIENTIFIC. https://doi.org/10.1142/9789814273596_0009

Krupa, J. S., Rizzo, D. M., Eppstein, M. J., Brad Lanute, D., Gaalema, D. E., Lakkaraju, K., & Warrender, C. E. (2014). Analysis of a consumer survey on plug-in hybrid electric vehicles. *Transportation Research Part A: Policy and Practice*, *64*, 14–31. https://doi.org/10.1016/j.tra.2014.02.019

Kuratko, D. F., Covin, J. G., & Hornsby, J. S. (2014). Why implementing corporate innovation is so difficult. *Business Horizons*, *57*(5), 647–655. https://doi.org/10.1016/j.bushor.2014.05.007

Lazonick, W. (2004). Indigenous Innovation and Economic Development: Lessons from China's Leap into the Information Age. *Industry & Innovation*, *11*(4), 273–297. https://doi.org/10.1080/1366271042000289360

Lember, V., Kalvet, T., & Kattel, R. (2011). Urban Competitiveness and Public Procurement for Innovation. *Urban Studies*, *48*(7), 1373–1395. https://doi.org/10.1177/0042098010374512

Lember, V., Kattel, R., & Kalvet, T. (Eds.). (2014). *Public Procurement, Innovation and Policy*. Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-40258-6

Li, W., Long, R., & Chen, H. (2016). Consumers' evaluation of national new energy vehicle policy in China: An analysis based on a four paradigm model. *Energy Policy*, *99*, 33–41. https://doi.org/10.1016/j.enpol.2016.09.050

Li, Y. (2017). Assessing Public Procurement of Innovation as a Cross-Domain Policy: A Framework and Application to the Chinese Context. *Review of Policy Research*, *34*(3), 421–446. https://doi.org/10.1111/ropr.12229

Li, Y., & Georghiou, L. (2016). Signaling and accrediting new technology: Use of procurement for innovation in China. *Science and Public Policy*, *43*(3), 338–351. https://doi.org/10.1093/scipol/scv044

Li, Y., Georghiou, L., & Rigby, J. (2015). Public procurement for innovation elements in the Chinese new energy vehicles program. In Charles Edquist, N. Vonortas, J. Zabala-Iturriagagoitia, & J. Edler, *Public Procurement for Innovation* (pp. 179–208). Edward Elgar Publishing. https://doi.org/10.4337/9781783471898.00014

Li, Y., Ribeiro, C. G., Rauen, A. T., & Júnior, E. I. (2020). Buying to Develop: The Experience of Brazil and China in Using Public Procurement to Drive Innovation. *International Journal of Innovation and Technology Management*. https://doi.org/10.1142/S0219877020500212

Library of Congress. (2020, March). *Government Procurement Law and Policy: China*. https://www.loc.gov/law/help/govt-procurement-law/china.php

Lindskog, H. (2012). *How public procurement can influence business and social development*. 12.

Liu, F., Simon, D. F., Sun, Y., & Cao, C. (2011). China's innovation policies: Evolution,

institutional structure, and trajectory. *Research Policy*, *40*(7), 917–931. https://doi.org/10.1016/j.respol.2011.05.005

Liu, X., & Peng, C. (2015). An Evaluation of Indigenous Innovation Policy in China. In P. Shome & P. Sharma (Eds.), *Emerging Economies: Food and Energy Security, and Technology and Innovation* (pp. 311–328). Springer India. https://doi.org/10.1007/978-81-322-2101-2_12

Liu, Y., & Kokko, A. (2013). Who does what in China's new energy vehicle industry? *Energy Policy*, *57*, 21–29. https://doi.org/10.1016/j.enpol.2012.05.046

Losacker, S., & Liefner, I. (2020). Implications of China's innovation policy shift: Does "indigenous" mean closed? *Growth and Change*, *51*(3), 1124–1141. https://doi.org/10.1111/grow.12400

Lundvall, B.-Å. (1992). *The Learning Economy and the Economics of Hope*. Anthem Press. https://doi.org/10.26530/OAPEN_626406

Malerba, F. (2005). Sectoral systems of innovation: A framework for linking innovation to the knowledge base, structure and dynamics of sectors. *Economics of Innovation and New Technology*, *14*(1–2), 63–82. https://doi.org/10.1080/1043859042000228688

Mariotto, F. L., Zanni, P. P., & Moraes, G. H. S. (2014). What is the use of a single-case study in management research? *Revista de Administração de Empresas*, *54*(4), 358–369.

McGregor, J. (2010a). China's drive for 'indigenous innovation.' *Retrieved From*.

McGregor, J. (2010b). China's drive for 'indigenous innovation': A web of industrial policies. *US Chamber of Commerce*, *27*.

MIIT. (2009). 中华人民共和国工业和信息化部. https://www.miit.gov.cn/

Mingers, J. (2004). Real-izing information systems: Critical realism as an underpinning philosophy for information systems. *Information and Organization*, *14*(2), 87–103. https://doi.org/10.1016/j.infoandorg.2003.06.001

Nakata, T. (2000). Analysis of the impact of hybrid vehicles on energy systems in Japan.

Transportation Research Part D: Transport and Environment, *5*(5), 373–383. https://doi.org/10.1016/S1361-9209(00)00005-5

Nelson, R. R. (1959). The Simple Economics of Basic Scientific Research. *Journal of Political Economy*, *67*(3), 297–306. https://doi.org/10.1086/258177

Nelson, R. R. (1993). *National Innovation Systems: A Comparative Analysis*. Oxford University Press.

NPC. (2002). *The Government Procurement Law of the People's Republic of China*. http://www.npc.gov.cn/wxzl/wxzl/2002-07/10/content_297298.htm

OECD. (2007). *OECD reviews of innovation policy China synthesis report*. OECD Publications. http://www.oecd.org/science/inno/39177453.pdf

OECD. (2009a). *OECD Reviews of Innovation Policy: Korea - OECD*. https://www.oecd.org/sti/inno/oecdreviewsofinnovationpolicykorea.htm#HTO

OECD. (2009b). *OECD Reviews of Innovation Policy: Mexico - OECD*. https://www.oecd.org/sti/inno/oecdreviewsofinnovationpolicymexico.htm

OECD. (2016). *Measuring the Link between Public Procurement and Innovation*. https://doi.org/10.1787/5jlvc7sl1w7h-en

Olson, E. L., & Bakke, G. (2001). Implementing the lead user method in a high technology firm: A longitudinal study of intentions versus actions. *Journal of Product Innovation Management: An International Publication of the Product Development & Management Association*, *18*(6), 388–395.

O'Sullivan, D., & Dooley, L. (2009). Applying Innovation.(I. SAGE Publications, Ed.). *United Kingdom*.

Peng, H. (2010, September 9). *China's Indigenous Innovation Policy and its Effect on Foreign Intellectual Property Rights Holders*. China Law Insight. https://www.chinalawinsight.com/2010/09/articles/intellectual-property/chinas-indigenous-innovation-policy-and-its-effect-on-foreign-intellectual-property-rights-holders/

Reed, M. (2005). Reflections on the "Realist Turn" in Organization and Management Studies.

Journal of Management Studies, *42*(8), 1621–1644. https://doi.org/10.1111/j.1467-6486.2005.00559.x

Riggs, W. M., & Hippel, E. von. (1992). *The impact of scientific and commercial values on the sources of scientific instrument innovation*.

Rothwell, R. (1984). Creating a Regional Innovation-Oriented Infrastructure: The Role of Public Procurement*. *Annals of Public and Cooperative Economics*, *55*(2), 159–172. https://doi.org/10.1111/j.1467-8292.1984.tb01890.x

Rothwell, Roy., & Zegveld, Walter. (1981). *Industrial innovation and public policy: Preparing for the 1980s and the 1990s*. Frances Pinter; /z-wcorg/.

Saunders, M. N. K., Lewis, P., & Thornhill, A. (2019). *Research methods for business students* (Eighth Edition). Pearson.

Sayer, R. A. (2000). *Realism and social science*. Sage.

Simeon, D., Federica, S., & Asif, I. (2016, December 1). *Is public procurement a rich country's policy?* https://blogs.worldbank.org/governance/public-procurement-rich-country-s-policy

Smits, R. (2002). Innovation studies in the 21st century: Questions from a user's perspective. *Technological Forecasting*, 23.

Sorte Junior, W. F. (2016). Nurturing domestic firms through public procurement: A comparison between Brazil and Japan. *Public Policy and Administration*, *31*(1), 29–50. https://doi.org/10.1177/0952076715603444

Srivastava, V. (2001). *India's accession to the GPA: Identifying costs and benefits* (Issue 74). National Council of Applied Economic Research.

State Council. (2006). *The National Medium- and Long-Term Program for Science and Technology Development (2006-2020)*. The State Council of The People's Republic of China. https://www.itu.int/en/ITU-D/Cybersecurity/Documents/National_Strategies_Repository/China_2006.pdf

Tollefson, J. (2018). China declared world's largest producer of scientific articles. *Nature*, *553*(7689), 390–390. https://doi.org/10.1038/d41586-018-00927-4

UNESCO. (2006). *Science Park and Business Incubator UNESCO - WTA INITIATIVES (2006—2010)*. http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/SC/pdf/sc_unesco-wta_initiatives_en.pdf

UNESCO. (2020). *Science parks around the world | United Nations Educational, Scientific and Cultural Organization*. http://www.unesco.org/new/en/natural-sciences/science-technology/university-industry-partnerships/science-parks-around-the-world/

Uyarra, E., & Flanagan, K. (2010). Understanding the Innovation Impacts of Public Procurement. *European Planning Studies*, *18*(1), 123–143. https://doi.org/10.1080/09654310903343567

Uyarra, E., Zabala-Iturriagagoitia, J. M., Flanagan, K., & Magro, E. (2020). Public procurement, innovation and industrial policy: Rationales, roles, capabilities and implementation. *Research Policy*, *49*(1), 103844. https://doi.org/10.1016/j.respol.2019.103844

Vinig, T., & Bossink, B. (2015). China's indigenous innovation approach: The emergence of Chinese innovation theory? *Technology Analysis & Strategic Management*, *27*(6), 621–627. https://doi.org/10.1080/09537325.2015.1036537

Vonortas, N. S., Bhatia, P., & Mayer, D. P. (2011). *PUBLIC PROCUREMENT AND INNOVATION IN THE UNITED STATES*. 63.

Wang, C., & Li, X. (2014). Centralizing Public Procurement in China: Task environment and organizational structure. *Public Management Review*, *16*(6), 900–921. https://doi.org/10.1080/14719037.2013.770056

Wikipedia. (2020). New energy vehicles in China. In *Wikipedia*. https://en.wikipedia.org/w/index.php?title=New_energy_vehicles_in_China&oldid=996

755351

WIPO. (2020). World Intellectual Property Indicators 2020. *Intellectual Property*, 237.

Wolff, A. W. (2007). China's drive toward innovation. *Issues in Science and Technology*, *23*(3), 54–62.

WTO. (2020). *WTO ¦ Government procurement gateway*. https://www.wto.org/english/tratop_e/gproc_e/gproc_e.htm

WTO. (2020, December 2). *UK and Switzerland confirm participation in revised government procurement pact*. https://www.wto.org/english/news_e/news20_e/gpro_02dec20_e.htm

Wynstra, F., Van Weele, A., Axeisson, B., Wynstraa, F., Axelssonb, B., & Van Weelea, A. (1998). *Purchasing involvement in product development*.

Xie, Y., Wu, D., & Zhu, S. (2021). Can new energy vehicles subsidy curb the urban air pollution? Empirical evidence from pilot cities in China. *Science of The Total Environment*, *754*, 142232. https://doi.org/10.1016/j.scitotenv.2020.142232

Xinhua News. (2019). *China has 340 mln vehicles by mid-2019—Xinhua | English.news.cn*. http://www.xinhuanet.com/english/2019-07/04/c_138196389.htm

Yanchao Li. (2011). *Paper to be presented at the Public procurement as a demand-side innovation policy tool in China -a national level case study*. https://doi.org/10.13140/2.1.3004.6725

Yang, Y., Chen, H., & Chen, L. (2010). Strategy analysis of self-brand car in China. *2010 International Conference on Computer and Communication Technologies in Agriculture Engineering*.

Yin, R. K. (1991). *Case study research: Design and methods. Newbury Park, Rev. Ed*. Sage Publications.

Yin, Robert K. (2003). *Case study research: Design and methods (Vol. 5)*.

Yin, Robert K. (2011). *Applications of case study research*. sage.

Yu, P., Zhang, J., Yang, D., Lin, X., & Xu, T. (2019). The Evolution of China's New Energy

Vehicle Industry from the Perspective of a Technology–Market–Policy Framework. *Sustainability*, *11*(6), 1711. https://doi.org/10.3390/su11061711

Zheng, J., Mehndiratta, S., Guo, J. Y., & Liu, Z. (2012). Strategic policies and demonstration program of electric vehicle in China. *Transport Policy*, *19*(1), 17–25. https://doi.org/10.1016/j.tranpol.2011.07.006

Zhou, Y., Wang, M., Hao, H., Johnson, L., Wang, H., & Hao, H. (2015). Plug-in electric vehicle market penetration and incentives: A global review. *Mitigation and Adaptation Strategies for Global Change*, *20*(5), 777–795. https://doi.org/10.1007/s11027-014-9611-2

Zuijdwijk, T. (2019, May 15). *Understanding the Intellectual Property Disputes between China and the United States*. Centre for International Governance Innovation. https://www.cigionline.org/articles/understanding-intellectual-property-disputes-between-china-and-united-states

7. List of Appendices