PUBLIC PROCUREMENT AS A DEMAND-SIDE INNOVATION POLICY IN CHINA

An Exploratory and Evaluative Study

A Thesis Submitted to the University of Manchester for the Degree of Doctor of Philosophy (PhD)
in the Faculty of Humanities

2013

YANCHAO LI

Manchester Institute of Innovation Research (MIOIR)

Manchester Business School

List of Contents

Word Count: 81,210

Main text
including tables and footnotes
excluding preliminary pages, references and appendices

List of Figures

List of Tables

Abstract

Public Procurement as a Demand-side Innovation Policy in China
– an Exploratory and Evaluative Study

A thesis submitted for the degree of Doctor of Philosophy (PhD)
in the University of Manchester
Yanchao Li, 2013

There has been increased interest internationally in using public procurement as an innovation policy. China too has employed *innovation oriented public procurement* (IOPP) to implement its 'indigenous innovation' strategy. This thesis *explores* China's IOPP policy processes, *evaluates* the appropriateness of these policies, and *explains* key issues identified.

Literature strands on innovation, policy, public procurement, and IOPP are drawn upon to analyse IOPP and related policies. IOPP processes are conceptualized as dynamics shaped by the institutions, actors and interactions of innovation and public procurement systems. IOPP policies are framed as horizontal mixes of cross-domain interventions, and vertical mixes of goals, rationales, instruments, designed implementation structures, actual implementation processes, and outcomes. A criterion for evaluating policy appropriateness is *coherence* between the various dimensions. Macro-level policies impact on micro-level processes which in turn provide evidence of implementation. A multi-level case study methodology is adopted to link up macro/national, meso/regional and micro/local levels of policy design, articulation and implementation.

Implementation is characterized through three IOPP policy channels, a channel being a characteristic group of policies to promote IOPP. Channel 1 employed 'innovation catalogues', which was unexpectedly terminated in 2011 in response to concerns from other countries over China's perceived protectionist tendency. Channel 1 was found to be a centralized mechanism to implement *general* IOPP across all regions, sectors and levels of governance. As a one-size-fits-all approach requiring cross-domain, cross-level coordination, it failed to achieve coherence with the institutional fragmentation of China's innovation and procurement systems. The other two channels were implicit, *strategic* IOPP approaches i.e. commercialization projects for 'major technological equipment' with a rationale of pre-commercial procurement (Channel 2), and demonstration programmes for emerging technologies with a rationale of creating lead markets (Channel 3). These two channels realized better coherence with China's systems as both were targeted at specific sectors and levels. Cross-case analysis suggests that micro-level IOPP processes were more frequently shaped by local contexts of stakeholders, interactions and *informal* institutions rather than IOPP policies. Interventionist local governments and proactive suppliers played stronger roles than procurers in initiating IOPP. IOPP cycles followed diverse and informal pathways not always competition-based, which might have breached *de jure* procurement regulations but China's weak formal institutions allowed this flexibility. Informal institutions sometimes mitigated flaws of formal ones and facilitated IOPP, but could easily play competing roles (notably regional protectionism) that hinder policy implementation.

This thesis contributes to IOPP knowledge by: offering a conceptual approach to IOPP policy analysis concerning implementation and appropriateness evaluation; uncovering China's IOPP dynamics based on which the understanding of IOPP as a research subject is deepened. Policy implications include lessons for catching-up countries emphasizing institutional capacity and government capability, and more general issues highlighting policy differentiation and complementarity, and intermediation.

Declaration

No portion of the work referred to in the thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.

Copyright Statement

Abbreviations

863 Programme	National High-tech R&D Programme
AMSC	American Superconductor Corporation
CAS	Chinese Academy of Sciences
CCGP	China Central Government Procurement
CPU	Central Processing Unit
D-D	Demand-Demand (interaction)
D-I	Demand-Intermediary (interaction)
DRC	Development and Reform Commission
D-S	Demand-Supply (interaction)
DSIP	Demand Side Innovation Policy
EC	European Commission
EPB	Earth Pressure Balanced (shield machines)
EU	European Union
EUCCC	European Union Chamber of Commerce in China
EV	Electric Vehicle
EXPO	Exposition (World’s Fair)
FCP	Forward Commitment Procurement
FDI	Foreign Direct Investment
FEBP	First (set of) Equipment Breakthrough Programme
GDP	Gross Domestic Product
GPA	Agreement on Government Procurement
ICT	Information and Communications Technology
I-D	Intermediary-Demand (interaction)
I-I	Intermediary-Intermediary (interaction)
IOGP	Innovation Oriented Government Procurement
IOPP	Innovation Oriented Public Procurement
IPR	Intellectual Property Right
I-S	Intermediary-Supply (interaction)
LED	Light Emitting Diode
LGP	Law on Government Procurement
LMI	Lead Market Initiative
LTB	Law on Tendering and Bidding
MBR	Membrane Bioreactor
METI/MITI	Ministry of Economy/International Trade and Industry (Japan)
MIIT	Ministry of Industry and Information Technology

MLP	The National Medium- and Long-Term Programme for Science and Technology Development – an outline (2006-2020)
MOF	Ministry of Finance
MOST	Ministry of Science and Technology
MTE	Major Technological Equipment
NDRC	National Development and Reform Commission
NEV	New Energy Vehicle
NIS	National Innovation System
OBM	Own Brand Manufacturing
ODM	Own Design Manufacturing
OECD	Organisation for Economic Co-operation and Development
OEM	Own Equipment Manufacturing
PCP	Pre-Commercial Procurement
PPC	Public Procurement Cycle
PRC	People's Republic of China
PRI	Public Research Institute
R&D	Research and Development
SASAC	State-owned Assets Supervision and Administration Commission
S&T	Science and Technology
SBIR	Small Business Innovation Research (US)
S-D	Supply-Demand (interaction)
SHEITC	Shanghai Municipal Economic and Informatization Commission
S-I	Supply-Intermediary (interaction)
SME	Small and Medium Enterprise
SOE	State-Owned Enterprise
S-S	Supply-Supply (interaction)
STEC	Shanghai Tunnel Engineering Co. Ltd
STI	Science, Technology and Innovation
TBM	Tunnel Boring Machines
TLC	Technology Life Cycle
UK	United Kingdom
US	United States
USCBC	US-China Business Council
WTO	World Trade Organization

About the Author

Yanchao Li entered the full-time PhD programme in Manchester Institute of Innovation Research (MIOIR) in September 2009. Prior to this, she obtained her Master's degree in Tsinghua University, Beijing, and Bachelor's degree in Jiao Tong University, Shanghai; both in electrical engineering. She became very interested in science, technology and innovation policies through elective courses in Tsinghua University, switching to the current discipline for doctoral study.

Yanchao has been involved in various teaching and research activities in MIOIR. She served as a seminar leader for undergraduate courses 'International Business Strategy' and 'International Management of Knowledge and Technology'. Meanwhile she has participated in a number of research projects including 'Understanding Public Procurement for Innovation' (UNDERPINN) and 'Policies for Research and Innovation in Small Member States' (ERA-PRISM). Both projects were on public procurement as a demand-side innovation policy in the European context.

Yanchao has presented different aspects of her work in conferences including DRUID 2011, UNDERPINN 2012, EU-SPRI 2012, and Atlanta Conference on STI Policies 2013. Currently she is working together with Prof. Luke Georghiou and Dr. John Rigby on further publications.

Acknowledgement

My deepest gratitude goes to my supervisors, the two intelligent English gentlemen, Prof. Luke Georghiou and Dr. John Rigby. In late November 2008 I approached Luke; this turned out to be the best decision I made in my education history. Luke is wise, reachable, generous, responsive, constructive, and always able to capture the big picture, saving me for so many times from morasses during the course of this complicated project. In fact, no words can fully express my gratitude to him. John, on the other hand, is a wonderful mentor and friend with whom I have shared and debated about various ideas; his meticulous comments and insights have always enlightened me.

I am truly thankful to the informants who have been open-minded enough to participate in this study, frankly sharing their experience, opinions, and resources. Especially I thank NO_2, R2O_1, R2O_2, and R4O_1, who have not only given me interview opportunities, but also patiently offered advice when I bothered them again and again.

I am sincerely grateful to my examiners, Prof. Gustavo Piga and Prof. Jakob Edler, for their constructive feedback after the viva which helped me improve this thesis. A number of MIOIR staff members deserve to be mentioned here for their beneficial influence and kind support. The splendid progress in IOPP research achieved by Prof. Jakob Edler, and the ‘procurement group’ (notably Dr. Elvira Uyarra, Dr. Jillian Yeow, and Dr. Sally Gee) led by him, underpins this study. The experience of working with them in various projects has significantly accelerated the development of my own research; I feel extremely lucky and grateful. I thank Prof. Philippe Laredo and Ms. Kate Barker who offered me valuable advice on research through year reviews. I thank the two lovely ladies Lisa Gledhill and Wendy Walker for making the office life organized and easier. I thank all the MIOIR people for the great atmosphere. I must also thank the School for sponsoring me with sufficient funding throughout the four years.

I thank my PhD buddies/friends, including my officemates Ambarin Asad Khan, Kalle Stahl Nielsen, and Zeynep Kaplan; flatmate Jungmin Han; ‘corridor-mates’ Zhenmei Zhu, Omid Omidvar, Zemin Chen, Thomas Schroeder, Robert Lai, Lilian Kishimbo, and Roman Kislov; and ‘couple-mates’ Lei Wang and Jing Chen. It was these mates that made the PhD life bearable, and enjoyable. Especially I thank Anqi Guo, who has been a sincere friend since the first day of my PhD life, and shared the four years of pains and joys with me. Back in China and around the world, too many friends to be named should be thanked for their encouragements and (more often) distractions, reminding me of the colourful world beyond PhD.

I am heavily indebted to my mother Shie Zhang, who insisted me to pursue a PhD abroad despite the loneliness she needs to bear, and who is always there for me with her genuine love. My parents-in-law Qinglin Wang and Heying Chang should also be thanked for their constant support and confidence in me. Special gratitude goes to my uncle Dr. Xinmin Zhang, whose support assisted me throughout my research and personal life. I thank everyone in my big family, for the warm care they devoted to me.

Finally, I thank my husband, Pengfei Wang, for unconditionally supporting and spoiling me. His selfless and endless love, which I often take for granted, is deeply appreciated here. He is the reason why I decided to start, and the reason why I managed to finish.

Dedicated to

My dear father

Mingshi Li

(September 20th 1960 – September 10th 2005)

Chapter 1: Introducing the Thesis

1.1 The global interest in public procurement to drive innovation

Innovation has long been recognized as the main driving force of economic growth, international competitiveness and social welfare (Schumpeter, 1934; Fagerberg et al., 2005). Today it is becoming even more pivotal in such a globalized, knowledge-based world faced by complex and interconnected problems for which the term ‘grand challenges’ (Georghiou, 2008; Edler et al., 2012) is increasingly used. Government interventions targeted at stimulating innovation, i.e. innovation policies, are being emphasized more than ever before across the world[1]. While developed countries seek innovation to maintain competitiveness, developing countries seek innovation to catch up (Fagerberg and Godinho, 2005; Nelson, 2004).

Since the early 2000s China, the largest developing country, the ‘world factory’ (Zhang, 2006), has been trying to transform its economy mode from one overwhelmingly dependent on investment-driven, extensive growth to one featuring intensive growth and sustainable development (Jin, 2007). An approach proposed firstly by academia and then by policymakers to achieving this transition has been ‘*indigenous innovation*’ (Chen, 1994; Hu, 2006), which was launched as a national strategy through the *National Medium- and Long-Term Programme for Science and Technology Development – an outline (2006-2020)* (MLP, see State Council, 2006a). One important innovation policy adopted by MLP has been ‘*government procurement favouring indigenous innovation*’ (ibid., Section VIII, Article 3). This thesis titles this type of policy as ‘*innovation oriented public procurement*’ (IOPP), and sets out to investigate the Chinese approach to using it.

A basic rationale of IOPP policy is to utilize *public demand* to lever innovation performance (Edler, 2013). Demand has been recognized as an important factor in spurring and shaping innovation processes (Section 2.2.2). Representing 15-20% (proportion *excluding* defence expenditures) of most countries’ gross domestic product (GDP) (Piga, 2011), public procurement can provide a considerable market for innovative solutions. Recognized impacts of IOPP policies include creating lead

[1] See Organisation for Economic Co-operation and Development, OECD, Reviews of Innovation Policy.

markets, overcoming market and system failures, catalysing private demand, and improving public infrastructures (Edler and Georghiou, 2007).

China is neither the first, nor the only country that has recognized the potential of public procurement in fostering innovation. IOPP has historically facilitated the innovation and industrialization processes in the United States (US), Japan, Korea and several European countries (Weiss and Thurbon, 2006; Wade, 1990; Edquist et al., 2000). Nevertheless, IOPP has been underused as an innovation policy owing to, firstly, a neglect of the demand side by policymakers guided by a ‘supply-side oriented’ policy approach (Edquist and Hommen, 1999), and secondly, that public procurement as a multi-faceted policy tool is constrained by regulations targeted at diverse objectives among which innovation is usually not a priority (see Chapter 3).

Over the last decade a new wave of interest in IOPP among policymakers across the world has been evident. In the European Union (EU) context, both individual countries and the EU as a whole have put IOPP high on the agenda (see Appendix 4). Initiatives taken by other countries include, but are not limited to, Australia’s Small and Medium Enterprise (SME) ‘Market Validation Programme’, Korea’s strategic procurement policy for innovation (OECD, 2011a), and Brazil’s explicit measures to support SMEs with IOPP policies (Silva, 2011).

Echoing the actions in the political arena has been the burgeoning area of IOPP research. Departing from early works such as Rothwell (1984) and Geroski (1990), IOPP research has been advancing fast since the 2000s, aiming to provide academic knowledge to inform policy practices (see e.g. Edquist et al., 2000; Edler and Georghiou, 2007; Uyarra and Flanagan, 2010; Rolfstam, 2012a; Georghiou et al., 2013; Edler and Yeow, 2013). A deeper understanding of the phenomenon has been developed (see Chapter 4). Rich evidence of micro-level IOPP processes has been collected, mainly in the form of case studies in the EU context (see e.g. Edquist et al., 2000; Edler et al., 2005; Lember et al., 2007; OMC-PTP, 2009; Tsipouri et al., 2010; Georghiou et al., 2010).

1.2 Innovation oriented public procurement (IOPP) in China

China’s explicit approach to IOPP had a strong catching-up focus in addition to objectives of economic growth and sustainability. The establishment of an *innovation* *oriented government procurement* (IOGP)[2] mechanism in China started in 2006, following high-level mandates outlined in the MLP. It featured the (intended) use of *catalogues of indigenous innovation products* (i.e. 'innovation catalogues') and *catalogues of government procurement of indigenous innovation products* (i.e. 'IOGP catalogues') to enhance communication and coordination between various stakeholders. The Ministry of Science and Technology (MOST) together with Ministry of Finance (MOF) and National Development and Reform Commission (NDRC) were expected to produce centralized *innovation catalogues* to include qualified products, based on which *IOGP catalogues* would be produced to guide government procurers nationwide to conduct IOGP. The 'indigenousness' i.e. a 'Chinese nationality' of products and the potential to substitute import were very much emphasized by the ministries as a criterion for product accreditation. Qualified innovative solutions were supposed to enjoy preferential treatment in public tendering. Inspired by the central government initiative, regions announced their IOGP policies as well, primarily following approaches similar to that at the central level (US-China Business Council, USCBC, 2011f). The IOGP policy setup in China by 2011 seemed more ambitious than that in any other countries.

Driven partly by this policy initiative and partly by the rising research interest internationally, the quantity of Chinese publications debating IOPP has increased significantly since 2006; a variety of topics including rationale justification, legislative issues, and advice on policy making and implementation has been addressed (for more details see Appendix 1). Nevertheless, few of those publications offered in-depth knowledge about China's actual policy approach and implementation process[3].

Internationally there has been only a handful of publications devoted to this phenomenon. Edler et al. (2008) provided a concise assessment of the content of the newly announced Chinese IOGP policies. Alongside the unfolding of China's policies, reports expressing concerns over perceived protectionism were published by American practitioners (USCBC, 2009; USCBC, 2010b; Ahrens, 2010; McGregor, 2010).

[2] In this thesis *innovation oriented public procurement* (IOPP) is distinguished from *innovation oriented government procurement* (IOGP) as the scope of 'government procurement' is much narrower than 'public procurement' in the context of China (Section 3.4).

[3] Interviewee Researcher_1 implied that policy researchers in China tend to adopt quantitative methods such as 'mathematical modelling' to draw theoretically derived policy implications rather than 'going to the field', as policy processes in the Chinese context are rather 'opaque' and 'politically sensitive'; access to primary data proved to be very difficult.

Indigenous innovation especially IOPP policies became a major source of economic friction between China and US, and ranked as a top priority to be addressed between the two countries during 2010-2011 (see a series of publications by USCBC). Meanwhile the European Union Chamber of Commerce in China (EUCCC) conducted a survey on EU companies' bidding experiences in China and raised their concerns as well (EUCCC, 2011). Those reports draw attention to the tensions between China and international stakeholders owing to the former's ambitious intention to utilize IOPP policies. Nonetheless, there is little knowledge about how the Chinese policies worked and why those tensions emerged.

Tracing IOPP policy changes from government websites in China, the national innovation catalogues were not published as planned. Regional experience varied significantly from one area to another, e.g. active regions such as Beijing and Guangdong had produced several versions of innovation catalogues by May 2011, while most of the others did not publish any (Section 6.3). Little secondary data is available to make any assessment about the implementation of national or regional policies. What made this phenomenon even more paradoxical was the termination of four key national IOGP policies in July 2011 as a result of high-end US-China dialogues. The Chinese policy effort seemed to have failed under the international political-economic pressure.

1.3 Gaps, objectives and research question

This study belongs to the general area of policy research which, distinct from research projects that are more theoretically driven, has been perceived as a rather pragmatic, and 'action' and 'application' oriented discipline (Hill, 1997; Uyarra, 2003; DeLeon, 2008). In particular for science, technology and innovation (STI) policy research, Morlacchi and Martin (2009) considered that

> *'…rather than being theory-driven or paradigm-driven, it is primarily a* ***problem-oriented field that focuses on practical issues to do with specific policies*** *for science, technology and innovation…' (p.572)*

The *problems* that this study aims to deal with are expressed in the following perceived *gaps*. An immediate gap observed in the Chinese context has been a lack of in-depth knowledge regarding the country's IOPP policy process, and consequently a lack of evaluation of the previous approach to inform future policies[4]. Hence the first objective of this study is to investigate China's IOPP policy process, and provide an evaluation of the policy approach. Rather than a comprehensive policy evaluation that usually requires the effort of a research group and availability of extensive data, the evaluation conducted by this study is an initial effort to evaluate the *appropriateness* of the IOPP *policy process* (i.e. the *design*, *articulation* and *implementation* of the policy).

To address the first gap, there is a need for a research approach with an evaluative focus, which points to another gap existing in IOPP research, i.e. methodologically a lack of criteria and approach to the evaluation of IOPP policies. This as part of the broader issues of evaluating *demand-side innovation policies* has been identified by Edler et al. (2012) as '*a severe evaluation gap*' and '*an increasingly apparent shortcoming*' (p.2). The second objective of this study is hence to make an early contribution to addressing this gap by proposing concepts and methods for evaluation of IOPP policies.

To fulfil the above mentioned two objectives, a conceptual approach linking up the *multiple levels* and *multiple aspects* of the IOPP policy phenomenon is very much needed. This, however, is seriously lacking in IOPP research. Despite the gratifying achievements in both empirical and conceptual terms, existing theoretical accounts of IOPP still focus on the micro level only (Section 4.3); there has been no holistic framework to situate and conceptualize IOPP in the broader context of a policy process. This leads to the third objective of this study, i.e. to develop such a framework.

Driven by the objectives, this topic of research is defined by the broad issue of how IOPP was situated in the context of China. This is later articulated in Chapter 5 as the research question:

How was the use of public procurement as an innovation policy mediated by the innovation and procurement systems in China?

Sub-questions will cover themes such as the contextual situation, the policy process, and micro-level IOPP dynamics (Section 5.3).

[4] This has been a common problem in the OECD context as well, as argued by Edler et al. (2012) that '…*demand-side policies remain an elusive concept where policy development follows intuition and is characterized by policy imitation rather than evidence, reasoning, and informed learning*.' (p.2)

1.4 Scope of this study

China is the largest developing country with 31 provinces (mainland only) unevenly developed (OECD, 2008); the vastness of the subject makes it a prerequisite to clearly define the geographical scope of this study. Three levels of policy process are differentiated, namely *national/macro level* and *regional/provincial/municipal level* of policy design, articulation and implementation, and *local/micro level* of policy implementation (procurement processes). For national and regional levels this study seeks an overall understanding of the 'landscape' across the country, while for the micro level a *purposive sampling strategy* (Section 5.5.1) is adopted to identify concrete IOPP cases. The cases were situated within five selected regions (Beijing, Shanghai, Guangdong, Shandong and Jiangsu) which featured a high level of activity in terms of IOPP policies, high positions in GDP and innovativeness rankings, and easier access to primary data. Admittedly this sample is not representative, but it enables a deeper look into concrete issues that emerge during procurement processes. This depth is considered necessary for evaluating the *implementation* or *process* of policies (Patton, 1987).

This study comes with a clear time scope as well. The termination of national-level key IOGP policies took place in July 2011, *after* the main stage of fieldwork for this study which was conducted in April-June 2011, thus the primary data used to reconstruct concrete IOPP processes in this study are centred on practices that took place before the policy change.

It should be noted that defence procurement, i.e. the procurement of goods and services which are primarily intended to be used for military purposes (SIGMA, 2011), is not dealt with in this thesis due to its sensitive nature and characteristics distinct from public procurement for civil use (ibid.).

1.5 The research approach in brief

The severe lack of preliminary knowledge about the subject determines that this study is by nature *exploratory* research, which is defined by Stebbins (2001) as a

> *'...**purposive**, **systematic**, **prearranged** undertaking designed to maximize the discovery of generalizations leading to **description** and **understanding** of an area of social life' (p.3).*

The exploration of the subject started with a scoping of literature and secondary data in both Chinese and English languages. Besides the literature specifically focused on IOPP, literature strands on innovation (including perspectives on *innovation systems*, *policies* and *catching-up*) and public procurement (including perspectives on *processes*, *regulations*, and *development-related issues*) are found closely relevant to this subject.

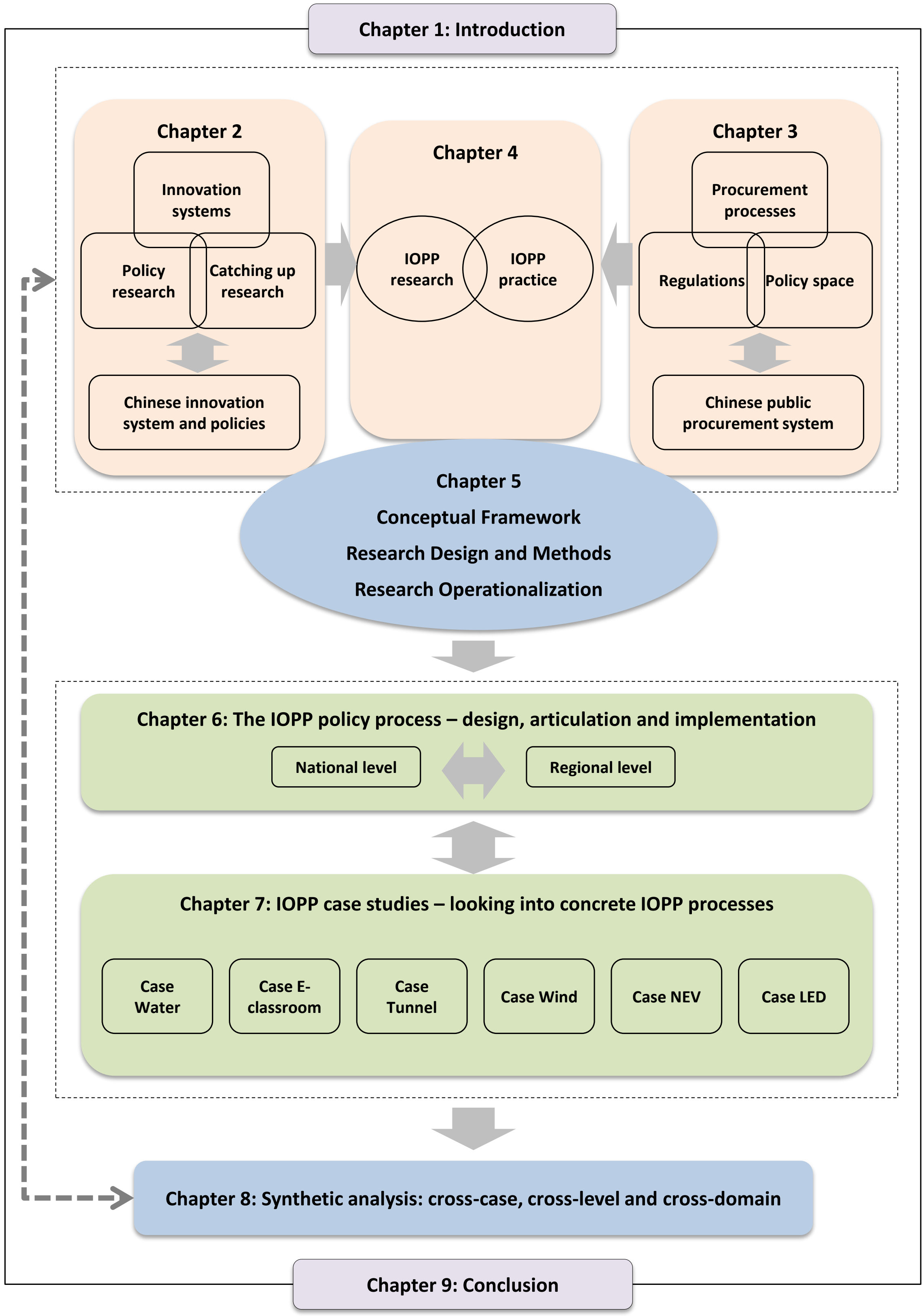
Drawing upon these literature strands, this study considers that IOPP for a certain country/region/sector is situated at the 'intersection' of the country/region/sector's innovation system and public procurement system (Section 5.2). IOPP can be conceptualized as dynamics shaped by contexts, actors, institutions and interactions of both innovation and procurement systems, i.e. a 'system mix' perspective (Figure 5.2). IOPP policy is conceptualized as a multi-level, multi-dimensional intervention across the domains of innovation and procurement policies; it is by nature a 'policy mix' (Section 2.3.3), which is vertically a mix of its various dimensions including goals, rationales, instruments, implementation structures, processes and outcomes, and horizontally, a mix of innovation and procurement related interventions. IOPP policies can be considered as driving forces impacting upon IOPP processes which are meanwhile shaped by innovation and procurement systems.

Guided by this 'system mix' – 'policy mix' conceptualization, a criterion adopted to evaluate the appropriateness and implementation of IOPP policy is ***coherence***. *Coherence* of an IOPP policy is further delineated into ***vertical coherence*** between various dimensions of the policy, and ***horizontal coherence*** with contextual factors. Three aspects of data are to be examined, i.e. the context for IOPP (including the Chinese innovation and procurement systems, and broader issues if relevant), the policy setup (design and articulation of IOPP policies) and the implementation process (concrete IOPP processes). These aspects lead to a contextual, multi-level research strategy (Section 5.4).

1.6 Thesis structure

The main body of this thesis, as illustrated in Figure 1.1, consists of four major parts, i.e. a review of perspectives and issues related to IOPP (Chapters 2, 3 and 4), conceptual framework and research design (Chapter 5), data presentation and analysis (Chapters 6 and 7), and synthetic analysis (Chapter 8).

Figure 1.1 Thesis structure



Source: Author

Chapter 2 outlines *the context of innovation* where IOPP locates by reviewing relevant perspectives on innovation systems, policies, and catching-up. Public procurement is positioned as a demand-side innovation policy (DSIP) influencing complex innovation processes through addressing system failures and contributing to system functions. An overview of China's innovation system and policies is then conducted to further contextualize the subject.

Chapter 3 outlines *the context of public procurement* where IOPP locates by reviewing general aspects (elements, processes, functions, and regulations) of public procurement as a *multi-functional* government activity. Further contextualization of the subject is then achieved through an overview of the Chinese public procurement system.

Chapter 4 reviews research and practices explicitly focused on IOPP in the OECD context. IOPP's *functioning mechanisms* are appreciated, followed by summaries of *practices* and *associated issues* in the context of OECD countries, which provides reference for comparison with the Chinese approach later on.

Chapter 5 sets out to integrate perspectives covered in Chapters 2-4, whereby the *'system mix' – 'policy mix' conceptualization* of IOPP and IOPP policy is proposed and justified. It then articulates the core research question into a set of sub-questions based on the conceptualization, and proposes a research framework of 'multi-level case study'. Operational issues such as data collection and analysis methods are then addressed.

Chapter 6 investigates the *design*, *articulation* and *implementation* of IOPP policies at the national/macro and regional/meso levels through policy documentation analysis supplemented with analysis of data collected from interviews. Besides the explicit IOGP policy channel based on 'innovation catalogues', two other policy channels were identified through iterations and interactions between documentation analysis and fieldwork. These three channels are discussed in turn.

Chapter 7 carries on investigating the policy implementation down to the *micro level*, i.e. concrete IOPP examples stimulated by the policies. Six case studies situated in the three policy channels are presented, primarily following the logic of procurement cycles. The involved technologies, policies, demands, procurement processes, obstacles, and outcomes/impacts are introduced in turn, followed by a cross-case summary laying out the basis for synthesis.

Chapter 8 integrates outcomes from previous chapters and conducts a synthetic analysis underpinned by the conceptual framework proposed in Chapter 5. Moving on from the micro-level cases presented in Chapter 7, this chapter firstly conducts a *cross-case analysis* to identify patterns of IOPP dynamics, covering the dimensions outlined in case studies with stakeholder interactions and the roles played by institutions highlighted. It then links up the knowledge about the micro level with that about upper levels as presented in Chapter 6, to evaluate the *vertical coherence* of the three policy channels through *cross-level analysis*. Following this *horizontal coherence* is appraised through *cross-domain analysis* which identifies signs of *lack of coherence* between the IOPP policies and their contexts including the innovation and the public procurement systems, and the broader, international context.

Chapter 9 reflects on the research approach and limitations, reviews key findings from the preceding chapters, and clarifies the contributions of this study. It moves on to propose implications for future IOPP policies and practices, and then concludes the whole thesis by indicating future directions of research.

Chapter 2: Innovation, Policy, and the Context of China

2.1 Introduction

This chapter attempts to set the context of innovation and policy studies for IOPP by reviewing relevant conceptual origins and issues. This study adopts the definition by the Oslo Manual (OECD, 2005b), that innovation is

> *'…the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations… the minimum requirement for an innovation is that the product, process, marketing method or organizational method must be new (or significantly improved) to the firm' (p.46).*

Section 2.2 reviews key perspectives on innovation systems with a focus on where IOPP policy functions i.e. the demand side. Section 2.3 moves on to discuss key dimensions of innovation policies which has been effectively informed by innovation studies and possesses an increasingly dynamic, systemic and complex nature (Mytelka and Smith, 2002; Flanagan et al., 2011). Considerations on policy (implementation) analysis and evaluation are developed. Given the fact that most of the theoretical and policy perspectives have been derived based on conditions of developed countries (Liu and White, 2001), an additional understanding of innovation in catching-up economies (Section 2.4) is provided to suit the purpose of this thesis. Section 2.5 provides an overview of China's innovation system and innovation policies driven by its 'indigenous innovation' strategy, followed by Section 2.6 concluding the chapter.

2.2 Innovation systems and the demand

2.2.1 Innovation systems – actors, institutions, and interactions

An early definition of a national innovation system (NIS) by Freeman (1987) is:

> *'…the **network of institutions** in the public and private sectors whose **activities** and **interactions** initiate, import, modify and diffuse new technologies' (p.1)*

Lundvall (1992) further articulated that an NIS is:

> *'…the **elements** and **relationships** which **interact** in the production, diffusion and use of new, and economically useful, knowledge...and are either located within or rooted inside the borders of a nation state' (p.2).*

A variety of definitions of NIS has been developed afterwards (see e.g. Nelson, 1993; Patel and Pavitt, 1994). A common consideration shared by those definitions has been that the *creation* and *diffusion* of innovations are the core activities/processes of NIS, shaped by *institutions* and *actors*, and *interactions* among those elements. As policy research this study finds it useful to draw from Metcalfe (1995) who has shed light on the role of *policies* by defining an NIS as:

> *'...**a set of distinct institutions** which jointly and individually contribute to the development and diffusion of new technologies and **which provides the framework within which governments form and implement policies to influence the innovation process**. As such it is a system of interconnected institutions which create, store and transfer the knowledge and skills which define new technologies' (p.38).*

A *policy* may be regarded as:

> *'...both a **statement of intent** by those seeking to change or control behaviour, and a **negotiated output** emerging from the implementation process' (Barrett, 2004, p.253).*

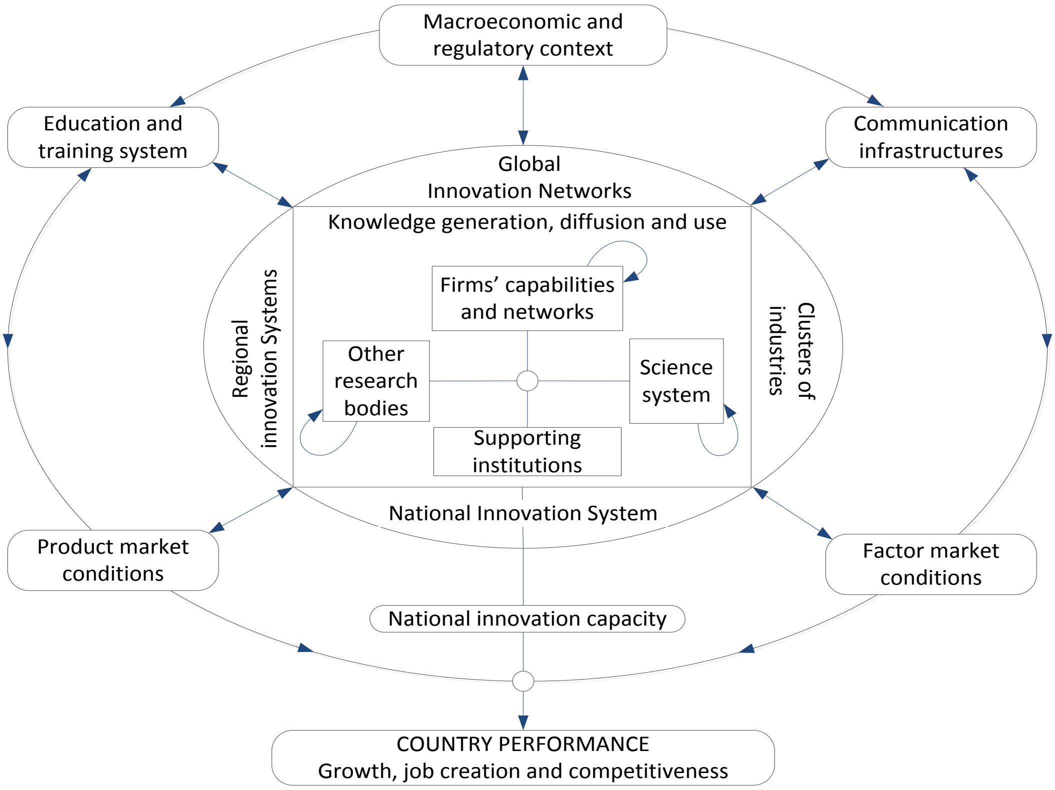
The relationship between *policies* and *institutions* has been summarized by Edquist et al. (2000) as:

> *'...policy is both **based on** institutions and often acts to **change** them.' (p.284)*

Therefore, an innovation policy can be considered as a measure taken by the government to influence innovation processes through changing or control institutions and the behaviour of target groups, and meanwhile the impacts of policies are outcomes negotiated by actors and institutions.

Despite the fact that it is impossible to fully describe NIS due to its complexity (Edquist, 2001), it is necessary to provide a characterization in order to conduct concrete analysis. A simplified, visualized picture of NIS and its wider context is illustrated in Figure 2.1. Main types of actors in NIS include: firms/suppliers as the core players undertaking innovation, public research institutes (PRIs) and universities as the main actors producing knowledge, the government who facilitates innovation through policy support, and users who consume as well as stimulate innovation (Lundvall, 1992; Edquist and Hommen, 1999). *Interactive learning* between actors is considered as the core element of innovation processes (ibid.), contributing to system performance by fulfilling functions such as knowledge development and diffusion, demand articulation, resources mobilization, and market formation (Smits and Kuhlmann, 2004; Hekkert et al., 2007; Bergek et al., 2010), and further contributing to socioeconomic development and competitiveness of the country. Institutions shape interactive learning by providing 'stability', setting 'preconditions', and supporting the storage, transmission and utilization of knowledge (Johnson, 1992). Institutions often form part of *framework* *conditions* (OECD, 2008; Allman et al., 2011), which, as shown in the diagram, include but are not limited to macroeconomic and regulatory context, education and training system, infrastructures, and market conditions. *Actors*, *institutions*, *interactions*, and *contextual factors* influence each other and form the dynamics of NIS. Innovation policies serve as driving forces impacting upon the dynamics.

Figure 2.1 An exemplary national innovation system



Source: OECD (1999)

The NIS conceptualization was then adapted to technological (Carlsson, 1997), regional/local (Cooke, 1997), sectoral (Breschi and Malerba, 1997) and more recently supranational (Edquist, 2001; Bacaria-Colom et al., 2010). Hence innovation systems vary not only in terms of 'what composes them', but also in terms of their scope, levels and contexts, which will further affect the units of analysis for research. Edquist (1997) provided a rather broad definition of *generic* innovation system which is:

> *'…all important economic, social, political, organizational, and other factors that influence the development, diffusion and use of innovations' (p.14).*

An innovation system is then considered as a combination of all contextual factors surrounding innovation processes. As a conceptual framework it realistically admits the uncertainty and complexity of innovation processes. Every single innovation system differs from the others because there are always differences in certain dimensions. Innovation-system perspectives appreciate the differences rather than searching for 'one-size-fits-all' models (Todtling and Trippl, 2005).

Given that 'institutions' are being widely used but ambiguously defined in this area (Edquist, 1997; Nelson, 2008), it is necessary to make a clarification here. This study adopts a classic definition by North (1991) that *institutions* are:

> *'...the humanly devised constraints that* ***structure*** *political, economic and social* ***interaction****. They consist of both* ***informal constraints*** *(sanctions, taboos, customs, traditions, and codes of conduct), and* ***formal rules*** *(constitutions, laws, property rights)' (p.97).*

Helmke and Levitsky (2004) defined that formal institutions are:

> *'...****rules and procedures*** *that are created, communicated, and enforced through* ***channels widely accepted as official****',*

while informal institutions are

> *'...****socially shared rules****, usually* ***unwritten****, that are created, communicated, and enforced* ***outside of officially sanctioned channels****' (p.727).*

Helmke and Levitsky (2004) distinguish between 'complementary' and 'substitutive', and 'competing' and 'accommodating' informal institutions based on whether the resulting outcomes of informal institutions converge with or diverge from that of formal ones. Informal institutions can '*shape the performance of formal institutions in important and often unexpected ways*' (Helmke and Levitsky, 2004, p.726). Some informal institutions, and the activities enforcing them i.e. '*informal practices*', emerge as consequences of formal institutions' weaknesses (Ledeneva, 2008). In the context of an innovation system, institutions are the 'rules of games' (Nelson and Sampat, 2001) structuring the interactions between actors.

2.2.2 The influence of demand on innovation

Demand[5], commonly described in economics as *the desire and willingness to pay a price for a specific good or service,* was explicitly emphasized as a significant force to 'pull' innovation by Schmookler (1966). Non-linear innovation perspectives[6] (Edquist

---

[5] Part of this section was used in an adapted form by the Author in preparing the proposal for EC project *Innovation Demand-side Monitoring System* (No 276/PP/ENT/CIP/13/C/N03C041), July 2013.
[6] See Appendix 2 for a summary of non-linear innovation perspectives related to the role of demand-side.

and Hommen, 1999) such as 'user-producer interactive learning' (Lundvall, 1988) and 'distributed innovation process' (von Hippel, 1988) explicitly highlighted the crucial role played by users. Integrating their perspectives with that from Malerba et al. (2007), Uyarra and Flanagan (2010), OECD (2011a), and Stefano et al. (2012), this thesis considers that the major impacts of demand upon innovation include:

- Selection: demand as 'selecting mechanisms' in evolutionary processes;
- Feedback: users/markets providing feedback to improve innovation;
- Stimulation: expected markets stimulating the creation and diffusion of innovation;
- Innovation/co-innovation: users as innovators/co-innovators.

Both the size and the structure of demand have impacts on innovation. While large-scaled markets can reduce the uncertainty of innovation processes and provide suppliers with the benefits of economies of scale (Schmookler, 1966; Uyarra and Flanagan, 2010), demand structures interact and co-evolve with innovation processes in a more dynamic way (Malerba et al., 2007). Certain arrangements of significantly sized demand can favour innovation processes. In particular, the notion of 'lead users' has been raised by von Hippel (1988) to characterize a crucial demand arrangement for innovation, which is defined as '*users whose present strong needs will become general in a marketplace months or years in the future*' (p.107). Lead users can potentially address all of the four types of impacts identified above. Similarly, the concept of 'lead markets' was brought about to characterize the demand mechanism where certain markets' present preferences for specific technologies which later on become adopted in other markets as well (Beise, 2004). Lead markets can then realize both the size and the structure required for innovation. Moving from lead users to lead markets, as argued by Georghiou (2006), requires early adoption of innovation by multiple users or else through '*a single user with sufficient purchasing power to constitute a market on its own*' (p.13). This role of 'single user' can be fulfilled by the government through public procurement.

2.3 Innovation policies

Lundvall and Borrás (2005) consider that innovation policies should cover all the issues related to innovation and target at '*overall innovative performance of the economy*' (p.615). Innovation policies are likely to go across different policy domains and overlap with other public policies in order to realize better overall performance (OECD, 2010; Flanagan et al., 2011). Influenced by innovation-system perspectives, the design, implementation and evaluation of innovation policies are evolving with an increasingly ‘systemic’ feature (Arnold, 2004; Smits and Kuhlmann, 2004; Boekholt, 2010).

2.3.1 Justifying public interventions – market and system failures

A class justification for public interventions has been *market failures*, i.e. ‘*the inability of a market economy to reach certain desirable outcomes in resource use*’ (Datta-Chaudhturi, 1990, p.25); typical market failures include information asymmetries and negative externalities. Underpinned by innovation-system perspectives, rationales of innovation policies can be justified through the lens of ‘system failures’ (Smith, 2000; Woolthuis et al., 2005). Diagnosis of existing innovation systems is considered prerequisite for systemic policy design (Edquist, 2011). A range of system failures is summarized here synthesizing perspectives from Carlsson and Jacobsson (1997), Smith (2000), Woolthuis et al. (2005) and Edquist (2011).

- ***Infrastructural failures*** refer to failures resulting from imperfect scientific infrastructure (e.g. research labs, universities), physical infrastructure (e.g. transport, accommodation), and network infrastructure (e.g. IT facilities).
- ***Institutional failures*** are failures resulting from problematically established or poorly functioning institutions. In particular, *hard* institutional failures refer to the formal institutions, e.g. laws, industrial standards, regulations, that may hinder innovation, while *soft* institutional failures refer to the cultural, political, and social value factors that may hinder innovation.
- ***Interaction failures*** are failures resulting from problematic links, relationships and interactions between actors of the system. In particular, *strong* network failures refer to the situation when actors have too close internal network and they have the ‘blindness’ to what happens outside; *weak* network failures refer to the lack of interactions between actors which can cause poor interactive learning and insufficient complementarities.
- ***Capability failures*** refer to the failures caused by actors’ incapability of learning rapidly and making the adjustment or leap from old technologies to new ones or to a new technological paradigm. ‘Transition’ failures and ‘lock-in’ failures (Smith, 2000) are hence categorized as capability failures here.

Preconditions for public interventions are twofold, as argued by Chaminade and Edquist (2006), i.e. the existence of system and market failures which indicate 'public policy opportunities', and that the government has the 'policy competences' to overcome them.

2.3.2 Demand-side innovation policy (DSIP) instruments

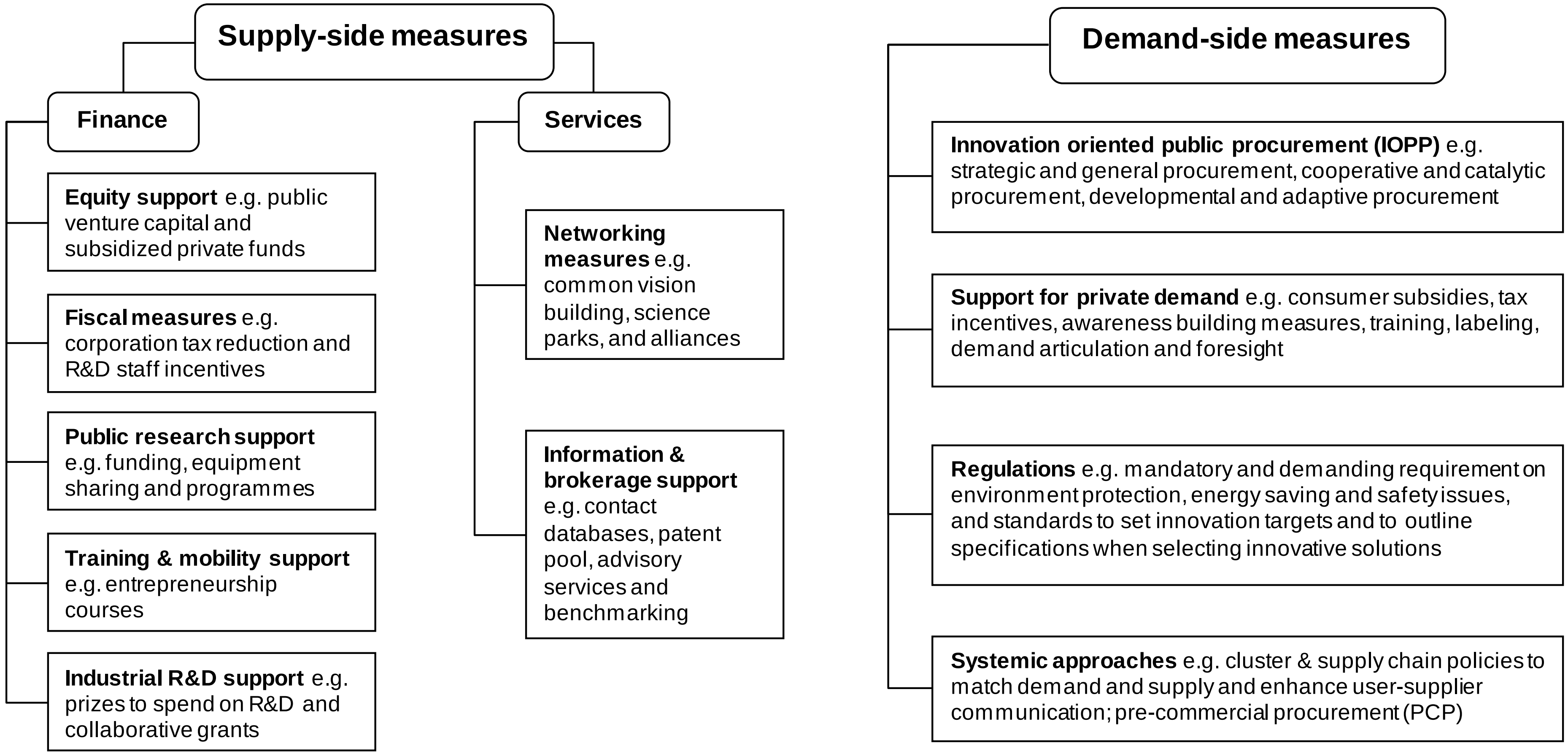
Policy justification based on innovation-system approaches led to an increasingly wide range of policy instruments (Borrás and Edquist, 2013). The scope of innovation policies varies depending on the context and it is impossible to provide a complete list. This study follows Edler and Georghiou (2007) and summarizes some widely recognized instruments classified into supply-side and demand-side policies, as illustrated in Figure 2.2.

As discussed in Section 2.2.2, if properly arranged, demand can trigger the creation and/or accelerate the diffusion of innovations. Nevertheless, in reality the demand side does not always function well without public interventions; there is a range of system and market failures that are particularly demand-related. Edler (2010) generalized those failures into two broad categories, i.e. *insufficiency of demand* which prevents users from voluntarily adopting innovations with a high potential benefit (as elaborated in Geroski, 1990 and Dalpé, 1994), and *insufficiency of demand articulation* which prevents suppliers from adequately satisfying users' needs (as elaborated in Mowery and Rosenberg, 1979). Within the former category are failures such as high entry costs due to the very early stage of the product cycle, high transaction costs for users to learn about and adopt innovations, lack of awareness among potential users of the benefits and characteristics of innovations, and path dependencies and technological lock-ins (Edler, 2010; Edler, 2013). Within the latter category are failures such as inadequate user-supplier interactions, lack of understanding among suppliers of user's unmet needs, and lack of abilities among users to clearly specify their preferences.

Those failures point to gaps to be addressed by ***demand-side innovation policies*** (DSIPs), which are defined as:

> *'…all public measures to **induce** innovations and/or **speed up** diffusion of innovations through **increasing** the demand for innovations, **defining** new functional requirement for products and services or better **articulating** demand' (Edler and Georghiou, 2007, p.952)*

Figure 2.2 Taxonomy of innovation policy instruments



Source: Author adapted from Edler and Georghiou (2007) and Edler (2013)

Four major types of DSIP[7] have been recognized, i.e. IOPP policies, private demand policies, regulations, and 'systemic approaches' (Edler, 2013). Although some systemic approaches such as supply chain measures and pre-commercial procurement (PCP) stand in the middle of supply and demand sides, Edler and Georghiou (2007) argued that they are treated as DSIP because of their '*critical role in bringing users and suppliers together*' (p.953). DSIP and supply-side policies are complementary with rather than alternative to each other; coordination and integration of these instruments are crucial in addressing system failures (Borrás and Edquist, 2013).

Support of private demand can lower transaction costs and trigger the creation and diffusion of innovations (OECD, 2011a; Edler, 2013); established private markets can serve as selecting mechanisms. Awareness-building measures can contribute to mitigating market failures and soft institutional failures. Regulations and standards can specify demand, shape the structure of markets, and stimulate and select innovative solutions through mandates or industrial competition (Blind, 2009). Adjusting regulations and standards with an innovation focus can contribute to remedying hard institutional failures. Systemic approaches can address market, interaction and capability failures by enhancing interactive learning between stakeholders.

IOPP policy has the potential to fulfil all the tasks above since it can serve as 'a *cornerstone of a co-ordinated and technology or sector specific mix of policies*' (Edler and Georghiou, 2007, p.953). By setting demanding yet realistic technological and performance specifications, IOPP can stimulate new solutions and the tendering processes can serve as selecting mechanisms. IOPP features dynamic user-producer interactions, whereby improvement of solutions based on feedback and (co-)innovation can be realized. The predictable market offered by IOPP can significantly lower entry/transaction costs and risks for firms (ibid.). Demonstration effects of public procurement can further stimulate private demand and 'pull' pre-commercial technologies into commercialized solutions (Edler 2010). Outcomes of IOPP such as improved public facilities and supply chains can address infrastructure and capability failures and contribute to socioeconomic development in general (ibid.).

[7] This part was used in an adapted form by the Author in preparing the proposal for EC project *Innovation Demand-side Monitoring System* (No 276/PP/ENT/CIP/13/C/N03C041), July 2013.

In terms of system functions (Hekkert et al., 2007), IOPP policies can contribute to *market formation* by creating critical mass and articulating demand. IOPP policies together with regulations can enhance the *diffusion of knowledge* and provide *guidance of the search*. Meanwhile DSIP can help direct the trajectories of the innovation system towards long-term goals by integrating societal considerations (e.g. dealing with grand challenges) into standards, regulations and public tendering criteria (Edler et al., 2012).

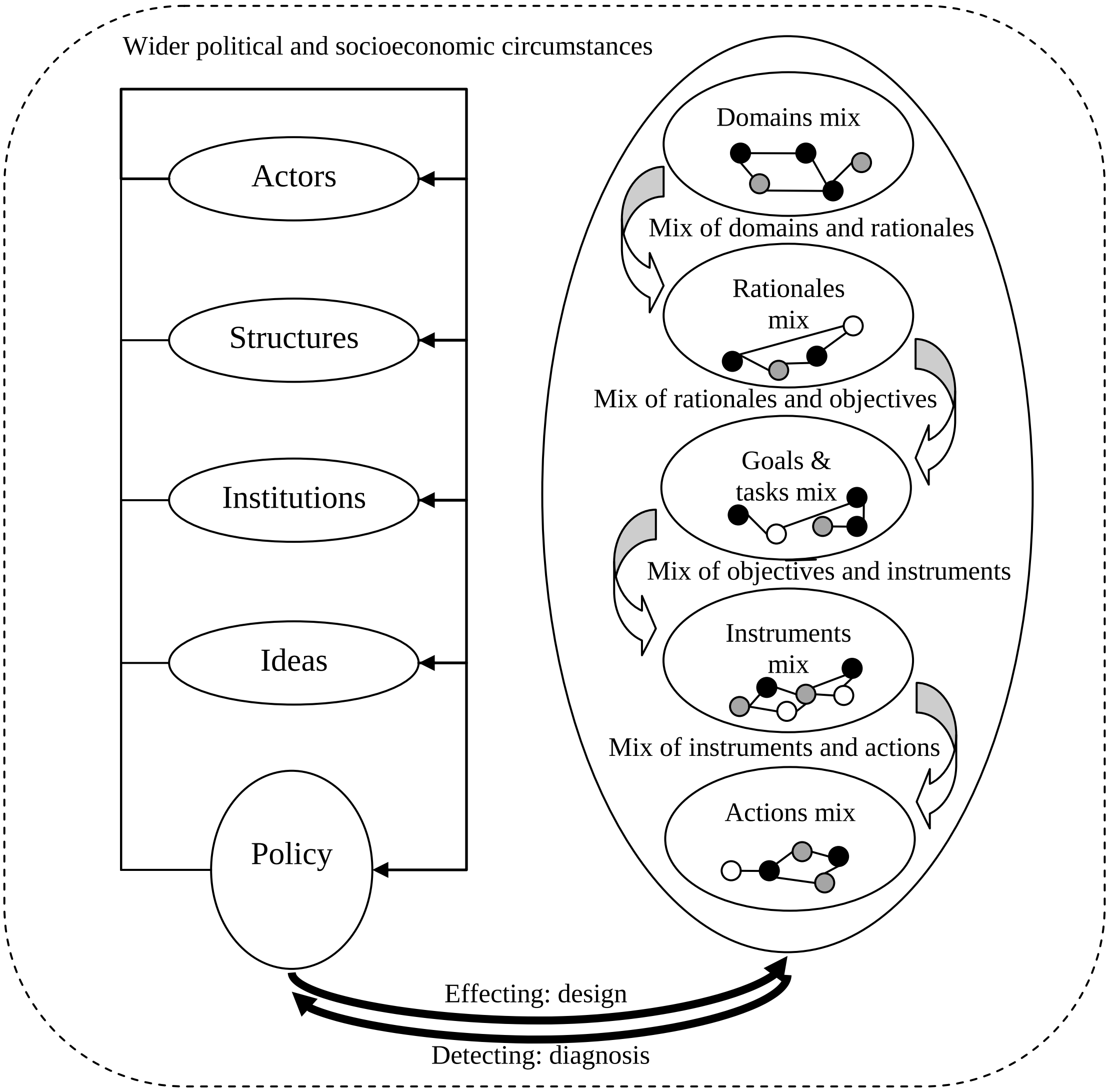
2.3.3 'Policy mix' as a conceptual tool for policy analysis

The increasingly complex and dynamic characteristics of innovation policies and the fact that their scope frequently overlaps with other policy domains led to the adoption of 'policy mix' as a conceptual tool to investigate the '*messy and complex, multi-level, multi-actor reality*' (Flanagan et al., 2011, p.702). 'Policy mix' approaches, inspired by innovation-system literature, appreciate the system dynamics of actors, institutions and interactions, and the impacts of contextual issues (Poel and Kool, 2009).

OECD (2010) suggests that the term 'policy mix' has two different types of meanings. The first refers to '*the alignment of different dimensions of policy, particularly between supporting rationales, strategic tasks and instruments deployed*' (p.256), highlighting issues of 'logical flow', 'alignment' and 'appropriateness'. The second refers to '*mixes of types of domain areas, mixes of types of rationales, mixes of types of strategic tasks and mixes of types of instruments*' (p.259), highlighting issues of 'balance' and 'coherence'. The mixes of different dimensions of a certain policy can be categorized as *vertical* mixes, e.g. as shown in Figure 2.3, 'mixes of rationales and objectives'; the mixes of same dimensions of different policies can be categorized as *horizontal* mixes, e.g. the 'domains mix'. The alignment and coherence of all dimensions underpinned by both meanings is considered as a prerequisite for policies to be 'appropriate' (ibid.)

Figure 2.3 illustrates the variations of innovation policy mixes (on the right hand side) and their dynamics within the innovation system (on the left hand side). To deal with this complexity, innovation policies are separated from other factors that affect innovation processes, i.e. actors, structures, institutions and ideas. The concept of actors adopted by OECD (2010) refers to a wide range of organizations and individuals including firms and governments. Also it is found useful to understand the roles of actors through the 'idealized' ones as proposed by Flanagan et al. (2011), including 'policy principals', 'policy entrepreneurs', 'policy targets', 'policy implementation agents' and 'policy beneficiaries'. 'Structures' refer to '*the material (and other resource) factors that shape the opportunities and constraints for innovation*', 'institutions' refer to '*rules of the game and codes of conduct*', and 'Ideas' refer to '*the socio-cognitive frameworks within which actors carry out their activities*' e.g. world views, normative beliefs and values (OECD, 2010, p.255). Together with policies these factors interact with each other and shape the innovation performance within the context of broader socioeconomic and political circumstances.

Figure 2.3 The dynamics of policy mixes



Source: Author adapted from OECD (2010) with reference to Flanagan et al. (2011)

On the right hand side, policies are characterized into domains, rationales, goals, instruments and actions. The *domains mix* to a large extent relates to the interactions between the domain of dedicated innovation policies (e.g. research and development (R&D) funding) and the domains of framework conditions (whose primary goals are not innovation e.g. environment protection policies). To enable implementation, complementarities and tradeoffs between these two types of domains are much needed (Flanagan et al., 2011). The *rationales mix* indicates a need for coherence between different justifications for a policy mix. The *goals & tasks mix* is about fulfilling functions and managing interfaces between different objectives. The *instrument mix*, which is the most frequently recognized type of policy mix (Howlett, 2005; Guy et al., 2009), calls for attention to potential opportunities and tensions occurred during interactions between individual instruments. The *actions mix* dimension added here highlights approaches to implementation, which reflects policymakers' methodological understandings of a certain policy, their interests/preferences, and the existing statuses of the innovation system (Howlett and Rayner, 2007; Ringeling, 2005). It is not included in OECD (2010) but this study adds it here since the approaches, structures and styles of implementation are also crucial determinants for policy outcomes (Flanagan et al., 2011; Eliadis et al., 2005; Hill, 1997).

OECD (2010) suggests that the notion of policy mix can serve two major functions for innovation policy research and practice. As shown in Figure 2.3, the *detecting* function can be adopted for diagnosis of problems and failures and *ex-post* evaluation of existing policy mixes, and the *effecting* function can be adopted for *ex-ante* assessment and directing new policies towards desired goals. Policy mix, although still conceptually ambiguous and theoretically underdeveloped (OECD, 2010; Flanagan et al., 2011) offers a relatively holistic framework to facilitate the analysis, design, and evaluation of cross-domain innovation policies.

2.3.4 Evaluating appropriateness and implementation of IOPP policies – a gap

Evaluation, i.e. '*the process of determining the merit or worth of entities*' (Scriven, 1994, quoted in Uyarra, 2003, p. 157), is

> *'…a type of policy research, designed to* ***help people make wise choices about future programming****…* ***offers systematic evidence that informs experience and judgment****…' (Weiss, quoted in Clarke and Dawson, 1999, pp.1-2).*

A distinction is often made between '*outcome/impact*' evaluation, and '*process*' as well as '*appropriateness*' evaluation (Patton, 1987; Clarke and Dawson, 1999; Robson, 2002; Edler et al., 2012). While the former concerns the *effectiveness* of a policy, the latter concerns the *design*, *implementation* and *internal dynamics* of a policy (ibid.). This study apparently belongs to the latter category.

Existing approaches to evaluation have been overwhelmingly focused on evaluation of *supply-side* policies (Edler et al., 2012) with a particular interest in assessing *effectiveness* of *programmes* (Papaconstantinou and Polt, 1997; Georghiou, 1998; Georghiou and Roessner, 2000). For effectiveness evaluation, established methods include the classic 'cost-benefit' analysis (ibid.), logic models/charts (Jordan, 2010), and the increasingly predominant approach of assessing *additionalities* i.e. '*the difference arising from an intervention*' (Georghiou, 1998, p.39). In particular, *behavioural additionality*, i.e. the *difference in target group behaviour resulting from the intervention*, has been recognized as a major indicator for wider appreciation of policy effects than input and output approaches (Georghiou et al., 2004; Gok and Edler, 2012). For process evaluation, nevertheless, a much smaller variety of methods and indicators have been developed; qualitative approaches such as case studies supported with stakeholder interviews to examine policy processes and dynamics have been often referred to as an appropriate option (Patton, 1987; Clarke and Dawson, 1999; OECD, 2011a).

For DSIP evaluation, as noted in Section 1.3, a 'severe gap' exists. According to Edler et al. (2012) methodological problems faced by DSIP evaluation researchers include:

- *the* ***difficulty of establishing a relevant baseline***
- *the* ***inability of public statistics*** *constructed in supply-side mode to capture actions*
- *the need to* ***engage with actors*** *who do not necessarily see themselves as part of the initiative being evaluated*
- *long* ***timescales*** *and potential wide* ***geographical scope***
- *measures that* ***span from micro to macro***
- ***blurred boundaries between implementation and impact***

(Edler et al., 2012, p.1)

Owing to these challenges and the lack of experience of DSIP in the political arena in general, IOPP policy as the most widely recognized DSIP (OECD, 2011a) has been barely evaluated in a systematic way (Uyarra, 2012). Existing evaluations have predominantly covered *short-term impacts* with fragmented evidence gathered (ibid.), taking the forms of case studies investigating micro-level procurement processes

(Section 4.4.1) and surveys gathering data from suppliers and other stakeholders (Georghiou et al., 2013; Peter et al., 2013).

This study benefits from the established evaluation work. Nevertheless, driven by the research objectives, this study concerns the *appropriateness* and *implementation* (whose boundary is 'blurred' with that of short-term impacts, Edler et al., 2012) of IOPP policy, for which there have been no ready-to-use evaluation approaches or baselines/indicators.

Despite the wide use by policy researchers and practitioners (Papaconstantinou and Polt, 1997; GAO, 1990; OECD, 2010), the term 'appropriateness' has been poorly defined. Indeed it is a rather subjective and elusive word – different actors behave according to their own understandings of appropriateness and logic of action, shaped by their institutional contexts and pervious experiences (March and Olsen, 2008). Ringeling (2005) argued that appropriateness relates largely to the 'fit' of policy instruments, including *feasibility* and *acceptability* (p.187). From the view of 'policy mix' reviewed in Section 2.3.3, appropriateness requires *alignment* and *coherence* between various dimensions.

Edler et al. (2012) have articulated *appropriateness* as 'are the *right* things proposed, is the scale *right'*, and *implementation* as 'are the things done *rightly'* (p.6). On what is 'right', they elaborated through proposing a set of evaluation questions concerning the *justification of policy rationales* (including *logical consistency* among instruments), and the *compliance of implementation process with the policy design* (including the *overall coherence* of the intervention).

All in all, an important methodological implication of existing evaluation literature for this study is that, evaluation of appropriateness and implementation involves, at least, justification of policy design, and a close look into implementation processes.

2.3.5 Policy implementation – analytical considerations

Given that policy implementation is ultimately an empirical process affected by a wide range of factors such as actors' attitudes and monetary issues (Pressman and Wildavsky, 1973), the analysis of it is seen as a complex and challenging exercise (Hjern and Porter, 1981; Palumbo and Calista, 1990). In the area of innovation policy research which is relatively new and underdeveloped (Morlacchi and Martin, 2009), little literature dedicated for implementation analysis is available, thus this section mainly draws upon the broader research area on public policy.

Implementation analysis is often trapped in the dichotomy of 'top-down' and 'bottom-up' approaches (O'Toole, 1986; Matland, 1995; Saetren, 2005). The top-down approach considers decisions from central authorities as the starting point of analysis; policymakers are the key actors and other actors are expected to comply with policy mandates; effective implementation is perceived as the process where the actions of target groups cohere with each other and eventually achieve the goals of the central decision (Pressman and Wildavsky, 1973; Mazmanian and Sabatier, 1983; Hill and Hupe, 2009). On the contrary, the bottom-up approach pays attention to the micro-level of policy process and considers target groups and 'street-level bureaucrats' as the main players; it highlights the interactions between policies from upper levels and settings in localized contexts; implementation is hence perceived as the process where micro-level stakeholders adapt policies to their context; the implementation outcomes might not be coherent with the original top-level policy goals (Lipsky, 1978; Berman, 1978). Both approaches faced criticisms from the field. As argued by Matland (1995) and Sabatier (1986), the top-down approach overlooks the contextual background and other key actors of the policy process, and neglects political factors coming from beyond the administrative process; the bottom-up alternative, by contrast, is descriptive rather than explanatory and overemphasizes local autonomy and policy flexibility, which leads to limited uses for improvement of implementation outcomes.

More recent implementation literature features diversified perspectives trying to find a middle ground or alternatives of the two extremes (Hill, 1997). Hjern and Porter (1981) proposed 'implementation structures', embracing *clusters of parts of organizations* involved in the process, as an analytical unit. They argued that the starting point for analysis should be 'administrative imperatives' followed by analysis of organization and programme related issues. Matland (1995) proposed an 'ambiguity/conflicts' model which categorizes policy implementation processes into four types, i.e. *political* (low/high), *administrative* (low/low), *experimental* (high/low) and *symbolic* (high/high). Each type has its crucial determinants e.g. power, resources, contextual conditions and coalition strength. Matland (1995) suggested that top-down perspectives are more helpful in analysing administrative and political implementation types; bottom-up perspectives are more helpful in analysing experimental implementation; and in cases of symbolic implementation, both approaches are relevant to gain a holistic understanding.

Despite the methodological diversity in the implementation literature, there are common dimensions implied for consideration during analysis, such as the *policy* (including written policies and programmes), *resources* (including monetary, infrastructure and human resources), *implementation structures* (not only the designed but also the *actual* mechanisms constituted with involved institutions and actors at multiple levels), the *context* (contextual factors including cultural and socioeconomic circumstances), and *coherence/coordination* issues in terms of goals/interests alignment and efficiency of communication (Pressman and Wildavsky, 1973; Smith, 1973; Lipsky, 1978; O'Toole, 1986; Sabatier, 1991; Matland, 1995; Peters, 1998; Hill and Hupe, 2009).

2.4 Catching up through innovation

There is a growing body of literature integrating innovation-system perspectives with catching-up research (Ernst, 2002; Lundvall et al., 2009; Malerba and Nelson, 2011). Despite that the basic dimensions of innovation systems of developing countries remain similar to those of developed countries, differences and additional issues do exist (Ernst, 2002; Chaminade et al., 2009). Developing countries normally feature weak and unstable (formal) institutions, high heterogeneity in terms of social, political and economic structures, limited domestic knowledge bases, and relatively low learning capacities (ibid.). Innovations carried out by developing countries are usually 'new to the country', which might be well-established in the developed world already rather than world-level technological frontiers (Nelson, 2004). Firms in catching-up countries face more challenges and constraints to get access to and mobilize resources (Fagerberg and Godinho, 2005). More system failures are perceived to exist in innovation systems in the developing world, ranging from deficiencies of 'hardware' e.g. infrastructures to lack of 'software' e.g. *social capabilities* as coined by Abramovitz (1986).

History tells us that the roles played by the government and its interventions have been very important in influencing catching-up processes (Chaminade et al., 2009). As socioeconomic development relies increasingly on knowledge and innovation, catching-up policies significantly overlap with innovation policies. Innovation policies to effectively support catching-up are challenging and complex to exercise and feature strong 'trial and error' characteristics (Cimoli et al., 2009a). While many catching-up stories can be delineated as processes of capabilities accumulation and technological opportunity exploitation (Cimoli et al., 2009b), different regions had various experiences.

Efforts have been made to assist developing countries to realize transition, a notable one being the paradigm of 'Washington Consensus' (Gore, 2000). A core opinion of Washington Consensus is that developing countries should rely on *laissez-faire* policies to promote development (Williamson, 1990; McCleery and De Paolis, 2008). Latin America was the major geographical region that implemented this approach, whose economic performance in 20 years, however, was poorer than the countries that did not follow the Consensus, e.g. East Asian countries (Cimoli et al., 2009a). Through illustrating historical data, Chang (2002) pointed out that today's developed countries, although advocating *laissez-faire* industrial policies for present developing countries, did adopt very interventionist policies during their catching-up stages.

Successfully industrialized countries in East Asia featured explicit interventionism by acting as 'developmental states' (Johnson, 1982). The Ministry of International Trade and Industry (MITI, now Ministry of Economy, Trade and Industry, METI) in Japan adopted very activist, integrated, targeted and sometimes protectionist policies to catch up with the West by focusing on developing technologically most progressive industries (ibid.). Korea's strategy is characterized as 'imitation to innovation', following a pathway from 'own equipment manufacturing (OEM)' to 'own design manufacturing (ODM)' and finally to 'own brand manufacturing (OBM)' (Kim, 1997; Fagerberg and Godinho, 2005). The key to success has been a timely transformation from 'duplicative imitation' to 'creative imitation' and further to 'innovation' (Kim, 1997). Fagerberg and Godinho (2005) argued that although foreign direct investment (FDI) can be considered as a 'functional equivalent' to OEM, it is less favourable for 'indigenous innovation'. Neglect of indigenous development and over-dependence on external resources can lead to the danger of being 'trapped' (ibid.).

Successful catching-up involves innovation '*in an essential way*', often in incremental forms based on '*deliberate and often creative modifications to tailor practice to national conditions*' (Nelson, 2004, p.365). Two factors have been identified as crucial determinants, i.e. 'technological congruence' and 'social capabilities', the former referring to the degree of congruence of the follower country with the leader country in dimensions such as market size and factor supply, the latter referring to institutions and capacities in terms of mobilizing resources and supporting catching-up (Abramovitz, 1986). To strengthen social capabilities catching-up countries might need to adopt ‘institutional instruments’ to compensate ‘latecomer disadvantages’ (Fagerberg and Godinho, 2005). Historically, effective catching-up policies has been frequently linked with protectionist measures and subsidies (Chang, 2002). However, it is warned that protectionism can have double-sided effects i.e. besides the chance of building indigenous capabilities there is a risk of ending up with protected, inefficient home industries (Nelson, 2004). One way of avoiding ‘self-defeating’ is to keep up with moving targets, so that imitation can become increasingly ‘sophisticated’ and potentially transform to ‘creative design’ (ibid.). Other issues for consideration have also been raised, e.g. Malerba and Nelson (2011) highlighted the importance of differentiating policies for different sectors during catching-up; proposed variables for consideration by them include industry structure, access to international knowledge, relationships with multinational enterprises, and government policy.

Developing countries nowadays have better access to international resources by benefitting from open innovation through the ‘global production network’ (Ernst, 2002). Nevertheless, catching-up is perceived as an increasingly complex task as the capability gap between leading countries and followers is larger owing to the established international specialization and fiercer competition (Chang, 2003; Kattel, 2010). The expanding scope of international rules which facilitate global trade and enforce intelligence property right (IPR) protection has led to limited room for catching-up through ‘imitation’ (Nelson, 2004). *Indigenous capabilities* and *indigenous firms* are highlighted by development researchers as being more important in this trend of globalization (Nelson, 2004; Barnard et al., 2009). Developing a workable catching-up strategy requires special considerations of contextual specificities and an understanding of internal as well as external factors including the global dynamics (Chang, 2003; Cimoli et al., 2009a). All these considerations pose higher requirements of governance capacity in developing countries, the lack of which can easily lead to *government failures,* i.e. vis-à-vis market failure, the situation when the existence of a government intervention causes more inefficiency in resource allocation than the absence of it (Grand, 1991; Krueger, 1990).

2.5 China's innovation system and innovation policies

2.5.1 China's innovation system in transition

China's NIS has experienced a series of reforms since the 1970s driven by major policy changes (see Baark, 2001; Gu and Lundvall, 2006; Xue, 1997; OECD, 2008; Gu et al., 2009; Liu, 2009). Five development stages can be distinguished according to main policy themes, namely 'incubation', 'experimentation', 'structural reform', 'deepening the structural reform', and the current phase towards a *market-driven, firm-centred indigenous innovation system* marked by the launch of MLP (OECD, 2008; see Appendix 3 for more details). Principles guiding the current transition are defined in MLP through 16 Chinese characters, which translated into English is:

> *'…**indigenous innovation**, **leapfrogging in priority fields**, (STI) **enabling development**, and (STI) **leading the future**' (State Council, 2006a, Section II, Article 1)*

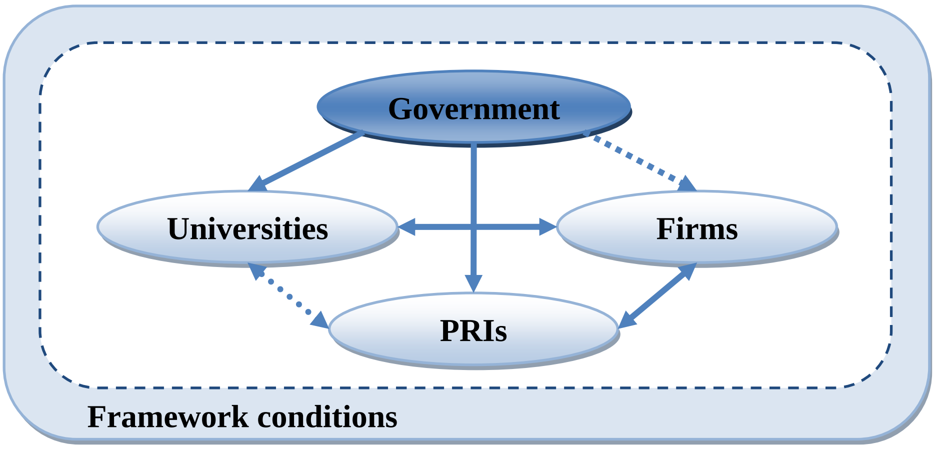
The term 'indigenous innovation' has been defined as:

> *'…**original innovation**, **integrated innovation**, and **re-innovation based on assimilation and absorption of imported technology**' (ibid.)*

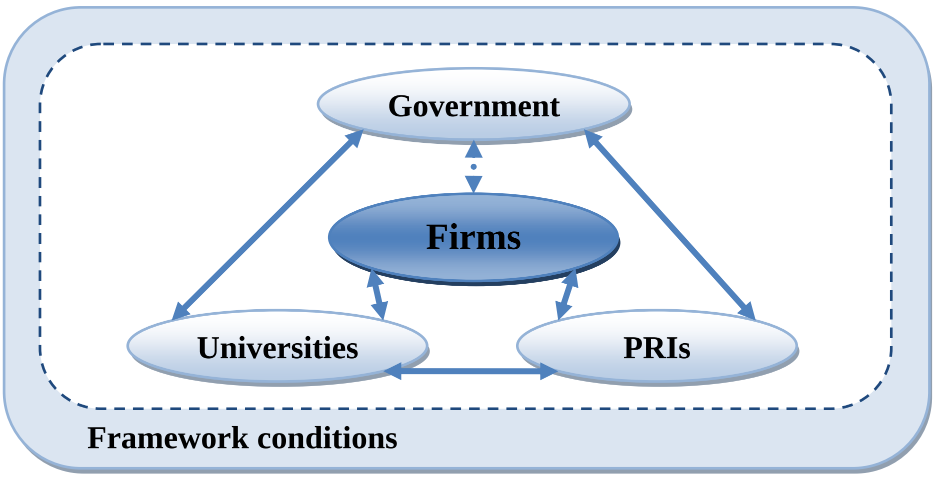
Despite the continuous reforms, China's NIS governance approach maintained some characteristics of a *centrally-planned* and *top-down* one (OECD, 2008). As illustrated in Figure 2.4(a), interactions between universities, PRIs and firms have been evident but in need of strengthening; main target groups of government interventions have been players from the public sector rather than firms from the private sector (Liu, 2009); R&D programmes seemed to be the '*single most important policy tool*' in China's NIS (OECD, 2008, p.489). By contrast, Figure 2.4(b) illustrates the blueprint for the future governance of China's NIS outlined by MLP. MLP emphasizes the importance of firms as the core player, surrounded by and interacting with other actors. MLP implies a new ideology of innovation governance, underpinned by 'a *more systemic understanding of innovation*' (Liu et al., 2011, p.930).

MLP also highlighted the importance of establishing '*regional innovation systems with diverse characteristics and strengths*' to support the building of an NIS (State Council, 2006a, Section VII, Article 4). Thus far 'significant disparities' across different regions in terms of innovation performance (evaluated according to statistics e.g. on patents and R&D personnel) have been observed (Arbolino, 2011; Li, 2009). Unevenness has been attributed to regional disparities in GDP per capita, public infrastructures, human resources and knowledge bases, and interactions and linkages between elements of innovation systems (ibid.).

Figure 2.4 China's NIS in transition



(a) Existing governance structure



(b) Towards a new governance structure by 2020

Source: Author adapted from OECD (2008)

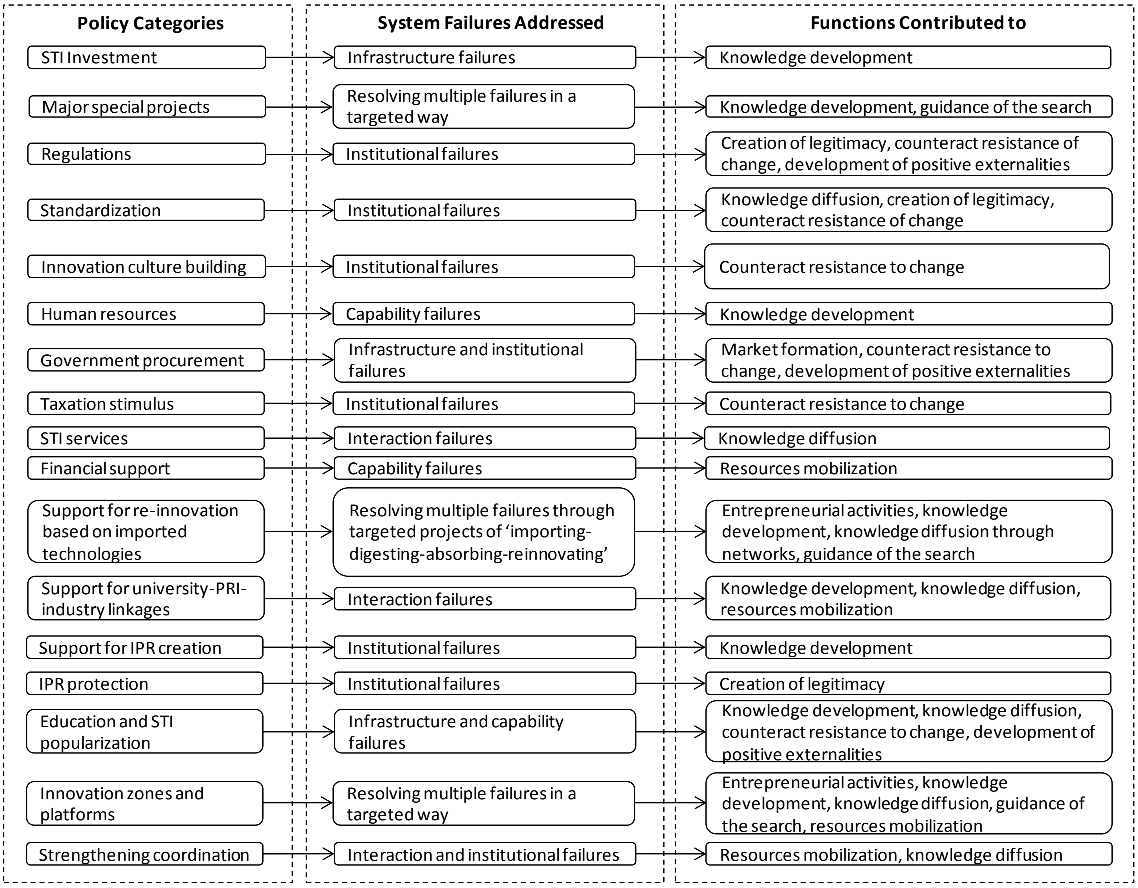
2.5.2 Policies supporting 'indigenous innovation'

MLP's emphasis on building a firm-centred NIS was accompanied by the launch of a portfolio of diversified STI policy instruments (see State Council, 2006b). Through the lenses of 'system failures' (Section 2.3.1) and 'system functions' (Hekkert et al., 2007), rationales of major types of policies are briefly analysed, summarized in Figure 2.5.

The policy portfolio in principle addresses all types of system failures and functions identified in the literature, featuring a strong *catching-up intention*. *Major Special*

Projects and *support for re-innovation based on imported technologies* offer targeted support for underdeveloped technologies (Article I-3, State Council, 2006b); human resources policies offer preferential treatment to attract returnee students from abroad (Article VII-42, ibid.); standardization policies aim to support domestic firms in gaining advantages in earlier stages of new technology development (Article VI-34, ibid.).

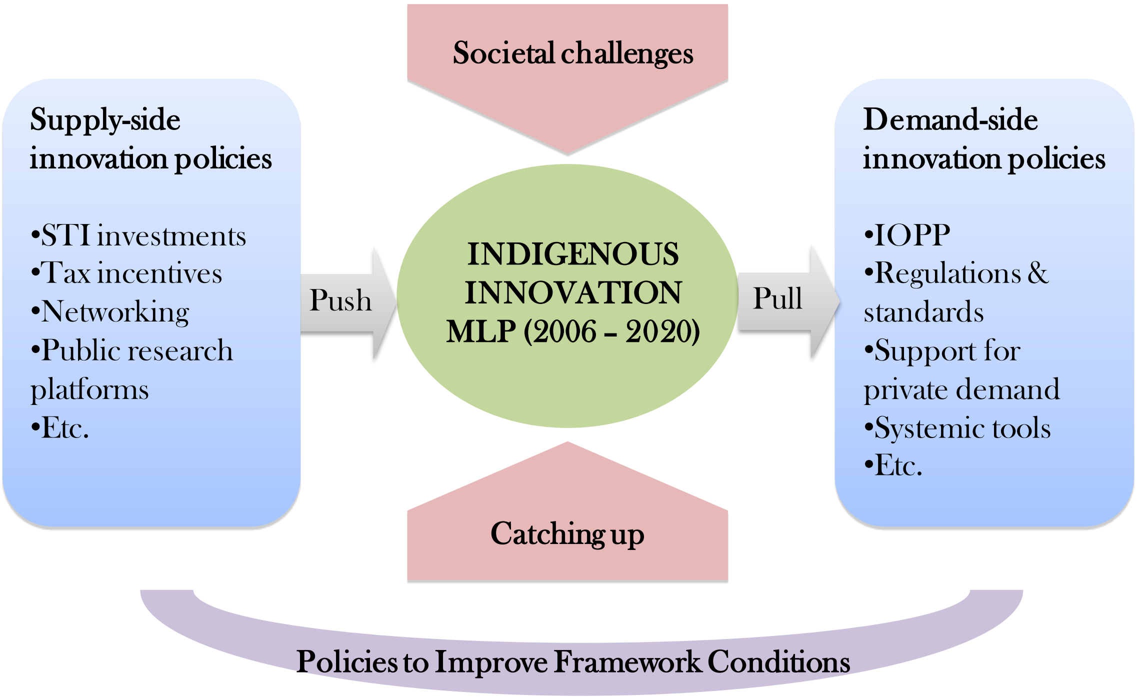
Figure 2.5 Rationale analysis of the MLP innovation policy portfolio



Source: Author based on policy analysis

Other than economic catching-up, solving societal problems such as pollution and ageing (i.e. 'harmonious development', Gu et al., 2009) has also been emphasized by the indigenous innovation strategy. In the MLP policy portfolio, special attention has been paid to technologies related to overcoming those 'grand challenges'; the top three areas with policy priority identified are *energy*, *water and mineral resources*, and *environmental pollution*. Analysis of the portfolio suggests that it covers both *supply-side* and *demand-side* policies, and measures on improving *framework conditions*. The driving forces (economic catching-up and overcoming societal challenges), overall strategy (indigenous innovation), and policy measures outlined by the MLP are linked together, as illustrated in Figure 2.6.

Figure 2.6 Indigenous innovation – driving forces and supporting policies



Source: Author based on policy analysis [8]

2.5.3 Governance and implementation structure

The Chinese political system has been recognized as a sophistically bureaucratic and seemingly centralized one (Lieberthal and Oksenberg, 1988; Blanchard and Shleifer, 2000; Martin, 2010). Either formally or in an unwritten way, there is a hierarchy existing among central government agencies in terms of political power. The National People's Congress (China's parliament) is the *de jure* top authority in legislation and state power; nevertheless, the State Council has the *de facto* top-level authority in policymaking and governance (OECD, 2005a; Liu et al., 2011).

Below the State Council are ministerial-level agencies with specialized division of labour. The unspoken hierarchy of political power at the ministerial level is that, *horizontal* policy (i.e. policies that influence across various sectors) issuers have higher authority than specialized *vertical* policy (i.e. policies that focus on a single sector) issuers (Liu et al., 2011). The former is represented by NDRC whose nickname is 'little

[8] Figure 2.6 was presented in adapted form at EU-SPRI Conference 2012.

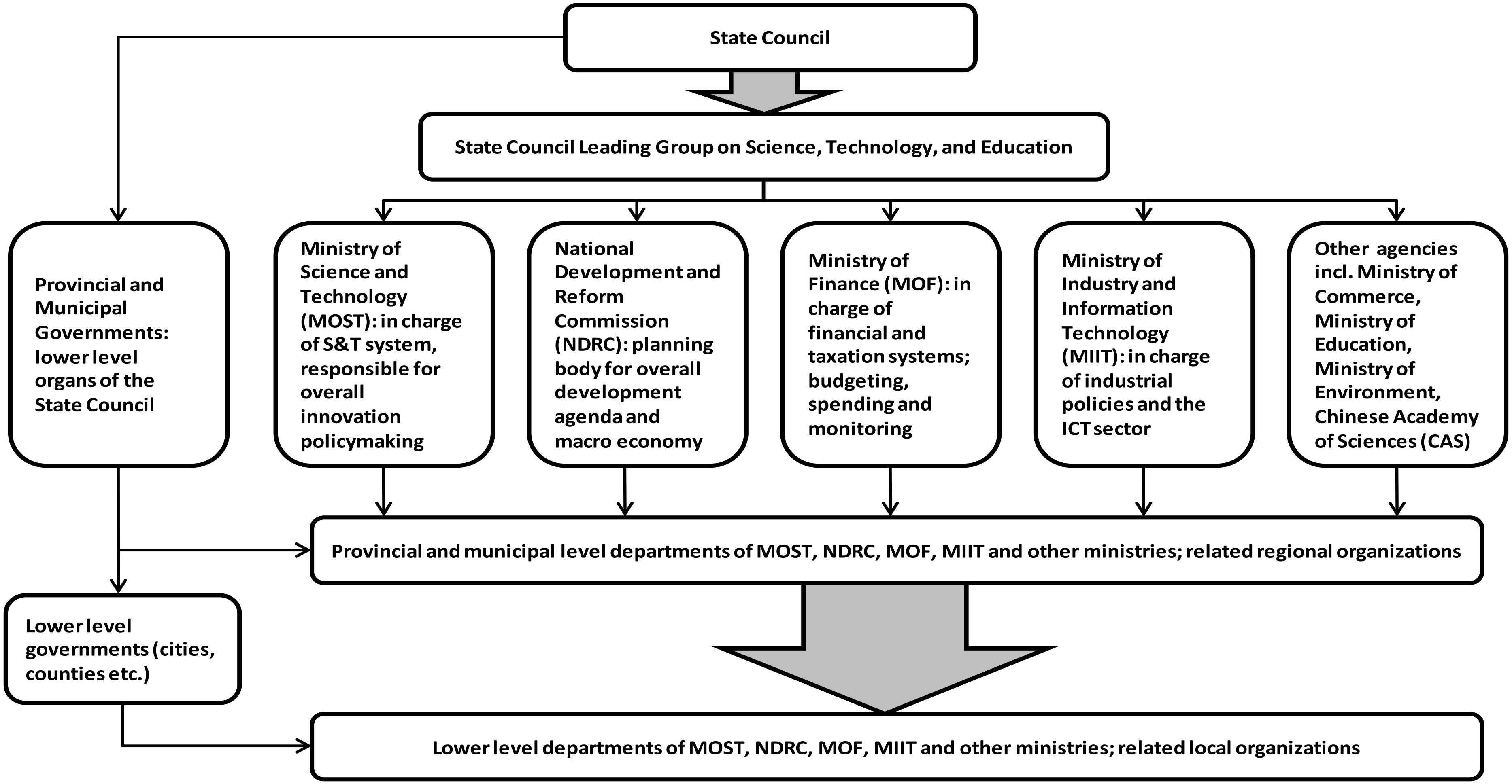
State Council' or 'Ministry of Ministries' (Voïta, 2008), and the latter represented by e.g. the Ministry of Agriculture. Figure 2.7 illustrates a simplified picture of this hierarchy and the division of labour among various government agencies related to the making and implementation of innovation policies.

- **The State Council Leading Group on Science, Technology, and Education**: Leading groups are guiding and coordinating mechanisms to enhance the making and implementation of policies requiring cross-department collaboration in China (OECD, 2005a). Led directly by the Premier and comprised of ministers and representatives from MOST, MOF, NDRC, Ministry of Industry and Information Technology (MIIT), Ministry of Education, Ministry of Commerce, Chinese Academy of Sciences (CAS) and other related organizations, the State Council Leading Group on Science, Technology, and Education create bridges from the top of the innovation governance system (Liu et al., 2011). It reviews, discusses and approves major plans and decisions related to STI development, and meanwhile functions as a coordinating and monitoring body for policy implementation.

- **MOF**: MOF oversees the financial system (including government procurement) and the taxation system. The role played by MOF regarding innovation policies gained more importance as the MLP policy portfolio highlighted the use of procurement and taxation measures.

- **MOST**: Prior to 2006, MOST and its lower-level departments (i.e. the vertical science and technology (S&T) governance system) were almost the only channel to conduct the making and implementation of innovation policies (Huang et al., 2004). Innovation policies were predominantly supply-side measures such as R&D programmes. Alongside the 'system' thinking and diversification of policy instruments introduced by the MLP, increasingly more policy domains are involved. MOST as the main body for innovation policymaking needs cooperation and support from agencies from beyond the traditional S&T governance system (Liu et al., 2011).

Figure 2.7 Key agencies related to indigenous innovation governance



Source: Author derived from OECD (2005a), and the State Council website http://english.gov.cn/links.htm#1 [accessed April 23rd 2013]

- **MIIT**: MIIT is in charge of the making and implementation of *industrial* policies, and meanwhile supervises the information and communications technology (ICT) sector. Industrial policies nowadays, especially for technology-intensive sectors such as ICT, considerably *overlap* and *intertwine* with innovation policies (Soete, 2007; Vorley and Nelles, 2010).

- **NDRC**: Cross-domain policies issued by joint agencies such as IOPP policies require coordination more than ever before; the resulted implementation structures now seem rather complex and multidimensional, varying from one policy instrument to another (Liu et al., 2011). NDRC as the 'Ministry of Ministries' (Voïta, 2008) is in charge of China's macroeconomic issues, socioeconomic development agenda, national investment and crucial sectors such as energy and raw materials. Given that socioeconomic development relies increasingly on innovation, NDRC is heavily involved in innovation policy issues and plays a vital role in coordinating different sectors to pave the way for implementation. In terms of governing public procurement, NDRC plays a role even more powerful than MOF as it supervises procurement activities of state-owned enterprises (SOEs) (Section 3.4).

Below the State Council and ministries are regional governments and regional agencies. Institutional setups of different levels of government are similar; the lower level in principle conforms to the higher level (Martin, 2010). As the central government makes national policies, lower-level governments learn from the central themes and articulate and implement them according to concrete situation of the region. In contrast to the *political centralization*, regions have a high degree of *financial autonomy* owing to waves of reforms towards financial decentralization (Zheng, 2007). Blanchard and Shleifer (2000) argued that this economic decentralization combined with political centralization was one crucial factor for the economic success of China. The political system in a way features characteristics of '*de facto federalism*' (Zheng, 2007). The role played by regional governments and their agencies in shaping China's innovation policy processes should not be underestimated.

The responsibility for innovation has been divided horizontally across ministries and vertically across levels of governments. This governance structure, although clarified in appearance, has made several aspects of innovation policies (from supply-side e.g.

supporting R&D to demand-side, e.g. industrial regulations, and to financial issues) fragmented across different players, notably across MOST, MIIT, and MOF. Liu et al. (2011) noted that

> *'…There has been and continues to be* ***serious fragmentation*** *of decision-making responsibilities and co-existence of institutions, old and new, with seemingly conflicting roles and mandates' (p. 930).*

2.6 Conclusion

This chapter has developed an understanding of the context of innovation and policies where IOPP locates. Through the lens of 'innovation systems', *innovation* is understood as a complex and interactive phenomenon shaped by various factors including the actors, institutions, interactions and the broader context. Users and their demand play important roles in stimulating, selecting and improving innovation, which implies the potential of public demand in levering innovation performance.

Systemic innovation perspectives offer new rationales beyond 'market failures' to justify government interventions in innovation systems, an important approach being detecting 'system failures'. IOPP policies can be understood as being situated in an innovation system, contributing to overcoming system failures and fulfilling system functions. Underpinned by 'system failure' rationales, diversified innovation policy instruments haven been designed and adopted; policy processes feature increasingly complex, multi-level and multi-actor characteristics. To deal with the complexity of IOPP policy process, this chapter adopted the notion of 'policy mix' to frame cross-domain, multi-level policies. Evaluating the appropriateness of IOPP policies remains unaddressed in the literature, except the foundational issues outlined by Edler et al. (2012). A major implication drawn from those perspectives for this study has been that *appropriateness* requires 'alignment', 'logical consistency', and 'coherence' of various dimensions of the policy; a closer look into the policy *design* and *implementation* is needed.

This chapter then complemented the understanding with a review of development literature which is highly relevant to the situation of China. 'Technological congruence' and 'social capabilities' have been identified as crucial factors determining successful catching-up. Constrained by limited resources and capabilities, innovation in catching-up countries has frequently taken the form of 'imitation' rather than leading-edge innovation. However, new circumstances nowadays such as fiercer international competition and tightened IPR protection rules imply that the room for catching up through 'imitation' has become rather limited. Developing countries are advised to develop indigenous capabilities and indigenous firms to avoid over-dependence on external resources (Nelson, 2004; Barnard et al., 2009).

Indeed 'indigenous' has become a key word in China's current innovation strategy outlined in MLP, with a strong catching-up focus. MLP brought about significant changes to the STI policy portfolio in China, which now embraces various demand-side policy instruments, the most emphasized one being government procurement. The diversification of innovation policies requires coordination between more types of government agencies than the traditional S&T system led by MOST, which, however, might be '*particularly difficult, if not impossible*' (Liu et al., 2011, p.930) owing to China's fragmented institutional setup for innovation governance. In the case of IOPP policies, implementation structures inevitably involve STI agencies, procurement agencies, suppliers, and users. The increasing complexity of Chinese innovation policy dynamics coheres with what has been observed in the broader, international context.

While conceptually setting up the innovation context for IOPP policies, this chapter has not elaborated upon *what public procurement is,* and *what it does as a multi-functional policy tool*; this is the issue addressed in the following chapter.

Chapter 3: Public Procurement and the Context of China

3.1 Introduction

Based on the elaboration of the innovation context where IOPP is situated in Chapter 2, this chapter attempts to provide an overview of public procurement as a *general activity with multiple functions.* This prepares the ground for Chapter 4 which deals specifically with IOPP. Section 3.2 of this chapter reviews overall knowledge about public procurement including its elements, processes, and functions. Section 3.3 introduces regulatory issues associated with public procurement both domestically and internationally; it then briefly discusses the tensions between those regulations by drawing upon perspectives from international trade and development study. Section 3.4 develops an understanding of *government* and *public* procurement regulations, policies and activities in China. Section 3.5 concludes the chapter.

3.2 Public procurement – elements, processes, and functions

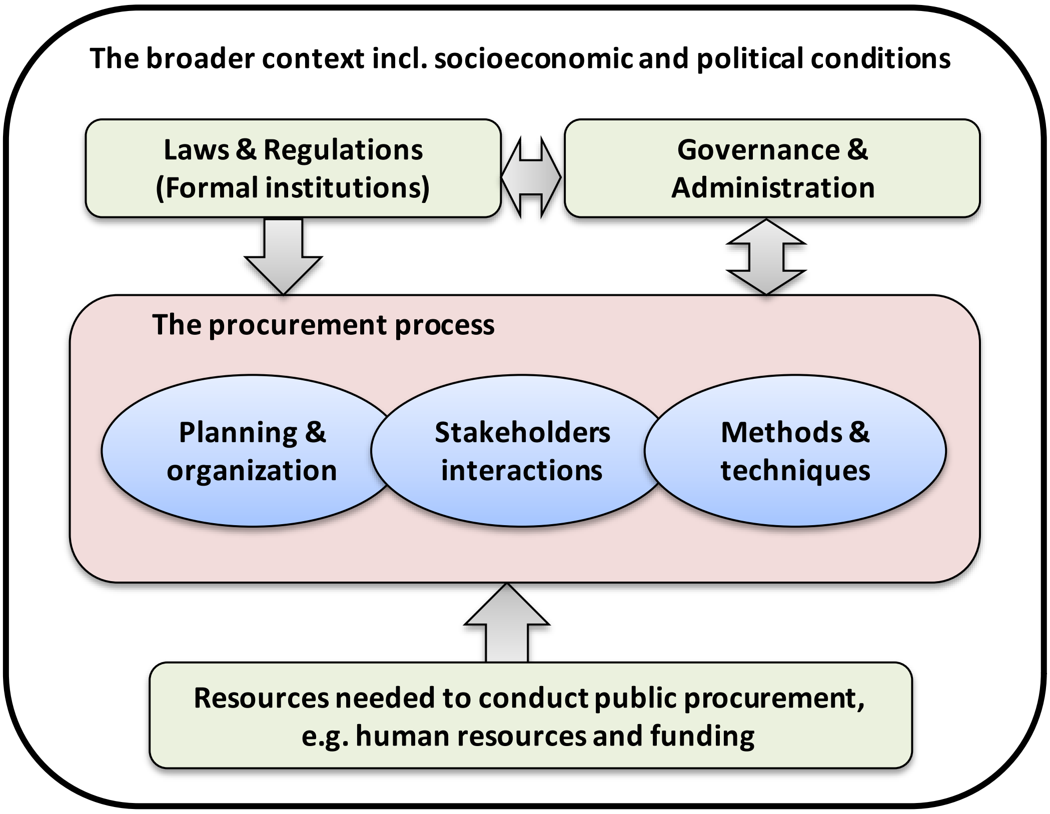
Modern public procurement was established as a government activity with the objectives of controlling public budgeting, achieving value for money, and improving accountability (Thomas, 1919). Internationally *public procurement* is considered equivalent to *government procurement*, referring to:

> *The process whereby* ***public bodies*** *(e.g. government agencies and SOEs)* ***acquire*** *various* ***goods and services*** *that they need for their activities* ***from third parties*** *(Arrowsmith et al., 2000; OGC, 2008).*

Procurable goods and services range widely from routine items such as printers and office furniture, to complex items such as railway construction and aircraft (ibid.). Public procurement is perceived to be much more complex and challenging than private procurement since additional requirements need to be fulfilled, including transparency, integrity, compliance with regulations, and coordination among stakeholders (Telgen et al., 2007). As noted in Chapter 1, public procurement accounts for a substantial part of domestic and global economies. Its proportion in GDP is perceived even higher in developing countries where governments make tremendous investments on public infrastructures (Arrowsmith et al., 2000; Anderson et al., 2012). Therefore, public procurement can serve as a powerful policy instrument to lever macro-level socio-economic performance (McCrudden, 2004; Arrowsmith, 2010).

Similarly to the subject of innovation, public procurement can be understood through ‘system’ thinking. Thai (2009) argued that public procurement is a complicated system built upon four pillars, i.e. *procurement laws and regulations*, *procurement workforce*, *procurement process and methods*, and *procurement organizational structure* (p.8). The procurement process, vis-à-vis innovation process, is the core activity in the system. A workforce employing various procurement methods can be considered as *actors*, while laws, regulations and organizational structures, can be regarded as *institutions* shaping procurement processes. Arrowsmith et al. (2000) also adopted the term ‘procurement system’ (see e.g. p.19); in particular they highlighted the importance of an adequate ‘procurement environment’ (i.e. the broader context) in supporting the implementation of regulations and policies related to public procurement. Drawing upon major dimensions outlined in the two books, Figure 3.1 illustrates an exemplary public procurement system.

Figure 3.1 An exemplary public procurement system

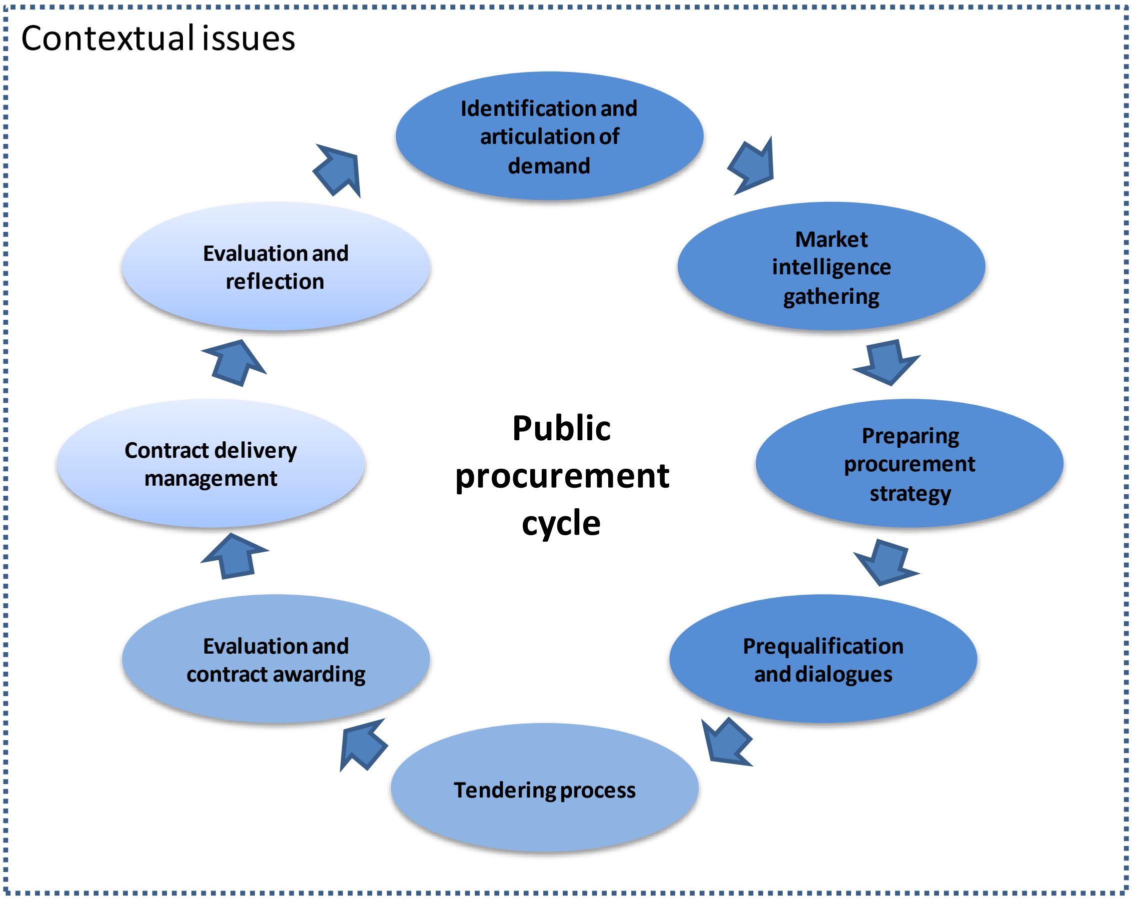


Source: Author derived from Thai (2009) and Arrowsmith et al. (2000)

The procurement process is shaped by both internal and external factors. Major internal factors include procurement planning and organization (e.g. the design of procedures), stakeholder interactions (e.g. dialogues between procurers and suppliers), and concrete methods and techniques (e.g. evaluation criteria). Major external factors include laws and regulations (e.g. international trade regulations), governance and administration (e.g. policy implementation structures), and more broadly, the overall context where the procurement system situates, including cultural, social, legal, economic and political circumstances. In particular, market conditions have direct impacts on procurement processes in the sense that favourable market conditions can enhance competition, transparency and equality, which can further stimulate the delivery of value-for-money and, in some cases, innovative solutions (Fiorentino, 2006; Anderson and Kovacic, 2009).

The notion of *public procurement cycle* (PPC) is often adopted to characterize major, distinguishable steps (as illustrated in Figure 3.2) throughout typical procurement processes (see e.g. OGC, 2004; Edler et al., 2005).

Figure 3.2 A typical public procurement cycle (PPC)



Source: Author derived from OGC (2004) and Wilkinson et al. (2005)

Regardless of the specific context, a procurement process typically consists of several procedural stages, including *pre-procurement* stages (identification and articulation of demand, market intelligence gathering, procurement strategy preparation and prequalification and dialogues), *procurement* stages (tendering, evaluation and contract awarding), and *post-procurement* stages (contract delivery, management and reflection) (Wilkinson et al., 2005; Edler et al., 2005). In practice for the stage of tendering different procedures might be adopted, including:

- ***open tendering****: whereby all interested suppliers can submit a bid based on the published call*
- ***restricted tendering****: whereby suppliers can submit a bid upon invitation or individual contacts from the procuring body*
- ***requests for proposals (in conjunction with competitive dialogues)****: whereby suppliers submit solution proposals upon invitation, followed by iterative communications between stakeholders*
- ***single-source procurement****: whereby procurers recognize only one potential supplier and competition is lacking*

Arrowsmith et al. (2000)

While open and restricted tendering procedures are suitable for procuring off-the-shelf goods, procurement of complex, technologically demanding solutions can benefit from ‘less formal’ procedures such as competitive dialogues based on proposals (OGC/HMT, 2008). A large variety of stakeholders are involved in public procurement processes, including procurers, beneficiaries (e.g. end users), suppliers and operators (e.g. in cases of public transportation), which indicates resulted complexity of coordination in practice (Thai, 2009).

Complexity of public procurement increases as it frequently serves as a multi-functional policy instrument to address issues such as societal development (social responsibilities e.g. caring for women, minorities and SMEs), economic growth and national competitiveness (e.g. IOPP), and sustainability (e.g. green procurement) (Kashap, 2004; McCrudden, 2004). Goals/interests alignment and balancing of various tasks are increasingly the main challenges faced by procurement practitioners (Schapper et al., 2006). Telgen et al. (2007) proposed a seven-stage framework to map the development of public procurement from purely purchasing to a multi-functional policy instrument. Arrowsmith (2010) proposed to distinguish public procurement’s additional functions, i.e. *horizontal policies* that reach beyond the scope of purchasing from its basic functions. Both perspectives help deepen the understanding of the *cross-domain nature* of public procurement policies for *socioeconomic purposes*. Different functions of public procurement are summarized in Table 3.1.

Table 3.1 Development stages and functions of public procurement

Stage of Development		Policy Domain
7	Deliverer of broader policy objectives	Cross-domain, horizontal, 'secondary' goals
6	Supporter of broader policy objectives	
5	Value for money	Mainly single-domain, vertical, 'primary' goals
4	Accountability	
3	Efficient use of public funds	
2	Compliance with legislation/regulations	
1	Delivering goods/services	

Source: Author adapted from Telgen et al. (2007), with reference to Arrowsmith (2010).

IOPP is therefore situated at stages 6 and 7 in the table. Through the lens of 'policy mix' (Section 2.3.3), IOPP in the broader picture of procurement can be understood as *being shaped by its basic/vertical and cross-domain/horizontal attributes simultaneously*.

3.3 Regulating public procurement

Public procurement is frequently associated with corruption and protectionism (Piga, 2011; Trionfetti, 2000). In order to avoid these problems and achieve various policy goals, different countries and international organizations have formulated laws and policies to regulate procurement activities. Domestic and international regulations significantly differ from each other in that the former seeks domestic socioeconomic development while the latter, notably the World Trade Organization (WTO) regime, is largely concerned with international free trade and non-discrimination (Anderson and Arrowsmith, 2011).

3.3.1 Domestic regulations to realize multiple objectives

In many domestic procurement systems, competition-based tendering increasingly becomes a compulsory procedure to ensure transparency and competition when the value of the procurement exceeds a certain threshold (OGC, 2008; Khorana and

Subramanian, 2012). Concrete measures for implementation fall into categories such as laws, administrative measures and guidelines. For legal regulations, the United Nations Commission on International Trade Law developed a model law to assist countries to build or improve their domestic regulatory systems. The model law adheres to the principles of *transparency* and *competition*, and provides a regulatory template to be supported with concrete measures designed to suit the contexts of adopting countries (UNCITRAL, 1994). However, it has put too much emphasis on *openness* and *non-discrimination* rather than on the adopting country's *own interest* in economy and efficiency (Westring, 1994).

Therefore, although the model law has been adopted by some countries to reform their public procurement systems, more countries actively exercise preferential treatments in procurements related to domestic interests (Watermeyer, 2003; Arrowsmith, 2004). A well-known example is the *Buy American Act* in the Unites States launched as early as 1933 (Knapp, 1961; Weiss and Thurbon, 2006; Luckey, 2009; Kono and Rickard, 2010; Linarelli, 2011). The essence of the Act is to require the US public agencies to implement preferential treatment for domestic goods and services (i.e. *goods/services with the cost of foreign components not exceeding 50% of the total cost*) in public procurement processes (Luckey, 2009). The Act has been consistently implemented ever since (ibid.). A recent reinforcement has been the launch of the *American Recovery and Reinvestment Act* to strengthen domestic competitiveness and cope with the economy crisis. It has been explicitly stipulated that:

> *'...**none of the funds** appropriated or otherwise made available by this Act **may be used** for a project for the construction, alteration, maintenance, or repair of a public building or public work **unless all of the iron, steel, and manufactured goods used in the project are produced in the United States.**' (ARRA, 2009, Section 1605a)*

This type of 'horizontal policies' (Arrowsmith, 2010) to realize socioeconomic goals can easily lead to national/regional protectionism and discrimination against foreign players, which is against the spirit of international regulations (Kashap, 2004).

3.3.2 International regulations to promote free trade

The most influential international regulation[9] on public procurement is the WTO Agreement on Government Procurement, widely known as GPA, which is a plurilateral treaty with 41 signatories (mostly developed countries) thus far[10]. GPA translated the basic principles of non-discrimination and transparency to concrete procedural regulations (Anderson and Arrowsmith, 2011). It requires that:

> *'...each government accepting or acceding to this Agreement shall ensure, not later than the date of entry into force of this Agreement for it, **the conformity of its laws, regulations and administrative procedures**, and the rules, procedures and practices applied by the entities contained in its lists annexed hereto, with the provisions of this Agreement' (GPA, 1994, Article XXIV-5-a).*

GPA is applicable for public contracts exceeding specified threshold values in member countries. The contents of concrete agreements (see GPA, 1994) include two major parts, i.e. general rules (articles), and detailed schedules (appendices including annexes). The former covers general regulations especially regarding procedural issues; the latter is an outcome of negotiations of the acceding country with existing GPA members, which defines details including the coverage (i.e. which public entities and which types of services are subject to the Agreement, and what are the exceptions) and monetary thresholds. The two parts together determine the scope of other GPA parties' access to the offering party's public procurement market. Main terms of the 1994 version of GPA are briefly listed in Figure 3.3.

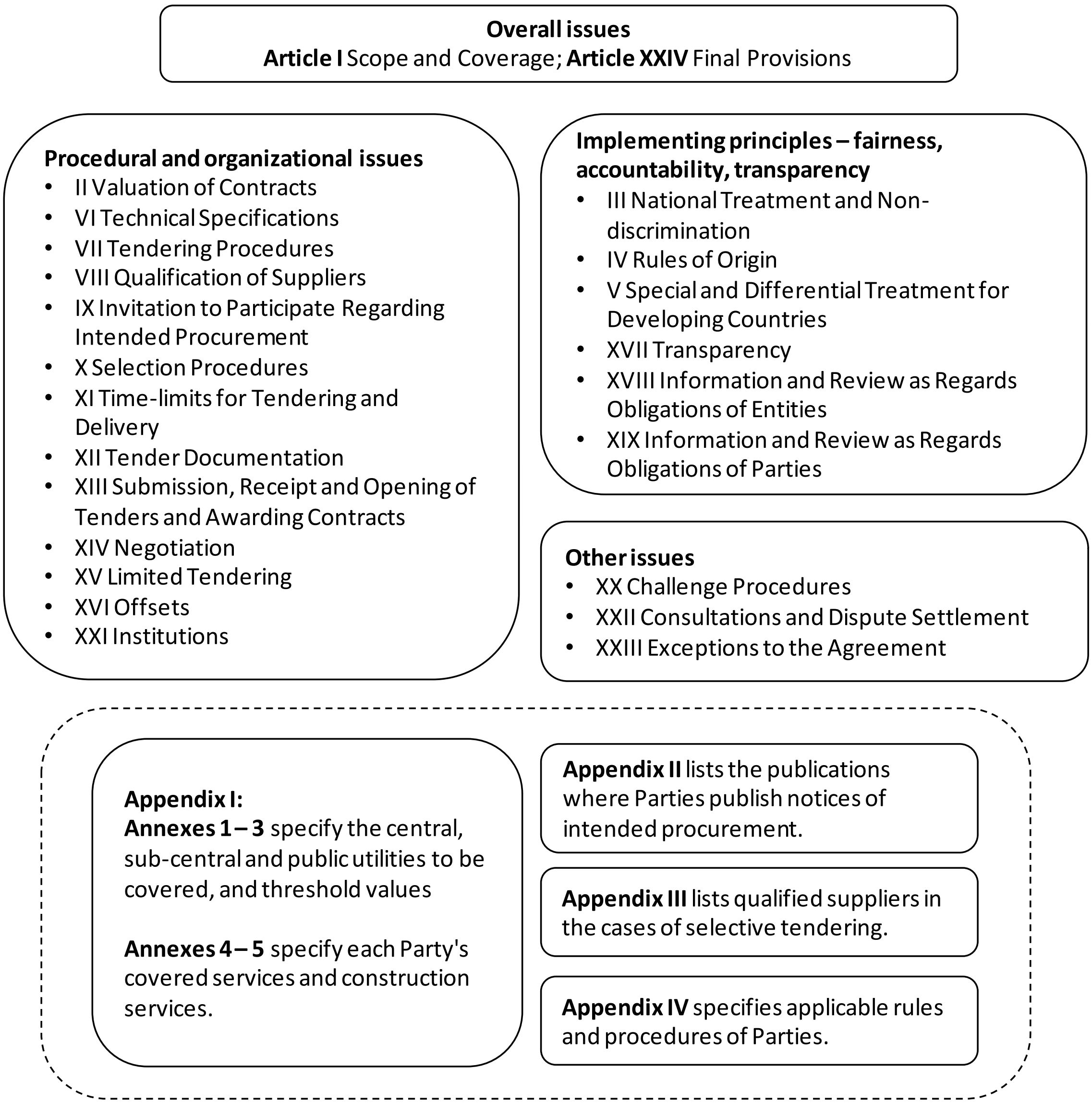
Although the coverage of GPA has expanded significantly in the past decades and continues expanding, compared to the hugeness of the global public procurement market it is still a 'small slice' (Anderson et al., 2012). Factors constraining GPA's coverage lie in two major aspects (ibid.). The first is, as addressed in the previous section, that many GPA signatories provide preferential treatment for their domestic suppliers in selected sectors or levels, hence only part of their domestic public procurement markets have been covered by the GPA (ibid.). The second is that most of the developing countries, including major catching-up economies such as China and India, are still outside the scope of the GPA and hesitating to join, primarily because of

[9] Another important international regulatory regime is the United Nations Convention against Corruption (see e.g. Edler et al., 2008 and Piga, 2011). The spirit of the Convention is anti-corruption, competition and transparency with which domestic regulations are in line. This section focuses on the WTO regime which poses constraints for domestic procurement policy-making.

[10] See http://www.wto.org/english/tratop_e/gproc_e/gp_gpa_e.htm [accessed April 30th 2013].

the incompatibility of their existing domestic regulatory systems and their intention to utilize public procurement to drive domestic development (Wang, 2009; Khorana and Subramanian, 2012).

Figure 3.3 Contents of the Agreement on Government Procurement (GPA)



Source: Author summarized from GPA (1994)

The most relevant article for developing countries is *Special and Differential Treatment for Developing Countries*, which stipulates that GPA parties shall

> *'...**take into account the development, financial and trade needs of developing countries**'* and *'...in the preparation and application of laws, regulations and procedures affecting government procurement, **facilitate increased imports from developing countries**...' (Article V, GPA, 1994)*

However, these special and differential treatments provisions have been criticized as being ambiguous in terms of wording, and impractical for implementation, '*arguably promising the moon and the stars but guaranteeing nothing*' (Muller, 2011, p.340).

Little explicit attention has been paid by GPA to the room for employing horizontal especially industrial policies (Davies, 2011). Acceding countries need to *negotiate* with the signatories if they wish to bind public procurement with domestic socioeconomic policies (Arrowsmith, 2010).

3.3.3 Policy space and development – current debates

Although GPA is plurilateral thus far, developing countries that joined the WTO face the pressure of reforming their government procurement systems and consequently joining the GPA (Wang, 2009). In development literature, the concept of 'policy space' has emerged to refer to

> *'...the **scope** a nation has for building its **own national development strategy** and its **relationships with the world economy and markets**' (Muchhala, 2007, p.1)*

It has been heatedly debated whether or not international trade regulations have caused the 'shrinking' of development policy space for developing countries (Wade, 2003; Hoekman, 2004; Chang, 2006; ODI, 2007; Muchhala, 2007; Mayer, 2009).

Two contrary perspectives exist. One is that openness is beneficial for all parties and there is still plenty of space for developing countries to utilize public procurement as an approach to overall development (Anderson and Arrowsmith, 2011; Yukins and Anderson, 2012). As Arrowsmith (2003) argued:

> *'…GPA coverage is very **flexible**. Parties can use this flexibility both to apply policies that do not fit with GPA rules, and to avoid any uncertainty over the status of particular policies that have been adopted…'(p.348)*

This perspective has been echoed by McCrudden (2007), who argued that the GPA can be flexibly interpreted to allow sufficient legal space and suit member countries' needs to realize socioeconomic objectives. However, utilizing this flexibility requires strong capabilities in addition to well-established framework conditions, which might not be easy to achieve for most developing countries (Kattel and Lember, 2010).

The contrary perspective has been that the freedom for developing countries to implement horizontal policies through public procurement is fundamentally limited once they accede to the GPA (Mosoti, 2004; Kattel and Lember, 2010; Tayob, 2010). Although special and differential treatment is provided for developing countries, the provisions '*appear only as an 'add-ons' in these agreements*' (Hamwey, 2005, p.17), largely stipulating longer timeframes for developing countries to implement their commitments rather than possessing a '*wide scope and integrated nature*' (ibid.). By drawing upon previous catching-up experiences of the currently developed countries, and contrasting the circumstances faced by developing countries with GPA regulations, Kattel and Lember (2010) concluded that '*developing countries are well advised not to join the GPA*' (p.5).

The tensions between GPA treaties and domestic public procurement objectives to an extent reflect the tensions between leading countries (most of which are existing GPA signatories) and catching-up countries (most of which have not been subject to GPA but under increasing pressure of accessions). These tensions are very relevant to the situation of public procurement in China, which, as discussed in the next section, is regulated by a system distinct from that of the existing GPA signatories.

3.4 Government and public procurement in China

3.4.1 The two primary laws regulating procurement

As part of the efforts to transform its economy from a centrally-planned to a market-based one, China started domestic procurement reforms in the mid-1980s through adopting tendering procedures in large-scale procurements (Wang and Zhang, 2010). Although its recent development in public procurement regulations has been well influenced by international institutions (Chou, 2006b; Wang and Zhang, 2010), the Chinese system appears rather detached from international practices. China commenced GPA accession negotiations in late 2007 (Wang, 2009). Thus far it has submitted four versions of Appendix I offers (see Figure 3.3, indicating the coverage in terms of procuring bodies and thresholds), which has been improving from version to version but still not substantial enough to satisfy the requirement raised by existing GPA signatories (ICTSD, 2012; EUCCC, 2012). One fundamental obstacle for China to implement integration into the global public procurement system lies in that its domestic regulations and governance are largely different from what is stipulated in GPA (Chou, 2006a; Chou, 2006b; Anderson, 2008; Wang, 2009; Wang and Zhang, 2010; EUCCC, 2011).

The scope of *government procurement* in China is much narrower than that of *public procurement*, with the former referring to:

> *'...the purchasing of goods, works and services (either listed on the centralized procurement catalogues or above certain thresholds) by various levels of* ***government agencies, public institutes and social organizations with fiscal funds****' (Article II in the Law on Government Procurement, see LGP, 2002).*

The subject of this definition only includes public organizations *relying on fiscal funds*, while SOEs are excluded (Wang, 2009). Given that most of the suppliers of public infrastructures and services in China are SOEs (Wang, 2007), the scope of *government procurement* defined by the Law on Government Procurement (LGP) is much narrower than that of *public procurement* given in Section 3.2. There is no unified definition for *public procurement* in China, but academics tend to adopt internationally recognized definitions when conducting research in this area, e.g. Cao (2010). Hence what is defined as 'government procurement' by LGP only represents part of 'public procurement' in China.

Public procurement activities in China are regulated by two primary laws, i.e. the Law on Tendering and Bidding (LTB, see LTB, 1999) and the LGP. The LTB was drafted by the NDRC and its implementation is in principle supervised by NDRC and regional level Development and Reform Commissions (DRCs). It is concerned about tendering issues only rather than serving as a holistic regulatory framework for public procurement. It applies to tendering activities in the private sector as well as the public sector (Article II of LTB). The LTB adopts a mixture of voluntary and compulsory stipulations to define its coverage. While private-sector procurers have the freedom to decide whether or not to comply, certain procurements in the public sector are compulsorily subject to the LTB. As stipulated in Article III in LTB (1999), tendering processes must be organized when conducting procurements related to large-scale public infrastructure and utilities projects, projects invested completely or partly by the government, and projects using loans from international organizations or foreign governments. In this sense, procurement activities conducted by SOEs are subject to LTB as long as the contract value exceeds a certain threshold; however, the threshold to define 'large-scale' is not fixed in the Law but subject to approvals of NDRC. Hence the concrete measures and implementation structure vary significantly depending on the contexts of individual procurements. Different levels of government, ministerial departments and other public utilities have their interpretations of the law; in practice they implement LTB in conjunction with their specific, secondary regulations. Wang and Zhang (2010) criticized that the LTB

> *'...**lacks many features of modern public procurement legislation** such as a clear definition of public procurement and procurement methods other than competitive tendering procedures' (p.5).*

The LGP was drafted by MOF and has been directly supervised by MOF and its lower-levels agencies. It detailed requirements regarding publicity, tendering procedures, challenge mechanisms and supervision issues. Implementation of LGP is highly centralized through top-down channels led by MOF. Official websites have been set up to publish procurement-related information, e.g. the website of China Central Government Procurement, CCGP[11]. Implementation structures and concrete measures are generally coherent across levels of government and across various procuring bodies. Nevertheless, Wang and Zhang (2010) consider that the LGP is '*arguably a disappointing one*' since it adopts a very *narrow* definition of government procurement. It is estimated by EUCCC (2011) that the coverage of LGP as a percentage of the whole *public procurement* market in China is only 10%. The most part of the market is in principle within the coverage of LTB, the boundary of which, however, is ambiguously defined.

Functions of the two laws were supposed to be complementary, with the LGP focused on government procurement issues and the LTB covering tendering issues in general. Key dimensions of the LTB and LGP are compared in Table 3.2. A linkage between LTB and LGP is very briefly stipulated in LGP that

> *'...if a tendering/bidding procedure is required in government procurement of construction, the LTB is applicable' (Article IV, LGP, 2002)*

However, there have been competition and contradictions between the two primary laws due to the 'piecemeal manner' of governance led by the two ministerial-level authorities i.e. NDRC and MOF (Wang and Zhang, 2010, p.150). 'Deliberate ambiguity' is evident in the wording of both laws, which '*destroyed the balance between legal certainty and flexibility*' (ibid. p.154). The boundaries and functions of LTB and LGP frequently overlap in practice.

[11] See http://www.ccgp.gov.cn/ for CCGP website [accessed May 6th 2013].

Table 3.2 Comparison of LTB and LGP

	The Law on Tendering and Bidding (LTB)	**The Law on Government Procurement (LGP)**
Came into force	January 1st, 2000	January 1st, 2003
Main objectives	Competition liberalization; efficiency	Anti-corruption, efficiency, cost-effectiveness
Issuing body	NDRC	MOF
Supervising body	NDRC and its lower level departments i.e. local DRCs	MOF and its lower level departments i.e. local finance departments
Subject procuring bodies	All procurers (public and private sectors); compulsory for procurements related to large-scale public infrastructure and utilities projects, projects invested by the government or using loans from international organizations; voluntary for other procurements	Government agencies and public organizations relying on government funds (e.g. schools, hospitals, and PRIs); compulsory
Scope	Regulating tendering activities, rather than covering all issues related to procurement	Regulating government procurement in the narrow sense, e.g. procurement of stationeries, and computers
Market value	Estimated 20% of China's GDP by EUCCC[12]	2% of China's GDP
Implementation structure	Decentralized; differing across levels of governments and industrial sectors	Centralized; involving MOF, finance departments and their agencies, and fiscally funded organizations
Covered by GPA offering?	No	MOF is responsible for GPA accession negotiations; it included *government procurement* at the central level and in 8 selected regions in the previous offers made during 2007 – 2012 (see Lv and Lu, 2012; EUCCC (2012) considers China's offers 'highly disappointing')

Source: Author derived from Wang and Zhang (2010), EUCCC (2011), LTB (1999) and LGP (2002)

One consequence of this institutional fragmentation is the difficulty to track public procurement transactions and conduct accurate statistics. According to the data provided by MOF, government procurement expenditure in China accounts for around 2% of the GDP[13], while EUCCC (2011) argued that public procurement in China represents '*well*

[12] Different opinions exist regarding this proportion; see EUCCC (2011) and Wang and Zhang (2010).
[13] See http://www.ccgp.gov.cn/llsj/llts/201101/t20110121_1489131.shtml [accessed April 30th 2013].

over 20% of China's rapidly growing economy' (p.2). Although it is impossible to calculate the exact size, it is certain that the Chinese public procurement market is vast, which indicates great potential for utilizing public procurement to fulfil multiple functions including promoting innovation.

3.4.2 The fragmented picture of implementation

The regulatory system underpinned by the two primary laws has made implementation processes of public procurement in China rather fragmented (Wang and Zhang, 2010; EUCCC, 2011). Due to the lack of unified national-level regulations, provinces and their lower-level governments have published numerous regulatory measures to carry out procurement. Although China's narrow-sense government procurement and defence procurement have been centralized since the early 2000s (Dimitri et al., 2006), the overall picture of public procurement in China is seriously fragmented cross sectors, regions and levels of governments due to the limited coverage of LGP on the one hand and the ambiguous boundary of LTB on the other. Regions enjoy sufficient autonomy regarding economic development and taxation (Section 2.5.3), which means a large proportion of the Chinese public procurement market is under the control of localities (Chou, 2006a).

Implementation regulations published by ministries and levels of governments formed the 'backbone' of the Chinese public procurement regulatory system (Wang and Zhang, 2010). These regulations often compete rather than coordinate with each other due to their contradictory roots institutionally (ibid.). The State Council has been aware of the poor coordination between ministries and regions and the inconsistency it resulted in. In 2004 the *Advice on Further Regulating Tendering and Bidding Activities* (State Council, 2004) was published, following which the NDRC announced the *Interim Measures for Inter-Ministry Coordination of Public Tendering and Bidding* (NDRC, 2005). However, this coordination mechanism proved to be rather weak given the unchanged institutional setup (Chen, 2009).

Government procurement in China is increasingly undertaking multiple functions as a policy instrument, promoting green procurement (Geng and Doberstein, 2008), indigenous innovation (Li[a], 2011), and development of SMEs, minorities and less-developed regions (Wang and Zhang, 2010). Similarly with the catalogues to support

IOGP (Section 1.2), various types of product lists/catalogues have been used in China to facilitate functions such as green procurement (USCBC, 2009). Despite the fragmentation and narrow understanding, government procurement in China has achieved '*modest success in cost-saving and coverage expansion*' (Chou, 2006a, p.534) since the initiation of reforms.

With respect to the seven development stages (see Table 3.1), the Chinese public procurement system has not achieved all the primary functions although it is employed for higher-stage functions already. Compliance with broader regulations (e.g. GPA) is clearly not realized yet; the lack of accountability and transparency has been criticized extensively by researchers and stakeholders (Chou, 2006a; Chou, 2006b; EUCCC, 2011; EU SME Centre, 2012). Government procurement reforms in China still have a long way to go before it can qualify as being highly developed.

Twelve years after the enactment of the law, the *Implementation Regulations of the LTB* was announced (State Council, 2011b). Meanwhile the *Exposure Draft of Implementation Regulations of the LGP* has been published for public consultation (State Council, 2010). Nevertheless, analysis of the contents of these (draft) legislation suggests that both of them are focused on clarification of terminologies and procedural issues rather than proposing a coherent regulatory framework for public procurement. Therefore, even if the formal version of the Implementation Regulations of LGP is issued, fundamental problems are likely to remain unresolved as the institutional basis remains unchanged.

3.5 Conclusion

This chapter has developed an understanding of public procurement as an important government activity undertaking multiple tasks. Some 'system' thoughts in the procurement literature have been drawn upon to conceptualize 'public procurement systems' vis-à-vis 'innovation systems'. A public procurement system is a complex and dynamic one, embedding various elements including institutions and stakeholders with a wide range of interests and objectives. Procurement processes as the core element in public procurement systems are shaped by those institutions and stakeholders.

Public procurement has been regulated to fulfil both primary goals (e.g. transparency, compliance and efficiency) and secondary/horizontal functions (i.e. supporting various aspects of socioeconomic development). Domestic regulations promoting horizontal goals often stipulate *preferential treatment* for certain product/supplier groups, while internationally the WTO-GPA aims to promote free trade by implementing the principle of *non-discrimination*. There are *constant tensions* between domestic and international procurement regimes, which proved to be a major concern preventing developing countries from joining the GPA.

Moving to the Chinese context, this chapter has argued that although China has been an observer negotiating accession to the GPA since 2007, its public procurement system remains rather inconsistent with norms adopted by GPA signatories. The system is underpinned by two frequently competing laws i.e. the LTB and the LGP supervised by NDRC and MOF respectively. The divided legal framework led to severe fragmentation during the implementation stage. Different ministries and levels of governments built their own fortresses of implementation measures, making procurement activities rather opaque to monitor. Despite the fact that the system has not fulfilled all primary goals, it is undertaking a range of horizontal tasks already, one of which being promoting innovation.

Chapter 2 and Chapter 3 have *contextualized* the research subject, IOPP, in relation to *innovation* and *public procurement* respectively. Chapter 4 will *focus on* IOPP and discuss important perspectives, practices, and issues surrounding it.

Chapter 4: Innovation Oriented Public Procurement (IOPP)

4.1 Introduction

Moving on from the understanding developed in Chapters 2 and 3 with respect to innovation and public procurement, this chapter attempts to review perspectives and practices treating public procurement as an innovation policy instrument. Section 4.2 provides an introduction to definitional issues and background knowledge. Section 4.3 looks into different functioning mechanisms of IOPP identified by existing literature, whereby different types of IOPP are summarized. Section 4.4 briefly reviews (bottom-up) IOPP practices and (top-down) policy initiatives taken by OECD countries; these will be reflected on in later chapters where China's practices are analysed. Section 4.5 summarizes factors and issues influencing IOPP processes based on reviews of literature and practices. Section 4.6 concludes the chapter.

4.2 Definitional and background issues

Different authors have adopted different terminologies to refer to the subject, ranging from 'innovation-oriented public procurement' (Rothwell, 1984), 'public technology procurement' (Edquist et al., 2000), to recently 'public procurement of innovation' (Edler and Yeow, 2013). In general, it is agreed that *innovation oriented procurement* should be distinguished from *regular procurement*, i.e. procurement of off-the-shelf products for which no further innovation is required and no additional interaction between suppliers and users is needed (Edquist et al., 2000; Uyarra and Flanagan, 2010). To avoid definitional ambiguity, this thesis adopts the term IOPP, defined as ***any public procurement activities that stimulate, or aim at stimulating the creation, improvement, adaption and diffusion of innovations***.

The potential of public procurement as an innovation policy has long been recognized by researchers from different aspects. Some perspectives are listed below:

> *'...**properly implemented**, innovation-oriented public procurement is perhaps **potentially the most powerful tool** of all...' (Rothwell (1984, p.330).*

> *'…procurement policy can be used effectively – and probably more effectively than R & D subsidies – to stimulate industrial innovation… **success requires some centralization in purchasing combined around basic long-term and clearly articulated user needs, with an appropriate structure of contract specifications**…' (Geroski, 1990, p.196).*

> *'...public procurement has the **greatest immediate impact** on innovation outputs if small firms – especially in economically challenged regions – are aware of them and can participate in a way that suits their limited resources.'* (Aschhoff and Sofka, 2009, p.1244).

Dalpé (1994) pointed out that even if public procurement is not directed to stimulating innovation i.e. in cases of *regular* procurement, it has impacts on innovation processes since

> *'... their (the government's, added by author)* ***decisions concerning prices, quantities, and standards affect innovation****, positively or negatively, in a group of industries involved in government procurement'* (p.66).

To sum up, IOPP policy is a potentially very powerful (under certain circumstances, the most powerful) instrument to drive innovation; but to utilize it adequately, attention needs to be paid to factors and issues which affect policy design and implementation.

Despite the initiation in academia and some exceptional early practices, the utilization of IOPP policies in recent decades has been limited (Edquist et al., 2000; Edler and Georghiou, 2007). Interactions between supply and demand sides are not encouraged, if not forbidden, in procurement processes under most circumstances out of concerns over corruption (Edquist et al., 2000). However, as addressed in Section 2.2, innovation by nature is a process of *interactive learning* between actors especially between users and suppliers (von Hippel, 1988; Lundvall, 1992). IOPP as a process embedding demand-driven innovation requires exactly communications and interactions between suppliers and procurers/users and perhaps other stakeholders as well (Granstrand, 1984; Rolfstam, 2010). Researchers and practitioners in the EU have been actively calling for attention to the potential of IOPP policies, e.g. Georghiou et al. (2003), OGC (2004), Wilkinson et al., (2005), Georghiou (2006) and Aho et al. (2006). This wave of interest has been echoed elsewhere in the world (OECD, 2011a); the research and practice of IOPP have been revitalized.

4.3 Typologies and functioning mechanisms of IOPP

Researchers have developed various typologies in order to understand the functioning mechanisms of IOPP from different angles of views[14]. A classification of major perspectives is presented in Table 4.1.

[14] Part of this section was used in an adapted form by the author in preparing the proposal for EC project *Innovation Demand-side Monitoring System* (No 276/PP/ENT/CIP/13/C/N03C041), July 2013.

Table 4.1 A classification of IOPP typologies

Developed by	Typology according to	Typological categories
Rothwell and Zegveld (1981)	Market structure	• Monopsony • Polypsony • Oligopsony
Edquist and Hommen (2000)	Type of innovation (technology life cycle, TLC)	• Developmental • Adaptive
	End users	• Procurers as end-users • Procurers as catalysts
	Market structure	• Monopsony • Polypsony • Oligopsony
Edler et al. (2005)	Strategic nature	• General • Strategic
	End users	• Direct • Cooperative • Catalytic
	Market development process	• Market creation • Market escalation • Market consolidation
Edler and Georghiou (2007)	End users	• State in connection with private users
	Strategic nature	• General • Strategic
	Commercialization stage	• Commercial • Pre-commercial
Hommen and Rolfstam (2009)	End users	• Direct • Cooperative • Catalytic
	Market development process	• Early (Fluid) • Middle (Transitory) • Late (Specific)
Uyarra and Flanagan (2010)	Nature of procured items	• Adapted procurement • Technological procurement • Experimental procurement • Efficient procurement
Rolfstam (2012b)	End users	• Direct • Cooperative • Catalytic • Distributed
	Market development process	• Initiation (Development) • Escalation (Adaption) • Consolidation (Standardization) • Destruction (Removal)

Source: Author derived from literature listed in the table

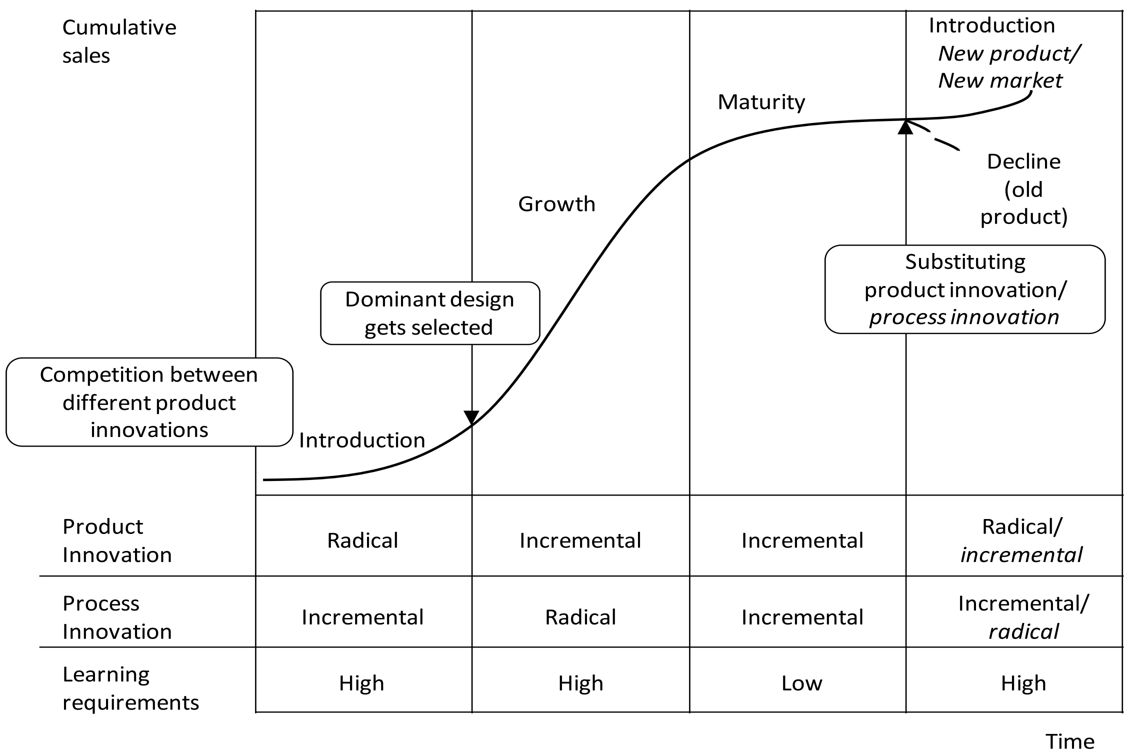
Demand structures, i.e. the market positions of public demand in relation to suppliers, were distinguished by Rothwell and Zegveld (1981) and Edquist and Hommen (2000) into: *monopsony* (one buyer faced by many suppliers), *oligopsony* (a small number of buyers, often powerful with big shares, faced by a larger number of sellers), and *polypsony* (many buyers existing with small, fragmented shares). In the situation of monopsony, 'demand pull' is highly concentrated, easy to be articulated, and likely to form *critical mass* to facilitate innovation breakthroughs. In the situation of oligopsony, the public sector can play the role of *lead users* and *catalyse* private demand, whereby the diffusion of innovation can be accelerated. In the situation of polypsony, IOPP is '*often a practical impossibility*' (Edquist and Hommen, 2000, p.56) because demand articulation is difficult and the bargaining power of buyers is limited. However, public agencies faced by polypsony can still identify commonly-shared societal needs and perform as coordinators to articulate the demand distributed across these small buyers (Nilsson, 1994).

Strategic nature was raised by Edler et al. (2005) followed by Edler and Georghiou (2007) as a criterion to distinguish *general IOPP* from *strategic IOPP*. The former refers to the situation that '*government procurement can generally be so organised, that innovation can become an essential criterion in the tender and assessment of tender documents*', and the latter refers to the situation that '*the demand for certain technologies, products or services is encouraged in order to stimulate a certain market*' (ibid., p.14). This distinction is meaningful in the sense that the utilization of strategic and general IOPP potentially requires different implementation measures, since overall procurement and specialized procurement in a country are likely to be conducted by different departments, e.g. in the case of China as discussed in Chapter 3.

End user, i.e. who is the end user of the procured items, the procuring body or private users, or both, is another important criterion in classifying IOPP in the literature (Edquist and Hommen, 2000; Edler et al., 2005; Edler and Georghiou, 2007; Hommen and Rolfstam, 2009; Rolfstam, 2012b). A distinction is often made between *direct IOPP* (whereby public agencies purchase items for their own use), *cooperative IOPP* (whereby public buyers purchase in conjunction with private buyers), and *catalytic IOPP* (whereby public agencies initiate or involve in procurement process, but the procured items are to suit the need of private users). The latter two types were titled as '*state in connection with private users*' IOPP by Edler and Georghiou (2007). Recently this classification was extended further by Rolfstam (2012b) with one more type, i.e. *distributed IOPP* (whereby the public agencies 'signal' some information about demand without specifications or commitment of procurement; hence it is the supplier's job to exploit any potential demand). By distinguishing these types of 'user composition', different IOPP policy measures can be adopted to articulate demand and engage stakeholders.

Types of innovation, market development stages and commercialization stages are all related to different phases of the technology/product life cycle. As illustrated in Figure 4.1, a technology in general goes through four stages from *introduction* followed by *growth*, to *maturity* and finally to *decline* of old products and introduction of new ones.

Figure 4.1 Technology life cycle (TLC) and types of innovation



Source: Smeds (1994) adapted from Tushman and Nadler (1986)

Early stages of the cycle involves mostly radical innovation (i.e. '*completely new products, processes or systems*', Edquist and Hommen, 2000, p.21) which is not yet commercialized, thus pre-commercial procurement (PCP) can be very promising in accelerating growth and shortening the cycle (Edler and Georghiou, 2007). The procurement of commercialized radical innovation is titled as '*developmental IOPP*' (Edquist et al., 2000). The stage of market development corresponding to this period is '*market creation*' followed by '*market escalation*' (Edler et al., 2005). Later on along the technology life cycle (TLC), i.e. during the commercial period from growth towards maturation, innovation is mostly of an incremental nature (or '*new to the country of procurement*', Edquist and Hommen, 2000, p.21), in the form of adapted solutions. *Adaptive IOPP* is hence the main approach during this period, and correspondingly, the market enters into its *consolidation* stage (Edler et al., 2005). Rolfstam (2012b) added one more stage in terms of market development, i.e. *destruction/removal*, which corresponds to the decline stage of old products. This typological dimension indicates that the *timing* of IOPP is very important since it can influence the trajectories of technological development.

Nature of procured services and goods was raised by Uyarra and Flanagan (2010) as a key criterion to distinguish between different IOPP practices. They elaborated four different scenarios of public procurement, i.e. *adapted procurement* (of customized designs by niche users), *technological procurement* (of a certain design by sophisticated customers), *experimental procurement* (of prototypes by lead users) and *efficient procurement* (of standard products by cost-driven customers).

4.4 IOPP practices and policies in OECD countries

4.4.1 Bottom-up IOPP cases

Driven by public authorities' demand, quite a few IOPP examples emerged in a *bottom-up* way in Europe well *before* the launch of top-down IOPP policy initiatives by governments (see e.g. Edquist et al., 2000 for cases dating back to the 1980s or even earlier). Table 4.2 summarizes contents of publications that presented IOPP case studies. Analysis has been mostly centred on public procurement cycles (PPCs), with specific issues highlighted such as risks, coordination, policies, and geographical scope. Technological areas that nurtured a largest number of cases included public transport, education, ICT, energy-saving and environmentally-friendly sectors.

Table 4.2 Summary of IOPP case studies in EU countries

Publications	Contents and cases	Analytical considerations
Edquist et al. (2000)	Sectoral coverage on transport (X2000), electricity (high-voltage-direct-current transmission), ICT (Compis school computers; digital switching systems in Sweden, France, Italy and Greece, and the Finnish Nokia case)	Chronological case descriptions followed by comparative analysis on: the dimension of time, competence and user-producer interaction, political influence and levels of intervention, and interaction environment (e.g. demand structures and institutions)
Edler et al. (2005)	Sectoral coverage on public infrastructure (lighting, telecommunication), public transport, ICT (maritime radio system, e-file, benefit card, variable message signage) in countries of Germany, Austria, Norway, Netherlands, United Kingdom (UK) and Italy	Descriptive analysis covered: agency and policy background, impact, procurement cycle, success factors, and major impediments overcome. Two major issues relevant to the process and outcomes of IOPP have been identified, i.e. risk control and internal organization
Lember et al. (2007)	City-level (Copenhagen, Stockholm, Tallinn, Malmo and Berlin) IOPP practices in sectors of education, transport, ICT, and new energy	Methodologically following Edler et al. (2005) but with an explicit focus on *local* IOPP operating mechanisms and inter-regional cooperation
OMC-PTP (2009)	Sectoral coverage on ICT (e.g. e-ID card and ticketing), green technologies (e.g. emission control), and social care	Case analysis highlighted procedural issues, especially in relation to IOPP policy as *part* of policy mixes and cross-domain coordination
Tsipouri et al. (2010)	Cases mostly covered in above-mentioned reports already, covering ICT, new energy and lighting	Analysis focused on risk management issues associated with different stages of PPC and various types of IOPP
Georghiou et al. (2010)	Sectoral coverage on ICT (smart card, data centre), public services, chemistry, and waste treatment	Analytical approach similar to Edler et al. (2005), with a focus on the context of small countries with limited capabilities and resources
Edquist and Zabala-Iturriagagoitia (2012)	Cases mostly covered in early publications already including Edquist et al. (2000); covering sectors including transport, ICT, and lighting	New analytical lenses applied to 'old' cases, concerning procedures, types and consequences of IOPP, and issues related to grand challenges and policy mix
Edler and Yeow (2013)	Two cases on healthcare equipment procurement carried out in National Health Services, UK	Highlighted the role of intermediation in addressing linkage, implementation and capability gaps in IOPP processes

Source: Author derived from publications listed in the table

A range of obstacles hindering the conduct of IOPP has been identified by those studies, four of which have been most frequently discussed. Firstly, there has been a lack of skills and competence among various stakeholders in undertaking IOPP (Edler et al., 2005; Lember et al., 2007). Procuring agencies easily suffer from a lack of intelligence as they are not likely to possess the expertise related to specific, leading-edge technologies; suppliers' design and manufacturing capabilities are challenged when faced with uncertain, usually performance-based specifications. Secondly, risk aversion or lack of acceptance has been observed as a common barrier in various contexts. Public procurers, as civil servants with the task of making good use of public money, are often risk-averse and not willing to bear the responsibility to fulfil the uncertain and 'redundant' task of spurring innovation (Tsipouri et al., 2010). Thirdly, coordination deficiency appeared to be a stubborn obstacle as a result of a high level of complexity and stakeholder heterogeneity. Fourthly, EU's strict procurement regulations have been found too inflexible and frequently hindering user-producer interactions, while those interactions are exactly what is required in IOPP (Edler et al., 2005; Georghiou et al., 2010). Section 4.5 will carry on discussing major issues associated with IOPP addressed by the literature.

4.4.2 Top-down policy initiatives

Since the 2000s IOPP policy initiatives have been increasingly widespread in OECD countries, primarily due to the pressure resulted from a shortage of public funding and the '*lagging innovation and productivity performance*' (OECD, 2011a, p.3), and the belief that IOPP is a promising, powerful instrument to revitalize economy and cope with *grand challenges* (Edquist and Zabala-Iturriagagoitia, 2012). Diversified policy measures have been taken. Table 4.3 presents a classification of policy measures by drawing upon the framework developed by Georghiou et al. (2013) and evidence collected by Uyarra (2012), as well as a review of policy initiatives taken by OECD countries (for more details see Appendix 4).

Four broad categories of policies to support IOPP practices have been identified in the OECD context, i.e. improvement of framework conditions, enhancing organization and capabilities, articulation and signalling of needs, and incentivising innovative solutions (Georghiou et al., 2013). The rationales of those policies correspond to the market and system failures associated with the demand side (Section 2.3.2), as well as the various issues to be reviewed in Section 4.5. Major deficiencies addressed include lack of stakeholder awareness and capabilities, insufficient demand and demand articulation, risk aversion, and various hard institutional failures hindering IOPP (ibid.). Instruments employed to implement policies include amending legislation and procurement procedures, networking and training schemes, stakeholder subsidies, strategic intelligence, and tariff/price incentives (ibid.).

Among the existing concrete policy measures the US Small Business Innovation Research (SBIR) programme has been a well-established approach to supporting SME innovation and commercialization dating back to the 1970s (Uyarra, 2012). SMEs as an important type of innovators face unequally high entry/transaction costs if they were treated 'equally' in procurement processes (Yukins and Piga, 2013); this approach has been adapted to different contexts by other countries (Table 4.3). SBIR-type programmes have meanwhile been recognized as an important approach to pre-commercial procurement (PCP) which is not constrained by commercial procurement regulations such as the GPA and EU Directives (Rigby et al., 2012; Rigby, 2013).

Table 4.3 IOPP policy measures adopted in OECD countries

Category	Rationales	Instrument types	Policy initiatives
Framework conditions	Adjusting institutions that disadvantage innovation	Introducing legislation & tendering procedures to favour innovation	Revision of European Commission (EC) Directives on public procurement; use of electronic portals; special budgeting for SMEs
Organization and capabilities	Raising organizations and stakeholders' awareness and capabilities in conducting IOPP	Training schemes; good practice networks; guidelines for practitioners; subsidies for extra costs in conducting IOPP	Netherlands PIANOo support network; LMI networks of contracting authorities; brochures and strategic reports published in EU Member countries e.g. Germany and UK
Identification, specification and signalling of needs	Strengthening communication between various procurement functions; improving knowledge about suppliers' innovation potential	Procurement of R&D to develop & demonstrate solutions; employment of strategic intelligence e.g. foresight; platforms for communication and collaboration	US Small Business Innovation Research (SBIR) programme; SBIR-type policies in Netherlands, Australia and UK; competitive dialogue procedure; Lead Market Initiatives; pre-commercial procurement, PCP
Incentivising innovative solutions	Overcoming risks; overcoming risk aversion by procurers and users	Calls for tender requiring innovation; user subsidies; tariff or price premium; insurance guarantees	Forward commitment procurement (FCP) in UK; German laws enabling innovation demands in tenders; Korean scheme for product certification

Source: Author derived from Georghiou et al. (2013), Uyarra (2012), and a review of OECD countries' initiatives (Appendix 4)

In Europe at the Union level, the European Commission (EC) employed the Lead Market Initiative (LMI) to support innovation in six selected strategic sectors, which can be considered as a systemic approach integrating a mix of demand-side policy measures including public procurement (CSES and Oxford Research, 2011; Edler et al., 2012; Uyarra, 2012). Individual EU countries launched country-specific initiatives, such as the UK Forward Commitment Procurement (FCP) whereby public authorities signal their demands for innovation to potential suppliers and commission reassured contracts once the requirements are fulfilled (Uyarra, 2012).

Although the existing policy portfolio seems all-round, through analysis of a dedicated survey of UK suppliers Georghiou et al. (2013) concluded that the current scope of policy measures does not address all the barriers encountered by suppliers. The scope is yet to be extended in time, breadth of reach, and depth (ibid.).

4.5 Issues associated with IOPP implementation

Timing is a crucial factor affecting IOPP in terms of both the *public procurement cycle* (PPC, see Figure 3.2) and the *technology life cycle* (TLC, see Figure 4.1). Proactive engagement of procurers with suppliers during *early stages* of the PPC (i.e. *pre-procurement stages*) is more likely to trigger innovation, as intensive user-producer interactive learning can contribute to better demand articulation and more suitable selection of procedures, and further contribute to the likelihood of success (Edquist et al., 2000; OGC, 2004; Wilkinson et al., 2005). Once the earlier stages are finalized, tendering and evaluation stages can serve as a screening mechanism to pick the most workable solution. During the contract delivery stages, however, the possibility of stimulating innovation is smaller. In terms of TLC, it is important for procurers to engage with suppliers during early stages since, as illustrated in Figure 4.1, that is when innovation (be it product or process, or radical or incremental) is more likely to occur and the market mechanism is not fully established (Rothwell and Zegveld, 1985; Geroski, 1990; Edquist et al., 2000). If a technology is promising and strategically important but not commercialized yet (i.e. a ‘sunrise’ technology as in Geroski, 1990), a ‘pull’ force provided by public procurement can form critical mass and facilitate the market transformation process (Nilsson, 1994).

The **heterogeneity of stakeholders** is a key feature of the IOPP policy implementation process. As a policy mix across the domains of innovation and procurement systems, IOPP policy’s main target groups include *procurers*, *suppliers*, *end users*, *government officials* (from all related departments which might be diverse) and others (e.g. secondary suppliers and experts); each group has its objectives, incentives, priorities and knowledge base (Edler et al., 2005). This heterogeneity poses difficulties for inter-stakeholder coordination. Hence many IOPP policy measures (see Table 4.3) are focused on enhancing the communication, awareness, and capabilities of stakeholders, so that they might reach consensuses and collaborate with each other. Even if a common understanding and required capabilities are gained, goal alignment among stakeholders proved to be a tough issue, since most of them have primary tasks for their original domain, e.g. pursuing innovation is not necessarily the top priority of sectoral officials (Edler and Georghiou, 2007). Two types of actors have been identified as having the potential to facilitate coordination and alignment, namely ‘champions’ (Yeow and Edler, 2012), and ‘intermediaries’ (Edler and Yeow, 2013). The former, who are ‘*typically powerful individuals high in the management of an organization*’ (Yeow and Edler, 2012, p.510), can overcome ‘*indifference or resistance that the new idea may provoke*’ (Rogers, 2003, p.473) through strong leadership. While the latter, who act as ‘*an agent or broker in any aspect of the innovation process between two or more parties*’ (Howells, 2006, p.720), can address various capability and linkage gaps in IOPP processes (Edler and Yeow, 2013).

Sectoral characteristics should be taken into account to realize more targeted and effective IOPP (Nyiri et al., 2007; Cave and Frinking, 2007; Izsak and Edler, 2011). When it comes to IOPP, sectors are potentially distinct from one to another since firstly, the market structure of public versus private demand can be different, and the potential for IOPP varies (Cave and Frinking, 2007). For instance, public demand is more likely to form a critical mass in the transportation sector than in the non-prescription medicine sector. Secondly, the stage of sectoral development is highly related to its key technology status in terms of TLC, which means that underdeveloped yet promising sectors with new technologies might benefit more from IOPP policies, e.g. the ICT sector (Nyiri et al., 2007) and the electric mobility sector (Izsak and Edler, 2011).

Demand articulation is a critical and challenging issue to be addressed during the early stages of the IOPP process (Rothwell, 1984; Edquist et al., 2000; Edler and Georghiou, 2007). It is defined by Boon et al. (2007) as

> *‘...an **iterative**, inherently **creative** process in which **stakeholders** try to **unravel preferences** for and address what they perceive as important characteristics of an emerging innovation’ (p.645)*

The articulation of demand on the one hand means *integrating* the demand of various stakeholders, including the *centralizing* of scattered demand to form critical mass, and in cases of catalytic and cooperative procurement, the *mobilizing* of private demand (Edler et al., 2005). On the other hand, it means *translating* the demand into specifications, so that public agencies can signal the demand explicitly and clearly to potential suppliers (Edler and Georghiou, 2007). Ideally the specifications should be about the *performance* and *functions* (describing what is to be done) rather than the design (describing how it is to be done) of new solutions, in order to allow alternative designs to emerge (Rothwell and Zegveld, 1985; Geroski, 1990).

Special procurement techniques are often needed in dealing with IOPP. In terms of tendering procedures, competitive dialogues are more suitable than open tendering for buying complex and innovative solutions to allow communication between procurers and suppliers. The FCP approach adopted by the UK (Section 4.4.2) enables very early engagement of procurers with suppliers, which can significantly reduce risks and enhance interactions. PCP of prototypes can accelerate the commercialization process and reduce suppliers' entry costs. In some cases where the needed solution is only in 'concept' phase, 'competition of ideas' can enable the emerging of alternative designs in an open way (OMC-PTP, 2009). In terms of evaluation of bids, *life cycle costing*, i.e. to evaluate the cost of solutions in terms of '*total costs incurred over the normal lifetime of product use*' (Rothwell, 1983, p.167), can be adopted to prevent innovative yet expensive solutions from being disadvantaged.

Uncertainty is an intrinsic characteristic of the innovation process (Kline and Rosenberg, 1986), thus IOPP is an uncertain and risky undertaking as well (Edler et al., 2005). Tsipouri et al. (2010) identified five major types of risks, namely *technological* (resulted from incompetence of suppliers, leading to under-performance or false performance of procured items), *organizational and societal* (resulted from incompetence or lack of acceptance on the procurer/user side), *market* (resulted from no responding suppliers or consumers), *financial* (resulted from lack of funding or failed cost control), and *turbulence risks* (specially associated with complex and large-scale projects). All these risks should be taken into account throughout the PPC (ibid.). Dealing with the above listed issues (i.e. timing, stakeholder coordination, demand articulation, and employment of dedicated procurement techniques) in a proper way can considerably reduce risks (ibid.).

Institutions play an important role in shaping IOPP processes (see Edquist et al., 2000; Edler et al., 2005; and a series of publications by Rolfstam). Rolfstam (2012a) pointed out that the institutional setup for IOPP is fundamentally *multilevel*, e.g. a simplified setup for procurement activities conducted in EU include *global*, *supranational*, *national*, *local* and *divisional* levels; a certain organization is influenced by both *endogenous* and *exogenous* institutions in its procurement activities; in reality, institutions not specific to public procurement might be applicable as well. Formal institutions such as procurement legislation are well recognized by practitioners; adjustments are being made in some contexts to create opportunities for IOPP policies (e.g. the revision of EU Directives, see Arrowsmith, 2012). Informal institutions, as argued by Edquist et al. (2000), also affect IOPP in different ways ranging from ‘complementing’ to ‘conflicting’ with formal institutions.

4.6 Conclusion

This chapter has developed an understanding of IOPP through reviewing both academic and practical achievements. IOPP can function in a number of ways corresponding to: various stages of the TLC and market development, structures of demand, and different strategic natures. In Europe, bottom-up practices emerged before top-down policy initiatives; IOPP examples have been investigated through case studies, which offered methodological implications for this study in analysing micro-level IOPP processes. A wide range of measures including individual instruments such as network-building, as well as systemic approaches such as SBIR and LMI, have been employed. Quite a few issues have been identified affecting the process and outcomes of IOPP, including timing, risk management, stakeholder engagement and interaction, demand articulation, sectoral characteristics, institutions, and procurement techniques. IOPP has characteristics of innovation e.g. uncertainty and interactive learning, and characteristics of procurement e.g. heterogeneous stakeholders.

This research area is still underdeveloped in both methodological and theoretical terms. Methodologically, case studies on concrete IOPP processes remain the dominant approach; while operational issues have been studied, evaluation of IOPP policies has not been addressed. The conceptualization of IOPP remains at the micro-level, while a holistic one embracing various dimensions is lacking. This gap is to be dealt with in Chapter 5, followed by an elaboration on the research design.

Chapter 5: Conceptual Framework and Research Design

5.1 Introduction

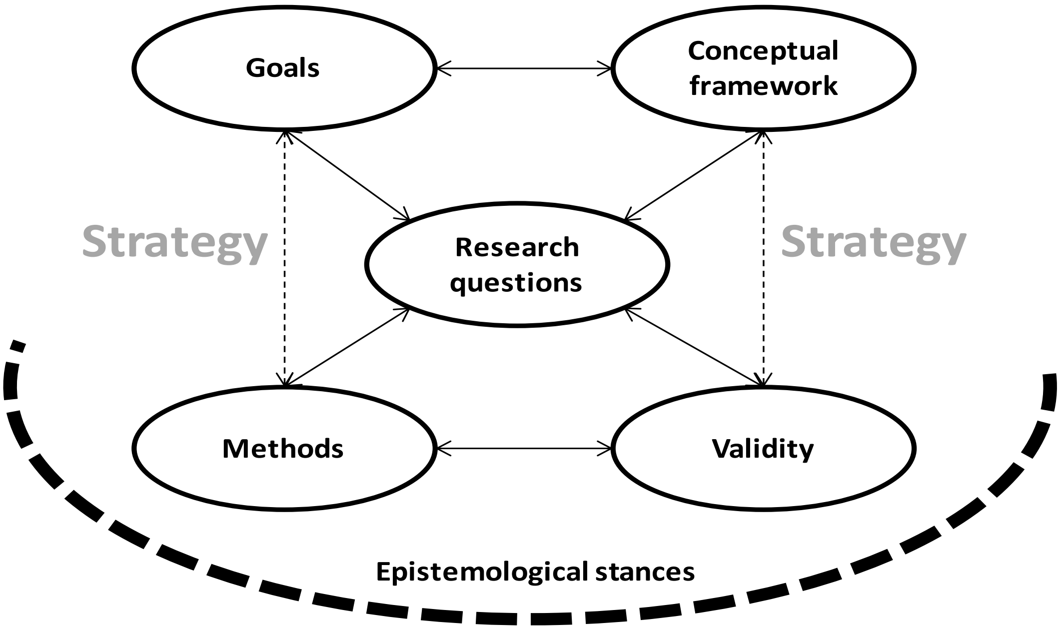
This chapter now focuses on the elaboration of the conceptual and methodological approach of the research. The research question requires an *in-depth, contextual* understanding of complex policy processes, implying a *qualitative nature* for this study (Miles and Huberman, 1994; Punch, 2005). Qualitative approaches are considered suitable for exploratory research to facilitate the development of initial, open-ended knowledge (Creswell, 2009). Evaluation researchers believe that while quantitative approaches suit purposes of 'verification', qualitative approaches suit 'discovery' oriented research (Reichardt and Cook, 1979). Qualitative approaches are considered appropriate for evaluating the 'process', 'implementation' and 'appropriateness' (Patton, 1987; Edler et al., 2012) of policies. Moreover, quantitative information available for IOPP is perceived to be deficient (Edler et al., 2012). There has been no published quantitative data reflecting the implementation status of IOPP policies in China, which prevents this study from employing mixed methods.

Punch (2005) defines research design as a broad plan for research integrating the *strategy*, the *conceptual framework*, the *research questions*, and *methodological issues*. Qualitative research design has been recognized as an interactive process which

> *'…involves **'tacking' back and forth between the different components of the design**, assessing the implications of goals, theories, research questions, methods, and validity threats for one another' (Maxwell, 2005, p.3)*

An interactive model of qualitative research design is illustrated in Figure 5.1. Although the process of designing and conducting this study has been indeed an interactive and iterative one, this chapter presents key issues in a sequential manner. Section 5.2 conceptualizes IOPP and IOPP policies by integrating key perspectives and concepts reviewed in Chapters 2-4. Section 5.3 draws from the conceptualization, and articulates the research question proposed in Chapter 1 into a set of sub-questions. Section 5.4 then proposes a strategy which links up different components of the research design together; underpinned by the conceptual framework, an evaluation framework based on a multilevel case study is developed. Section 5.5 addresses operational issues including data collection, data analysis, and ethical considerations. Section 5.6 reflects on the research design regarding validity issues and perceived limitations, followed by Section 5.7 concluding the chapter.

Figure 5.1 An interactive model of qualitative research design



Source: Author adapted from Maxwell (2005)

5.2 Conceptualizing IOPP – proposing a framework

A conceptual framework

> *'…**explains** either graphically, or in narrative form, **the main things to be studied** – the key **factors**, **concepts** or **variables** – and the presumed **relationship** among them' (Miles and Huberman, 1994, p.18).*

Serving as 'intermediate theories' (Shields and Tajalli, 2006), conceptual frameworks contribute to the research process in pluralist ways including guiding literature review, informing research design, structuring discussions, drawing conclusions and enhancing validity (Smyth, 2004). Although exploratory research does not set out to test a rigidly defined hypothesis (Reiter, 2013), methodologists insist that it still needs to depart from an 'explicitly formulated theory' (ibid. p.4) with clarified strategy and criteria for judging the quality of research (Yin, 2009). Given the lack of a ready-to-use conceptual framework in this research area, this section proposes a tentative one built upon key perspectives reviewed in the preceding chapters.

Chapter 4 has reviewed the functioning mechanisms and associated issues of IOPP. It has been manifest that IOPP processes possess characteristics of both innovation and procurement processes. Owing to the innovation dimension, IOPP processes are *uncertain* and potentially *risky*, requiring *interactive learning* between various actors. Owing to the procurement dimension, IOPP is concerned with *primary principles* such as equality and transparency, and is *constrained* by domestic as well as international regulations and political-economic circumstances. Owing to both dimensions, timing is an important issue in terms of both TLC and PPC, pointing to different functioning mechanisms and procedures of IOPP. Policy measures promoting IOPP in OECD countries have been targeted at building capabilities of both innovation and procurement practitioners, and enhancing the communication and compatibility of procurement systems with innovation systems (Table 4.3), since issues associated with IOPP implementation (Section 4.5) arise either from the innovation side (e.g. sectoral characteristics) or the procurement side (e.g. special procurement techniques), or from some commonly concerned dimensions (e.g. timing, institutions and stakeholders).

Reflecting on the issues reviewed in Chapters 2 and 3, this study considers that the innovation process is the core element shaped by institutions, actors and interactions within the *innovation system* (Section 2.2), and that the procurement process is the core element shaped by institutions (procurement regulations and norms), actors and interactions of the *procurement system* (Section 3.2). IOPP can be considered as an activity in the innovation system, similarly it is also an activity in the public procurement system. Here it is useful to draw from the classic *General System Theory* (Bertalanffy, 1968), which argued that systems are '*organized complexities*' (p.17) that exist '*everywhere'* (p.1), constituted of *interrelated and interacting elements*; social phenomena are essentially *open systems interacting with their environments* (contexts). This 'system thinking' enables further conceptualization of IOPP as *an interactive phenomenon embedded in both innovation and procurement systems*; a fundamental difference between IOPP's two facets lies in what is its priority – for innovation system it is certainly to stimulate and facilitate innovation, while for procurement system it might need to give way to other goals.

Institutions from both the innovation and procurement systems (e.g. technological standards and procurement laws) can influence the conduct of IOPP; *actors* from both systems are involved in IOPP processes (e.g. suppliers, users, procurers, and intermediaries); furthermore, *interactions* between actors from both systems can influence IOPP processes (e.g. procurer-supplier interactions). Metaphorically IOPP operates at the 'intersection' of innovation and procurement systems, shaped by institutions, actors and interactions of both systems. Interactions between supply-side and demand-side actors from the two systems can be enhanced through intermediaries who serve as brokers, experts, performers and/or trainers. Meanwhile, innovation and procurement systems are affected by their contexts constituted of both domestic and international circumstances. Hence IOPP is also influenced by those broader contextual factors (e.g. trade frictions between countries in the case of China). The IOPP process itself is by nature *interactive learning processes between actors from innovation and procurement systems*. The overall picture of IOPP can be considered as a 'system mix' vis-à-vis 'policy mix'.

The boundary of an innovation or public procurement system here can be various, depending on the scope of involved institutions and actors. It can be supranational (e.g. in the case of the EU), national, regional (e.g. in the case of a federal state with autonomous innovation and procurement systems) or sectoral (e.g. in the case of the Chinese railway system whose procurements are beyond the scope of LGP, Wang, 2009). Hence for China such a big country with unevenly developed regional innovation systems (Section 2.5) and fragmented procurement regimes (Section 3.4), the national innovation and procurement systems are actually 'clusters' of intertwined sub-systems.

This section now moves from the micro-level processes of innovation, procurement and IOPP to higher levels of policy processes. As addressed in Section 2.2 the position of policies in innovation systems is considered as driving forces influencing innovation processes. Similarly policies in procurement systems are considered as playing equivalent roles in influencing procurement processes. Policies with their rationales, instruments and target groups can impact on innovation/procurement processes to move towards desired policy goals. The concept of 'policy mix' (Section 2.3.3) is helpful here to conceptualize the relationship between innovation/procurement processes and policy processes. Figure 2.3 offers an idea of linking policies with innovation and procurement processes; the left hand side is essentially dynamics of actors, institutions and interactions; the right hand side is essentially various dimensions of policy design.

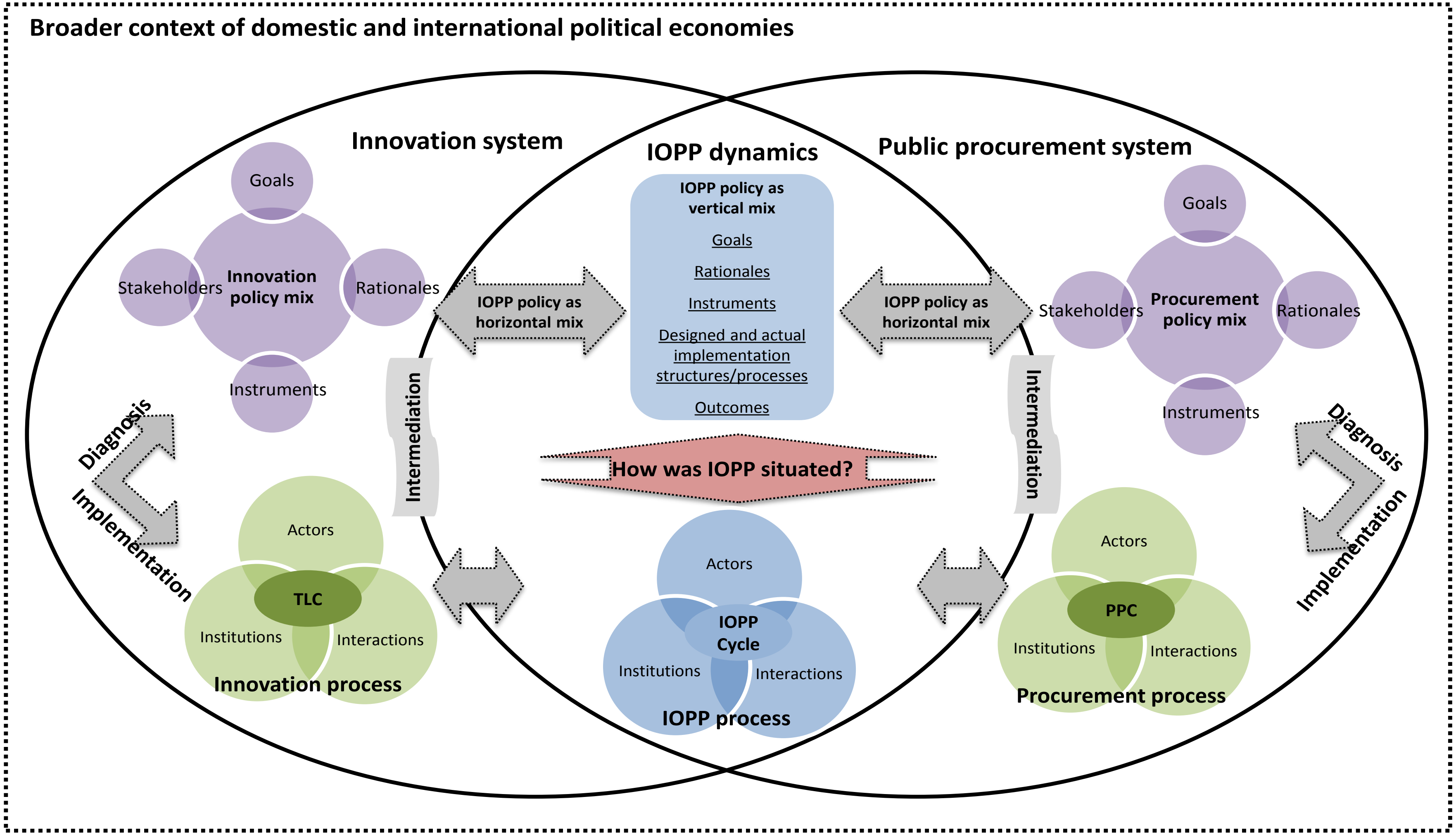
In order to link up the *design*, *articulation* and *implementation* stages of policy processes with micro-level innovation and procurement processes, this study carries on with this idea and extends vertical dimensions in Figure 2.3 by including *designed* *implementation structures, actual implementation processes,* and *outcomes*. Without the presence of IOPP policy mandates, innovation policies and procurement policies function in their *own* domains, although there might be some interactions between the two, e.g. *occasional* IOPP cases that emerged from bottom up (Section 4.4.1). With deliberate IOPP policy mandates, innovation and procurement systems are desired to *interact* with each other to enable the implementation of IOPP. Micro-level processes can be understood as manifestation of policy implementation. Implementation processes might or might not follow the designed pathways, affected by various factors during the course (Section 2.3.5). *Diagnosing* micro-level processes (e.g. detecting '*system failures*'[15], Section 2.3.1) can enable policy evaluation and inform future policy design.

Through the lens of 'policy mix', IOPP policy can then be conceptualized as being constituted of two dimensions, i.e. a horizontal dimension and a vertical dimension. Horizontally IOPP policy is *a cross-domain mix of innovation and procurement related interventions*, while vertically IOPP policy is *a mix of goals, rationales, instruments, designed implementation structures*, *actual implementation processes*, *and outcomes.* As suggested by perspectives reviewed in Section 2.3.4, the 'fit', 'feasibility', 'alignment', 'logical consistency', 'compliance' and 'overall coherence' between various elements along both horizontal and vertical dimensions are prerequisites for the *appropriateness* and *effective implementation* of a policy. Among those terms, ***coherence***, i.e. the quality of '*being logical and consistent*' and '*forming a unified whole*' (Oxford Dictionaries) is the most inclusive one to capture those prerequisites. ***Coherence of both the vertical and the horizontal dimensions of IOPP policies can be employed as a criterion for evaluating appropriateness and implementation***. This study titles the two dimensions of coherence as *vertical coherence* and *horizontal coherence* respectively, which will be further elaborated in Section 5.4.2.

A simplified, visualized version of the conceptual framework is presented in Figure 5.2. The centre of the diagram is the research question proposed in Chapter 1, which will be articulated in next section.

[15] It should be noted that the concept of 'system failures' applies not only to innovation systems but also to various types of systems (Chapman, 2004).

Figure 5.2 A 'system mix' – 'policy mix' conceptualization of IOPP



Source: Author

5.3 Articulating the research question

Chapter 1 proposed a tentative research question i.e. ***how was IOPP situated in the context of China?*** Underpinned by the conceptual framework, this research question is restructured to reflect the focus of this study, and articulated into a set of sub-questions (SQs) to serve as the '*hub…to connect all of the other components of the design, and should inform, and be sensitive to, these components'* (Maxwell, 2005, p.5).

Main Research Question: ***How was the use of public procurement as an innovation policy mediated by the innovation and procurement systems in China?***

SQ 1: What was the contextual situation for IOPP in China in terms of the innovation and procurement systems? (Addressed in Chapters 2, 3, 4)

SQ 2: How did IOPP policy originate, and how was it articulated from an overall strategy into specific, innovation and procurement related interventions? (Addressed in Chapter 6)

SQ 3: How were the concrete implementation processes of IOPP conducted driven by those interventions? (Addressed in Chapter 7)

SQ 4: How did the actors (including but not limited to suppliers, users, procurers and intermediaries), institutions, and their interactions, from innovation and procurement systems, shape the IOPP dynamics and affect the implementation of IOPP policies? (Addressed in Section 8.2)

SQ 5: How was China's IOPP policy expressed in terms of vertical coherence i.e. were its goals, rationales, instruments, designed implementation structures, actual implementation processes, and outcomes coherent with each other? (Addressed in Section 8.3)

SQ 6: How was China's IOPP policy expressed in terms of horizontal coherence i.e. has there been any lack of coherence between it and the innovation and procurement systems, and broader contexts of the two? (Addressed in Section 8.4)

SQ 7: How did the IOPP practices of China (a catching-up country) differ from those of OECD countries (developed countries)? (Addressed in Section 8.6)

These questions are located illustratively in the research framework (Figure 5.3).

5.4 Research strategy – a multilevel, evaluative case study

Based on the conceptual framework and the research questions elaborated above (i.e. the upper triangle of Figure 5.1), this section attempts to provide linkages between various components of the research design, and move on to the bottom triangle i.e. methodological issues.

5.4.1 Epistemological stances

A clarification of epistemological stances is helpful to maintain the coherence throughout the conduct of research, to realize the 'fit' of different components, and to enhance the internal validity (Punch, 2005). This thesis adopts a *critical realist* perspective underpinned by a *stratified* social ontology (Fleetwood, 2005; Easton, 2010). It is believed that human beings can explore the reality of world only to a certain extent (Danermark et al., 2002). The mission of social sciences should be uncovering the *causal mechanisms* underpinning social phenomena as much as possible, rather than searching universal regularities and making predictions (ibid.). Knowledge should be evaluated according to its *explanatory power* and *practical adequacy* (Sayer, 1992).

Methodological implications of critical realism for this study are twofold. The first is *contextualization*, i.e. all causal mechanisms should be analysed with their contexts taken into account since the social world is essentially an open system which continuously interacts with its context (Sayer, 1992; Danermark et al., 2002). The second is the *retroduction* mode of inference, i.e. an inference approach that involves *interplays of induction and deduction* (Harrison, 2002). Retroduction normally moves from description of empirical entities, to analysis of the phenomena and eventually reconstructing the preconditions that determine these entities to be what they are, i.e. the *causal mechanisms* (Easton, 2010). Descriptive reporting of empirical data should aim to reflect what 'actually' happened in context; once 'what happened' and 'how they happened' have been addressed descriptively, synthetic analysis is supposed to be in an explanatory fashion, aiming to uncover the causal mechanisms that made things happen in a certain way.

As the three major purposes of inquiry identified by methodologists (Robson, 2002), *exploration, description,* and *explanation* are not mutually exclusive; instead, '*the* *purpose may also change as the study proceeds*' (ibid. p.58). Furthermore, an 'evaluation' is, rather than a 'new or different research strategy', '*a study which has a distinctive purpose*' (ibid. p.202); evaluation of policy implementation is considered compatible with exploration and description (Stebbins, 2001; Patton, 1987). For this thesis, 'exploration' is the '*grand'* purpose of opening up a new area of knowledge; 'description' is an '*intermediary*' purpose which will lead to 'evaluation', the *immediate* purpose of evaluating the Chinese IOPP approach, and to 'explanation', pursuing an in-depth understanding of the subject.

5.4.2 A multilevel evaluation framework

Evaluation research is

> *'…essentially* ***indistinguishable*** *from other research in terms of design, data collection techniques and methods of analysis' (Robson, 2002, p.204).*

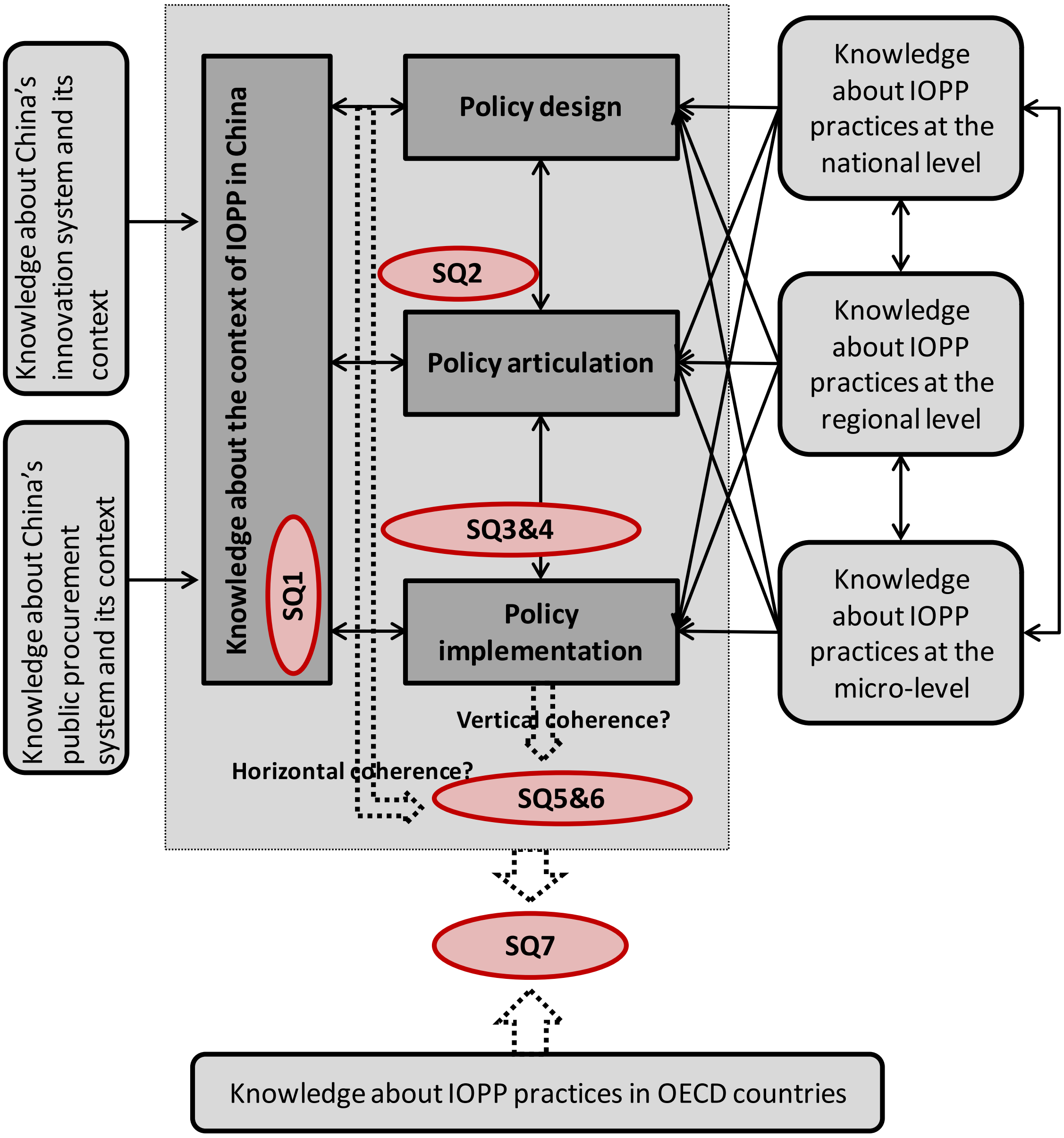
A wide range of practical methods can be employed to conduct qualitative, process evaluations (Patton, 1987). The crucial factor determining the choice of methodologies lies in the research questions, conceptualization and other considerations such as social, political and utility issues (ibid.; Clarke and Dawson, 1999).

As addressed in Chapter 1, this study considers the policy process constituted of three levels, i.e. the *top/macro level of policy design*, the *intermediary/meso level of policy articulation*, and the *micro level of policy implementation*. More specifically, 'policy design' is defined as *the process of analysing and identifying the problem, specifying the policy objective, and conceptualizing and selecting specific prescriptions for achieving the policy objective* (Adach, 2011). 'Policy articulation' is defined by this study as *the process of taking a policy written at a higher level of principle and breaking it down into its key components, and the ways in which they are related, which may then be implemented*. Adding this intermediary level is necessary in order to delineate the vertical mix of a policy. 'Policy implementation' is defined as *the process by which a policy is turned into actions which have been given the specific objectives and resources needed to progress that policy*.

In the context of China these three conceptual levels in general mirror the *national, regional and micro levels* in practice. The *national* level concerns the design and articulation of IOPP policies by the central government including the State Council and the ministries. The *regional* level, including provinces/municipalities and lower-level localities, is the intermediary level that links macro-level policies to micro-level practices, playing a critical role in shaping the process of policy implementation. For IOPP the *micro* level mostly concerns procurement processes. A scoping of secondary data suggested that there had been IOPP examples stimulated by IOPP policies in certain regions in China. Studies on these examples, similarly to the case studies summarized in Table 4.2, can help understand the micro-level IOPP dynamics.

Guided by the conceptual framework, the evaluation framework (Figure 5.3) looks into the three levels of policy process, and vertical and horizontal coherence issues.

Figure 5.3 A multilevel evaluation framework for IOPP policy in China



Source: Author

Research sub-questions (SQs) are located in the context of conceptual issues (items within the shaded box in the middle of Figure 5.3), and conceptual issues are translated into practical issues for which empirical knowledge (i.e. knowledge about China's innovation and public procurement systems and each system's contexts, knowledge about IOPP practices at the national, regional and micro levels, and knowledge about IOPP practices in the broader, international context) is needed. Various aspects are linked together through data analysis. This approach is consistent with perspectives raised in Edler et al. (2012), that both the horizontal and the vertical coordination issues should be considered in evaluating implementation, and that evaluation should connect '*at least the micro and the meso if not the macro levels*' (p.12).

Section 5.2 proposed vertical and horizontal coherence as a criterion for evaluating appropriateness. The definition of these terms and concrete approaches used by this study are clarified in Table 5.1.

Table 5.1 Vertical and horizontal coherence as a criterion for evaluation

	Vertical coherence	**Horizontal coherence**
Definition by this study	The status that goals, rationales, instruments, designed implementation structures, actual implementation processes, and outcomes of the IOPP policy are logically consistent with each other. *Designed* coherence is a prerequisite for *actual* coherence.	The status that IOPP policy is coherent with horizontally-linked policy domains, i.e. the innovation system and the procurement system, including innovation and procurement related policies beyond deliberate IOPP policies.
Approach by this study	• Designed vertical coherence Justifying the rationale and logic of the policy design; *implementability*; from goals to implementation structures, are all the elements coherent? Any mismatches? • Actual vertical coherence Judging the *actual implementation* of the policy. From design to implementation, and from outcomes back to goals, are the elements coherent? Any mismatches?	• Detecting '*lack of coherence*' 'Lack of coherence' can be adopted as a qualitative indicator for evaluating coherence; it would be manifested for example in the policy domains proceeding under their own logic without regard for other domains, and potentially therefore creating *contradictions* and *inconsistencies*. Lack of coherence may result from the *existence of factors hindering policy process*, or from *the absence of factors supporting policy process*.

Source: Author

Underpinning the approaches and definitions is the notion of a 'logic model' (Jordan, 2010) or 'logic chart' (Edler et al., 2012) in '*relating activity to objectives and effects*' (ibid. p.3). Although logic models/charts have been predominantly used in programme evaluation and should ideally be embedded in the programme design process already to build 'shared understanding of performance expectations' (Jordan, 2010, p.271), this thinking facilitates this study to '*check the logical consistency of an intervention*' (Edler et al., 2012, p.7), as demonstrated through the cross-level and cross-domain analysis in Chapter 8.

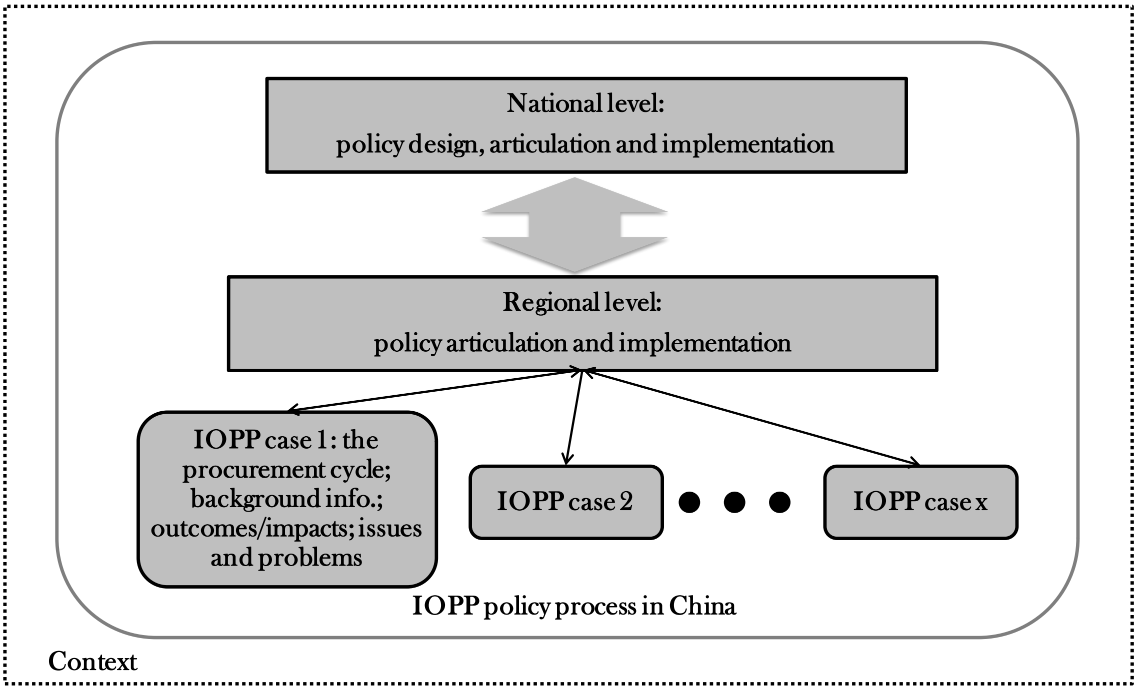
5.4.3 Case study – justification and design

The case study research strategy, defined as '*an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context*' (Yin, 2009, p.18), is especially relevant for answering 'how' questions requiring no control of behavioural events (Hartley, 2004). It is well suited for the qualitative, exploratory, contextual characteristics of this study. Furthermore, case study has been increasingly applied to the area of evaluation research, and recognized as being instrumental for understanding policy implementation processes (Hill, 1997; Patton, 1987; GAO, 1990; Uyarra, 2003; Yin, 2009). In addition, as reviewed in Chapter 4, the case study approach is popular among IOPP researchers; adopting a similar approach can enable this study to benefit from the achievements of existing literature. At the epistemological level, case study has been justified as being coherent with the critical realist stance taken by this study (Easton, 2010).

Determined by the evaluation framework, this thesis as a case study is a multilevel one, covering the national, regional and micro levels of the IOPP policy process in China. In particular, multiple regions have been approached to explore the regional level, and multiple IOPP procurement examples have been investigated to explore the micro level. This design of case study is similar to what Yin (2009) titled 'embedded case study design', which is constituted of several levels of analysis and different units of analysis are adopted at each level. The three types of unit of analysis adopted in this study are, micro-level IOPP case centred on procurement cycles, IOPP policy channels crossing multiple levels of governance, and the 'larger unit of analysis' (ibid. p.52), i.e. China's IOPP policy process.

The design of the case study is briefly illustrated in Figure 5.4. The boundary of each level and unit was further clarified through the first round of fieldwork (Section 5.5.1.2). Since the whole thesis is dealing with one case only, i.e. the case of China, the term 'case' is adopted to refer to concrete IOPP examples; when this thesis talks about 'IOPP case', it means one procurement, or several very closely-related procurements (see the IOPP cases in Chapter 7). As implied by case studies reviewed in Section 4.4.1, the descriptive part of micro-level IOPP cases need to cover at least four types of information, i.e. background knowledge (including the policy, the business sector and the technology); basic information about the innovative solutions and stakeholders (what was procured, by whom and for what reasons); information about the procurement cycle (e.g. specifications and procedures); and outcomes/impacts and problems encountered.

Figure 5.4 The design of a multilevel, embedded case study



Source: Author

5.5 Research operationalization

5.5.1 Data collection

5.5.1.1 Data collection methods – interviews and documentation

The use of *multiple* sources of data *converging on the same facts or findings* is highly encouraged to enhance the validity of case study research (Hartley, 2004; Punch, 2005; Yin, 2009). Both primary and secondary data were collected to build the cases and develop the knowledge required by the evaluation framework illustrated in Figure 5.3.

For primary data collection the main method adopted was interviews supplemented with questionnaires sent out to potential interviewees beforehand (i.e. 'pre-interview' questionnaires). Interviews, '*whose purpose is to gather descriptions of the life-world of the interviewee with respect to interpretation of the meaning of the described phenomena*' (Kvale, 1983, p.174), is the dominant one among various data collection methods in qualitative research due to its capability of capturing contextualized, rich data in a flexible way (Robson, 2002; King, 2004a). For case study, interviews have been recognized as 'essential sources' of evidence through which well-informed interviewees can provide insights into human affairs or behavioural events (Yin, 2009). For IOPP research which potentially sounds unfamiliar to Chinese IOPP practitioners, using interviews can enhance the interactions between researchers and informants, so that conceptual ambiguity[16] can be avoided.

For secondary data the main source was documentation, which can be used flexibly under different epistemological paradigms and methodological strategies (Punch, 2005). For policy related research it is especially instrumental since government policies and analytical reports normally take the form of documentation. Types of documentation involved in this study, besides the above mentioned policy documents, include mass media coverage on technologies and markets, organizational websites, technology catalogues published by governments, and documents collected from the field which are not available online. However, it has been warned by methodologists that the accuracy of documentary data should not be taken for granted; the use of them should be carefully organized, ideally drawing upon more than one information source (Yin, 2009). To enable the tracing back to original documents for this study, digital documents were carefully saved and stored in the portable document format (pdf).

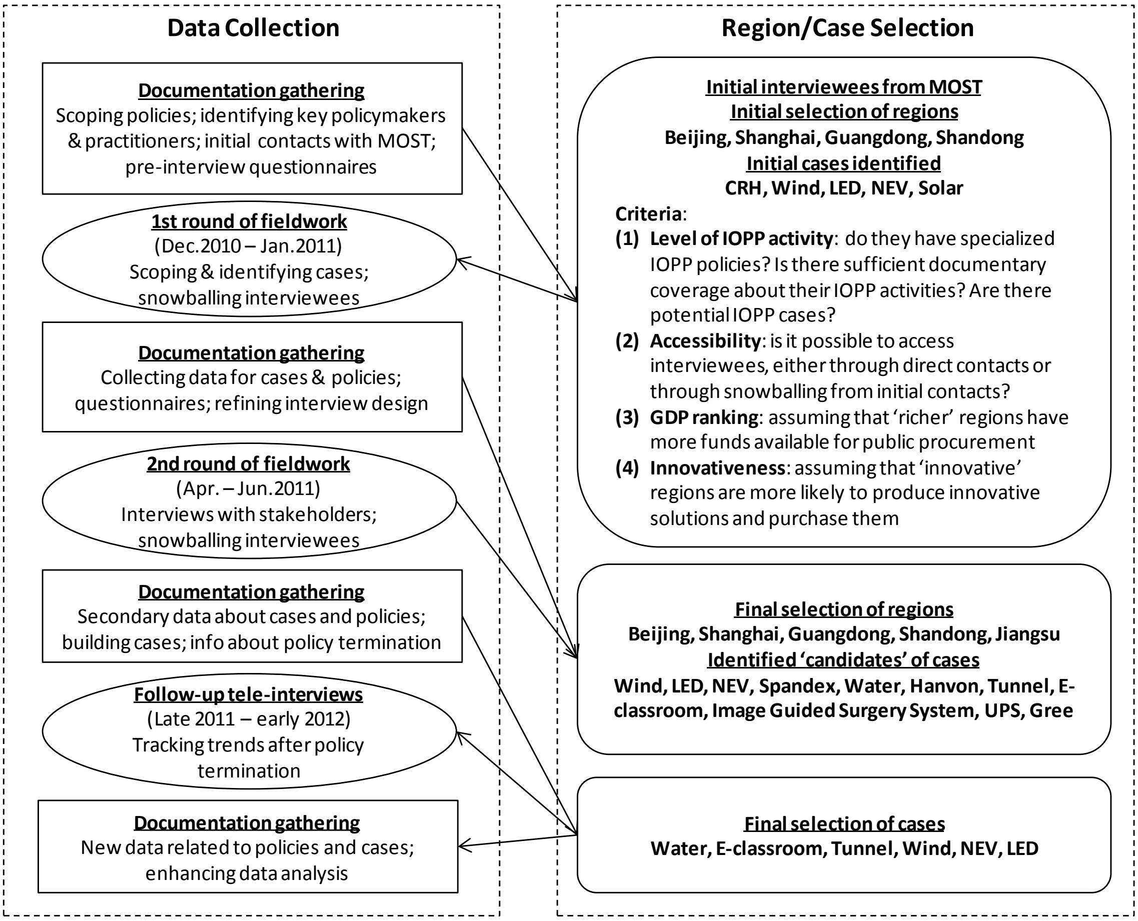
5.5.1.2 An iterative process of case selection and data collection

Due to the vastness of the subject, this study decided to select only a limited number of regions and their related IOPP cases to examine. This is an issue of 'purposive sampling' which is the most common technique used in qualitative research (Miles and Huberman, 1994). The selection of regions, cases and interviewees in this study was not finalized before, but evolving *after* the fieldwork started, which is one of the 'key features of

[16] For example practitioners might possess various understandings of innovation; IOPP might have occurred in some cases that practitioners did not see it as IOPP, thus interactions with and explanations to them are necessary.

qualitative sampling' (ibid. p.27). The overall process is an iterative one, illustrated in Figure 5.5.

Figure 5.5 An iterative process of case selection and data collection



Source: Author

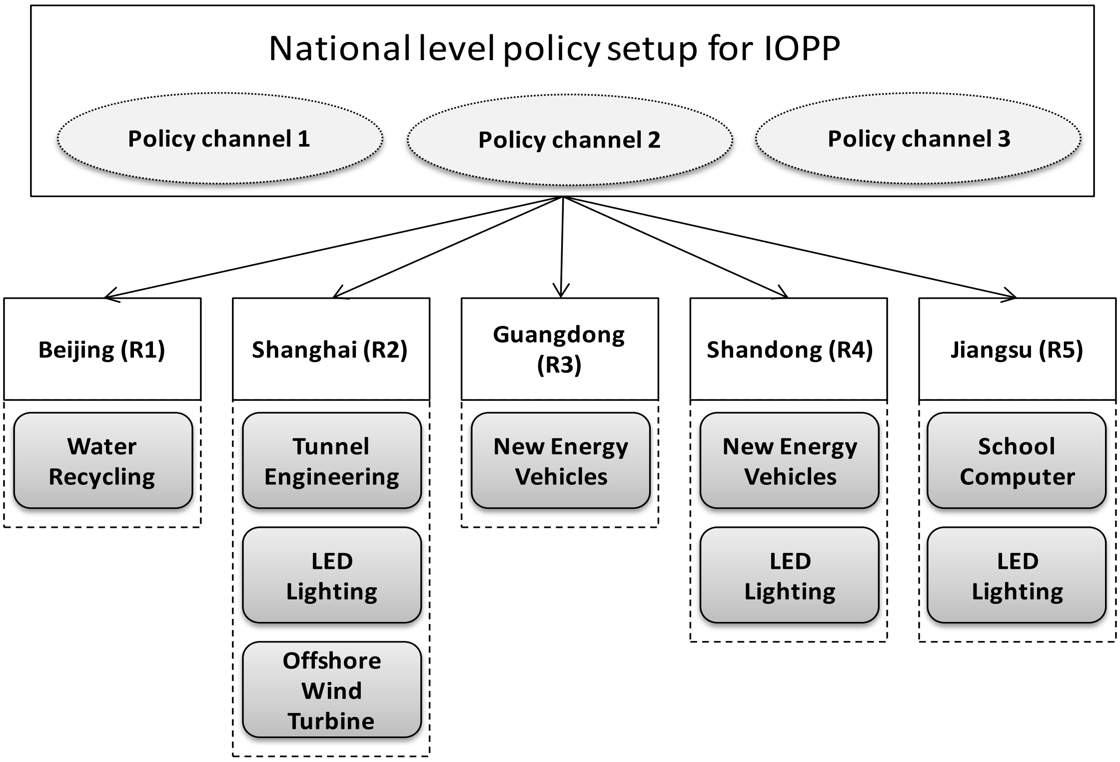
Four major criteria were adopted to select the regions, namely *level of activity in terms of IOPP*, *accessibility to interviewees*, *GDP ranking*, and *innovativeness ranking*. The former two dimensions are concerned with the sufficiency of secondary and primary data. These are important for this exploratory study on policy processes situated in the context of China, where the political system is frequently criticised as being 'opaque' (Martin, 2010) and gaining access to data is perceived very challenging (Heimer and Thøgersen, 2006). Although this topic is not supposed to be sensitive, the opaqueness of policy processes in China and the US-China disputes over 'indigenous innovation' (O'Brien, 2010) added some political sensitivity to it. Hence accessibility to data is an essential criterion for choosing regions, cases as well as interviewees. The latter two dimensions are based on analysis of policy documents and Chinese literature which suggested that regions tend to procure their own innovative products rather than products from other regions; hence it is assumed that wealthier and more innovative regions are more likely to generate IOPP cases.

Five regions were selected, including two municipalities (Beijing and Shanghai) and three provinces (Shandong, Jiangsu and Guangdong). These five regions are among the most developed in China, all situated along the coastline in the East (Wu, 2002). Considering that different regions in China are unevenly developed, this selection is definitely not representative. Rather the sample is fairly ‘homogeneous’ (Miles and Huberman, 1994), to enable the initial attempt to look into micro-level IOPP cases in China. An *extensive* scoping of secondary data regarding IOPP policy actions across all the provinces and municipalities has been carried out to complement this *intensive* understanding about particular regions. This integration of overall understanding of the subject as a whole (i.e. IOPP in the country of China) with intensive understanding of specific units of analysis is necessary since, as argued by Yin (2009), a major pitfall of embedded case study design is that it easily ‘focuses only on the subunit level and fails to return to the larger unit of analysis’ (p.52).

After the regions were selected, IOPP cases were chosen according to, firstly, ***whether the case is qualified as an IOPP case*** (i.e. was it public procurement? Was there innovation created, improved, adapted or diffused because of the procurement?); secondly, ***interviewees’ recommendations*** **and** ***promised access to further interviewees***; and thirdly, ***secondary data coverage on the case***. Interviewees for each IOPP case should ideally cover the range of stakeholders; this turned out to be extremely difficult in practice. What was accomplished was that at least two types of stakeholders were interviewed for each IOPP case. Beyond the stakeholders involved in IOPP processes, another type of interviewee was that of *researchers* closely related to this topic; their insights contributed to the author’s understanding of international IOPP research and practices. Some interviewees during the second trip were not ‘planned’, but ‘snowballed’ in the field from earlier interviewees. ‘Snowballing’ is a frequently used technique to sample and get access to respondents (Brammer and Walker, 2011), especially for politically sensitive areas or research that needs high-status interviewees (Beamer, 2002).

After fieldwork, final IOPP cases (as illustrated in Figure 5.6) were decided through screening out unqualified 'candidate cases' (Yin, 2009). IOPP cases in this study fall into two broad categories. One category is IOPP cases occurred within certain regions e.g. the Tunnel Engineering case; the other category is cross-region cases with multiple sub-cases e.g. the Light-emitting Diode (LED) Lighting Programme. It should be noted that although the explicit national policy on IOPP was through the use of 'innovation catalogues', cases recommended by interviewees were mostly *not* stimulated by the catalogue approach (see the following chapters).

Figure 5.6 IOPP cases identified



Source: Author

5.5.1.3 Interview design and implementation

To design interviews two key issues need to be addressed, i.e. what type of interviews to choose, and what questions to ask (King, 2004a; Kvale, 2007). The choice of interview type depends largely on the degree of *flexibility* or the data collection *stage* of the research (Turner, 2010); questions in the protocol are supposed to be inherently '*narrowing of the central question and sub-questions of the research study*' (Creswell, 2007, p.133). A distinction is usually made between *fully-structured*, *semi-structured*, and *unstructured* interviews (Robson, 2002). Fully-structured interviews have pre-determined questions with fixed wording; semi-structured ones have pre-determined main questions, but concrete questions, sequence and wording can be decided according to the interview context (ibid.). Semi-structured design was preferred by this study since it is *focused enough* to follow a settled research protocol as well as *flexible enough* to be carried out in the form of guided conversations. Unstructured interviews do not have lists of specific questions, but are very open-ended and in-depth (Robson, 2002).

Interviewees approached by this study covered different roles of stakeholders situated at different levels of governance. The design of interview protocols considered the specific features of each type of interviewee. Interviews with the two national-level, high-status officials in the first fieldwork trip were unstructured since the main objectives were to explore what was going on in as much as possible depth, to establish connections and to snowball further informants. As for researchers, interviews were unstructured to enable exchange of peer ideas in a freer style. A summary of the topics covered in unstructured interviews is presented in Appendix 8. Semi-structured interviews were used for the other interviewees. Core questions are summarized in Table 5.2. Interview protocols are attached as Appendix 9. Protocols were designed based on research sub-questions, issues implied by the literature, and interviewees' answers in questionnaires; they were refined during and after the first fieldwork trip.

Table 5.2 Core questions covered in semi-structured interviews

Type of interviewee	Core questions asked in semi-structured interviews
STI officials **Finance officials**	• How have the making and implementation of IOPP policies been conducted from the perspective of you and your department? • What are your knowledge, opinions and (if applicable) experience with respect to this/these IOPP case(s)?
Suppliers	• How has the experience of you and your company been like with respect to (national as well as regional) IOPP policies? • Could you please describe in detail the process of this IOPP case?
Procurers	• How has the experience of you and your organization been like with respect to (national as well as regional) IOPP policies? • Why and how did your organization carry out this procurement?
Users	• How has the experience of you (and your organization if applicable) been like with respect to IOPP? • How was your experience with respect to this IOPP case, and with respect to the use of the products/solutions procured?

Source: Author

There was a risk that unknowledgeable interviewees could be selected. Pre-interview questionnaires helped to gain information about the potential interviewees' background, knowledge and basic attitudes about IOPP. This was also a structured way of primary data collection. A questionnaire example is presented in Appendix 7.

In total 52 questionnaires were collected; 49 interviews were conducted, *excluding* follow-up telephone interviews which were very short (less than 20 minutes) with limited information collected. Primary data collected are briefly summarized in Table 5.3. For more details regarding data collection see Appendix 5.

Table 5.3 Brief summary of primary data collected

Category	Quantity	Details
Pre-interview questionnaires See Appendix 7 for a sample	52	• Sent out to potential Chinese interviewees • Covered issues such as stakeholders' background, experience, and attitudes regarding IOPP; requesting for recommendations of IOPP examples
Interviews[17] For detailed summary of interviews see Appendix 10	49	• 43 semi-structured, 6 unstructured • 46 in Chinese, 3 in English • 8 in December 2010 (1st fieldwork trip for scoping), 39 in April-June 2011 (2nd fieldwork trip), 2 in Europe afterwards • 19 STI officials (including S&T, industrial, and sectoral officials), 7 finance officials and procurers, 16 suppliers, 3 users, 4 researchers • 4 from the national level, 7 from Beijing (R1), 10 from Shanghai (R2), 6 from Guangdong (R3), 10 from Shandong (R4), 10 from Jiangsu (R5), 2 from EU
Follow-up telephone interviews	10	• Conducted in late 2011 and early 2012 to check stakeholders' opinions after policy termination • With interviewees NO_2, R1O_1, R2O_1, NA_LED, R4O_2, R5O_1, Researcher_2, R5F, R1S_HV, R1S_OW; (text messages were sent to all reachable Chinese interviewees; telephone interviews were done with the ones who replied and were available)

Source: Author

[17] During the course of fieldwork, more than 80 informants were approached for interviews, information, or snowballing interviewees. Conversations with some informants were very short and were not counted as interviews; nevertheless, these conversations contributed to the building of certain cases, and to the overall understanding of the subject. Meanwhile, data from some interviews e.g. Spandex, CRH, Solar and Havon were not explicitly used to build cases as those procurement examples were screened out afterwards (see Figure 5.5 and Appendix 5).

5.5.2 Data analysis – overview of the approach and techniques

Data analysis in this study, which should '*rely on theoretical propositions... that led to your case study*' (Yin, 2009, p.130), is inherently guided by the theoretical propositions outlined before, i.e. the conceptual framework (Section 5.2), research questions (Section 5.3) and the research strategy (Section 5.4), with IOPP issues reviewed in Chapter 4 taken into account.

Three rounds of analysis were implemented in a *retroductive* manner, going deeper and deeper. The first was what Miles and Huberman (1994) titled 'early steps in analysis' (p.50), involved with coding, mapping interviews into cases and themes, and pre-structuring. The second was writing up individual, descriptive pieces about policy settings and IOPP cases (i.e. 'within-case displays', ibid. p.90). The third moved further to seek patterns and explanations, attempting to answer the research question.

The analysis is constituted of three major parts:

(1) **Policy process analysis** about the *design*, *articulation* and *implementation* of IOPP policies at the national and regional levels. Informed by implementation analysis perspectives reviewed in Section 2.3.5, this study integrates the top-down and bottom-up approaches into a *reiterative* one through *interactions* between documentation and fieldwork. An outcome is that two more 'hidden' IOPP policy channels were identified, which would not have been achieved through a purely top-down or bottom-up approach. This part of analysis is presented in Chapter 6.

(2) **Case studies** of concrete, micro-level or cross-level IOPP processes, using data collected from both interviews and documentation in a *converging* pattern. Template and chronological analysis is conducted to cover issues related to the background and the procurement cycle. This part of analysis is presented in Chapter 7.

(3) **Synthesis** of the above two aspects. Firstly cross-case comparative analysis is conducted to identify patterns; secondly cross-level analysis is conducted to connect the three levels of policy process and evaluate the vertical coherence; thirdly cross-domain analysis is conducted to compare Chinese IOPP dynamics with contextual issues and identify horizontal 'lack of coherence'. This part of analysis is presented in Chapter 8.

Concrete analysis techniques employed were drawn from methodology literature as well as IOPP literature. *Cognitive mapping* as a technique for visualizing the relations among data (McDonald et al., 2004) was used for initial, raw analysis (i.e. the first round of analysis) and data management. *Template analysis* (i.e. using a designed 'template' to represent themes identified in the textual data, King, 2004b) supplemented with *chronological* or *time-series analysis* (Yin, 2009) was adopted for later stages of characterizing policy channels and cases. In particular, templates for IOPP cases were developed based on existing examples as reviewed in Section 4.4.1. Chronological analysis considered timelines of policies, technologies and procurement cycles. Techniques of *comparison* are extensively adopted to synthesize cross-case, cross-level and cross-domain findings, and enable the evaluation of coherence.

5.5.3 Ethical considerations

Ethics, i.e. *conformity to a code of moral conduct* (Robson, 2002), is an important issue that all researchers (especially social researchers doing qualitative research) need to consider when conducting '*real world studies*' (ibid., p.65; Miles and Huberman, 1994; Orb et al., 2000; Robson, 2002). As Maxwell (2005) insisted, '…*ethical concerns should be involved in every aspect of (research) design*' (p.7). This study has made several efforts to protect informants and live up to ethical standards, using the checklist of ethical issues summarized in Punch (2005).

These efforts included that, before the fieldwork trips, sending an *introduction to the topic* with ethical issues considered (see Appendix 6); right before the interviews, *consent forms* were presented and explained, and signed by interviewees (i.e. ' informed consent', Orb et al., 2000, p.94); during the transcribing, analysis and writing up stages, all the interviewees were *anonymized*. Although this subject of research is considered a politically sensitive one, it is not as ethically sensitive as studies related to individuals, so these efforts are considered sufficient to protect informants' rights.

5.6 Validity issues and limitations

The evaluation of qualitative research adopts inherently different criteria from that of quantitative research (Golafshani, 2003). While the latter normally includes 'reliability' as an essential criterion (i.e. results should be replicable through repeating the same research processes), researchers in the qualitative paradigm argue that replication is not applicable for qualitative studies (Stenbacka, 2001). Golafshani (2003) argued that 'reliability is a consequence of the validity' (p.602), and a broadened concept of 'validity' is gaining ground. Yin (2009) distinguishes among *construct validity* (i.e. the correctness of arrangements of operational measures), *internal validity* (i.e. for explanatory studies only, seeking to establish causal relationships; this is coherent with the critical realist view of 'explanatory power', Sayer, 1992) and *external validity* (more frequently known as 'generalizability').

To enhance the construct validity, this study on the one hand attempted to strengthen the logical link between various components of the research design (e.g. the conceptual framework – research questions – research strategy – research methods link), and on the other, justify the feasibility of each stage of the research process (e.g. the sampling strategy and data collection techniques). Internal validity is addressed during the synthetic, explanatory analysis stage, by taking tactics suggested by Yin (2009) such as 'pattern matching' and using 'logic models' (pp.41-43). The enhancing of generalizability is built on the critical realist understanding of generalization, which considers *analytic generalizability* as the criterion, i.e. the ability of the findings to explain phenomena in other contexts (Sayer, 1992; Easton, 2010; Yin, 2009). Although this is by nature a single case study on China, its analytic generalizability is enhanced through measures such as a multi-level case study design with lower levels constituted of multiple units of analysis to enable comparison across cases, levels and domains; a review of international research and practices enabled comparison between China and other countries. Triangulation of data sources and analytical methods has been implemented to enhance all of the three kinds of validity.

The efforts made do not mean that this research design has no limitations. Primarily due to the complexity and limited access to the research object (including the difficulty to establish connections, and the limited fieldwork time and budgets), the sampling and types of interviewees consulted have some drawbacks. To realize the depth required by qualitative research, the sampling was purposive, with five of the most 'IOPP-active' and accessible regions selected. Although the national and regional level analysis is supplemented with an extensive policy search across the 31 regions, there is still a risk that some valuable evidence beyond the five regions might have been missed. The identification of policy channels and IOPP cases, rather than being linear and sequential, was an iterative and interactive process, thus the selection of micro-level cases was not perfectly controllable. Instead of evenly corresponding to the three channels of policies, five of the nine cases were located in Channel 3, while for Channel 2 only limited primary data were collected in the context of Shanghai. The numbers of different types of interviewees accessed were not balanced, e.g. at the national level, only the MOST, a national-level alliance and a research institute were approached, while attempts to approach MOF and NDRC failed; fortunately secondary data especially policy reports were very helpful in building the national-level governance scenario. At lower levels this problem was mitigated and various government departments were consulted, but still, not all types of stakeholders for all IOPP cases were approached. Furthermore, some potentially useful data such as tender documentation were not collected owing to the lack of accountability and transparency in China's procurement system (Wang and Li, 2013). This prevents this study from looking into details of tendering and contracting.

5.7 Conclusion

Adapting the interactive model of qualitative research design proposed by Maxwell (2005) (Figure 5.1), this chapter has covered and linked up each of the components in turn. The conceptual research approach adopted by this study can be summarized as: a multi-level, evaluative case study with exploratory and explanatory purposes based on a 'policy mix' – 'system mix' conceptualization of IOPP and related policies. Operational issues were then addressed, including the data collection approach based on purposive sampling with interviews and documentation as the main sources, and the data analysis strategy underpinned by the conceptual framework and supported by various techniques such as chronological and template analysis. Reflections were then made on research ethics and validity issues.

The following chapter, driven by the multi-level (national, regional, and micro) research design presented in this chapter, elaborates the IOPP policy process in China at the national and regional levels.

Chapter 6: The IOPP Policy Process

6.1 Introduction

This chapter[18] attempts to elaborate the design, articulation and implementation of IOPP policies at the national/macro and regional/meso levels in China, and provides the policy context for case studies in Chapter 7. This chapter should be read in the context outlined by Sections 2.5 and 3.4, i.e. China's innovation and procurement systems. Although the explicit IOPP policies made by China were mostly based on the narrow understanding of government procurement (Section 3.4), elaboration in this chapter is based on the broader notion, trying to explore as many as possible channels that led to IOPP practices. This broader understanding is coherent with international IOPP research and practices reviewed in Chapter 4, as well as with what was observed through fieldwork regarding concrete IOPP processes in China (see Chapter 7).

Section 6.2 firstly reviews the IOPP policy initiatives taken by the central government following its indigenous innovation scheme, including policy mandates outlined in the MLP and the more detailed policy measures that ensued. It then clarifies the *three IOPP policy channels* identified by this study, i.e. routine procurement mechanisms based on innovation and IOGP catalogues (Channel 1), policies promoting the commercialization of major technological equipment (MTE) (Channel 2), and IOPP elements in sectoral programs (Channel 3). Sections 6.3 – 6.5 elaborate on each of the channels in turn, following a chronological, top-down sequence. Section 6.6 concludes the chapter.

6.2 The emergence of IOPP policies

6.2.1 Procurement mandates in the MLP

As addressed in Section 2.5, government procurement was included as one of the categories of STI policies supporting indigenous innovation. Article VIII-3 of the MLP states that responsible government agencies should:

> *'…Formulate implementing regulations of the People's Republic of China (PRC) Government Procurement Law to encourage and protect indigenous innovation. Establish a coordination mechanism for government procurement of indigenous innovative products. Government practices a first-buy policy for major domestically made high-tech equipment and products that possess proprietary intellectual property rights. Provide policy support to enterprises in procuring domestic high-tech equipment.*

[18] Parts of this chapter have been published in modified forms in Li (2011) and Li and Georghiou (2013), and presented at conferences DRUID 2011, UNDERPINN 2012, and EU-SPRI 2012.

> *Develop relevant technology standards through government procurement…' (State Council, 2006a, p.54)*

The five sentences covered five points to utilize IOPP in China. The first is to make the Chinese regulatory system of government procurement more innovation friendly, which is also what the EU countries have been doing (Section 4.4.2). However, the MLP specifically pointed out that implementation regulations of the LGP (Section 3.4) needed to be formulated without mentioning any issues regarding the LTB. As discussed in Section 3.4, the LGP actually has a much narrower scope than the LTB does in terms of regulating procurements in the public sector, and these two laws have been frequently competing with each other. Therefore, the scope of 'IOPP' outlined here is only within the scope of the LGP, i.e. the narrow sense of *government procurement* (titled as IOGP by this study). The potential of IOPP might be fundamentally constrained without taking SOE procurement into account.

The second is to call for an approach to coordinating stakeholders and forming a concrete mechanism to carry out IOGP activities. As reviewed in Section 4.5, this is very relevant since coordination is perceived challenging owing to the cross-domain nature of the policy. Due to the narrow scope of the government procurement regulatory system, in principle this coordination mechanism only involves government agencies and government-funded organizations.

The third calls for specialized procurement procedures for strategically important equipment and products with a strong catching-up intention, which is different from the objectives of OECD countries.

The fourth is also regarding strategically important equipment, and aims to reduce enterprise users' risk when they procure these items. This can be considered as an approach to incentivising users. It is worth noting that this subsidy measure enlarged the scope of the IOGP policy – enterprise users of MTE are very likely to be SOEs which undertake construction projects for public infrastructures.

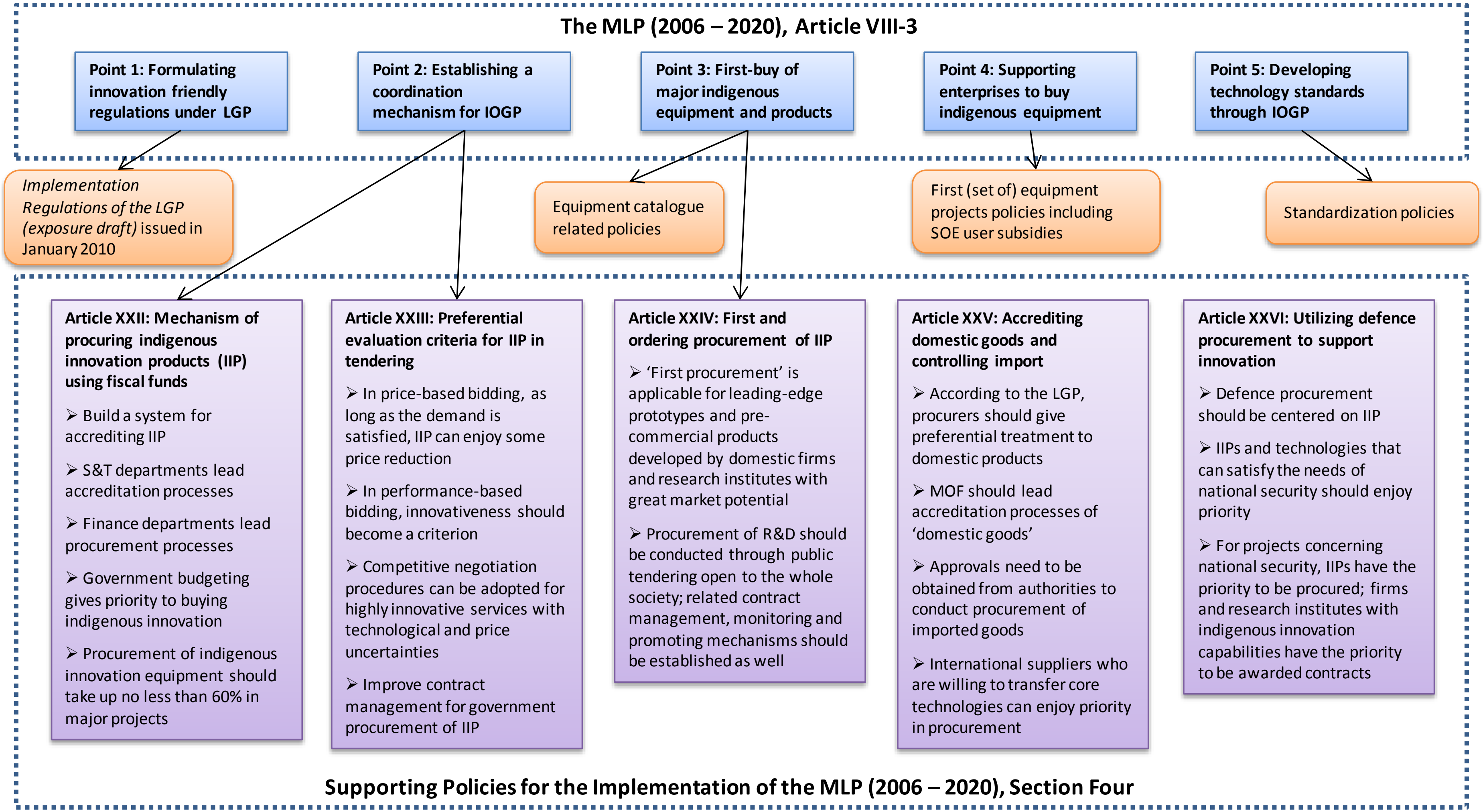
The fifth is concerned with the coordination between IOPP policies with standardization, which can be considered as an attempt to utilize the complementarity between different DSIPs.

These are very brief policy mandates pointing out the general directions regarding IOPP in China. They are all relevant points and can be justified with the perspectives reviewed in earlier chapters. Considerable room exists for further interpretation and articulation.

Shortly after the launch of the MLP, the government launched the *Supporting Policies for Implementation of the MLP* (State Council, 2006b). Article VIII-3 in the MLP was articulated into a set of policies for implementation. The key points of these articles are summarized in Figure 6.1, and linked up with Article VIII-3 in the MLP. Some of the key points in the MLP were addressed instead by *implementation measures*[19] announced by ministerial-level agencies. Table 6.1 provides a list of implementation measures.

[19] For details of the range of measures see http://www.gov.cn/ztzl/kjfzgh/ [accessed May 30th 2013].

Figure 6.1 Articulation of Article VIII-3 in the MLP



Source: Author developed based on policy analysis (IIP: indigenous innovation products)

Table 6.1 IOPP-related implementation measures following MLP

Policy name	Issue time	Issued by	Policy code	Corresponding to	Covered in
Advice on Accelerating the Revitalization of Equipment Manufacturing Industry	June 2006	State Council	Guofa [2006]8	MLP and its Supporting Policies	Section 6.4
Advice on the Implementation of Government Procurement Policy to Promote Indigenous Innovation	June 2006	MOF	Caiku [2006]47	MLP and its Supporting Policies	Section 6.3
Administrative Measures on the Accreditation of National Indigenous Innovation Products (Trial)	December 2006	MOST, NDRC, MOF	Guokefajizi [2006]539	Supporting Policies of the MLP	Section 6.3
Administrative Measures on Budget Management for Government Procurement of Indigenous Innovation Products	April 2007	MOF	Caiku [2007]29	Supporting Policies of the MLP	Section 6.3
Evaluation Measures for Government Procurement of Indigenous Innovation Products	April 2007	MOF	Caiku [2007]30	Supporting Policies of the MLP	Section 6.3
Administrative Measures on Contract Management for Government Procurement of Indigenous Innovation Products	April 2007	MOF	Caiku [2007]31	Supporting Policies of the MLP	Section 6.3
Administrative Measures on Government First Procurement and Ordering Procurement of Indigenous Innovation Products	December 2007	MOF	Caiku [2007] 120	Supporting Policies of the MLP	Section 6.3 Section 6.4
Administrative Measures on Government Procurement of Imported Products	December 2007	MOF	Caiku [2007] 119	Supporting Policies of the MLP	Section 6.2.2.3
Administrative Measures on First (set of) Major Technology Equipment Experiments and Demonstration Projects	January 2008	NDRC, MOST, MOF, Commission for STI for National Defence (part of MIIT)	Fagaigongye [2008]224	Guofa [2006]8	Section 6.4
Notice on the Initiating of Accreditation Work for National Indigenous Innovation Product (2009)	October 2009	MOST, NDRC, MOF	Guokefaji [2009]618	Supporting Policies of the MLP, Guokefajizi [2006]539	Section 6.3
Guiding Catalogues for Indigenous Innovation in Major Technological Equipment (2009), updated versions in 2010, 2011 and 2012	December 2009	MIIT, MOST, MOF, State-owned Assets Supervision and Administration Commission (SASAC)	N/A	Advice on Division of Labour, Guofa[2009]13	Section 6.4
Notice on the Initiating of Accreditation Work for National Indigenous Innovation Product for 2010 (exposure draft)	April 2010	MOST, NDRC, MOF	N/A	The Law on Science and Technology Advancement	Section 6.3
Administrative Measures for the Government Procurement of Domestic Products (exposure draft)	May 2010	MOF, Ministry of Commerce, NDRC, the General Administration of Customs	N/A	The LGP	Section 6.2.2.3

Source: Author derived from policy analysis; for other details see Appendix 11.

6.2.2 Policy articulation following the MLP

6.2.2.1 Establishing an IOGP system based on innovation catalogues

As illustrated in Figure 6.1, Articles XXII and XXIII of the Supporting Policies are follow-up policies corresponding to Point 2. Both aimed to introduce a routine mechanism based on accreditation of indigenous innovation products; qualified products would form IOGP catalogues and government procurers are obligated to provide preferential treatment for listed goods. Article XXII elaborates on overall organizational issues. It stipulated that the production of catalogues would rely on coordination between S&T and finance departments, with the former in charge of accrediting indigenous innovation products together with 'general economic departments', and the latter in charge of identifying procurable products to form the catalogues together with 'related departments'. Article XXII is echoed by another article which states that[20]

> *'…Finance departments take the lead to form coordination mechanisms with S&T and development and reform departments, to make concrete measures for implementation, to monitor implementation progress, and to resolve difficulties and problems during implementation…'* Article XXXXXV in State Council (2006b)

Article XXIII deals with issues related to tendering procedures. It stipulates that indigenous innovation should be an essential criterion in product evaluation. The articulation and implementation of this policy at national and regional levels are further elaborated in Section 6.3.

6.2.2.2 First and ordering procurement

Article XXIV corresponds to Point 3 in the MLP. It introduced 'first procurement' and 'ordering procurement', stipulating that a 'first procurement' procedure is applicable for buying leading-edge prototypes and pre-commercial products developed by domestic suppliers with great market potential, and 'ordering procurement' should be carried out through open tendering to buy R&D services that government agencies are in need of. This is similar to the notion of 'procurement of R&D' or 'pre-commercial procurement' in the EU (EC, 2006; Edler and Georghiou, 2007; Apostol, 2012). The revised *Law on Science and Technology Advancement of the PRC*[21] explicitly supported first and

---

[20] All direct quotes of policy contents are author's own translations except for State Council (2006a).
[21] Full text of the Law is available at http://www.gov.cn/flfg/2007-12/29/content_847331.htm [accessed September 1st 2013].

ordering procurement. The implementation of ‘first procurement’ was then detailed in policies related to Channel 1 (Section 6.3), while ordering procurement was frequently associated with equipment commercialization projects (Section 6.4).

6.2.2.3 Controlling import and ‘buy Chinese’

The Supporting Policies added two aspects which were not covered by the MLP, i.e. Article XXV regarding preferential treatment of domestic goods, and Article XXVI regarding defence procurement’s potential in stimulating indigenous innovation. Article XXVI is a coordinating policy trying to bring STI activities in the military and those in civil sectors in line (see Cheung, 2011 for a detailed account). This is beyond the scope of this thesis.

The origin of Article XXV is a ‘Buy Chinese’ article from the LGP (Article 10 in LGP, 2002) which is believed to have never been properly implemented before owing to the long-existing problem of ‘discrimination against domestic goods’ in China (Ma, G., 2009; also mentioned in Edler et al., 2008). Article XXV could be further supported by *Administrative Measures for the Government Procurement of Domestic Products* (State Council, 2010), whose exposure draft was released in May 2010; as of February 2013, the final version, however, has not been released[22].

Echoing Article XXV, *Administrative Measures on Government Procurement of Imported Products* (see Table 6.1) detailed regulations controlling government procurement of imported products. It is stipulated that government procurers need approvals from financial authorities to buy imported goods if they indeed could not find any domestic ones to fulfil the demand (Article IV); for major technologies, equipment, and S&T instruments, the import of which is restricted, approvals from the NDRC or MOST are needed to procure imported ones (Article X). When government procurers purchase imported goods, they should stick to the principles of supporting indigenous innovation, and give priority to foreign suppliers that are willing to transfer technologies, provide training services, or provide other compensation measures (Article V).

Regional finance departments mostly posted these central policies on their websites. Nevertheless, procurer interviewees all indicated that there has still been a tendency of

[22] The story of Channel 1 presented in Section 6.3 implies that China, faced by powerful international stakeholders, is unlikely to succeed in announcing an explicitly protectionist regulation.

favouring imported products over domestic ones due to a long-lasting perception of imported products as having good quality.

These ‘control import’ and ‘buy domestic’ policies, although announced as part of the ‘buy indigenous innovation’ scheme by the central government, are not considered as an independent channel leading to IOPP practices in this thesis. They do not necessarily lead to innovation due to the strong protectionist nature without specifications in terms of innovativeness. Nevertheless, they do have the potential to serve as a factor to stimulate indigenous innovation; the Wind Turbine case as presented in Chapter 7 can be considered as one example backed by a strong ‘buy domestic’ intention from top officials.

6.2.3 Identified IOPP policy channels

The preceding section briefly reviewed the explicit policies linking public procurement to indigenous innovation following the mandates in MLP. Two major implementation channels were recognized. One was a routine IOGP mechanism based on innovation catalogues, the design, articulation, implementation, and (unexpected) termination of which is elaborated in Section 6.3. The second channel is underpinned by promotion policies targeted at the commercialization of MTE that was in great need in the country through the use of signalling and supporting policies, which is elaborated in Section 6.4. It should be noted that some other policies that served as driving forces of IOPP cases were rather ‘hidden’ and not well recognized if only based on top-down policy analysis. A third channel was identified in a bottom-up way from fieldwork, i.e. IOPP elements embedded in supporting/demonstration programmes for key, emerging technological sectors (‘sunrise’ sectors as noted by Geroski, 1990), which is discussed briefly in Section 6.5. The classification should be considered as an exploratory rather than comprehensive one, since the IOPP policy dynamics in China proved to be very complicated and constantly changing, with diverse implementation structures across different regions and sectors. The following sections look into their details in turn.

6.3 Channel 1: IOGP mechanism based on catalogues

6.3.1 The national IOGP mechanism

Following the MLP and Supporting Policies, MOF issued *Advice on the Implementation of Government Procurement Policy to Promote Indigenous Innovation* (see Table 6.1) in June 2006 to provide an overall guideline of implementation for its lower-level agencies. It recognized that IOGP was 'a complex, systemic project' and 'an entirely new task', and stipulated that finance departments at all levels should treat this task seriously, and actively coordinate with S&T departments. It clarified that before the announcement of concrete national implementation measures, regional finance departments could make their own transitional measures to conduct IOGP according to their local circumstances. These transitional measures should be reported to MOF; if a provincial-level S&T department had already established an accreditation mechanism and produced innovation catalogues, it should report its accreditation criteria, evaluation procedure and innovation catalogues to MOST to get approved; these records would serve as part of the basis for MOF to produce IOGP catalogues.

According to this design, IOGP catalogues should be produced based on innovation catalogues. The criteria for being included in the former, which were explained later on by another policy, seemed ambiguous though:

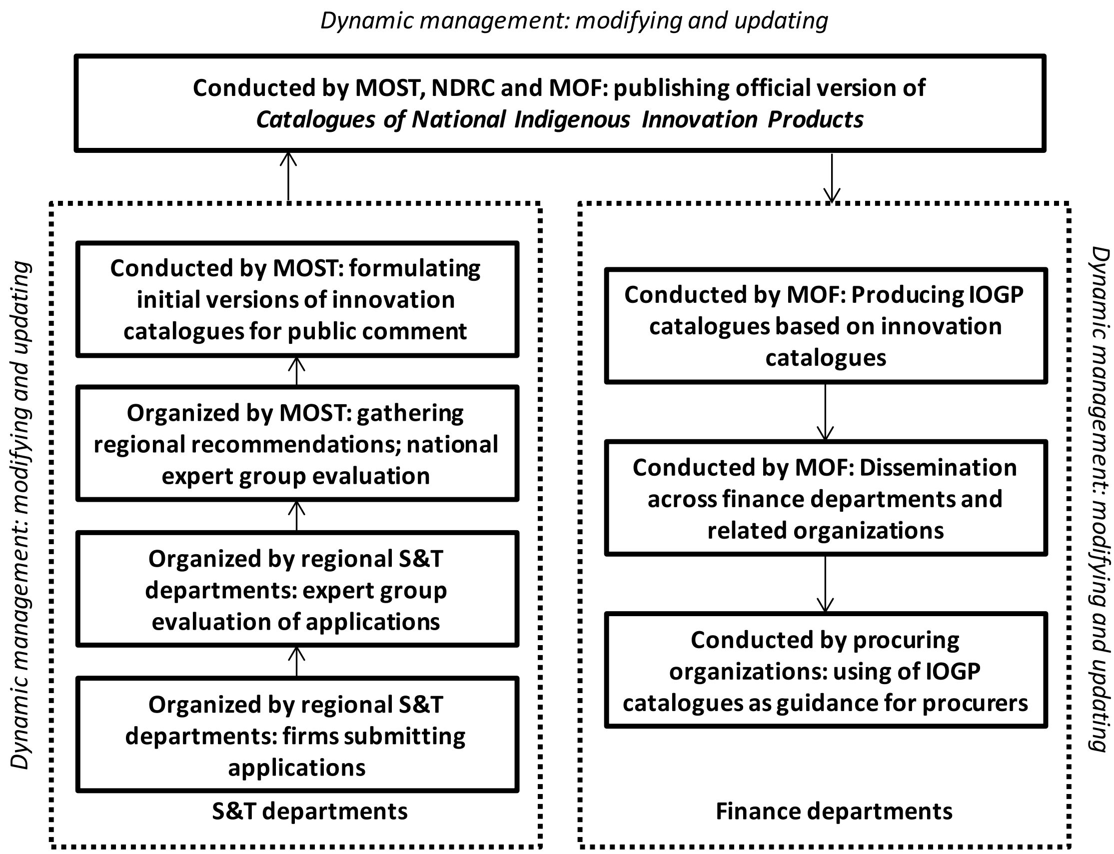
> *'MOF will work together with related departments to produce catalogues of government procurement of indigenous innovation products according to the demand of government procurement policies and the actual situations…'(Article 4, Section 5, Appendix of Guokefaji [2009]618, see Table 6.1)*

In December 2006, MOST, NDRC and MOF jointly issued *Administrative Measures on the Accreditation of National Indigenous Innovation Products (Trial)*, policy code Guokefajizi [2006]539, to detail the procedures, institutional setup and criteria for accreditation work. A flowchart of the IOGP mechanism outlined by this policy (followed by policy Guokefaji [2009]618 with more operational details) is illustrated in Figure 6.2. Innovation catalogues were supposed to serve as a 'bridge' whereby the innovation system and the procurement system could coordinate with each other.

On the innovation system side (i.e. the left hand side of the figure), regional S&T departments should notify local firms about accreditation procedures and encourage them to submit applications on a voluntary basis; after gathering and checking the applications (in terms of format and application materials), regional S&T departments should organize expert groups to conduct preliminary evaluation, and recommend qualified products to MOST. MOST should gather recommendations from all regions, and organize expert groups to do fieldwork and finalize the evaluation results; MOST should then produce and publish an exposure draft of national innovation catalogue.

After all the dissents are solved, MOST, NDRC and MOF should jointly issue certificates to qualified products, and an official version of innovation catalogue will be published. Then on the procurement system side, MOF should produce an IOGP catalogue based on the innovation catalogue, and disseminate it to all the lower-level agencies and public organizations. The IOGP catalogue should then be adopted as a reference for government procurers. On both sides, continuous management is required to modify and update the catalogues. Certificates of different products have different lengths of validity period, ranging from two years to four years.

Figure 6.2 Flowchart of the IOGP mechanism designed by ministries



Source: Author developed based on policy analysis

To address operational issues for the use of IOGP catalogues, three policies were issued by MOF in April 2007. The *Administrative Measures on Budget Management for Government Procurement of Indigenous Innovation Products* (see Table 6.1) stipulated that:

> *Article IV: 'When the procurers are doing annual budgeting for their departments, specialized budget should be allocated and marked clearly for government procurement of indigenous innovation products from the IOGP catalogues…'*

> *Article VI: 'When expenditure on certain projects is fixed, indigenous innovation products from IOGP catalogues should enjoy the priority to be allocated budget…'*

The *Evaluation Measures for Government Procurement of Indigenous Innovation Products* (see Table 6.1) detailed procedural issues. A principle emphasized was that

> *Article IV: 'No organizations or individuals are allowed to obstruct or restrict the free access of suppliers of indigenous innovation products to the government procurement market in the locality or the industry, or discriminate the suppliers with unreasonable conditions…'*

Preferential treatment for indigenous innovation products was twofold. Firstly the requirements for suppliers (e.g. business size and qualifications) could be lowered accordingly, and secondly, bids of indigenous innovation products enjoy price reduction (5-10% reduction in price-based bidding) or extra points (4-8% extra in performance-based bidding) during the evaluation stage. Procedures can be flexible according to different situations, ranging from open and restricted tendering to competitive negotiation, and life cycle costing is applicable if the products' useful life is long.

The *Administrative Measures on Contract Management for Government Procurement of Indigenous Innovation Products* (see Table 6.1) detailed contracting issues related to IOGP. Clauses supporting indigenous innovation should be clarified, and suppliers of indigenous innovation products should be supported in the contract delivering stage. These policies also detailed reward and penalty measures, aiming to embed IOGP catalogues into procurement processes.

'First procurement' (see 6.2.2.2) was designed to be implemented through IOGP catalogues as well. Products for 'first procurement' need to be qualified as national indigenous innovation products, and should be in a very early stage of commercialization, which means

> *'…entering the market for the first time, without competitiveness but with great potential for market success and manufacturing capacity, in need of major support'(Article VIII, Caiku [2007] 120)*

6.3.2 Implementation at the national level

MOST carried out pilot, nationwide accreditation work during 2007-2009. The official accreditation work was jointly initiated by MOST, NDRC and MOF in October 2009 with the launch of *Notice on the Initiating of Accreditation Work for National*

Indigenous Innovation Products in 2009, policy code Guokefaji [2009]618, which detailed the principles, scope, criteria and procedures for accreditation. However, this round of accreditation work ended up with no catalogues produced. In April 2010, MOST, NDRC and MOF published another accreditation notice, i.e. *Notice on the Initiating of Accreditation Work for National Indigenous Innovation Product in 2010 (exposure draft)* (hereafter Notice 2010), and allowed one month for public consultation Three of the above mentioned policies (Guokefajizi [2006]539, Guokefaji [2009]618, and Notice 2010*)* detailed three versions of criteria to evaluate indigenous innovation products, as summarized in Table 6.2.

From Table 6.2 it can be observed that the 2009 criteria were largely the same as but more detailed than the 2006 criteria. To get their products qualified, suppliers needed to prove that the products were legally developed, with reliable quality, high degree of innovativeness and potential of market success or import substitution; most importantly, the supplier should have the ownership or use rights of indigenous IPRs. The 2009 criteria seemed to have posed more specific requirements *with a protectionist feature* regarding IPR issues, emphasizing the importance of being domestic and not being restricted by other parties from abroad. It also provided a short explanation about what ‘leading-edge’ technologies were, and posed a more rigid requirement about commercialization, i.e. ‘*the product has already entered the stage of commercialization*’.

The 2010 criteria, however, differed from the previous two versions significantly. Except for the criterion of legality, other criteria were all loosened to a certain degree. The most notable change was that requirements regarding ‘indigenousness’ disappeared. Stipulations about the ‘nationality’ of IPRs and import substitution were eliminated. The requirements about innovativeness and technology were fundamentally changed, from

> *‘…mastered core technologies and processes for product manufacturing; or applied new technological theories or new design concepts… or proposed technological standards for the first time domestically and abroad…’*

to

> *‘…contribute significantly to resource-saving, energy efficiency, reducing pollution… significantly improved performance compared with similar products…’*

In this way, the scope of potential ‘*indigenous’* innovation products would be considerably broadened to ‘*non-indigenous’* products, as long as the products are in the border of China.

Table 6.2 Versions of evaluation criteria for indigenous innovation products

	Legality	IPR issues	Trademark	Innovativeness	Technology	Quality	Commercialization
Guokefajizi [2006]539	Compliance with national laws and regulations, and national STI policies	Ownership of indigenous IPRs (i.e. the applicant legally obtained IPRs through innovation activities conducted by itself, or legally obtained the ownership or use rights of the IPRs legally obtained by other Chinese enterprises, organizations or citizens), with clear equity position.	The trademark is indigenous, i.e. the applicant possesses the ownership of the registered trademark of the product.	High innovativeness. Including: mastered core technologies and processes for product manufacturing; or applied new technological theories or new design concepts which led to fundamental improvements in structures, materials, or processes; or proposed technological standards for the first time domestically and abroad.	The technology is advanced and internationally leading-edge among similar products.	The product has reliable quality and passed tests by the National Certification and Accreditation Administration, or by laboratories and inspection agencies recognized by regional departments of quality control. Production permits from related authorities are needed for industries with specialized national-level regulations; compulsory certifications are needed when applicable.	The product has potential economic benefits and relatively great market potential, or can substitute the import.
Guokefaji [2009]618	Same as above.	Same as above. Plus: The use, disposal and secondary development by the applicant is not restricted by others from abroad.	Same as above. Plus: the initial registration place of the trademark is within the border of China, without restrictions from any foreign brands.	Same as above.	Same as above. Plus: 'leading-edge' means that the overall technology, or a core technology is internationally advanced, or the technology is advanced and already being exported, or the cost-performance rate is internationally competitive.	Same as above.	Same as above. Plus: the product has already entered the stage of commercialization.
Notice 2010	Same as above.	The applicant legally possesses the IPRs or the use rights of the IPRs of the products, either through technological innovation or through transfer, without any disputes.	The applicant legally possesses the ownership or the (exclusive) use rights of the product's trademark in China	The product can contribute significantly to resource-saving, energy efficiency, reducing pollution; or has fundamental improvements in structures, materials, or processes, which led to significantly improved performance compared with similar products.	The technology is advanced.	The product has reliable quality. Production permits from related authorities are needed for industries with specialized national-level regulations; compulsory certifications are needed when applicable.	The product has already entered the stage of commercialization, or has potential economic benefits and relatively great market potential.

Source: Author developed based on policy analysis

Besides the changes in criteria, Notice 2010 also differed from Guokefaji [2009]618 in two issues notably. The official 'origins' and wording of the policies were different. Guokefaji [2009]618 stated clearly that it was rooted in the MLP, and that IOGP catalogues would be formed based on the accreditation. Notice 2010, however, stated that it was rooted in the *Law on Science and Technology Advancement of the PRC* without mentioning the MLP, and that '*support will be provided to qualified products according to the law and related policies*', without mentioning 'procurement' explicitly. Another difference was the significantly extended time limits allowed for firm application and regional recommendation of products, from 40 and 60 days to 4 and 5 months respectively.

These changes seemed rather inconsistent with the previously announced IOGP policies. A deviation from the original, top-level policy was evident, especially in terms of the criteria and the wording. Meanwhile, the significantly prolonged evaluation cycle might not be responsive enough to capture innovations which are normally fast-changing.

Regarding the reason for policy change, a vice-minister of MOST explained that adjustments were made in response to concerns raised by some countries and foreign invested enterprises (see Ministry of Commerce, 2010); the new criteria '*featured the principles of non-discrimination, market orientation and IPR protection*'; meanwhile he emphasized that the accreditation work was an *inherent* part of China's indigenous innovation policy, and would be carried out as a 'long-term task' on a 'regular basis'. On the other hand, the Minister of the Ministry of Commerce (in charge of international trade, export and import and FDI issues) clarified that China's indigenous innovation policy was 'targeted at R&D activities', and it was 'not linked with trade policies'; indigenous innovation products would be defined according to its 'value added in China' only, regardless the nationality of enterprises. This policy change could be explained by disagreements between different ministries with different policy priorities (which was echoed by information provided by interviewees), and those disagreements were fundamentally due to the lack of coherence between the Chinese indigenous innovation policies and issues related to international trade and economic cooperation (Section 6.3.4).

The final version of the Notice 2010 was not published as planned, thus the accreditation work in 2010 was not officially initiated. The designed IOGP mechanism illustrated in Figure 6.2 was not implemented except that MOST organized nationwide pilot accreditation work, and issued indigenous innovation product certificates to related suppliers. According to STI official interviewees, 243 products had been accredited by MOST as national indigenous innovation products during the pilot accreditation stage; MOST had published *Notice on Releasing the Results of Pilot Accreditation of National Indigenous Innovation Products*, policy code Guokefaji[2009]221, which, however, is not available online anymore. The official version of national innovation catalogue was not published, and consequently there was no IOGP catalogue published either.

6.3.3 Implementation at the regional level

6.3.3.1 The issuing of IOGP policies by regions

The arrangement of regional implementation was briefly covered by MOF in *Advice on the Implementation of Government Procurement Policy to Promote Indigenous Innovation* (Caiku [2006]47), as mentioned in Section 6.3.1. Regional IOGP practices should have been based on national innovation catalogues published by MOST and IOGP catalogues published by MOF (see Figure 6.2). However, as elaborated in Section 6.3.2, the national innovation catalogue was not officially published after all, thus regional IOGP policies remained ‘transitional’ until the nationwide termination of key policies in 2011 (Section 6.3.4).

Most regions responded actively to ministerial initiatives regarding innovation catalogues. As illustrated in Figure 6.3, although not all regions conducted policy implementation explicitly (‘explicitly’ means that they published local policies on their official websites), all the governments of the 31 provincial level regions in mainland China at least mentioned their intention to use government procurement to support indigenous innovation at various websites.

The 18 regions that published local policies (see Appendix 12) largely followed the central-level approach, i.e. to establish mechanisms for accrediting indigenous innovation products in the localities, supported by preliminary accreditation work by their lower-level governments (including cities and counties). Numerous cities and counties took their IOGP actions accordingly, and some proactive ones published their own innovation catalogues[23]. Policy review conducted for this thesis did not go down to the city level or below for all the regions due to the very large quantity. Some proactive regions issued not only implementation measures for accreditation, but also various measures corresponding to the national IOGP policy portfolio; for example, Beijing and Jiangsu issued their local regulations on first and ordering procurement.

Figure 6.3 Map of regions in Mainland China as to IOGP initiatives

Source: Author developed based on policy analysis

As shown in Figure 6.3, most of the active regions are located in the eastern part of the country, which feature a relatively high level of financial income and innovativeness (see Table 6.3). The exceptions were Jiangxi and Yunnan from inland, which, although were less competitive than other regions according to the rankings in 2011, put strong emphasis on indigenous innovation and on the potential of using government

[23] For example, the cities of Jinan, Qingdao and Weifang in Shandong, Shenzhen in Guangdong, Wuhan in Hubei and Chengdu in Sichuan all published their own innovation catalogues.

procurement as a supporting policy in their medium- and long-term development plans (see Jiangxi Government, 2006; Yunnan Government, 2005). The other exception was Zhejiang province, which ranked very high in terms of both GDP and innovativeness (see Hanley et al., 2011, and Arbolino, 2011), but did not explicitly issue accreditation measures. It did, nevertheless, respond actively to the national accreditation initiative taken by MOST, NDRC and MOF in 2009 (Zhejiang S&T Department, 2009).

Table 6.3 GDP and innovativeness rankings of regions that were active in IOGP

Ranking	**Anhui**	**Beijing**	**Fujian**	**Guangdong**	**Hebei**	**Hubei**	**Hunan**
GDP	14	13	12	1	6	10	9
Innovativeness	15	3	14	2	19	13	11
Ranking	**Jiangsu**	**Jiangxi**	**Shandong**	**Shanghai**	**Sichuan**	**Tianjin**	**Yunnan**
GDP	2	19	3	11	8	20	24
Innovativeness	1	18	6	4	9	7	26

Source: regional rankings according to GDP and innovativeness, 2011[24]

The five selected regions demonstrated diverse trajectories of implementation. Beijing's IOPP practices had been centred on Zhongguancun Innovation Zone, which is elaborated in the Water case in Chapter 7. The rest of the four regions followed the national policy design illustrated in Figure 6.2, but with different progresses. The most active one was Guangdong, which established a systematic mechanism for IOGP and, according to interviewees R3O and R3F, fulfilled several rounds of implementation by May 2011. The operational measures adopted in Guangdong were documented in the *Operational Guidance of the Indigenous Innovation Products Government Procurement Mechanism* (Lao et al., 2009). Chen and Lao (2010) (who were also the authors of Lao et al., 2009) reviewed Guangdong's policy setup and concluded that it was more systematic and comprehensive compared with those of other regions or with the national setup. Shanghai also established a local IOGP mechanism, underpinned by local measures on accrediting indigenous innovation products and on operational issues during the conduct of IOGP (see Appendix 12). Specialized policies were designed by Shanghai for major projects of infrastructure construction concerning the procurement of equipment, which can be considered as a compensation for the narrow scope of the LGP. Jiangsu and Shandong, the two earliest regions in taking accreditation actions,

[24] GDP ranking information and regional innovativeness ranking information were retrieved from SEI (2012) and CRGSTDS (2011) respectively.

issued their local accreditation measures in 2006 and 2007 respectively. However, local interviewees (R4F and R5F) implied that no routine coordination mechanisms were implemented and no local IOGP catalogues were produced.

The contents of regional accreditation policies largely followed that of the national policy *Administrative Measures on the Accreditation of National Indigenous Innovation Products (Trial)* (see Table 6.1). Some regions specified criteria regarding the size of business, e.g. in Guangdong the sales revenue of the applying firm in the previous financial year needs to exceed 5 million Yuan; in Beijing the threshold was 2 million Yuan, or the applicant's domestic market share reached 20%, or the growth rate of sales revenue reached 20%. Beijing also explicitly stipulated that the requirement for business size and commercialization was not applicable to *first procurement* items, which could potentially address technological gaps in the domestic market. The designed frequency of accreditation work could be once a year, e.g. in Liaoning, Qinghai, Shandong and Shanghai, or twice a year, e.g. in Hunan; most regions did not specify the frequency, but claimed that they would conduct 'dynamic management' of innovation catalogues. The validity period of regional indigenous innovation product certificates was 3 years in most regions e.g. Shandong, Shanxi and Yunnan; Guangdong stipulated that the validity period would range between 2 and 4 years, depending on the characteristics of concrete products; Beijing designed longer validity periods e.g. 5 years for indigenous innovation products with longer technological life cycles.

6.3.3.2 The publishing of catalogues by regions

As illustrated in Figure 6.3, 14 regions had published provincial-level innovation catalogues by July 2011 (see Appendix 13). It is noteworthy that all the published innovation catalogues reached *beyond* the scope of the LGP, to technological areas such as equipment manufacturing. For example, more than one third of the 114 products accredited in Anhui were not directly procurable according to the centralized government procurement classification issued by MOF. Luo (2009) gathered insights from two regional financial officials regarding the broadening of product accreditation scope; the officials considered that this broadening, although could not guarantee the procurement of accredited products, could impact positively on those sectors outside the scope of the LGP. Nevertheless, several interviewees (R3F, R4F and R5F) implied that this *incompatibility* between innovation catalogues and Chinese government procurement classification had been an obstacle for procurers in conducting IOGP. R5F called for unification of the public procurement classification across the country, and ideally in conformity with the international classification. Regional catalogues included products from their localities only rather than products from elsewhere since, according to the original plan, regional agencies were supposed to recommend local products to MOST. This inclusion of local products, however, laid the foundation for discriminating non-local products during implementation processes.

Some proactive regions moved on and produced their local *IOGP* catalogues based on local innovation catalogues, e.g. Tianjin, Beijing, Guangdong, and Shanghai (see Appendix 14). Table 6.4 provides a summative comparison across the four regions regarding their innovation and IOGP catalogues. For each dimension, the upper sub-row is about innovation catalogues and the lower sub-row is about IOGP catalogues.

Tianjin's IOGP catalogues were published in the form of specialized catalogues on different sectors in May 2011; the first IOGP catalogue listed 14 products in the medical equipment sector, and the second IOGP catalogue listed 10 products in sectors of biochemical engineering and lighting equipment. Items on both catalogues were selected from the 2009 Tianjin innovation catalogue and would be procurable by public organizations such as hospitals and government agencies. However, it is noteworthy that the quantity difference between items listed on the innovation catalogue (156 items) and those listed on the IOGP catalogues (24 items) was significant, which means that the majority of indigenous innovation products accredited in Tianjin in 2009 did not (at least not explicitly) receive preferential treatment in government procurement. Another problem was the considerable time lag between the publishing of IOGP catalogues in May 2011 and the publishing of the innovation catalogue in June 2009. Two years of delay could mean that even the accredited products were procured eventually, the objective of promoting indigenous innovation would not be realized as the best timing in terms of TLC might have been missed.

Guangdong published three versions of innovation catalogues in May 2009, December 2009 and September 2010, based on which it produced three versions of local IOGP catalogues in November 2009, December 2010 and March 2011 respectively. The quantity differences between Guangdong's innovation and IOGP catalogues were much smaller than that of Tianjin; one explanation is that Guangdong has higher competitiveness in producing products suitable for *government procurement*, while Tianjin's advantage lies more in equipment manufacturing industry (NO_1).

Table 6.4 Summary of regional IOGP catalogues

	Tianjin	Guangdong	Shanghai	Beijing
Number of versions published	1 innovation catalogue	3 innovation catalogues	1 innovation catalogue	12 innovation catalogues
	2 IOGP catalogues on different sectors	3 IOGP catalogues	1 IOGP catalogue which was the same as the innovation catalogue	9 versions of 'catalogue of *first procurement* of indigenous innovation'
Quantity of products	156	130 + 276 + 578	523	In total 4681
	14 + 10	119 + 155 + 540	The same	In total 61
Covered sectors	Automobile, equipment manufacturing, ICT and medicine	ICT, electrical appliances, agriculture, environmental protection, energy efficiency technologies	ICT, biomedicine, equipment manufacturing, energy efficiency technologies, new materials, and transportation	ICT (hardware and software, e-solutions), green technologies, biomedicine, equipment manufacturing and transportation
	Included in the innovation catalogue; medical equipment, biochemical engineering and lighting equipment	Included in the innovation catalogue; sectoral coverage same as above	The same	Different from innovation catalogues, only targeted at 'first procurement'; Covering green technologies (e.g. new energy, waste treatment) and new medicine
Issue time	June 2009	May and December, 2009; September, 2010	August, 2009	During July 2007 – June 2011
	May 2011	November 2009, December 2010, March 2011	The same	During June 2009 – April 2011

Source: Author derived from documentation analysis

Shanghai published one innovation catalogue in August 2009, which was meanwhile announced as an IOGP catalogue. Among the 523 products in the catalogue, 48 products were marked as 'first procurement' products, which was in line with the stipulations in Caiku[2007]120 (see Table 6.1).

Beijing published 12 versions of innovation catalogues by June 2011 with 4681 accredited products in total, covering a very wide range of sectors. The products were mostly produced by suppliers from the Zhongguancun innovation zone. Differently from the other three regions which produced IOGP catalogues *based on* innovation catalogues, Beijing produced 9 versions of 'catalogues of *first procurement* of indigenous innovation' *separately* from innovation catalogues, to support new products in entering the market.

6.3.3.3 The utilization of catalogues by regions

Whether or not all the regions that published innovation or IOGP catalogues actually utilized their catalogues is difficult to know based on secondary data only. No official statistics or policy reports on IOGP have been published yet, and they are unlikely to be published in the future, given that the winding IOGP policy process ended up with being terminated in response to unexpected political pressure. Very brief surveys on the supplier side were conducted by some Chinese literature, e.g. Peng (2011) and Song et al. (2011). Nevertheless, they were only focused on issues such as suppliers' awareness of the policies, sufficiency of budgeting, and transparency of evaluation processes, rather than on implementation processes of the innovation catalogue approach.

Besides the IOPP cases presented in Chapter 7, there are a limited number of other examples briefly reported by Chinese mass media or literature. Li[b] (2011) provided a two-page summary of five IOPP examples in Zhongguancun in Beijing, involving technologies for underground transport systems, underground communication, waste treatment, water recycling and construction materials; a case study on the water recycling technology situated in the policy setup of Zhongguancun is presented in Chapter 7.

SSCTHA (2010) reviewed Shanghai's eight categories of STI policies in 2009 and provided a two-page summary regarding IOGP achievements. Several examples were mentioned, including a 'first procurement' example of medical equipment and illustrations of different benefits products enjoyed from being accredited as indigenous innovation. Interviews with local stakeholders, however, implied coordination problems between S&T and finance departments; the linkage between the two sides was not routinely implemented and the 'first procurement' illustrated in SSCTHA (2010) was rather a special case. SSCTHA (2011) carried on to review Shanghai's STI policy progress in 2010. A distinction from SSCTHA (2010) was that the 2011 report covered the other seven categories of STI policies *except* government procurement. The report briefly mentioned the reason:

> *'…the government procurement of indigenous innovation products policy has been in a period of adjustment during 2010, thus this report does not deal with the implementation results of this policy…'(SSCTHA, 2011, p.3).*

Retrospectively, this was an early sign of the unsmoothness of the IOGP policy implementation.

Guangdong was the most promising region in generating IOGP examples since it established and implemented the local IOGP mechanism. According to interviewee R3F, the S&T and finance departments of Guangdong did track the implementation statuses of IOGP catalogues and produced some statistical reports; however, R3F was not willing to disclose detailed information and insisted that the reports were '*not exactly accurate and for internal use only*'. Rough information provided by R3F was that the products accredited into the 2009 IOGP catalogue were procured for more than 6000 times by May 2011, with a total spending of approximately 6 billion Yuan. Main sectors covered were medical equipment, ICT, energy efficiency and environmental protection products. One IOGP example briefly mentioned by the CCGP website was the procurement of 'high-frequency digital uninterruptable power supply' by Guangdong Provincial Public Security Department (CLPEA, 2010). Nevertheless, due to the lack of accessibility to detailed data, no IOGP case study for Guangdong was conducted in this thesis. Chapter 7 presents two case studies in Shenzhen city in Guangdong, which were under the settings of new energy vehicles (NEV) and LED lighting programmes (Channel 3) rather than Channel 1.

No secondary data about the utilization of local innovation catalogues in Shandong and Jiangsu were found except the well-known 'first procurement' example of Loongson computers in Jiangsu, as elaborated in Chapter 7. Interviewee R4O_1 recommended one potential case regarding the procurement of a special type of spandex material; however, a following interview with the spandex supplier suggested that the procurement was for national defence use, and access to further data was rather restricted.

Beyond the geographical scope of this thesis, the city of Wuhan in Hubei Province made use of its East Lake High-tech Zone as a policy experimentation platform to carry out IOPP (Yang et al., 2011). The concept of public procurement adopted by Wuhan was the broader definition (Section 3.2). In 2010 Wuhan organized three symposiums (Wuhan S&T Bureau, 2010) to promote new products from the zone in semiconductor lighting, solar energy and ICT sectors; public organizations in the locality were encouraged by the city government to procure new products being promoted; contracts with a total value of around 800 million Yuan were signed during the three events. The Wuhan approach was similar to that of Beijing centred on the Zhongguancun Innovation Zone (Section 7.2).

6.3.4 Termination of policies related to innovation catalogues

As mentioned before, the Chinese indigenous innovation especially IOGP policies drew concerns from abroad and had become '*one of the most contentious issues in the US-China relationship in recent years*' (USCBC, 2012, p.4). As a protest on the foreign suppliers' side, on December 10th 2009 the USCBC collaborated with 33 other trade associations from Canada, Europe, Japan, Korea, and the United States to raise their concerns to Chinese ministries against the *Notice on the Initiating of Accreditation Work for National Indigenous Innovation Product (2009)*, i.e. Guokefaji [2009]618 (USCBC, 2010b). The most controversial issues were the evaluation criteria that discriminated against foreign suppliers and the frequent references to the objective of 'import substitution' (USCBC, 2011b). This partly explained why Notice 2010 adopted criteria that were significantly different from previous versions.

Nevertheless, the amended criteria were still not considered acceptable for the USCBC and its member companies. On May 10th 2010 the USCBC published its comment on Notice 2010 (USCBC, 2010c), suggesting that the Chinese government clarify that the accredited products would be provided with *non-discriminative* supporting measures such as R&D and taxation support rather than government procurement; that the Chinese government invalid any previous criteria published by central or regional governments and stick to the new, non-discriminative criteria; that the Chinese government improve transparency of the policy implementation process. All in all, the key message was suggesting the Chinese government '*give up the attempts to promote innovation through government procurement or product lists*' (ibid. p.2). The main justification given by the USCBC was based on USCBC (2010a), which briefly reviewed innovation policies of ten most innovative countries/regions and concluded that the Chinese approach was not coherent with '*international innovation best practices*' which rely on policies such as IPR protection and R&D policies rather than government procurement.

Meanwhile the IOGP policy became a priority topic in bilateral dialogues between the US and China. US officials raised their concerns over this issue during the US-China Strategic and Economic Dialogue 2010 (see US Department of the Treasury, 2010) and some other channels (see USCBC, 2012). One outcome at the end of 2010 was that

> *'…China agreed not to discriminate in government procurement based on the origin of intellectual property or to use discriminatory criteria to select industrial equipment…' (U.S.-China Joint Commission on Commerce and Trade, 2010)*

In January 2011, President Hu made a commitment to delink government procurement from innovation during his visit to the US (USCBC, 2011e). This was furthered by the US-China Strategic and Economic Dialogue in May 2011, whereby

> *'…China pledged to eliminate all of its government procurement indigenous innovation products catalogues and revise Article 9 of the draft Government Procurement Law Implementing Regulations' (US Department of the Treasury, 2011)*

The official termination of key, national-level IOGP policies started in June 2011 (see Table 6.5). On June 23rd 2011, MOF announced the termination of three implementation measures (MOF, 2011) i.e. *Administrative Measures on Budget Management for Government Procurement of Indigenous Innovation Products* (Caiku [2007]29), *Evaluation Measures for Government Procurement of Indigenous Innovation Products* (Caiku [2007]30), and *Administrative Measures on Contract Management for Government Procurement of Indigenous Innovation Products* (Caiku [2007]31). On July 4th 2011, MOST, NDRC and MOF announced the termination (see MOST et al., 2011) of *Administrative Measures on the Accreditation of National Indigenous Innovation Products (Trial)* (Guokefajizi [2006]539). The termination of these four policies marked that the national IOGP mechanism outlined in Figure 6.2, which had not been implemented after all, was in effect abolished. The two notices did not provide any explanation regarding the reasons for policy termination, except that they stated at the beginning of the documents that '*it was decided based on research that*…' Nor did the notices specify what the regions should do with their local policies and catalogues.

Table 6.5 National notices to terminate IOGP policies

Issued by	Issue date/policy code	Terminated which policy	In force from
MOF	Caiku [2011]85	Caiku [2007]29; Caiku [2007]30; Caiku [2007]31	July 1st 2011
MOST, NDRC, MOF	Guokefaji [2011]260	Guokefajizi [2006]539	July 10th 2011
the State Council	Guobanfamingdian [2011]41	Aimed to conduct a nationwide 'deep cleanup' of policy documents linking government procurement preferences with innovation	December 1st 2011

Source: Author based on policy analysis

Initial responses at the regional level were diverse. Some regions transmitted the national notices and terminated their corresponding local policies very soon, e.g. Anhui, Chongqing, Fujian, Shandong, Shanghai and Tianjin; some regions did not respond explicitly, e.g. Hainan and Heilongjiang; and some regions carried on with their local implementation, e.g. Beijing. The USCBC continued monitoring China's national and sub-national actions in fulfilling the 'delink' commitment and urged a thorough implementation by sub-national governments (USCBC, 2011a). In November 2011, the State Council issued an urgent telegraph titled *Notice on Conducting a Nationwide Deep Clean-up of Policy Documents Linking Government Procurement Preferences with Innovation* (policy code Guobanfamingdian [2011]41), stating that

> *'...to fulfil the external commitment of 'delinking China's innovation policies from government procurement', all the regions and related departments should stop implementing any policy measures that linked innovation policies with government procurement by December 1st 2011, and meanwhile arrangements should be made to ensure the clean-up of related policies'.*

Following this strong mandate from the central government, all the regions that made their own IOGP policies or published local catalogues explicitly terminated their local policies/catalogues (see Appendix 16). Although some regions did not publish notices of termination, e.g. Hainan, Heilongjiang, Jilin, Shaanxi and Tibet, they were among the regions that did not initiate the regional implementation in the first place.

Among the policies related to the IOGP channel listed in Table 6.1, only the *Administrative measures on Government First Procurement and Ordering Procurement of Indigenous Innovation Products* (Caiku[2007]120) is still in force. As discussed in Section 6.3.1, 'first procurement' was designed to be implemented through innovation catalogues as well, thus the stipulations regarding 'first procurement' in Caiku[2007]120 are actually invalid. Ordering procurement in the current policy settings in China does not stand alone as an independent implementation channel for IOPP. It can be said that by the end of 2011, Channel 1 at both the national and regional levels had been officially terminated. USCBC (2013) claimed that its member companies experienced 'no positive change' since the policy termination, and that the USCBC would continue urging the Chinese government to translate the 'delink effort on paper' into 'real change' (p.2). However, this study gathered opinions from various stakeholders on the China side (interviewees R2O_1, R2O_3, R4F, R4O_1, R5F, R5O_1, and R5S_E), which suggested that the policy did not result in notable changes in practice in their regions (Shanghai, Shandong and Jiangsu) in the first place.

No official report was published regarding the trajectories afterwards. The CCGP website published very brief news about regional actions in November 2011 based on feedback from suppliers and government procurers (CCGP, 2011). It reported that domestic suppliers interviewed (mostly IT and automobile suppliers) were still very confident about their chance in winning government procurement contracts; many procurers actually 'welcomed' the cancellation of 'innovativeness' as a criterion since it simplified the evaluation process, and meanwhile enabled more effective use of product quality and supplier qualification as criteria to 'improve the quality of procurements'. It concluded that '*all aspects of government procurement work have been carried out smoothly after the termination*'.

Follow-up telephone interviews of this study (carried out in February 2012) implied that practitioners held different opinions about policy termination. Interviewee NO_2 admitted that many officials in MOST used to hold high expectations for the IOGP policy instrument, and wished to utilize the demonstration effect of government procurement to build an innovation-friendly culture; termination of related policies could be discouraging for domestic firms. Those worries were shared by interviewees R5O_1 and Researcher_2 (who considered this issue from the innovation side). Nevertheless, interviewee R5F (the procurer side) considered that originally there were other things required to facilitate procurement of innovation aside from creating IOGP catalogues, such as aligning the procurement classifications; the policy termination did not have significant impacts on their routine procurement activities. From the supplier side, interviewee R1S_HV considered that the termination would not affect their company very much, as they did not count on the IOGP policy anyway; while interviewee R1S_OW (the supplier in the Water case in Chapter 7) considered it a pity if Zhongguancun decided to eliminate procurement from the policy portfolio.

A later initiative by the central government to exploit the potential of government procurement as a horizontal policy has been the announcement of *Interim Measures on Government Procurement Promoting the Development of SMEs* (MOF and MIIT, 2011). This document detailed the preferential treatment for SMEs that government procurers are obligated to implement, including allocating special procurement budgets annually for SMEs, price reduction in public tendering, and risk sharing with suppliers. This move is coherent with international practices as reviewed in Chapter 4.

6.3.5 Highlights

This has been a long section and it is necessary to highlight some key issues in need of further discussion in Chapter 8.

- Was Channel 1 coherent vertically, i.e. were its goals, rationales, instruments, designed implementation structure, actual implementation process and outcomes coherent with each other?
- Implementation at the national level – if there was no external pressure and the national innovation and IOGP catalogues were produced as planned, would the nationwide implementation be coherent and effective?
- Implementation at the regional level – if only the national policies were terminated, and the regions were able to maintain their own IOGP mechanisms, would the country as a whole benefit from regional practices?
- Compatibility between the Chinese innovation and procurement systems regarding IOPP – are the two domains coherent with each other horizontally? If there were incompatibilities would Channel 1 be able to address them?
- International pressure and policy termination – this has been vivid evidence that the IOGP channel was not coherent horizontally with its international context. In the light of related perspectives reviewed in Chapters 2 and 3, how can this lack of coherence be explained?

6.4 Channel 2: major technological equipment (MTE) commercialization

6.4.1 The policy setup

The actual scope of IOPP policies outlined by the MLP and its lower-level policies was *broader* than the narrow understanding of government procurement, largely owing to the inclusion of equipment procurement issues. The main users of MTE in China are SOEs, thus most equipment procurements are by nature *public procurement*.

The development of MTE was very much emphasized by top-level innovation policies in China. One of the main objectives set by the MLP was

> *'…to master a number of core technologies that are closely related to national competitiveness in the industries of equipment manufacturing…' (Article II-2, State Council, 2006a)*

The State Council announced *Advice on Accelerating the Revitalization of Equipment Manufacturing Industry*, listing 16 areas of needed equipment technologies. Article XIII stated that

> *'Ordering procurement and use of domestically made first (set of) MTE are encouraged. For those national major projects that procure or use first (set of) equipment, they can be certified as demonstrating projects for technological advancement and enjoy priority during implementation…' (Guofa[2006]8, see State Council, 2006c)*

State Council (2006c) was further supported by *Administrative Measures on First (set of) Major Technology Equipment Experiments and Demonstration Projects* (NDRC et al., 2008). MTE was defined as:

> *'equipment products that have great impacts on national economy security, defence construction, and the sustainable development of national economy, and that can facilitate the transformation of economy structure, escalation of industries, and energy saving and emission reduction' (Article I, Fagaigongye [2008]224, see NDRC et al., 2008)*

and *first (set of) MTE* refers to

> *'the (sets of) equipment that integrates mechanical, electrical and automatic control technologies developed through original innovation, integrated innovation or re-innovation based on digesting imported technologies, featuring indigenously developed core IPRs, indigenous trademarks and significant energy efficiency and low (zero) emissions, but has not achieved market performance' (ibid.)*

Experiments were defined as the cases where 'the MTE adopted by the organization is applied for the first time *internationally'*, and *demonstration projects* as the cases where 'the MTE is applied for the first time *domestically'* (Article II). NDRC et al. (2008) stipulated that all organizations can apply for the status of national experiment or demonstration projects as long as they procure and use first (set of) MTE. Qualified projects can enjoy a range of supporting measures such as credit support and tax reduction for importing necessary components for equipment manufacturing (Article VII). NDRC et al. (2008) also considered regulatory issues of procurement; concrete procurement procedures and evaluation criteria were coherent with that for 'ordering procurement' as stipulated in Caiku[2007]120 (see Table 6.1); and

> *'...for those first (set of) MTE experiment demonstration projects* ***outside the scope of government procurement****, the project owner organizations should organize tendering processes to choose the equipment R&D service supplier* ***according to regulations stipulated in the Law on Tendering and Bidding*** *of the PRC…' (Article VI, NDRC et al., 2008)*

The first (set of) MTE projects outlined by this policy can be understood as a channel of *equipment commercialization based on pre-commercial procurement* (Channel 2). The announcement of Channel 2 looks rather detached from that of Channel 1. It was through the fieldwork that the function of equipment-related policies in facilitating IOPP was recognized by the author. Policy analysis was conducted retrospectively to trace the origin of this channel. Due to the time limit and lack of access to new types of stakeholders, not much primary data about the implementation processes in all five regions was obtained; this has been one of the many obstacles encountered by this exploratory study. Only two procurement examples from Shanghai related to this channel are presented in Chapter 7, i.e. the Tunnel and the Shanghai-LED cases.

6.4.2 Equipment catalogues and linkage with innovation catalogues

By listing the technological areas in need of development in China, Guofa [2006]8 played a 'catalogue' role in signalling national demand for MTE. The explicit notion of *equipment catalogues* came from the State Council's *Advice on Division of Labour to Implement <Report on the Work of the Government 2009>*, policy code Guofa[2009]13, which stated that the MIIT, MOST, NDRC, MOF and State-owned Assets Supervision and Administration Commission (SASAC)[25] should

> *'…implement domestic support programmes and government procurement policies to support MTE developed from indigenous R&D activities, and formulate MTE*

[25] SASAC, led by the State Council, supervises SOEs in China.

> *Catalogues to…improve the level of integrated innovation and domesticalization of the equipment manufacturing industry' (Article XVIII, Guofa[2009]13)*

Following this arrangement, the government agencies published the *Guiding Catalogue for Indigenous Innovation in MTE*, i.e. the equipment catalogue. The 2009 catalogue listed 18 technological areas and 240 equipment products that had a certain level of technological foundation but still need further support to realise commercialization in the short term. The introduction of the catalogue stated that

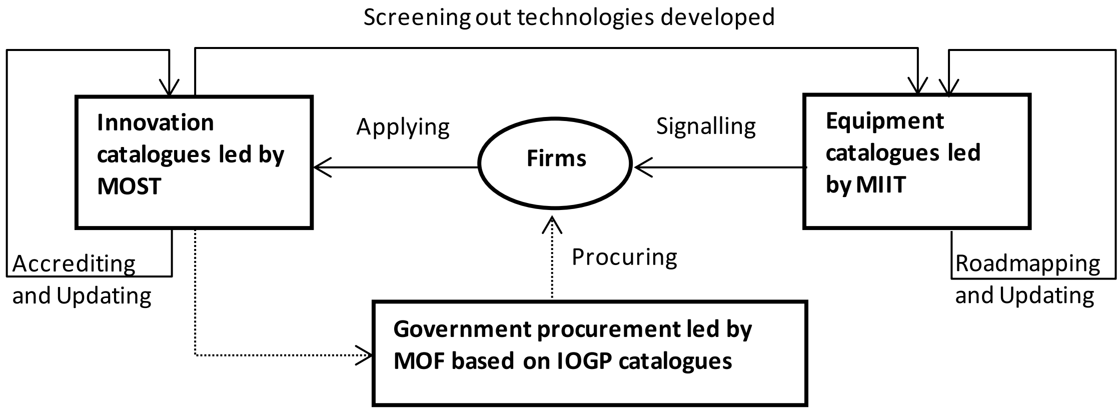
> *'…products listed in this catalogue have the* **priority** *to… enjoy related national policies encouraging* ***the use of first (set of) equipment****; once the products are developed successfully and qualify as national indigenous innovation products,* ***they have the priority to be included in IOGP catalogues and enjoy government procurement policy support****…' (MIIT et al., 2009)*

The 18 areas are mostly beyond the scope of narrowly defined government procurement and not procurable by government agencies, such as power generation and transmission equipment, rail transportation equipment, and mining equipment. In this sense, the catalogue adopted the broad concept of *public procurement* and consequently by including MTE products 'IOGP catalogues' would become 'IOPP catalogues'.

Different from an innovation or IOGP catalogue which was a 'what we have' list, the equipment catalogue was a 'what we want' list, underpinned by a strong intention of catching-up and targeted at world-leading technologies. The equipment catalogue has been updated on a yearly basis, serving multiple functions, including: working as a *signalling* instrument to guide the directions of R&D, providing policy *justification* for government agencies to support the equipment manufacturing industry through various measures, and functioning *in conjunction with* innovation as well as IOGP catalogues.

As shown in Figure 6.4, according to the original policy design, the equipment catalogues, innovation catalogues and IOGP catalogues should work together to form a *signalling* and *accrediting* mechanism. The communication and coordination between the innovation and public procurement systems could then be enhanced. Government procurers were expected to use IOGP catalogues as references when they conduct procurements, and suppliers (mostly firms) were expected to refer to equipment catalogues for R&D. By working together in both directions, equipment (signalling) and innovation (accrediting) catalogues were intended to stimulate indigenous innovation through both 'push' and 'pull' forces. Given the termination of Channel 1, the implementation of the linkage between innovation and equipment catalogues has arguably failed.

Figure 6.4 Designed use of innovation, equipment and IOGP catalogues



Source: Author adapted from Li and Georghiou (2013)

Concerns about potential discrimination against foreign products by the equipment catalogue and related policies were raised by USCBC as well (USCBC, 2011a). In particular, the USCBC wrote a letter to the Minister of the MIIT, in order to push the Chinese government to seek alternative approaches to support equipment innovation (USCBC, 2011d). USCBC listed several reasons for its argument, including that

> *'…the Catalogue focuses on existing technologies instead of future innovative equipment. In addition, lists and catalogues risk becoming quickly outdated because of the rapid pace of technology advances… Finally, the Catalogue creates the potential for uneven implementation across China, limiting the ability and willingness of innovative non-Chinese equipment manufacturers to bring their technology and investment to China…'(ibid., p.1).*

It also proposed suggestions for the MIIT to modify the equipment catalogue, including

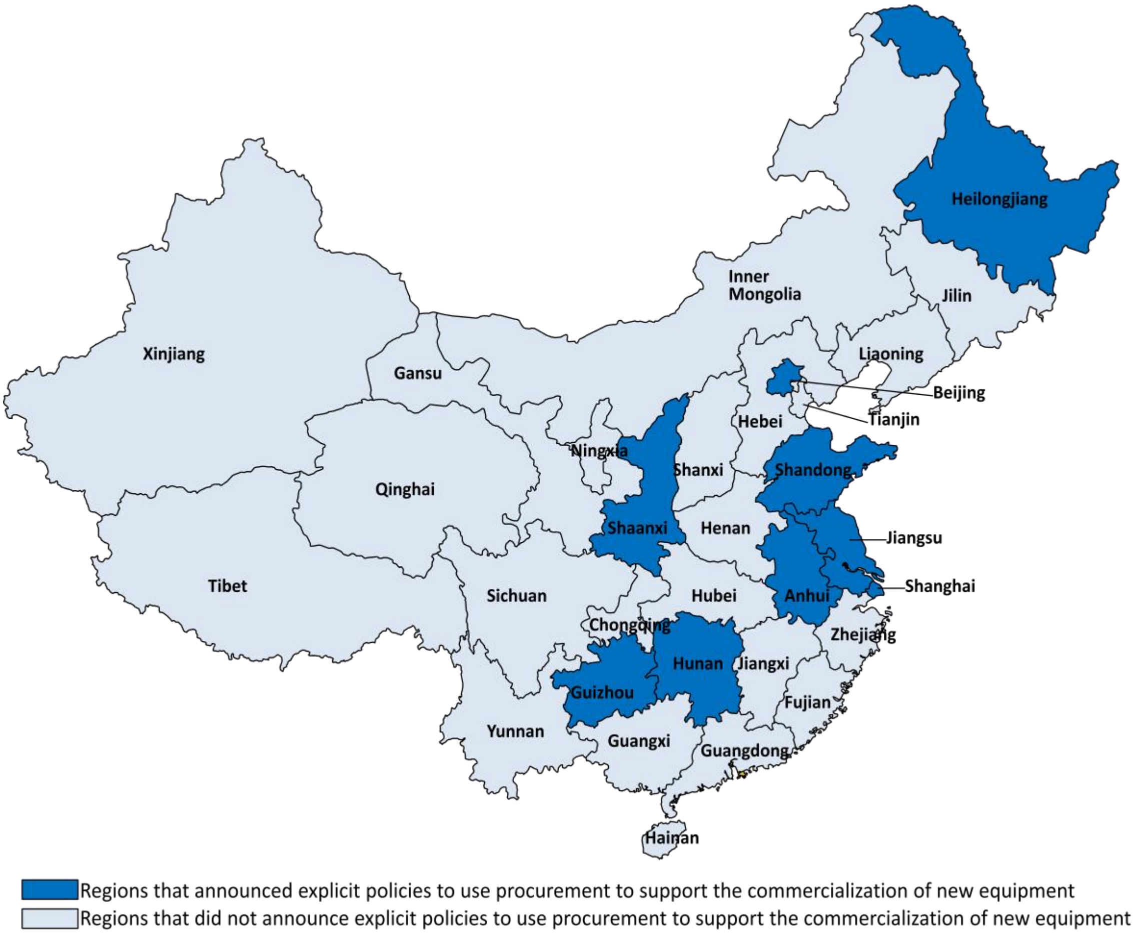
> *'…add specific language to the Catalogue stating that foreign and domestic companies shall be treated equally when applying for and being considered for the Catalogue, and accessing benefits available through the Catalogue…'(ibid., p.2).*

Thus far the equipment catalogue approach has still been in force. Although the MIIT did not 'add specific language' as proposed by USCBC (2011d), it removed explicit language regarding import substitution and government procurement supporting MTE in the latest version of equipment catalogue (see MIIT et al., 2012).

6.4.3 Regional actions

Corresponding to the national policies on first (set of) MTE, many regions issued their local policies to promote the commercialization of locally produced MTE (see Appendix 15). As shown in Figure 6.5, the regions marked by blue colour explicitly announced that they would use government procurement to facilitate the commercialization of locally developed MTE. Other supporting policies were also employed, including user subsidies, tax refunds and risk compensation, which all targeted to facilitate commercialization from the demand side.

Figure 6.5 Regions in Mainland China that linked procurement with MTE commercialization



Source: Author developed based on policy analysis

Compared with the widespread implementation of Channel 1 at the regional level, Channel 2 was only implemented by regions with relatively advanced equipment manufacturing industries, e.g. Beijing, Jiangsu, Shandong, Heilongjiang and Shanghai. Concrete approaches to using this policy instrument, however, were not always detailed in regional policies. Beijing adopted the broader notion of public procurement and integrated Channels 1 and 2 into one mechanism centreed on Zhongguancun (Section 7.2). For other regions including Anhui, Heilongjiang, Jiangsu and Shandong, a common approach adopted was based on another type of ‘accreditation’ work, i.e. to accredit local ‘first (set of) MTE’ to form catalogues and provide supporting policies (including government procurement) accordingly for listed products or needed components. Shanghai adopted an approach similar to the national ‘experiment’ and ‘demonstration’ project approach, called ‘First (set of) Equipment Breakthrough Programme’ which will be elaborated in the Tunnel case in Chapter 7. Similarly to regional IOGP catalogue policies, those equipment-related policies are only applicable to local firms.

6.4.4 Signalling and accrediting policies/catalogues for innovation

Insights gained from policy analysis and fieldwork suggest that the innovation and equipment catalogues actually belong to two broader categories i.e. *accrediting* and *signalling* policies/catalogues. National and regional governments in China frequently utilize ‘catalogues’ (sometimes in the form of plans and general policies) to signal national/regional needs, and accredit national/regional outcomes of innovation. Table 6.6 presents some examples.

Table 6.6 Signalling and accrediting policies/catalogues

	Signalling Innovation Needs	Accrediting Innovation Outcomes
National examples	• Guiding Catalogues for Indigenous Innovation in Major Technological Equipment • STI Development Plan for the 12th Five-year Period	• Catalogues of Indigenous Innovation Products • Catalogues of Recommended Vehicle Models for the Energy-saving and New Energy Vehicles Demonstration Programme
Regional examples	• Beijing: Advice on Strengthening Indigenous Innovation Capability and Building an Innovative City • Shenzhen: Implementation Plan for NEV Demonstrating Operation During the 26th Summer Universiade	• Regional catalogues of innovation products • Shanghai: Catalogue of Indigenous Innovation in Construction & Transport Sectors • Regional catalogues of local innovative equipment and components

Source: Author adapted from Li and Georghiou (2013)

Regardless of their implementation status, by rationale accrediting catalogues can contribute to *gathering market intelligence*, while signalling policies/catalogues can contribute to *demand articulation*. Both can potentially *facilitate the communication and coordination* between demand and supply of innovation.

6.5 Channel 3: procurement elements in demonstration programmes

As mentioned this channel was not explicitly announced as part of the IOGP policies and was identified in a bottom-up manner. Several interviewees during the 1st round of fieldwork spontaneously referred to sectoral demonstration programmes (sometimes under the titles of ‘promotion’ or ‘commercialization’ programmes/projects) when they were requested to recommend IOPP cases.

The recent years have seen a strong rise of this kind of programmes led by the government (of China as well as other countries) to promote the development of emerging and strategically important sectors (see OECD, 2011a). They are mainly targeted at new technologies that are promising in coping with grand challenges (Edquist and Zabala-Iturriagagoitia, 2012), especially the ones that the private sector or the market mechanism itself would not be able (or willing) to adopt. International examples include the LMI in the EU, the electric vehicle (EV) demonstration projects in the US (NWV, 2011), and the hydrogen-based social system demonstration programme in Japan (METI, 2010). These programmes can be considered as systemic policies with various DSIPs adopted, e.g. technological standards, consumer subsidies, capacity building and public procurement. In China, well-known examples include the two programmes selected by this study i.e. the ‘New Energy Vehicle’ (NEV) Programme (also called ‘ten cities, thousands of NEVs’, see Zheng, 2011 and Sun, 2012), and the LED Lighting Programme (also called ‘Ten cities, Ten thousand of LED lights’, see ISA, 2012).

The NEV and the LED lighting programmes were both initiated in 2009 to promote the commercialization and diffusion of new technologies in both sectors, as well as to cope with issues such as the global economy crisis, energy shortage and environmental pollution. All of the five selected regions were involved in both programmes. Details about policy settings and the implementation of procurement elements are elaborated in Chapter 7 in the corresponding case studies.

6.6 Conclusion

This chapter has reviewed China's IOPP policies which resulted from a strong mandate by the MLP. A variety of national-level policy measures were employed afterwards to articulate and implement the mandate, ranging from the attempts to establish a routine IOGP mechanism and pre-commercial procurement, to import control and 'buy Chinese' regulations. Integrating data gathered from policy analysis and fieldwork, this study identified that at least three IOPP policy channels exist(ed); the scope of IOPP policies in China is broader than the boundary of the LGP but narrower than that of the LTB; the exact scope seemed ambiguous though.

The most explicit and controversial channel was the IOGP mechanism based on innovation and IOGP catalogues (Channel 1), backed by a set of policy measures issued by MOST, NDRC and MOF (Figure 6.2). Its rationale was to enhance inter-departmental coordination by bringing the innovation and procurement systems together through catalogues of accredited indigenous innovation products. The central government appeared determined in implementing this channel and more than half of the regions responded actively by articulating national policies. During the 'transitional' stage when the national catalogues were not yet produced, regions demonstrated both compliance and autonomy characteristics, with diverse approaches and progresses of implementation. Regional experiences indicated incompatibility between IOPP and China's procurement systems, mainly due to the too narrow scope of government procurement; in some regions the issue was mitigated through local policies. However, later-on implementation trajectories of this channel, especially that after the three ministries launched the nationwide accreditation work in late 2009, were heavily obstructed by external factors – notably the political pressure from the US government out of concerns about China's protectionism. After rounds of bilateral negotiations, the Chinese government officially terminated this channel in 2011. The exact impacts of the establishment and the termination of this channel on the country as a whole remain unknown; yet available data suggested that different stakeholders situated in different regions held diverse opinions, depending on their own experiences of the policy. The story of this channel certainly implies the lack of coherence of the Chinese approach with its horizontal contexts, i.e. the domestic procurement system, as well as international circumstances.

Another channel is through policies that aim to promote the commercialization of MTE (Channel 2). SOE procurement of indigenous innovation equipment was heavily encouraged by the central government, but was treated separately from the IOGP channel because, again, of the narrow scope of government procurement. The rationale of this channel was on the one hand, signalling the national demand to potential suppliers through equipment catalogues, and on the other, conducting experiment or demonstration projects to use newly developed equipment. Regions featuring strong equipment industry bases followed this initiative and commenced their own approaches. Again, both compliance and autonomy were observed; while regions followed the national equipment catalogues, they utilized various instruments such as accrediting and supporting locally developed new equipment. This channel was threatened with international pressure as well, notably regarding the equipment catalogue's explicit pursuit of import substitution when initially launched in 2009. Its later regulations modified the wording and thus far it remains valid and seems promising in accelerating China's catching-up pace.

The third channel identified is through IOPP elements embedded in demonstration programmes for emerging technologies (Channel 3). This chapter did not look into the details of this channel as every single demonstration programme has its special background and policy settings. Concrete IOPP processes through these programmes as well as through other channels are elaborated in the form of case studies in the following chapter.

Chapter 7: IOPP Case Studies

7.1 Introduction

This chapter[26] presents six case studies regarding the concrete processes of IOPP in China. Four of them are single cases i.e. cases within a single contextual setting, including the cases of Water Recycling (Section 7.2), E-classroom Solutions (Section 7.3), Tunnel Engineering (Section 7.4) and Offshore Wind Turbines (Section 7.5). For each case five aspects are addressed in turn, i.e. an overview of the case with key stakeholders and steps illustrated, background information (e.g. the technology, demand, supplier, and policies), the procurement process, main obstacles encountered, and outcomes/impacts. The other two, i.e. procurement elements in the NEV and LED lighting programmes (Sections 7.6 and 7.7), are complex cases with multiple sub-cases. For each of them four broad aspects are addressed, i.e. an introduction, background information about the demonstration programmes, sub-cases of procurement processes conducted in participant cities, followed by a section highlighting key issues identified. Structures of these cases are not exactly the same, as each case followed a unique trajectory. Section 7.8 briefly reviews IOPP processes covered by the cases by abstracting their key dimensions, followed by Section 7.9 concluding the chapter.

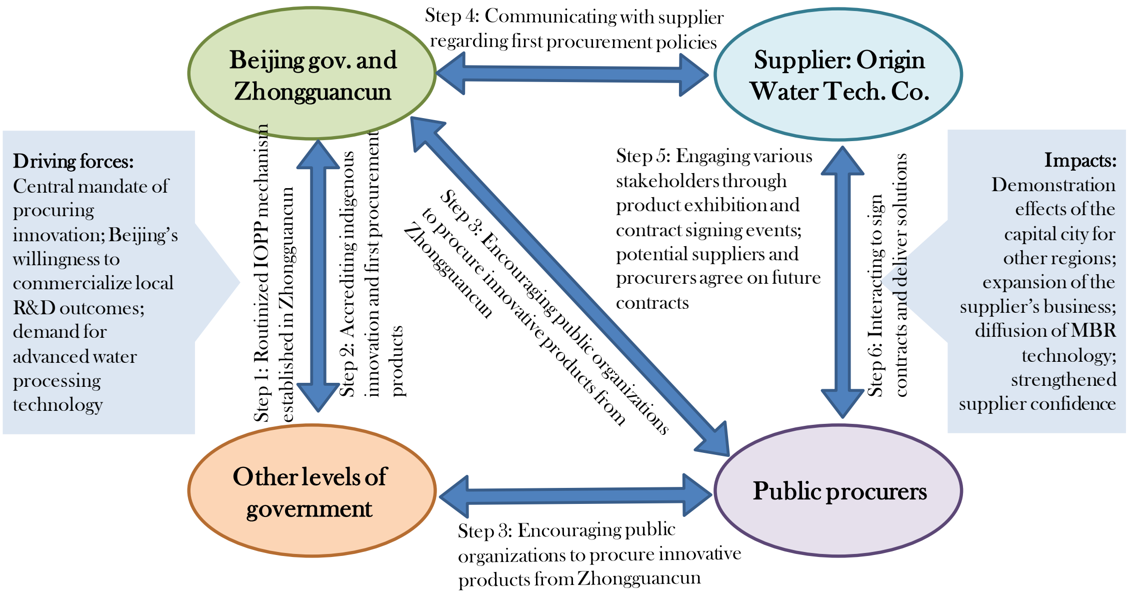
7.2 Case I: Water recycling solutions

7.2.1 Overview

This case is about the procurement of Membrane Bioreactor (MBR) water recycling solutions from the Zhongguancun National Innovation Demonstration Zone in Beijing. Procured items were included in national (2009) and Beijing's (2009 and 2010) innovation catalogues. The immediate approach to matching the demand and supply was through 'contract-signing conferences' organized by the Beijing government, which led to several contracts for the supplier. The overall process is illustrated in Figure 7.1.

[26] Parts of this chapter have been published in modified forms in Li and Georghiou (2013), and Li et al. (2013), and presented at conferences UNDERPINN 2012 and EU-SPRI 2012.

Figure 7.1 Overall process of the Water Case



Source: Author

7.2.2 Background information

7.2.2.1 The technology, supplier and commercialization challenge

MBR is a recently commercialized technology for water recycling, and increasingly an attractive alternative to traditional technologies (Yang et al., 2006). Membrane plant configurations vary but the rationale is to resolve wastewater through bioreactor units containing high concentrations of microorganisms, and to separate solid and water apart through hollow fibre membrane units. Compared with conventional settlement systems, MBRs produce recycled water more quickly with higher quality, occupy less space, and can be upgraded easily. In China MBR used to be a rare approach, mainly imported from abroad at very high price (R1O_2). The Chinese market has just entered an era of rapid development (Huang et al., 2010).

The supplier in this case, Origin Water, is a privately owned SME founded in Zhongguancun by returnee students who studied abroad. By 2009 it had obtained full IPRs for membrane manufacturing and become a leading player in China's MBR market (ibid.). Faced by commercialization challenges, Origin Water conducted some demonstration projects for its solutions before Beijing's IOPP support (see Appendix 17 for details).

Seeing the high cost and market demand of MBR technology, Beijing emphasized the importance of commercializing locally produced MBR (Beijing Government, 2009b); Zhongguancun announced the diffusion of Origin Water's MBR units as a priority (Zhongguancun, 2010a). This move was also partially driven by Beijing's innovation strategy in general, which, according to interviewee R1O_1, targets at commercializing local R&D outcomes:

> *'…In terms of R&D resources, we always say* ***Beijing occupies around one third of the total amount of the country****…the major challenge faced by Beijing is, different from any other regions, a problem of how to make better use of these resources, and that* ***how to release the endogenous energy of research results to contribute to development****… we are trying to explore a* ***better institutional structure*** *to guide the transformation of research outcomes into innovations with commercial or social values…' (R1O_1)*

7.2.2.2 IOPP policy setup in Beijing

A key policy that elaborated Beijing's IOPP mechanism was *Measures on Conducting Experimental Government Procurement of Indigenous Innovation Products in Zhongguancun Science Park* (Beijing Government, 2008). It adopted the broader concept of public procurement by defining four types of IOPP, i.e. *first procurement*, *ordering procurement*, *first (set of) MTE experiment/demonstration*, and *promotion/application*, which in essence integrated multiple IOPP policy channels. To engage public procurers, both incentives and mandatory rules were employed:

> *'…We encourage procurers to participate by offering* ***incentives such as larger procurement budgets*** *for the forthcoming year. Innovation and first procurement catalogues*[27] *are valid for the whole city – no matter which public body you are, you* ***will need to*** *follow them when procuring things…' (R1O_1)*

Beijing DRC has been the coordinator for implementing IOPP. Two approaches were employed to enhancing cross-departmental coordination: a city-level leading group constituted of officials from related government agencies; and a 'joint conference' engaging different levels of government, ranging from higher-level ministries to lower-level district governments. R1O_2 introduced that:

> *'…Sometimes we need to* ***innovate in policy implementation*** *– we call it* ***policy breakthrough*** *– to remove barriers hindering regional development… Some policies are related to national-level issues, thus we have to* ***communicate with ministries through joint conferences****… Another approach is that* ***we take the initiative*** *by*

[27] See Table 6.4.

> *organizing* ***thematic procurement events****… we hope that capable firms can bring their new products for 'first procurement'…' (R1O_2)*

A recent move to enhance coordination has been the establishment of a '*Working Group for New Technology/Product Government Procurement and Promotion*' (R1O_2), undertaking intermediary tasks of information gathering, procurer-supplier matching and project tracking. After the nationwide termination of Channel 1, Beijing exchanged the concept of 'indigenous innovation' with 'native innovation' (i.e. innovation that is created in the country, regardless the nationalities of IPRs), and adopted a more sophisticated way to carry on with IOPP (Guo, 2013).

7.2.3 The procurement process

7.2.3.1 Contract-signing conferences

To put IOPP policies into action, in March 2009 the Beijing government organized a technology exhibition for new products produced by Zhongguancun, followed by a government procurement contract-signing conference i.e. 'thematic procurement events' as titled by R1O_2. The conference achieved contracts (which were actually *intents of procurement* rather than formal contracts) for nine projects in six areas including energy-saving, water-processing, and waste treatment, with a total government investment of 1.74 billion Yuan.

The Beijing government considered the first conference as a success and decided to organize more thematic promotion conferences for Zhongguancun's innovative products in key, strategic areas regularly (R1O_1). The 'routine' of contract-signing conferences is described as:

> *'…The* ***procurement office in the zone*** *normally asks us whether or not to participate in the forthcoming contract-signing session. If we want to participate we need to fill in information forms and submit supporting documents about our new technologies… The office then organizes experts to discuss practicability and* ***notice potential procurers****…' (R1S_OW)*

When questioned whether the signing of contracts is compulsory or not, the supplier interviewee answered:

> *'…it is a bit complicated and hard to say… if you say it is compulsory, it is actually not – no obvious rules saying you* ***have to*** *buy new products from the event; if you say it is not compulsory, the government is actually looking forward to scheduled progress… basically* ***it is the government who makes a match, but it is not 'arranged marriage'****…*

> *lower-level departments tend to ingratiate their superiors, which is kind of* ***administrative pressure****…' (R1S_OW)*

In 2010, twenty-five government departments in Beijing won 'Organizational Prize', and five SOEs won 'Application Prize', for 'Government Procurement of Zhongguancun Indigenous Innovative Products in 2009' (Zhongguancun, 2010b), awarded by the Beijing municipal government.

7.2.3.2 'First procurement' contracts obtained by the supplier

Table 7.1 lists brief information of the contracts obtained by the supplier from contract-signing conferences during 2009-2010. The first three contracts took up around 30% of Origin Water's annual contract value in 2009; for each contract the recycling solution was more advanced than the previous one with the newest technologies adopted, which is a requirement for the supplier to enjoy Beijing's 'first procurement' policy (R1S_OW).

Table 7.1 'First procurement' contracts obtained by the supplier (2009-2010)

Conference	Procurer information	Project information
March 2009	• Beijing Drainage Group	• Upgrade Project for Beixiaohe Recycling Plant *Valued 44 million Yuan*
April 2009	• Beijing Drainage Group • Yanqing county	• Upgrade Project for Qinghe Recycling Plant • General Treatment Project for Jing-Jin Fengshayuan Watershed *Valued over 150 million Yuan*
August 2010	• Beijing Drainage Group • Water Authority of Fengtai district • Water Authority of Fangshan district	• Gaobeidian project of water recycling plant and re-usage • Fengtai Hexi project of water recycling plant • Fangshan Chengguan project of water recycling plant *Valued around 380 million Yuan*

Source: Author derived from documentation analysis

According to R1S_OW, suppliers and intended procurers normally start communication for business protocol (e.g. the cooperation schedule and product design) immediately after or even during the conference; more formal dialogues/negotiations would follow to set technological specifications; owing to the signing of procurement intents, supplier-procurer communication and coordination is normally smooth.

Although the supplier owned core IPRs before the contract-signing and the product was quite stable already (which was one of the requirements for enjoying 'first procurement' policies), it did achieve some innovation to suit customers' requirements. One example was 'compact wastewater treatment system' that deals with the difficulty of processing distributed polluted water sources (R1S_OW).

7.2.4 Obstacles

Because of local protectionism posed by other regions, the supplier had to collaborate with a local firm or even 'localize' to gain contracts outside Beijing; local operators for traditional recycling plants were also a hindering force for adopting MBR technology; another issue was perceived unwillingness of public organizations in Beijing in conducting IOPP, but 'administrative pressure' helped overcome this (R1S_OW).

7.2.5 Outcomes and impacts

Beijing as the capital city generated demonstration effect for using the supplier's MBR technologies; Origin Water's products diffused quickly to other regions despite barriers of regional protectionism. In April 2010 Origin Water got listed on the Chinese SME board, for which R1S_OW considered the reputation gained from government procurement contracts extremely helpful. Meanwhile it was realized that Beijing's market is not enough for the supplier:

> *'…We can't fully depend on the good policies from Zhongguancun… for projects outside the city we have to compete with powerful players such as GE and Siemens… our advantages are better value for money and localized services… for some strategic regions we established new sub-companies…' (R1S_OW)*

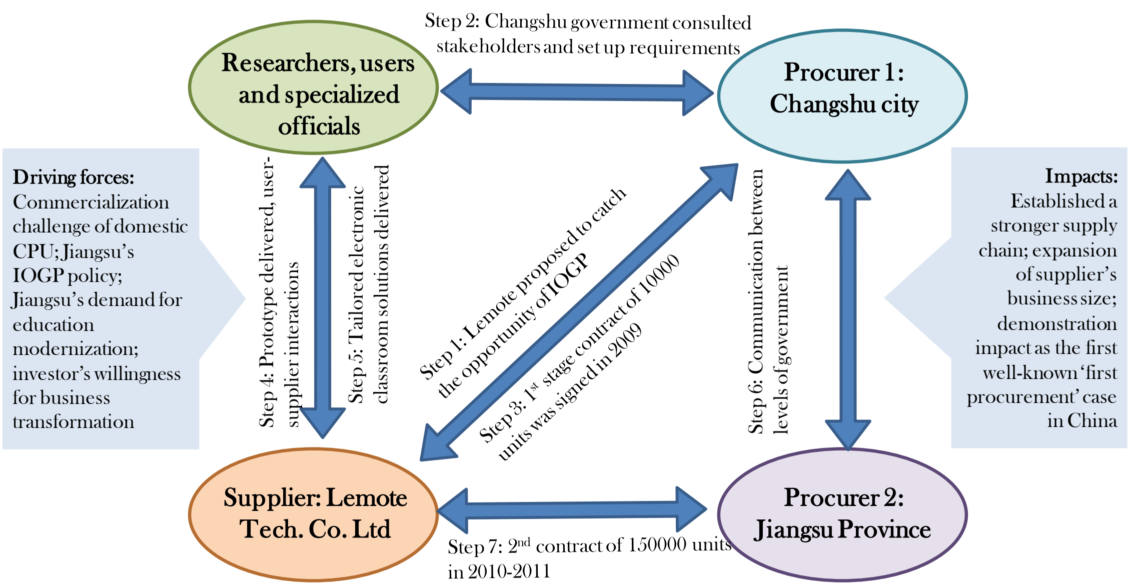
Zhongguancun as the top innovation demonstration zone in China has great impacts on technology development; its active promotion of MBR technology accelerated water recycling revolution countrywide (NO_2). Against the background of the 2008 global economy crisis, this move brought confidence to firms in the zone (R1S_OW).

7.3 Case II: E-classroom solutions

7.3.1 Overview

This case is about the procurement of e-classroom solutions in Jiangsu. Two factors i.e. the national and provincial policies regarding IOGP, and Jiangsu's province-wide initiative to modernize teaching and learning infrastructure, came together to bring the supplier an opportunity to develop tailored e-classroom solutions based on Loongson processors (China's domestic central processing unit, CPU). The first round of procurement was conducted by the city of Changshu where the supplier locates in April 2009. A second, larger-scale procurement was conducted by Jiangsu province in December 2009. The overall process is illustrated in Figure 7.2.

Figure 7.2 Overall process of the E-classroom Case



Source: Author

7.3.2 Background information

7.3.2.1 Loongson processor and the commercialization challenge

The central government considered it very necessary to develop domestic CPU since domestic processors can potentially lead to higher value added and bargaining power for Chinese firms who were only involved in downstream business of the supply chain dominated by American CPU makers (R5S_E). Another consideration was a concern with national security issues:

> *'…**We cannot fully rely on American processors for every purpose of uses**... When our Lenovo acquired the PC business of IBM, the US government was so concerned that it could affect their **national security; it's the same for us**… **developing our own chips is a strategic move**…' (R5O_CS)*

The CAS was commissioned by the State Council to develop domestic processors; CAS's R&D outcome, the Loongson processor based on MIPS (Microprocessor without Interlocked Pipeline Stages) instruction set was born in 2002. An initial effort to commercialize Loongson processors eventually failed (see Appendix 18 for more details). The joint establishment of Lemote (the supplier company in this case) by CAS and the Menglan Group[28] in 2006 marked a starting point of commercializing Loongson processors.

R5S_E introduced that Lemote has changed its strategy from confronting American CPU makers directly to an adapted one, i.e. purchasing licenses from MIPS to avoid IPR disputes; Lemote actively seeks policy support from the local government, and pays attention to opportunities in the public sector rather than purely relying on private consumption. Loongson-based products by Lemote include off-the-shelf devices for private consumers, specialized items for defence use and super computers (e.g. Dawning 6000), as well as customized solutions such as the one presented in this case.

7.3.2.2 Provincial and local policies related to this case

As mentioned in Chapter 6, Jiangsu issued its local regulations and innovation catalogues soon after the central initiative. Loongson-based products were listed in the 2009 (unpublished) national innovation catalogue, and several versions of Jiangsu's innovation catalogues.

R5O_1 confirmed that commercialization of innovative solutions has been a priority of the provincial government's work in recent years:

> *'…This topic (referring to IOPP) is very important and challenging for us. **We are devoted to implement this policy as we have so many innovative SMEs – commercialization is a common problem for all of them**… still what we have done is far from enough… **what has been achieved is more like dots from here and there, not the layers as targeted**…' (R5O_1)*

[28] Menglan Group is a privately owned enterprise situated in Menglan village, Changshu city. Its motivation to invest in Loongson processors lay primarily in its intention to transform the business from traditional textile manufacturing to a more diversified one integrating high technology (R5S_E).

Another policy factor was that the Jiangsu province was trying to modernize their education system, i.e. to equip primary/middle/high schools with computer systems for ‘e-teaching’ (R5O_CS). Lemote identified great potential from this policy initiative – they could take the opportunity to promote and improve their products as well as contribute to education modernization (R5S_E). The founder[29] of the Menglan Group made a proposal titled *Coping with the Global Economy Recession, Supporting Indigenous Innovation: proposal on promoting Loongson-based computers in education sector* (Qian, 2009) to draw attention from the central government. This proposal won support from the then President and Premier, which positively accelerated the procurement process (R5O_CS).

Changshu as a city was trying to transform its development mode towards a more technology-intensive one. R5O_CS said that the local government was very supportive for local firms who sought transformation together with the city; Menglan and Lemote were among the leading business actors in the locality, thus the city government was willing to be the first buyer of Lemote’s new products.

7.3.3 The procurement process

7.3.3.1 The first procurement by the city

Seeing the market potential in the local education sector, the supplier approached the city government who showed strong interest in supporting Loongson-based products. Officials responded actively and took the procurement as a high priority. A temporary coordination mechanism was set up, engaging chief officials from S&T, finance, and education departments in Changshu to facilitate policy implementation. Performance requirements for solutions to be procured were decided on the basis of consultation with those departments.

On April 28th 2009 a contract was signed between the Changshu city and Lemote regarding the procurement of 10000 units of computers for e-learning/teaching in 114 local primary and middle schools. A basic idea of ‘Loongson multi-media interactive e-classroom’ was to facilitate multimedia interactions between teachers and students using connected computers in class, e.g. paperless exams.

[29] The founder was elected as one of ‘the top 10 outstanding ladies’ in China, and a representative of the National People's Congress.

The e-classroom solution was co-designed by the Institute of Teaching Equipment Research, Ministry of Education, East China Normal University, CAS and Lemote, based on the national and provincial education informationization guidelines. It needed to be tailored to suit the needs of different levels and modules, integrating a wide range of teaching materials.

User feedback greatly helped Lemote improve and finalize its solution. R5U_E, a teacher as well as a manager in charge of computer procurement from one of the first primary schools equipped with Loongson e-classrooms, said that:

> *'…We keep updating our experience to Lemote and they keep sending people here to solve problems… many experiments of new Loongson products were conducted in our classrooms… it is safe to say that we contributed a lot to their products… we witnessed Lemote's development…' (R5U_E)*

The Loongson e-classroom solution was considered innovative and coherent with the national development trend by the Ministry of Education and the Jiangsu Department of Education, which provided a justification for the provincial procurement later on.

Afterwards the city provided further support for Lemote to promote Loongson-based products, including: facilitating Lemote to compete in the government procurement market in Jiangsu; initiating informationization programs using Loongson-based products for rural area. In 2010, the Changshu city held a Forum on Government Procurement of Innovation; the event attracted procurers from other regions to learn about Loongson products, which to an extent helped Lemote to expand its market in other provinces afterwards.

7.3.3.2 The second procurement province-wide

Inspired by the earlier experience, officials from the Changshu city reached the provincial government for further opportunities of procurement. This drew much attention from the provincial government as it could be the first IOPP case in Jiangsu. Top officials required the provincial Government Procurement Centre to '*treat this case seriously without breaking government procurement regulations*' (R5F). The centre developed a procurement plan based on advice from the provincial finance and education departments. Guided by the national policy Caiku [2007] 120 (see Table 6.1), this centre organized a 'first procurement' procedure based on negotiations between an expert group and Lemote. An agreement about the cost, performance requirements, timing and services was achieved.

In late 2009, a contract of approximately 150,000 units (maintaining and training services included) with a value of 350 million Yuan was signed between Lemote and Jiangsu government. The computer units were used to construct 4679 sets of Loongson e-classroom solutions in primary and middle schools in Jiangsu.

After the contract was signed, Lemote spent around 1 year interacting with users and education officials to further articulate technological specifications and to refine its solutions.

> *'…Our products are not regular, single computers. There are no fixed standards for us to follow… we did very wide and deep research, and they (referring to users) asked us to do many improvements as well…' (R5S_E)*

7.3.4 Obstacles

A lack of stakeholders willing to share the risks and help innovative firms was the main obstacle faced by Lemote:

> *'…There are many theoretically good innovation policies… when it comes to the implementation stage,* ***many officials don't want to be involved****…* ***not everyone wants to bear the responsibility****…' (R5O_CS)*
>
> *'…We spent so much energy persuading various departments to support us… from management staff in schools to higher-level officials in the government…* ***many of them rejected us as they thought nobody did that before****… there is* ***no measures to encourage and protect officials to support innovation****…' (R5S_E)*

R5O_1 considered that the unwillingness of procurers also lay in the limited scope of government procurement in China:

> *'…I don't blame the finance department for not purchasing products on innovation catalogues, as* ***many of the listed products are not suitable for government procurement****…* ***If Lemote really just waited for procurers to pick it, this example would not have emerged****…' (R5O_1)*

The proactiveness of Lemote supplemented with high-level political support was a crucial factor leading to the emergence of this case.

Lack of user readiness was another obstacle. Traditionally school computers in China were used to teach students basic knowledge about ICT; 'education informationization' and the promotion of e-classroom solutions required a reform of users' (especially teachers of various modules) perception.

> *'…To gain the contract we agreed to provide a 5-year product warranty, which is normally 3 years for mature products…* ***5-year is almost the whole life of the products, and this is actually a huge burden for us****…' (R5S_E)*

7.3.5 Outcomes and impacts

R5S_E considered IOGP much more effective than any other supporting policies:

> *'…The contract with Jiangsu government was the turning point for Loongson…* ***government procurement gave us a reassured market, bringing us not only money, but also business partners, loyal customers and a fast transition of our company from infancy to a player with competitiveness****…' (R5S_E)*

An initial supply chain based on Loongson CPU was formed during the process of contract delivery. Several hardware manufacturing and software companies approached Lemote for cooperation. To deliver the contracts on time Lemote had to invest a lot on capacity building, which led to an upgrade of the company. New IPRs were obtained by Lemote during the course of developing e-classroom solutions. Designing tailored solutions for public organizations (e.g. hospitals and transport operators) has become one of Lemote's business segments.

R5O_1, R5F and R4F considered this case as a reference for other regions that were trying to implement IOGP. Changshu attracted government procurers from other regions for experience learning, e.g. R4F:

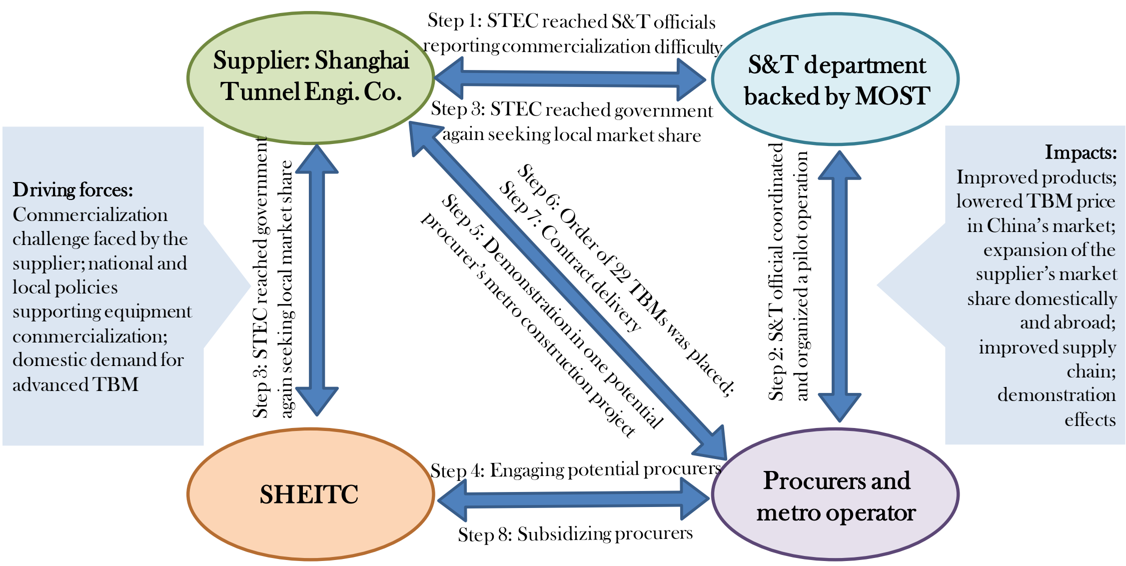
> *'…The Loongson example* ***was quite unique****…* ***but it was an outcome of implementing national policies, and it did lead to obvious outcomes, so I thought it was worth learning****…' (R4F)*

7.4 Case III: Tunnel engineering

7.4.1 Overview

This case was considered as an early practice of Shanghai's 'First (set of) Equipment Breakthrough Programme' (FEBP) by Shanghai Municipal Economic and Informatization Commission (SHEITC, supervised by MIIT). The supplier Shanghai Tunnel Engineering Company (STEC) developed an advanced shield machine prototype with MOST's R&D support, but encountered severe commercialization challenges afterwards. With the mediation and consumer subsidies provided by the local government, several state-owned project operators purchased 22 'Forerunner' shield machines. The overall process is illustrated in Figure 7.3.

Figure 7.3 Overall process of the Tunnel Case



Source: Author

7.4.2 Background information

7.4.2.1 The technology and the demand

A shield machine is a type of tunnel boring machine (TBM) (Sutcliffe, 1996) widely used in the construction of underground and water/electricity utilities. A modern shield machine is normally a tailored integration of various technologies including control, electronics, measurement and hydraulics, requiring detailed investigation into local soil characteristics (R2S_T). Developing TBM technologies for urban construction environment is challenging as disturbance to the ground surface is strictly forbidden (R2S_M).

According to R2S_T, since 2000 China has been the largest TBM market in the world; the market share of imported machines was higher than 95%. Some Chinese firms produced TBMs by collaborating with international suppliers, but they did not own IPRs for core technologies. The price of shield machines in China was very high given the low bargaining power of domestic buyers.

In 2006 numerous Chinese cities commenced the building of new underground lines which exceeded 1000 kilometres with an investment of more than 400 billion Yuan (JSRSRC, 2006), indicating tremendous demand for tunnel engineering equipment. Shanghai as the host city of EXPO 2010 was experiencing a particularly rapid growth of underground railways and trans-river tunnels; it was spending around 140 billion Yuan on building 332.5 kilometres of new underground railways and 8 new trans-river tunnels.

7.4.2.2 First (set of) equipment breakthrough programme (FEBP) in Shanghai

TBM was listed in Guofa[2006]8 (a key policy underpinning IOPP policy channel 2; Section 6.4) as one important technological area in need of development. Following Guofa[2006]8 the Shanghai government announced *Implementation Measures on Guofa[2006]8 in Shanghai* (policy code Hufu[2006]89) and *Shanghai Implementation Measures on Encouraging the Commercial Breakthrough of First Major Technology Equipment (Trial)* (Shanghai Government, 2007b), supported with *Shanghai Administrative Measures for Identifying First Major Technology Equipment Programmes (Trial)* (Shanghai Government, 2007a).

An FEBP is defined as:

> *'The process during which* ***the user for the first time uses major technology equipment*** *(within the 16 areas defined by Guofa[2006]8) that was independently developed or domestically manufactured by local companies.' (Article IV, Shanghai Government, 2007a)*

Although Shanghai published explicit equipment-related policies *after* the ministries did so, it actually initiated the FEBP approach *before* 2007; this Tunnel case was ratified as one of the early examples in Shanghai (R2O_1; see SHEITC, 2007 for the list of FEBP products). The coordinating agency for FEBP is the Office for Major Technology Equipment Coordination in SHEITC. Concrete supporting measures for FEBP include R&D projects, risk-sharing subsidies and direct government procurement for government-funded projects. R2O_2 briefly explained the procedure of FEBP:

> *'…In short we (SHEITC) work as* ***a coordinator between equipment suppliers and potential users****… suppliers need to submit applications first; then we organize expert groups to evaluate them… we five departments (S&T, finance, construction & transport, DRC, and SHEITC) will* ***jointly publish lists of qualified products****; users of those products will enjoy subsidies…* ***the value of subsidies is not high*** *– no more than 10% of the full price, or no more than 50% of the premiums… A feedback loop has been established to monitor the use of equipment products;* ***the users who enjoyed subsidies are obligated to provide comments to help improve product performance****… FEBP has been established as a* ***routine****. More and more equipment suppliers and users now know about this programme…' (R2O_2)*

7.4.2.3 The supplier faced by commercialization challenges

Through decades of development, STEC (for more details see Appendix 19) has been well experienced as a tunnel constructor (a TBM user) and more recently a TBM manufacturer. R2S_T considered this combination of dual roles as a major competitive advantage of STEC:

> *'…Construction departments can communicate with R&D departments efficiently regarding any technological issues…* ***practical knowledge is our treasure – we improve product quality based on our own user experience****…' (R2S_T)*

In 1997, STEC developed a fully domestic (i.e. the components were all produced by domestic suppliers) shield machine prototype, which, however, failed to perform well:

> *'…* ***We always wanted to produce our own shield machines using our own components, pursuing a high domesticalization rate*** *like many other equipment manufacturers… the failure in 1997 was caused by a fragile bearing made of unqualified domestic steel…* ***we have a weak steel industry base in our country, and we shouldn't let this weakness become the constraint of core technology development****…' (R2S_T)*

From then on STEC sought to strike a balance between 'domesticalization' and high performance by selectively deploying domestic as well as imported components. The central government was supportive and lowered custom tax to encourage STEC (and other equipment manufacturers faced with the same problem) to conduct global procurement of needed components (R2S_T).

In September 2004, a prototype of the ø6.34m earth-pressure-balanced (EPB) shield machine 'Forerunner' with core IPRs owned by Chinese firms was born in STEC.

STEC was eager to put the product into the market. However, the underground transport operating company considered it too risky to use real tunnel project as testing ground since Shanghai needed to finish most of the projects before the EXPO.

Considering that the prototype was an R&D outcome of a National High-tech R&D Programme led by the MOST (widely known as '863 programmes'), STEC approached Shanghai S&T Commission (supervised by MOST) regarding its difficulty. The official who was in charge of 863 programmes was very supportive; he helped STEC persuade the transportation department and the operating company to approve a 'not-so-important' project for prototype testing (R2S_T). Forerunner was tested in June 2005, achieving an average daily advance of 38.4 meters, slightly better than its imported counterparts whose average daily advance was approximately 31 meters (R2S_T). The operating company and the government were impressed and became more supportive to promote the use of Forerunner.

Produced in 2006, the model involved in this case, Forerunner No.2, was an improved version of Forerunner. A series of EPB shield machines by STEC was included in Shanghai's innovation catalogue 2009.

7.4.3 The procurement process

After the pilot operation was successfully conducted, STEC approached government officials again trying to promote their products in the local market before the EXPO. The local government (especially the SHEITC who was initiating the FEBP policy) warmly welcomed the idea of procuring indigenous innovation products to prepare for EXPO. They agreed to coordinate different construction companies in Shanghai to purchase 22 Forerunner No.2 machines.

However, for the following months STEC did not get any news from the expected buyers. STEC sent people to ask, and found that most of the construction company directors were actually against this deal – although Forerunner was much cheaper than imported products, the companies tended to choose well-known products to avoid uncertainty.

> *'…Most of the equipment* ***users prefer to use imported, expensive products – they feel more confident and responsible*** *as long as they choose the most advanced ones in the world.' (R2O_2)*

Encouraged and supported by SHEITC, STEC proposed to demonstrate the use of Forerunner No.2 for at least 100 meters in one potential user's real project. The product performance proved to be very stable and competitive.

Several state-owned constructing companies working for Shanghai underground projects agreed to place their orders with STEC, which were to be delivered by May 2007. The agreed price was 20 million Yuan each, i.e. around 30% cheaper than imported EPB shield machines. STEC sold 18 Forerunner machines to its construction competitors and kept 4 machines for itself.

The SHEITC organized an event afterwards to fulfil the subsidies for equipment users supported by FEBP. Besides tunnel engineering, other technological areas such as nuclear generation, wind energy, transport and construction equipment were also covered. The users of Forerunner No.2 enjoyed 2 million Yuan subsidy (10% of the price) for each machine. According to R2S_T, these 22 machines finished one third of Shanghai's newly developed underground lines in 2007.

7.4.4 Obstacles

Despite the policy support from the Shanghai government, STEC encountered difficulties in promoting its products to other regions.

> *'…Countrywide we don't see much friendliness…* ***some provinces require us to settle down as a local firm to gain their contracts****… but we can't as the initial investment of shield machine manufacturing is huge…* ***on the contrary, it is easier for us to enter the international market – as long as the products are qualified, everything will be simple****…' (R2S_T)*

Another obstacle raised by R2S_T was buyers' unwillingness to purchase domestic TBM:

> *'…Sometimes they (the procurers) state clearly in the call that* ***they don't consider domestic products****… they want to buy the best products in the world to fulfil their tasks… the whole environment for indigenous innovation is like this,* ***people are concerned with risks****…* ***the government needs to share more responsibility, or risk, since they claimed to serve the firms****…' (R2S_T)*

An obstacle raised by R2O_2 was inter-departmental coordination problems owing to the ambiguous division of labour between SHEITC, S&T and finance departments:

> *'…* ***We fought with other departments to gain the authority to coordinate FEBP****… Our plan was to promote equipment development through two ends – the first end is R&D*

> *funding, which we allocate to related institutes and companies; the other end is the use of new equipment, that is commercialization…* ***our strategy drew disagreements from other departments immediately****. S&T commission thought there was no need to specialize equipment R&D as they are in charge of R&D; the finance department disagreed as well, and refused to provide funding for FEBP subsidies… eventually we went to the municipal government;* ***a series of seminars was organized to solve the conflicts****, and the FEBP approach was established…' (R2O_2)*

7.4.5 Outcomes and impacts

During the course of contract delivery, incremental improvement of Forerunner's performance was realized, including improvement in the monitoring system with a database of more than 60 million instructions derived from STEC's construction experience, and the dynamic correction system preventing the driver from making operational errors.

By May 2011, STEC had sold 41 machines which occupied 30% of the Shanghai market. STEC also won contracts from other Chinese cities and from market abroad. The expansion of STEC's business has accelerated the development of firms along its supply chain.

Although the costs of shield machines vary depending on the configuration, the overall price of TBMs in China was lowered:

> *'…Our market share is not increasing as* ***there are more manufacturers competing in the domestic market****… but one achievement we are proud of was that,* ***we forced other competitors to lower their product price by around 20% and saved a lot of money for the infrastructure construction in our country****…' (R2S_T)*

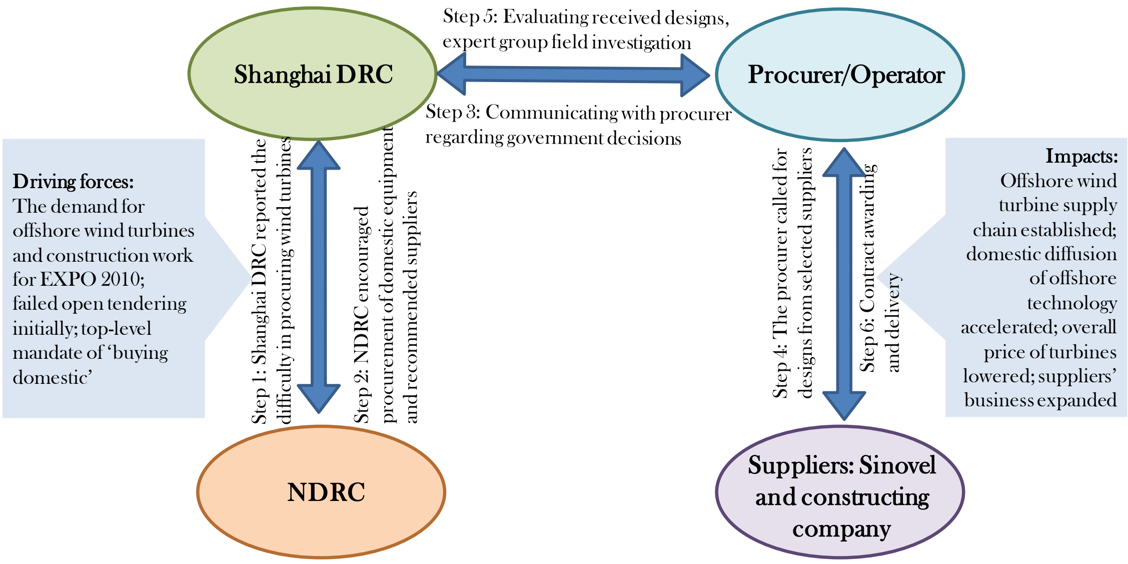
Two of the SOE users in this case were awarded the title of 'Meritorious User of First (set of) Major Equipment in China' by the 6^{th} China Industry Forum (Chen, 2010), which led to higher public awareness of indigenous equipment. This user-praise measure was carried on in the following years (Section 8.3.3).

7.5 Case IV: Offshore wind turbines

7.5.1 Overview

This case is about the procurement of turbines for the first offshore wind farm in China i.e. Shanghai Donghai Bridge Offshore Wind Farm. Backed by high-level political support, the procurer decided to purchase not-yet-existing, domestically made offshore turbines after the initial open call for international bids failed. Sinovel won the contract as its overall potential to deliver large-capacity offshore turbines before the Shanghai EXPO 2010 was the highest among domestic candidates. The process is briefly illustrated in Figure 7.4.

Figure 7.4 Overall process of the Wind Case



Source: Author

7.5.2 Background information

7.5.2.1 Offshore wind-energy technology and Chinese policies

Turning wind energy to mechanical power and further to electricity, wind-energy power generation is considered as one important alternative to traditional fossil-fuel generation (Saidur et al., 2010). Advantages of offshore wind power generation systems over onshore ones include: access to tremendous and stable wind resources on the sea, no need to occupy land space and consequently few geographical obstructions, little side-effect of noise pollution, ecological damage and scenery loss (Snyder and Kaiser, 2009). For China where the majority of the population as well as that of wind resources concentrate in coastal regions, offshore systems can avoid the difficulty and high cost of long-distance power transmission (WIND_P). Nevertheless, developing offshore turbines is technologically more challenging than developing onshore ones (Chen, 2011). Offshore turbines need to have large capacities to achieve lower average generation cost, and high robustness to cope with corrosion and typhoon; construction, installation and maintenance are demanding as well due to the complicated offshore work environment.

China announced a range of STI policies to promote wind energy, from R&D support to industrialization-focused programmes, and recently to stricter regulations to 'cool down' the overheated sector (for more details see Appendix 20). As to IOPP policies, both the national 2009 (unpublished) and some regional catalogues included indigenously developed wind energy products. Wind energy equipment has been listed in all versions of equipment catalogue; the requirement becomes higher[30] as the catalogue updates. Nevertheless, the immediate political factor leading to this case was not the catalogues, but a government decision driven by a failed open call for imported products, which meanwhile echoed the 'buy domestic' and 'import control' initiatives (Section 6.2.2.3).

7.5.2.2 The demand and the failed open tender

After examining the scale and distribution of wind energy in the locality, the Shanghai government identified Donghai Bridge offshore area as an ideal venue for wind power generation. In 2006, the Shanghai DRC submitted a proposal to NDRC detailing their plan for a demonstration offshore wind farm in that area, which got approved soon.

Shanghai DRC then organized open tendering under NDRC's wind energy concession scheme[31]. A joint venture by four SOEs won the operation right; initial investment 460 million Yuan took up 20% of the total, and the rest 80% was mortgage from the World Bank (WIND_P). Planned generation capacity for the farm was 100 megawatts; planned capacity for each turbine was at least 2 megawatts. Shanghai was determined to finish the project before EXPO 2010, as 'green technology' was one of the themes of the event (R2O_3). Hence a set of large-capacity offshore wind turbines plus related work needed to be delivered within 3 years.

[30] For offshore technologies, from capacity requirement of 3-5 megawatts in 2009 to 5 megawatts in 2012; the product in this case addressed the gap of 3-megawatt turbines.

[31] See Saidur et al. (2010) and Appendix 20.3; for a fixed wind-farm programme, open tendering needs to be organized to select the developer and operator.

By that time no commercialized offshore wind turbines had existed in China. Internationally only a handful of suppliers had the experience to fulfil equivalent tasks. The operator made an open call for bids from worldwide trying to obtain the most qualified 3-megawatt offshore wind turbines and services, which, however, turned out unsuccessful due to '*extraordinarily high price and unacceptable after-sales conditions raised by the potential supplier*' (WIND_P).

Three foreign suppliers submitted bids, two of whom gave up halfway:

> *'…One reason was that large-capacity turbines were in short supply globally; most of* ***the suppliers were too busy to deliver on time****… another reason could be that they were* ***worried that their technologies might be copied by Chinese technicians****…' (WIND_P)*

The only bidder won at a price 50% higher than the international average, and raised many 'discriminative conditions' (WIND_P), including very high installation fees, no training sessions after contract delivery, and that Chinese technicians are not allowed to watch the installation process. The direct cause leading to the abortion of the deal was that:

> *'…****The supplier was very concerned about the confidentiality of its technologies****; it insisted to put the control system server in its home country. We certainly disagreed – everyday maintenance would be very bothersome without a local server…* ***we were also concerned that offshore wind resources data in our country would be abused by them.*** *We had no other choice but cancelling the deal.' (WIND_P)*

7.5.3 The procurement process

The procurer considered the project 'hopeless' (WIND_P) and reported the difficulty to the Shanghai DRC, who further reported to NDRC. The then Associate Director of NDRC was a strong advocate for domestic (especially new-energy related) equipment; he encouraged the procurer to give domestic manufacturers an opportunity. Both levels of government supported this idea in order to accelerate the development of domestic technologies as well as to save money (R2O_4). Considering the procurement of imported wind turbines needed approval from NDRC anyway (WIND_P; Section 6.2.2.3), the procurer accepted the decision.

The procurer adopted a restricted tendering procedure to choose a supplier from NDRC's recommendations, all of which were major turbine manufacturers in China (R2O_4). The procurer did not define detailed technological specifications, but left the freedom to supplier candidates to choose alternative designs. Evaluation criteria included: whether or not the product and services could be delivered before EXPO, whether the product could cope with offshore circumstances, and other considerations such as price and maintenance services. After proposals were collected, the procurer organized an expert group under the guidance of Shanghai DRC to conduct evaluation.

Sinovel's design and R&D progress were considered the most satisfactory among competitors; its collaboration with the Austrian turbine supplier Windtec (now part of American Superconductor, AMSC) reassured the likelihood to deliver products on time (WIND_S). Moreover, the maintenance solution proposed by Sinovel was considered very convenient and cost-effective (WIND_U). Installation work was contracted to a marine project construction company with more than 50 years' business experience.

Founded in 2006, Sinovel transformed from a state-owned electric equipment company (see Appendix 20) is definitely a 'latecomer' compared with other big Chinese turbine suppliers. It skipped the step of developing kilowatt-level turbines by purchasing a manufacturing license from a German company. Underpinned by perfect timing to enjoy powerful supporting policies launched by NDRC[32], Sinovel achieved dramatic development in a short time, overtaking Goldwind as the largest Chinese wind turbine supplier in 2010.

Nevertheless, as indicated by WIND_P, the selection of Sinovel was somehow a result of:

> *'…government intervention – or government support, or government guidance – depending on how you understand it… they (the government)* ***expected*** *us to buy, thus we felt* ***obligated****…* ***Sometimes we want them to intervene, they intervene; sometimes we don't, they still intervene****…' (WIND_P)*

By July 2010, 34 Sinovel 3-magewatt turbines with designed lifetime of 26 years had been delivered and connected to East China grid. Since it was the first offshore wind farm with a demonstration effect, Sinovel was required to provide a 5-year warranty; a specialized services group was formed to settle in the wind farm to monitor the turbines' performance (WIND_S).

> *'…***The cost for Sinovel is very high*** as the services group consists of 20-30 people… Currently our job is to cooperate with Sinovel for everyday maintenance. We have*

[32] NDRC issued a policy in 2005 stipulating that turbines used for concession projects needed to achieve a domesticalization rate of 70%, followed by various measures to support domestic, large-scale turbines development (Liu and Kokko, 2010); the requirement was cancelled in 2010 (see Appendix 20).

> ***routine meetings during which we communicate our needs with Sinovel****, and then they make changes accordingly… there is* ***still room for improvement****. Within five years we will have our own maintenance team…' (WIND_U)*

7.5.4 Controversies surrounding Sinovel

No significant obstacles were raised by the supplier interviewee. Rather it was found from multiple data sources that controversies exist regarding Sinovel's development mode and IPR issues.

Sinovel's 'fast-track' development mode through purchasing foreign licenses and replying on favourable policies has been frequently criticized (Chen and Yu, 2010; Yuan, 2013; Patton, 2013). An interviewee pointed out that a crucial factor leading to Sinovel's rise was powerful support from top-level officials from the central government, gained by Sinovel primarily through its effort in *domesticalizing* turbine technologies. The recent policy move to cool down the sector has been destructive for Sinovel. The company is suffering from a series of troubles (see Yuan, 2013) including IPR disputes with AMSC.

AMSC was the control system supplier for Sinovel's turbines. In 2011 the Chinese government required all wind turbines in China to reach a certain low-voltage-ride-through standard. Sinovel and AMSC could not reach an agreement on who should bear the loss for adapting old machines into qualified ones. The disagreement eventually led to a breakup, followed by AMSC accusing Sinovel for trading technological secrets with a former AMSC employee (Smith et al., 2011; Strickland, 2012). The dispute significantly affected Sinovel's reputation both domestically and internationally (Patton, 2013).

7.5.5 Outcomes and impacts

The main outcome of the case was that China eventually had domestically made offshore wind turbines, despite the controversies surrounding Sinovel. WIND_P said that the success of the first offshore project encouraged NDRC to commission more offshore wind energy projects afterwards. The overall development of Chinese offshore wind energy industry was accelerated. An obvious reduction of turbine price was observed by WIND_P, according to whom offers from suppliers were as low as 6000 Yuan/kilowatt in early 2011.

The R&D and commercialization of Sinovel's products were accelerated greatly (WIND_S). The supplier for construction work obtained a number of patents owing to the installation experience; to suit Shanghai's sea bottom which is all silt, a floating installation approach based on a 'soft landing system' and a 'targeting system' was developed. All parties involved gained valuable practical knowledge; an initial supply chain for offshore wind farms was established; suppliers for this project enjoyed extra points while bidding for public contracts afterwards (WIND_P).

7.6 Case V: Procurement elements in NEV programme

7.6.1 Introduction

This case[33] looks into the Chinese NEV demonstration programme, which stimulated widespread procurement practices among participant cities (see Appendix 21 for more details). The two examples presented here are Jinan's (provincial capital of Shandong, R4) procurement of hybrid coaches for the National Games 2009, and Shenzhen's (second largest city of Guangdong, R3) procurement of NEVs for Universiade 2011. In both cases local suppliers were selected, partly owing to long-standing relationships between key stakeholders and a wish to strengthen local industry, and partly owing to subsidies offered by provincial governments for procuring local NEVs. Section 7.6.5 highlights key issues identified.

7.6.2 Background information

7.6.2.1 Driving forces and supporting policies

According to the scope defined by the Chinese government (State Council, 2012), NEVs include hybrid vehicles, plug-in hybrid EVs, battery EVs and fuel cell vehicles. The government is determined to capture the opportunity of developing NEV and further escalate the automobile industry (NO_NEV). As a result of the high growth rate of the economy, the demand for vehicles has been increasing fast and the country suffers from a severe energy shortage and environmental pressure (World Bank, 2011). China has made a commitment to the United Nations to reduce its carbon emissions by 40-45%. The development of NEVs was recognized as an important way of achieving this target (State Council, 2011a). Meanwhile, although China is now the largest market for vehicles in terms of both manufacturing and sales in the world (Lin and Wang, 2012), engine related technologies have been imported from developed countries and controlled by multinational automobile suppliers; domestic firms occupy only a small share in the traditional vehicle market.

After years of R&D support the central government has more recently considered it timely to facilitate the commercialization of NEV technology. Major suppliers had developed their prototypes which were in need of market access (Gong et al., 2013).

[33] This case formed the basis of Li et al. (2013); the author was principally responsible for researching and drafting the sections included here.

Since 2009, a variety of innovation policies were announced to support NEV commercialization. A brief classification of the key policies is presented in Figure 7.5.

Figure 7.5 Classification of NEV-related innovation policies

Overall policies	
Policy type	**Authority**
Implementation measures for indigenous innovation strategy	State Council
Stimulus policies for emerging technology sectors	State Council
Development plan for energy saving and new energy vehicles (2012-2020)	State Council

Supply-side policies	
Policy type	**Authority**
R&D programs e.g. 863 projects (the National High-tech R&D Projects)	MOST
R&D funding for public research institutes, universities and SOEs	MOST
Networking measures e.g. alliances, incubators and training	MOST, MIIT

Demand-side policies		
Category	**Policy type**	**Authority**
NEV program focused polices	Overall measures detailing implementation procedures	MOF, MOST, MIIT, NDRC
	Funding/subsidies related measures	MOF
	Catalogues of approved NEV models	MIIT
	Regulations on other issues e.g. safety, infrastructure building	MOF, MOST, MIIT, NDRC
Regulations	Regulations on tax reduction, NEV supplier qualification, emission, and government procurement procedures for NEV	National Bureau of Taxation, MIIT and MOF
Standards	Standards on oil-saving rate testing and charging facilities etc.	MIIT

Source: Li et al. (2013)

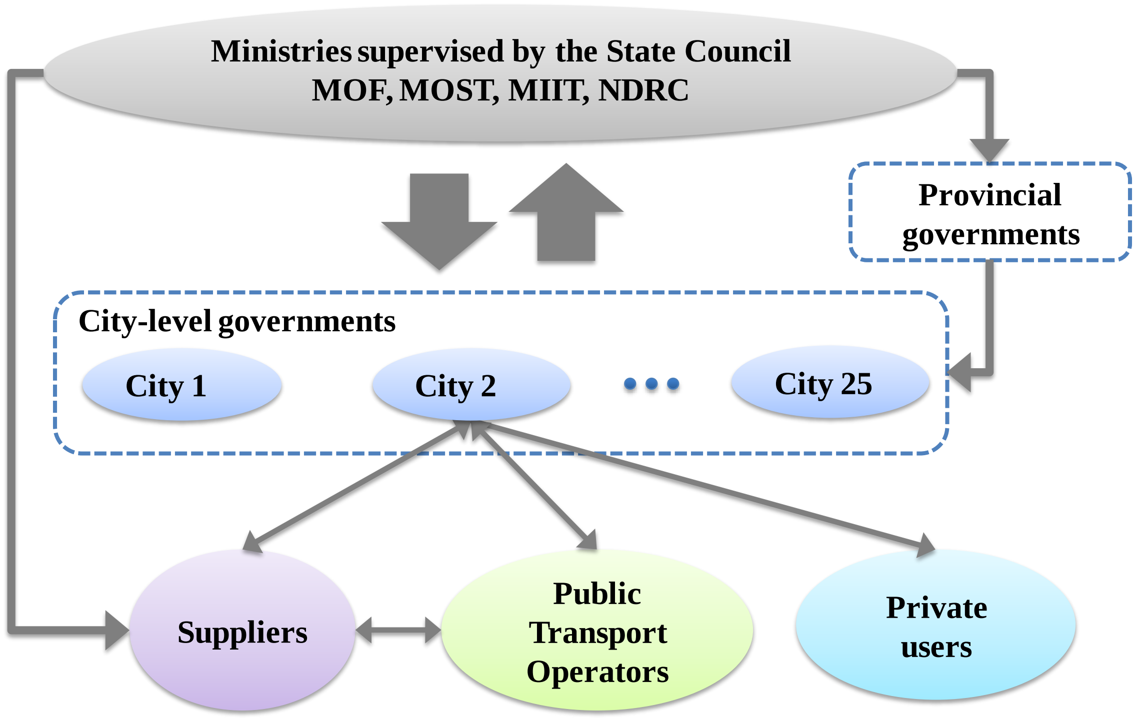
7.6.2.2 NEV demonstration programme – design and implementation

Initiated jointly by MOF, MOST, MIIT and NDRC in early 2009, the NEV programme aimed to promote the use of around 1000 NEVs in each of a series of selected cities during 2009-2012 (MOF et al., 2010b). In total 25 cities (the first batch of which including Jinan and Shenzhen) were selected as participants for the public sector demonstration, whereby government agencies or public transport companies (which are state-owned) would be given subsidies when purchasing NEVs. In addition, Shenzhen was one of the 6 participants selected for private consumer NEV demonstration (MOF et al., 2010a), i.e. citizens in Shenzhen enjoyed subsidies when purchasing NEVs for their own use.

According to NO_NEV, the selection of participant cities was conducted on the basis of proposals submitted by intended cities. Cities were required to design realistic implementation plans and ensure that they fulfil the goals by the end of 2012. Expert groups were then organized by the ministries to carry out fieldwork to evaluate the potential of candidates. Selection criteria included the size of the local market, the status of the local automobile industry and financial conditions of local government as well as a consideration of the national industry strategy. To get subsidized, procurers had to choose products from the *Catalogues of Recommended Vehicle Models for NEV Demonstration Programme* produced by the MIIT (MOF and MOST, 2009). Procurers were required to organize open tendering to buy NEVs with clear specifications of the model, quantity, price and after-sale services.

The design of the NEV demonstration programme is illustrated in a simplified way below in Figure 7.6.

Figure 7.6 The design of the NEV programme



Source: Li et al. (2013)

Participant cities have had the flexibility to design their own form of implementation. They demonstrated strong enthusiasm to promote NEVs, since each city has its carbon emission reduction task allocated from the central and provincial governments (NO_NEV). Cities with or without advantages in terms of traditional automotive technologies wanted to take the opportunity to develop local NEV industries as an instrument of economic development (Gong et al., 2013). Although the original target set by the central government was 1000 NEVs per city, most of the participants set up their own targets at a level far higher than this (CATARC et al., 2010); Shenzhen aimed to promote 24000 NEVs by the end of 2012 (R3O).

The progress of participant cities has been uneven; none have in fact achieved their 3-year targets (Gong et al., 2013). On average only 38% of the targets set by cities for public use were realized by 2011 (Huang et al., 2012). The overall fulfilment ratio for both public and private uses was as low as 26%, primarily because of the unrealistic goals set by the cities in the first place (Gong et al., 2013). The actual quantity of promoted NEVs through the programme during 2009-2012 was 27,400 (MOST, 2013), approximately 23,000 of which were procured by public bodies and only 4400 NEVs purchased by private consumers. In terms of production, there were more than 400 NEV models produced by 76 manufacturers listed in the *Catalogues of Recommended Vehicle Models* by October 2011 (Gong et al., 2013).

Most interviewees considered the programme fairly effective in raising stakeholders' awareness and promoting technological advancement. In NO_NEV's view:

> *'…(The programme has been)* ***mostly about creating a trend to mobilise the industry****, which has been very obvious already…there are* ***many other cities, beyond the 25, doing NEV programs in their own way****…'*

7.6.3 Jinan – NEV procurement for the National Games 2009

7.6.3.1 Background information

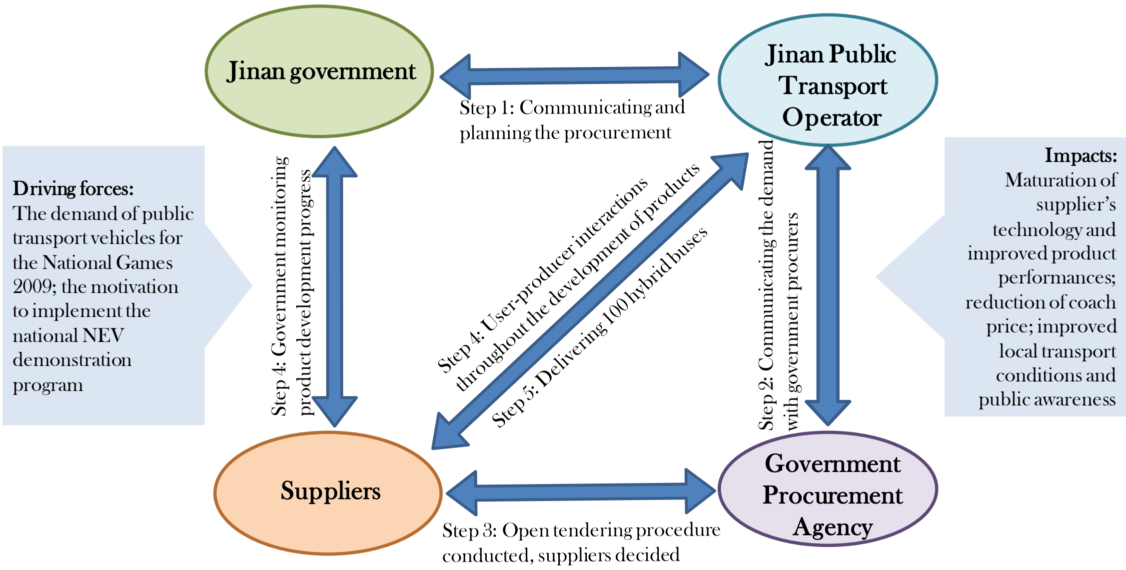
Jinan (see Appendix 21 for more details) was trying to shift its industrial focus from low-speed EVs to leading-edge NEV technologies by attracting key components suppliers to invest in the locality (R4O_NEV). It has been nurturing a local NEV industry since 2005 when the first battery factory was founded; by 2012 several domestic automobile suppliers have opened local branches there.

With a total budget of 100 million Yuan coupled with subsidies from central and provincial governments, the city government decided to kick off the implementation of the national NEV programme by procuring 100 hybrid buses, and meanwhile to serve the need of National Games 2009 hosted by Jinan. According to R4O_NEV, the government decided to buy hybrid coaches rather than electric ones because firstly, hybrid vehicle technologies were more mature than EVs in early 2009 when the demonstration programme had just begun; secondly, price of hybrid coaches was much cheaper which was suitable for the limited budget; thirdly, the locality was not able to build charging infrastructure for EVs in a short time.

7.6.3.2 Procurement process

The overall process of procurement is illustrated in Figure 7.7.

Figure 7.7 Overall process of NEV procurement for National Games 2009



Source: Li et al. (2013)

The Jinan government set up technological requirements jointly with the public transport operating company. They required that the coaches should be 12-metre long diesel-electric hybrid model with paralleled batteries, and their exhausts should be under China's national Tier IV standard. The operating company then published an invitation to open tendering via the Shandong Government Procurement centre, receiving bids from 9 manufacturers.

R4O_NEV said that the requirements were considered too demanding by most of the bidders; only two companies provided acceptable product design eventually. Company A[34] from Shandong province, obtained the top score and won a contract of 80 coaches; Company B from outside the province won a contract for 20 coaches. The deadline for delivering coaches was July 2009 as the National Games was starting in October.

[34] Company A and B anonymized at the request of interviewees.

R4O_NEV and R4P_NEV admitted that they preferred to buy products from company A, since the provincial government would provide subsidies (in addition to national subsidies) for the purchasing of NEVs from the province. If possible they would even prefer to purchase from a supplier situated in the city, hoping that procurement activities can contribute to the development of a local NEV industry.

Company A, however, asked for an extension of the deadline to the end of September. Under the pressure of delivering products in time it substituted the original key components (including the motor, the controller and the battery) with imported, good-quality alternatives to meet the requirements of the contract. R4P_NEV indicated that Company A's prototype was qualified to enter the market according to the MIIT criteria. However, Company A's manufacturing capacity was limited by that time, making the delivery of products on time difficult. Meanwhile the operating company was concerned about using such new products immediately during the period of the Games.

> *'…We were very* ***pragmatic*** *by then as time was extremely limited, we needed products with guaranteed high quality as we had to make sure the event go well… the demonstration programme just started and* ***we didn't want to risk to buy a product that had not existed before****…****we were not experienced as procurers and they were not experienced as a supplier****…' (R4P_NEV)*

According to the demonstration programme policies, only domestic products with 'indigenous IPRs' could enjoy subsidies, i.e. at least two of the three key components should be produced by domestic companies. In order to fulfil the contract requirement and get subsidies, company A spent months improving its products and capacity, and gradually substituted the imported components with its own products (key IPRs fully owned by company A).

Although an open tendering procedure was adopted, it is worth noting that the operating company and Company A have been in a co-operative relationship for a number of years. One major reason for this co-operation is that Company A is located close to Jinan, and hence it can provide more easily after-sales services. Company A is very familiar with the traffic conditions in Jinan and it can follow the national and industrial changes quickly to satisfy the changing needs of customers (R4O_NEV). This long-term relationship provided a basis of trust leading to the procurement.

At the end of 2010, the operating company published another tendering invitation for 100 hybrid coaches. Company A won the contract again due to its previous experience.

This time it submitted the bid at a lower price (around 900,000 Yuan for one coach) and other companies failed to provide competitive offers.

R4P_NEV mentioned that the operating company had heightened the testing standards for the second batch of coaches by ordering a prototype and conducting comprehensive examination with technological experts. They raised suggestions regarding battery configuration (the number and series of batteries were changed according to prediction of routine traffic conditions and a higher oil-saving rate was realized). Interactions between the user and the producer helped to identify problems first and reach a solution that better satisfied the customer demand before the model was put into larger scale production.

7.6.3.3 Outcomes and impacts

Company A's technologies improved during the process of delivering the first contract. By May 2011, the 80 coaches had been operating in public transport lines of Jinan for more than one year. R4P_NEV believes that the quality of these coaches is very good with an overall oil-saving rate of 26% (while the threshold for subsidizing is 20%). The performance of the key components was stable; the hybrid coaches can operate as frequently as traditional vehicles. In the second procurement, user-producer interactions facilitated further improvement of company A's products.

Reduction of price was realized in the second procurement; Company A submitted an offer that was around 25% lower than the price in the first batch.

After the Games the vehicles served as regular buses on four of the public transport lines in Jinan, which to an extent improved the local traffic conditions. Public awareness of NEVs in the locality was improved as the lines cover very popular routes in the city centre.

7.6.4 Shenzhen – NEV procurement for Universiade 2011

7.6.4.1 Background information

Shenzhen has a strong NEV industry base with BYD and Wuzhoulong as two major suppliers (see Appendix 21 for more details). In 2008 the Shenzhen government initiated a pilot project to demonstrate the use of NEVs in typical urban traffic circumstances, which was later on approved by the MOST as part of an 863 programme in order to provide a reference for further countrywide demonstration. Wuzhoulong and BYD were chosen as the suppliers for 30 hybrid buses (for public transport) and 20 electric cars (for government use) respectively. Public users were requested to provide feedback regarding vehicle functionalities. Frequent user-producer interactions occurred during the two years. Incremental improvements of product performance (such as a new design of dashboard, and a 'low-carbon' version of a car model from BYD) were achieved.

The project provided an opportunity for the government, suppliers and users to interact with each other, and hence build a relationship among them. Furthermore, R3S_NEV_1 indicated that regular communications with Shenzhen government had been an inherent part of their commercialization strategy:

> *'…It was more a gradual, step-by-step interactive process…* ***every time we develop new models, we inform the government in time and let them know that we would like to promote them where possible****… for example the K9 electric bus we developed last year,* ***we let the officials to experience it and listened to their comments****…' (R3S_NEV_1)*

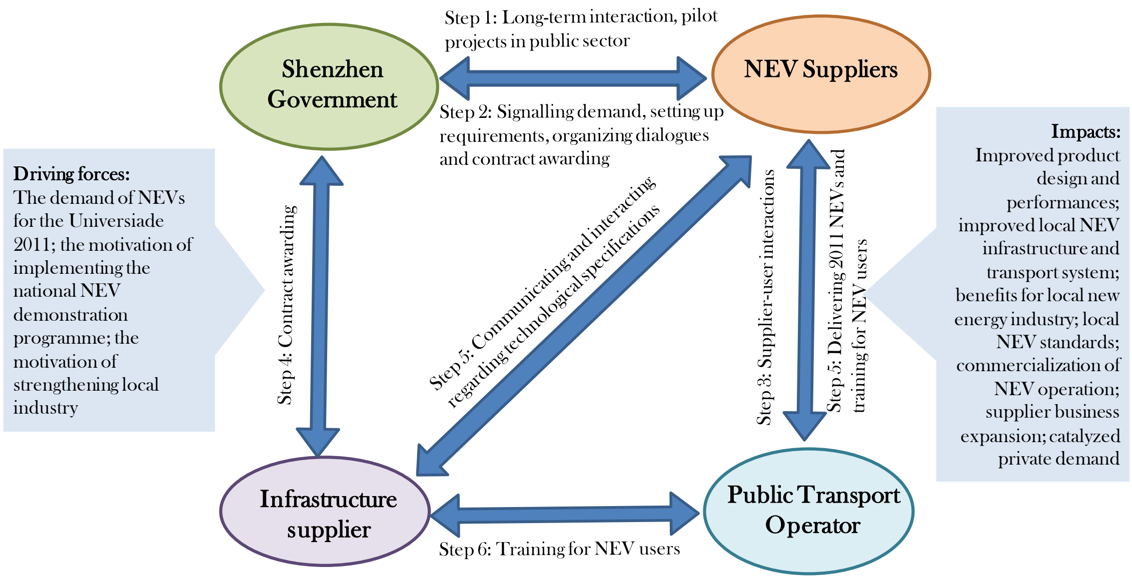
7.6.4.2 Procurement process

The 2011 Universiade with a 'green theme' hosted by Shenzhen provided a major opportunity for the city to implement the NEV demonstration programme, as well as to improve public infrastructure. The number of NEVs in Shenzhen increased significantly up to 2011 as a result of government procurement, exceeding the combined number in the Beijing Olympics in 2008 (around 500 NEVs) and Shanghai EXPO in 2010 (around 1300 NEVs). The procured vehicles covered a range of NEV types including hybrid, fuel-cell and battery-supplied. The overall process of the Shenzhen case is illustrated in Figure 7.8.

Performance requirements (including oil saving rate, charging speed, driving range and maximum speed) were set in a formal way by the Shenzhen government through *Implementation Plan for NEV Demonstrating Operation During the 26th Summer Universiade*. As there were not many commercialized NEVs in the market, the government adopted a restricted tendering procedure by sending out invitations to well-known suppliers to search for qualified designs (R3S_NEV_1).

The government compared available products and eventually decided to go for BYD and Wuzhoulong, as both of them are local companies and they were capable of providing good-quality products that the government knew about, and their income could feed back to local GDP growth (R3S_NEV_2). It was meanwhile a great opportunity for Shenzhen to demonstrate its innovativeness by using local products that were nationally leading-edge (R3O).

Figure 7.8 Overall process of NEV procurement for Universiade 2011



Source: Li et al. (2013)

Among the 2011 NEVs procured, BYD provided 200 pure electric buses and 300 pure electric taxis; Wuzhoulong provided the rest, a total of 1511 energy-saving and new-energy buses. All these NEVs were allocated into 77 public transport lines specialized for Universiade, covering all the sport venues and constituting an NEV transport network in Shenzhen.

The other part of the procurement was infrastructure construction. Shenzhen Bureau of Power Supply commissioned a local firm (which is part of the Putian Group controlled by SASAC) to conduct the work, which included two parts – upgrading existing charging stations, and building 34 new charging stations. The construction supplier and NEV suppliers cooperated closely with each other in order to develop a set of coherent technological specifications. In total the 59 charging stations were sufficient to provide power for all the NEVs during the event.

Interviewees, however, were unwilling to disclose what the Shenzhen government spent on these vehicles and infrastructure.

7.6.4.3 Outcomes and impacts

Both supplier interviewees indicated that the large-scale procurement provided a great opportunity for the suppliers to improve and refine their products, especially based on detailed feedback from drivers. In particular Wuzhoulong designed a two-layered hybrid bus model that was novel in the domestic market. Product costs were lowered effectively as well. Later on suppliers received invitations to tender from other regions and countries since their products performed very well for the event and their prices are competitive. Suppliers' collaboration with domestic and international business partners was enhanced as well.

The local public transport system especially charging infrastructure was upgraded. The 2011 NEVs became an important part of the regular transport system in Shenzhen. Citizens' awareness was greatly enhanced.

This procurement has provided practical experiences, and considerably accelerated Shenzhen's progress to fulfil the target for NEV demonstration programme. Shenzhen was awarded by the ministries as the '*Annual (2011) Best Participant City in the NEV Demonstration Programme*'.

The local new energy sector benefitted from the procurement as well. Shenzhen is now building a national-level industry base to promote various new energy technologies. The development of NEVs provided an opportunity for the supply chain to explore possibilities of inter-disciplinary innovation (R3S_NEV_1).

In 2010, guided by the government, infrastructure suppliers from the procurement developed *Technological Standards of EV Charging System in Shenzhen* and *Standards of Monitoring System on NEVs in Shenzhen*, making Shenzhen a pioneer in the country exploring a unified system of standards.

The NEV suppliers, infrastructure suppliers and the public transport operator from this procurement have signed a contract together to promote NEVs in a commercialized way. For future construction work, the government only provides funding for bus charging stations, while charging facilities for cars will be built using capital raised from the private sector.

7.6.5 Highlights: key issues identified

7.6.5.1 'NEV fever' and 'NEV fear'

A commonality across regions has been the engagement with local suppliers. Although in both cases public tendering was *de jure* organized, the *de facto* factor leading to a procurement decision appeared to be suppliers' long-term relationship with the government/procurer. In the absence of a well-regulated procurement system, maintaining regular communications and relationships proved to be beneficial for suppliers to gain public contracts.

The unevenness across regions in terms of implementation progress can be explained by different degrees of enthusiasm and regional capacity. Enthusiastic regions tend to be the ones with good industrial foundations; governments of those regions were having an 'NEV fever' (NO_NEV). The targeted number of NEVs set by participant cities by 2015 exceeded 5.5 million, although they only achieved less than 10,000 in 2011. An obstacle for realizing those targets has been limited manufacturing capacity of suppliers (R1O_1).

Although Jinan conducted one of the earliest procurements of NEVs, it is now one of the slowest and the least motivated participants (Huang et al., 2012), because:

> *'…We have been waiting and watching other participants' practices and* ***searching for an optimized solution****…we don't want to risk spending huge amount of money on experimenting various approaches'* (R4O_NEV)

NO_NEV implied that the actual reason for Jinan to hesitate was that it does not have strong local suppliers and hence lacks the 'economic incentive' to bear risks (NEV 'fear').

The central government introduced an elimination strategy to screen out laggards by the end of 2012. This policy induced inter-regional competition and severer protectionism, leading to over-commitment of development goals and a danger of sightless and low-quality industry expansion.

Regions demonstrated both 'compliance' and 'disobedience' in implementing the programme. Owing to the strictly designed centre-locality structure of the political system, implementation processes appeared to be efficient. Regions followed national moves quickly, trying to earn a better impression from the central government

(NO_NEV). On the other hand, regions optimize their own benefits as long as they do not conflict central goals explicitly. The targets and outcomes of policy implementation, which were set and evaluated quantitatively, might be incapable of reflecting the actual progress which the policies initially targeted at.

7.6.5.2 Pros and cons of ‘pilot programmes’

Due to the vastness of the country and uneven status of regional development, ‘pilot programmes’ are frequently adopted by the Chinese central government to experiment policies. As demonstration programmes encouraged the adoption of new technologies in certain regions, diffusion of innovation in non-participant regions might be discouraged. One NEV supplier interviewee from a non-participant city felt ‘ignored’ by supporting policies, complaining that as long as participant cities have the freedom to choose NEV models, they choose local companies over non-local ones. Although his company still carries out R&D on NEV technologies, it has no motivation to commercialize them:

> *‘...Subsidies provided by central and local governments in pilot cities are 120,000 (Yuan) in total, which means* ***our products need to be 120,000 cheaper than theirs – how can that happen?*** *...If we want to gain permission for manufacturing NEVs from MIIT, we need to spend lots of money to go through procedures.* ***We don’t bother to do that without seeing a potential market****...’ (R5S_NEV)*

Policy targets of the NEV programme also included stimulating private consumption. However, private consumer subsidy policies only cover 6 cities in the country, which restrained the willingness for private consumption in other localities (R4O_NEV).

7.7 Case VI: Procurement elements in LED lighting programme

7.7.1 Introduction

This case looks into the Chinese LED lighting demonstration programme led by MOST. Countless government procurements in participant cities and beyond were stimulated. Three cities' practices are presented. For Weifang (a medium-sized city in Shandong, R4), and Yangzhou (a medium-sized city in Jiangsu, R5), two examples[35] are briefly described to gain an understanding about local government procurement. The Shanghai (R2) example is about SOE procurement of an LED lighting control system for a tunnel project. Section 7.7.6 highlights issues identified from the three examples, as well as that from interviews with national and regional officials in Beijing (R1) and Shenzhen (R3).

7.7.2 Background information

7.7.2.1 The technology and supporting policies

LED (light-emitting diode), or solid-state, lighting technology is to use semiconductor chip as the lighting source that performs electroluminescence effects when switched on (Pimputkar et al., 2009). LED lighting supply chains generally consist of: technology- and funding-intensive upper-stream segments of chip and epitaxial materials manufacturing; technology- and labor-intensive middle-stream segments of module-packaging; and labor-intensive down-stream segments of lighting applications (NA_LED). LED's advantages over incandescent light sources include significantly reduced energy consumption, longer lifetime, smaller size, higher robustness and diversified colours with no need of coloured filters (Tsao et al., 2010). LED lighting has been considered as an important 'green technology', whose diffusion to private market has been hindered by its much higher price compared with traditional lighting (Pimputkar et al., 2009).

The global industry is going through a transition towards LED lighting to cope with energy shortage; many countries are actively promoting LED technologies to obtain competitive advantages in the forthcoming 'revolution' (ibid.). China initiated STI policy support for the LED lighting industry in 2003; policies since 2009 featured

[35] The examples are not as detailed as the others in this chapter, as they were only among the many small-scale contracts in the localities; interviewees could not recall specific details.

emphasis on commercialization, application and most recently, standardization. A classification of LED lighting related innovation policies is presented in Figure 7.9.

Figure 7.9 Classification of LED lighting-related innovation policies

Overall policies	
Policy type	**Authority**
Implementation measures for indigenous innovation strategy	State Council
Stimulating policies for emerging technology sectors	State Council
Advice on Solid State Lighting and Energy-saving Industry Development	Joint ministries

Supply-side policies	
Policy type	**Authority**
National Programme for Semiconductor Lighting 2003	MOST
863 Programme in the 11th Five-year Plan Period on Semiconductor Lighting	MOST
China Solid State Lighting Alliance (CSSLA) with multiple functions	Joint ministries

Demand-side policies		
Category	**Policy type**	**Authority in charge**
'Ten Cities, Ten Thousand of LED Lights' programme	Announcements of conducting the demonstration program	MOST
	Guidance on commercial operation modes for the program	MOST
Other demonstration projects	Circular on Organizing the Application for Semiconductor Lighting Demonstration Projects; call for applications for indoor lighting projects, street lighting projects and tunnel lighting projects	NDRC, Ministry of Housing and Urban-Rural Development, Ministry of Transport
Standardization (since 2013)	Notice on unifying and revising semiconductor lighting related standards including glossaries and interface specifications	Joint ministries

Source: Author based on policy analysis

7.7.2.2 LED lighting programme – implementation to date

In 2009 MOST initiated the 'Ten cities, Ten thousand of LED lights' programme (MOST, 2009). According to NO_2, MOST initially planned to select 10 cities, each city procuring 10,000 LED lights for diversified municipal uses through open tendering; *ex-post*[36] subsidies would be allocated based on cities' performance. Many cities with competitive advantages in lighting showed their enthusiasm to participate. In May 2009, MOST nominated 21 participant cities rather than 10 as planned, including the four covered by fieldwork i.e. Weifang, Yangzhou, Shanghai and Shenzhen. The number of cities increased to 37 in 2011. Participants were so enthusiastic that they set up targets much higher than 10,000.

[36] Interviewee NO_2 revealed the reason for providing *ex-post* rather than direct subsidies was that MOST does not have specialized funding to promote application programmes; MOST's funding for this programme came from its R&D budget from MOF. '…*Actually from the transactions, the subsidy money doesn't appear on MOST's account; it was* ***after*** *we finished the job that finance departments sent the money for R&D here…*' (NO_2).

Participants tended to consider LED lighting as street lighting only, or they simply promoted streetlights as 'demonstration-on-streets' was more 'recognizable' for the public and for their superiors (NA_LED). A risk was that cities promoted immature street-lighting products while ignoring the potential of more developed products for indoor lighting (NA_LED). Some local governments were so eager to promote LED lights that they exchanged newly installed streetlights into LED ones; this kind of 'political face project' led to a waste of resources (R3O_LED).

Owing to the programme, in 2009 around 220,000 LED streetlights were installed in China; in 2010 and 2011 the numbers were 350,000 and 530,000 respectively[37]. In terms of supply chain, NA_LED estimated that by early 2012, there had been 95 upper-stream, 1600 middle-stream, and more than 5000 down-stream suppliers.

> *'…There are too many LED firms in China…* ***The government's role is very, very strong****… once the government wants to develop certain industries, investors just follow, sometimes* ***without thinking clearly****…' (R5S_LED)*

Suppliers spread geographically across the country, leading to a rather fragmented industrial landscape (NA_LED). Owing to the lack of a national standards system, many regions have published their own ones; standards in one region differ from that of others, sometimes serving is a means to protect local firms (R4O_1). Prices of LED *streetlights* became competitive in the Chinese market as a result of a dramatic price drop (as severe as 40-75%) caused by fierce competition during 2011 (R4S_LED). Despite the messy status in terms of industrial development, overall quality and performance of LED lights were improved significantly (NA_LED and R3O_LED).

The picture appeared rather paradoxical – in the *emerging sector* of LED lighting, many suppliers decided to quit the business. An explanation was that:

> *'…Previously many people considered that the threshold of the industry was very low, so* ***they just headed into the field trying to earn policy support and market share****…now the trend is not so clear and the* ***profit is so low*** *in this business, therefore many small firms just shut down and headed to somewhere else…' (R3O_LED)*

The messy status of regional implementation might be partially attributed to the lack of cross-ministerial coordination at the central level. MOST firstly initiated the programme in 2009 which, however, did not receive explicit support from 'powerful' ministries

[37] Source: GG-LED News & Research Company.

such as the NDRC. Later in 2010, NDRC together with two ministries governing transport and construction organized public tendering for LED demonstration in state-funded construction projects (regulated by LTB), sending rather confusing signals to practitioners (see NDRC et al., 2010). By May 2011, various ministries had not reached an agreement on how to conduct future promotion work.

According to follow-up interviews in February 2012, MOST is coordinating other agencies to collectively promote the programme:

> *'…Main focus would be* ***publishing national standards****…and* ***breaking down inter-regional barriers*** *by enhancing communication and interactions between central and local governments and between participant cities…* ***solid-state lighting experience centres*** *will be built nationwide to further raise the* ***awareness of private consumers****… The industry is going through a* ***painful 'shuffle' process****… bigger firms eat smaller ones… the positive side is that innovative and capable firms will stand out, and the market will become more regulated…' (NA_LED)*
>
> *'…We will guide regions to shift the focus of promotion from streetlights to other types… we are making* ***stricter rules to regulate the suppliers*** *that enjoy subsidies, which can help* ***prevent the entry of low-quality products*** *into the market.' (NO_2)*

In early 2013 a 'Semiconductor Lighting Industry Plan' was announced jointly by the above mentioned ministries (NDRC et al., 2013), featuring an emphasis on high-quality products and high-end technologies. The three procurement examples below took place during 2006-2011, before the recent policy change.

7.7.3 Weifang – an example of local integration?

7.7.3.1 Background information

Weifang is one of the earliest localities that nurtured an LED lighting industry in China. The first and biggest LED lighting supplier in Weifang is AODevices, founded by returnee students from abroad. It owns independent IPRs for most core technologies and has close collaboration with Cree Inc. for chip technology (R4S_LED). AODevices was involved in the early preparation stage for the MOST demonstration programme, whose opening ceremony took place in Weifang in early 2009.

AODevices faced commercialization challenges at the beginning; it started product promotion in 2006 in Weifang by conducting demonstration projects for free:

> *'… We paid all the expenses of the projects to open the market, persuading potential customers by showing the lighting effects here and there… Still it was extremely hard;* ***the contracts from the government saved us in this sense****…' (R4S_LED)*

7.7.3.2 Procurement activities

In late 2006, Weifang government procured LED streetlights from AODevices for the first time. Around 400 sets of streetlights were purchased and installed on Beihai Road, which then became the first road equipped with LED streetlights in the world (R4S_LED). During one year's trial usage, some problems were identified and solved; the business opportunity facilitated the company to upgrade their products to a newer generation with more flexible adjustability in terms of light strength and color.

> *'…the color can be set as warm tone in winter and cool tone in summer…light strength can change according to daylight strength…When driving on the way I can tell the lighting is much better and enjoyable than before, with a smooth and even effect…' (R4S_LED)*

After this procurement, the Weifang government contracted AODevices many more projects on main roads in the city. Before the national LED programme, the number of LED streetlights in Weifang already exceeded 10,000; other venues equipped with LED lighting included hospitals, schools, and government buildings.

Weifang officially started the implementation of the national programme in August 2009. By May 2011, the city government had spent more than 200 million Yuan on procurements of LED lights (R4S_LED). Different from earlier years when the lights were all from AODevices, there have been more and more LED companies settled down in Weifang, leading to fiercer competition. AODevices products were still the majority by May 2011, taking up around 80% of the LED streetlights in Weifang (Weifang S&T informant).

7.7.3.3 Obstacles

An obstacle hindering the promotion of LED lighting technology implied by R4O_2 has been the barriers posed by interest structures of traditional lighting business:

> *'…Weifang's previous director for streetlights got dismissed because of poor cooperation… the development of new industries needs 'icing on the cake' and 'coal in the snow', but* ***a most important and difficult thing is perhaps breaking down interest structures of old technologies****…' (R4O_2)*

When questioned whether AODevices encountered protectionism in other localities, R4S_LED commented that,

> *'…**Regional protectionism is understandable and we accept it**… **At least there is some rule to follow, which is good**… by opening sub-companies we can gain more orders from the locality, and meanwhile contribute to the local economy… **localization is a win-win method, a realistic solution**…' (R4S_LED)*

7.7.3.4 Outcomes and impacts

Through government procurement and other supporting policies, Weifang has nurtured a local LED lighting industry. By May 2011, more than ten LED lighting companies had settled down in Weifang, including sub-companies of big firms from other regions, and smaller companies without core IPRs but focused on assembling.

AODevices has established sub-companies countrywide and even worldwide through 'localization'; it made investments in different regions, supported by local governments providing land and infrastructure. It started receiving public contracts from abroad, which R4S_LED considered easier to win as '*foreign business is more market-based*'.

7.7.4 Yangzhou – transitioning from traditional industry

7.7.4.1 Background information

Yangzhou is one of the main manufacturing bases of traditional lighting equipment in China, contributing to 30% of the total production (R5O_YZ). The down-stream part of Yangzhou's LED lighting supply chain has been competitive as local suppliers mostly specialize in manufacturing and assembling. Taking the opportunity of national LED programme, Yangzhou sought to:

> *'…transform the local industry into a leading one in the country, with the most comprehensive supply chain, the friendliest environment, and an integration of R&D and industrialization of both new energy and new lighting sectors...' (R5O_YZ)*

With the support of local policies, local firms have been developing fast. Meanwhile the increasingly comprehensive supply chain has attracted many firms from outside the locality to settle down.

7.7.4.2 Procurement activities

R5O_YZ introduced that the programme implementation in Yangzhou would take two major steps: 'trial application demonstrating stage (2009-2010)' and 'application promoting stage (2011-2015)'. Government procurement of LED lights in Yangzhou has been in line with this two-stage plan. Owing to the large number of local suppliers, open tendering is normally organized to offer local suppliers equal opportunities (R5O_YZ).

The example given here is the 'Yangzhou LED Transformation Programme – Phase 1' project in 2009 contracted to the local supplier SFT (see Appendix 22 for more details). Around 4000 streetlights and 6000 scenery lights were procured.

The transformation work for several old streets was very challenging as Yangzhou is a historical city with precious architectural and gardening heritage. SFT needed to avoid any damage to the existing lighting poles and chimneys and meanwhile guarantee the light strength and evenness. This heightened the requirement for the structure, light distribution, heat relief and weight control of the product (R5S_LED). Each of the LED light set developed for this project was composed of three LED lights to fit the chimney, and the three lights needed different light distribution techniques to enhance the strength and evenness of light. SFT overcame the challenge by adopting its previously patented grille distribution technology.

7.7.4.3 Outcomes and impacts

Incremental innovation was stimulated as a result of the demanding requirements for the supplier. R5S_LED introduced that the newly installed LED lights realized the same strength as high-pressure sodium lights with better evenness; the adjusted colour is visually more comfortable; the average electricity-saving rate reached 55%.

The supplier won more contracts of streetlights transformation work from Yangzhou, and contracts from other participant cities of the programme. R5O_YZ said that:

> *'…the* ***cities willing to purchase products from Yangzhou normally don't have local LED lighting suppliers****… other than diversity and good quality of products, SFT's main competitiveness is* **low cost owing to collaboration with chip suppliers***…' (R5O_YZ).*

An impact of local government procurement activities in general is that the LED lighting supply chain in Yangzhou has been strengthened. Yangzhou is playing an increasingly important role in the domestic market.

7.7.5 Shanghai – LED control system for tunnel lighting

7.7.5.1 Background information

Shanghai's LED lighting implementation plan has been centred on the preparation for EXPO 2010 (R2O_4). It did not focus on streetlights but explored a wider diversity of uses. The procurement example given here is about the development of an LED lighting control system by the Baosight Company (see Appendix 22 for more details) for Shanghai Tunnel Engineering Company (STEC, the supplier in Tunnel case). In particular this example features the strong role played by a proactive stakeholder, i.e. interviewee R2S_LED from Baosight.

Baosight deals with automation and artificial intelligence solutions for steel and equipment manufacturing. The role of R2S_LED has been multifold. He is a chief engineer of Baosight and meanwhile a PhD co-supervisor of a local university. When he works with partners, he is sometimes employed as part of partner companies to negotiate with the government and other parties. Hence he is familiar with many issues including technology, administration, and policies.

7.7.5.2 The procurement process

R2S_LED noticed in 2007 that commercialization of LED lighting technology was accelerated. As a professional in control solutions he found that a big advantage of LED over traditional lights, i.e. the outstanding controllability, was often ignored:

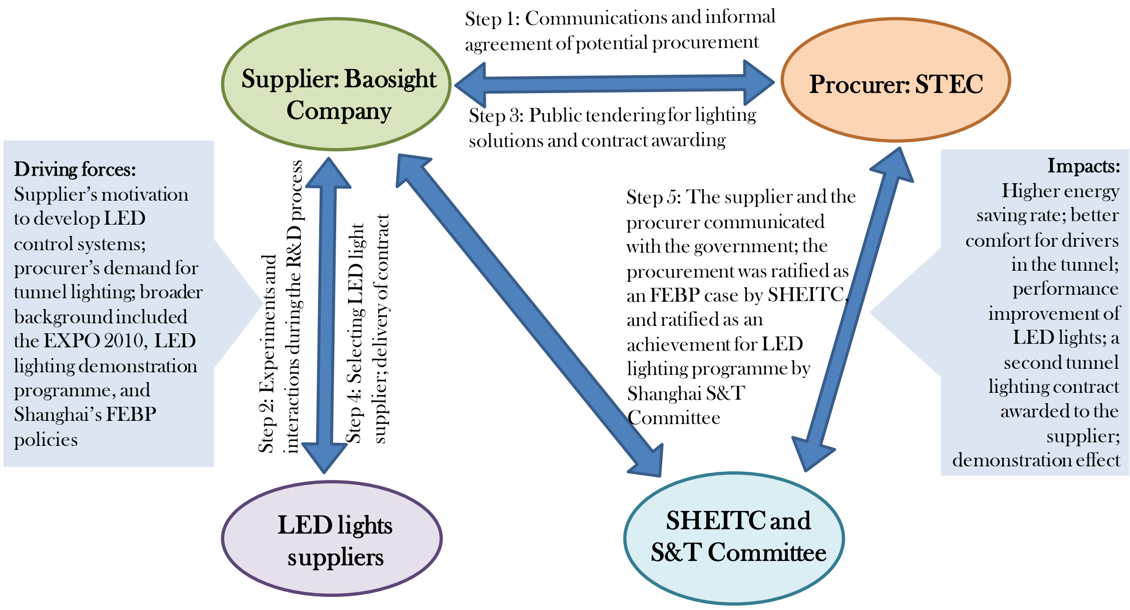
> *'...Stepless control can be realized on semiconductors; LED is born controllable… once the power is controlled smaller, the temperature of LED's PN junction will lower, and the LED can work for a longer time…' (R2S_LED)*

R2S_LED led his team to develop LED control systems since then; meanwhile he came across the idea of applying the control system to a reachable project. He is personally connected with a high-level manager of STEC. R2S_LED started tracking the progress of an ongoing project conducted by STEC, the Yangtze River Tunnel.

> *'...I just told him about the advantage of controlled LED lighting, and that it would be nice if he can not only finish the task he is supposed to do, but also* ***add some innovative part on it****… He was* ***willing to accept some new ideas to perfect his work****...' (R2S_LED)*

An informal agreement was achieved, which finally led to a procurement case. The overall process is illustrated in Figure 7.10.

Figure 7.10 Overall process of the procurement of LED control system



Source: Author

Baosight started collaborating with Fudan University for further R&D in 2008. The R&D team called for LED light firms to participate in their experiments, which received active responses from many suppliers.

> *'...The R&D process was very **interactive** and many firms contributed to it… we listened to suggestions from different people and did experiments for 8 months… **any criticisms were welcome**… **we helped many suppliers improve their products**…' (R2S_LED)*

Two solutions were developed for tunnel lighting control for STEC, namely 'time-based control', i.e. controlling the light strength according to peak and off time, and 'vision-based control', i.e. controlling light strength based on human sense of sight (see Appendix 22).

The STEC manager (procurer) was happy with the experiment results and offered practical suggestions for improvement. R2S_LED indicated that interactions with the procurer were very helpful and encouraged him to carry on in this area. The developed systems received good results from various testing centres.

When the tunnel construction work was nearly finished in 2009, STEC organized public tendering for accessories including a LED lighting solution. Baosight won the contract since '*only a few companies submitted bids and none of them considered the control issue thoroughly*' (R2S_LED). The final solution procured was composed of 6000 sets of LED lights with control system developed by Baosight. Baosight had the freedom to select suitable LED lights, which were from a Guangdong (R3) based company.

This procurement was considered retrospectively by Shanghai S&T Commission as part of Shanghai's achievement in the MOST LED programme (SLETA, 2010). It was ratified by SHEITC as a FEBP case (see the Tunnel case) as well (SHEITC, 2009).

> *'…We* ***already won the contract*** *when our marketing department found that SHEITC had some supporting policies called 'first procurement'. We considered our case qualified so we applied for the funding together with STEC… 2 million Yuan was subsidized to the user, and* ***the user shared 30% to us****...' R2S_LED*

7.7.5.3 Obstacles

One obstacle raised by R2S_LED was the absence of national standards on LED lighting,

> *'…The products from each of the seven suppliers we consulted were different from the others, but we need standardized lights with control-friendly features… Modularization can contribute to standardization and maintenance… we are still observing the policy trend and preparing for many varieties...' (R2S_LED)*

7.7.5.4 Outcomes and impacts

The procured control system realized requirements on light quality and energy-saving rate, and achieved some additional functions including 'nine-step light adjustment' and 'automatic self-inspection' (R2S_LED). Driving experience was significantly improved due to the smoothness and changing strength of LED lighting combined with the undulation of the tunnel (R2O_4). LED lighting in Yangtze River Tunnel has a demonstration effect, attracting delegates from other regions and countries to learn experience.

Although this procurement case was not stimulated by the FEBP policy, the FEBP title had very positive impact on the supplier's further business.

> *'…The FEBP title is not about money – the money is ignorable. It is about reputation – that's our evidence of affirmation by the government…' (R2S_LED)*

Owing to success of this one, in 2010 Baosight won a second contract from STEC for Qianjiang Tunnel, which was also a demonstration project authorized by NDRC (see Appendix 22).

7.7.6 Highlight: key issues identified

7.7.6.1 Smaller cities are institutionally more flexible?

Smaller cities such as Weifang and Yangzhou appeared more efficient in implementing the programme compared with bigger ones such as Shanghai and Shenzhen. R2O_4 considered the main reason for Shanghai to 'lag behind' as a lack of powerful support from the government, which was echoed by R2S_LED:

> *'...It's always risky to adopt new stuff, which is not popular among officials… they don't know how to report on their missions if there are accidents.* ***The best way is that there are some top-level leaders who would like to bear the risk so that lower-level people can be united to promote innovation****…' (R2S_LED)*
>
> *'...Before the programme, everything was fine for them (streetlight administration officials) and their suppliers… They don't want to break the* ***existing chains of cooperation and interests****…' (R2S_LED)*

Stronger procurement regulation in big cities was another reason preventing procurers from purchasing LED lights (R3O_LED). Smaller cities appeared to be institutionally more flexible:

> *'...****For (policy) implementation process at the local level, regulations are very weak****… in small cities like Weifang,* ***the local government is strong and bureaucratic enough*** *to promote LED lighting quickly…* ***interest structures in big cities are more redundant****…' (R4O_2)*

R3O_LED explained that Shenzhen's progress was 'intended' to be slow because of cautiousness:

> *'...****Shenzhen was under pressure because neighbour cities were actively supporting LED lighting****. We didn't compromise anyway, because we thought that* ***neither the technology nor the market was ready****. We conducted extensive product tests at that time.* ***Until recently we started to speed up because we have seen significant improvement of product quality****… I think this speed is reasonable and controllable. Ironically, I noticed that* ***some regions are slowing down because they experienced some failures at the beginning****…' (R3O_LED)*

Although Shenzhen has been progressing slowly in terms of quantitative targets, its testing activities have contributed to the overall development of the Chinese LED lighting industry (NO_2).

7.7.6.2 'Local integration' and protectionism

The Weifang case featured very strong integration of local demand and supply, which was justified by a local official that:

> *'...A focus of MOST was to revitalize the industry, so we had to prove that our local supply chain has the potential…* ***it was not stipulated whether Weifang should buy local products or not, but you can't just buy products from other regions since the aim was to stimulate the industry****…' (Weifang S&T Informant)*

Nevertheless, R3O_LED and NA_LED implied that Weifang's approach was a typical one shared by many underdeveloped regions in China as a means to 'attract investments through offering the local market'. This has caused severe local protectionism and duplicate production. Some suppliers focused on maintaining good relationship with local governments rather than technological development.

According to R3O_LED, Shenzhen has been preventing regional protectionism by organizing open tendering procedures for all the projects; as a procurer he was once under pressure because he did not protect local firms.

> *'...I told them even if they got the whole market in Shenzhen, it is only 300,000 lights… eventually they need to go outside the city.* ***Shenzhen should be a benchmark in the country with openness and a demonstration effect****... our firms are leading ones in the country. Although we don't have protection rules, contract winners were still mostly local firms…' (R3O_LED)*

7.7.6.3 Competing regulations of public procurement – the LGP and LTB

R3O_LED, a professional from a specialized government agency in Shenzhen for urban lighting infrastructure, pointed out that the fragmented procurement system posed difficulties for them to carry out procurement. The agency has been following two separate, sometimes conflicting procurement platforms supervised by construction (regulated by the LTB) and finance departments (regulated by the LGP) respectively.

R3O_LED introduced that the quantity of procurements via the financial platform was bigger as many public organizations have annual budget for repairing and maintaining; but the amount of expenditure via the construction platform was bigger as each single construction project needed considerable amount of new lights.

> *'…The two platforms complicated the procurement and maintenance processes…* ***we need to satisfy different authorities whose evaluation criteria are different****...* ***this*** *(different requirement of supplier qualifications)* ***leads to sub-contracting from chosen suppliers to other suppliers, which strictly speaking is illegal****… in practice we have no*

solution but ***try to comply with both sides and adopt the easier one when possible****...' (R3O_LED)*

7.8 Review of the cases – a summary

Key dimensions of the nine micro-level IOPP processes (i.e. Water Recycling, E-classroom, Tunnel Engineering, Offshore Wind Turbines, Jinan and Shenzhen procurements from the NEV case, and Weifang, Yangzhou and Shanghai procurements from the LED case) are summarized in Table 7.2. It is noteworthy that the scales of the three procurements associated with the LED programme were rather small, and the 'outcomes' and 'problems' dimensions of them are also about the broader picture of regional implementation of the programme. Cross-case analysis will be carried on in Section 8.2.

Table 7.2a Summary of IOPP cases – part 1 of 4

	Water recycling	**E-classroom solutions**	**Tunnel engineering**	**Offshore wind turbines**	**Jinan in NEV case**	**Shenzhen in NEV case**	**Weifang in LED case**	**Yangzhou in LED case**	**Shanghai LED control**
Policy channel	Channel 1&2: IOPP mechanism (Beijing)	Channel 1: National 'first procurement' regulations	Channel 2: FEBP programme (Shanghai)	Top-level 'buy domestic' mandate	Channel 3: Sectoral demonstration programmes	Channel 3: Sectoral demonstration programmes	Channel 3: Sectoral demonstration programmes	Channel 3: Sectoral demonstration programmes	Channel 3 complemented with Channel 2 FEBP programme
The demand	Beijing's demand for advanced water recycling solutions	Province-wide demand for modernizing the education system with ICT	Shanghai's demand for underground transport construction work for EXPO	Shanghai's demand for offshore wind turbines with construction and installation work for EXPO	Jinan's demand for NEVs for the 'green' theme in National Games 2009	Shenzhen's demand for NEVs for the 'green' theme in Universiade 2011	Weifang's demand for upgrading local street lighting infrastructure	Yangzhou's demand for upgrading local street lighting infrastructure	Construction company's demand for an LED lighting solution for Yangtze River Tunnel
Other driving forces	Government effort to commerciali ze local R&D outcomes	Proactive stakeholders' willingness to commercialize domestic processors	Proactive supplier's eagerness to commercialize its TBM prototype	The failed open call for international suppliers	Jinan government's willingness to nurture a local NEV industry	Shenzhen government's willingness to strengthen local new energy industry	Weifang government's willingness to develop local LED lighting industry	Yangzhou government's willingness to transform local traditional lighting industry	Proactive supplier's eagerness to develop LED control system
Timing in terms of TLC and market stages	Technology growth and market escalation at the global level	Maturity of technology at the global level; growing market for tailored solutions	Technology growth and market consolidation, especially in emerging markets	Technology growth and market creation and escalation at the global level	Technology growth for hybrid vehicles; market creation and escalation	Market creation and escalation following different newly-developed technological routes	Introduction of LED lighting to the locality; technology growth and market escalation	Introduction of LED lighting to the locality; technology growth and market escalation	Introduction of control technology to tunnel LED lighting; market creation

Source: Author

Table 7.2b Summary of IOPP cases – part 2 of 4

	Water recycling	**E-classroom solutions**	**Tunnel engineering**	**Offshore wind turbines**	**Jinan in NEV case**	**Shenzhen in NEV case**	**Weifang in LED case**	**Yangzhou in LED case**	**Shanghai LED control**
Levels and structures of governance	Formal coordination mechanism vertically across national to local government levels and horizontally across sectors	1st contract: temporary city-level cross-departmental group; 2nd contract: coordinated by the provincial procurement centre	Municipal-level coordination mechanism for FEBP programme led by SHEITC	Temporary coordination mechanism; Shanghai municipal DRC guided by NDRC	City-level cross-departmental administrative group supervised by cross-ministry leading group	City-level cross-departmental administrative group supervised by cross-ministry leading group	Temporary coordination for the procurement example; later on city-level leading group for 'city-county-district integration' for LED programme	City-level leading group composed of officials from relevant departments and lower levels of government	Ratified by municipal S&T Commission and SHEITC, who led the LED lighting demonstration programme and FEBP programme respectively
Initiator	Beijing government	The supplier, Loongson Co.	The supplier, STEC	Shanghai government	Jinan government	Shenzhen government	The supplier	Yangzhou government	The supplier
Procurer	Water authorities in Beijing	City and provincial governments	Subway construction companies	Wind farm operating company	Bus operating company	Shenzhen government	Weifang government	Yangzhou government	Construction company of the tunnel, STEC
End user	Water recycling plants	School teachers and students	Same as procurer	Same as procurer	Same as procurer	Bus and taxi operating companies	Citizens	Citizens	Citizens
What was procured, local or not?	MBR water recycling solutions, from a local firm	Loongson-based e-classroom solutions, from a local firm	'Forerunner' No.2 shield machines, from a local firm	3MW offshore wind turbines from non-local and construction from local firms	Hybrid coaches, from a firm in the same province but not the locality	NEVs based on various technologies, from two local firms	LED street lights, from a local firm	LED street and landscape lights, from a local firm	LED lighting solution, lights from non-local firm and control system from local firm

Source: Author

Table 7.2c Summary of IOPP cases – part 3 of 4

	Water recycling	**E-classroom solutions**	**Tunnel engineering**	**Offshore wind turbines**	**Jinan in NEV case**	**Shenzhen in NEV case**	**Weifang in LED case**	**Yangzhou in LED case**	**Shanghai LED control**
Local industry status	Strong in R&D; trying to commercialize and diffuse the technology	Strong in R&D; trying to commercialize and diffuse the technology	Strong in R&D; trying to commercialize and diffuse the technology	Domestic offshore wind turbines not available nationwide	Weak industry base; trying to nurture local NEV industry with the local market	Very strong; trying to strengthen the local new energy sector	No local LED firms until the suppler settled down; 'exchanging local market to nurture industry'	Strong traditional lighting industry; trying to transform to LED lighting industry	Competitive LED light manufacturing industry; controllability of LED lights ignored
Procurement procedure	Contract-signing conferences organized by Beijing government, followed by single-source procurement	Single-source procurement for the 1st contract; 'first procurement' regulated by Caiku [2007] 120 for the 2nd contract	Single-source procurement; contracts signed on the basis of one successful demonstration project, coordinated by SHEITC	Open tendering failed; a restricted tendering procedure with competitive dialogues was organized, guided by the NDRC	Open tendering procedure organized by the provincial government; choice of supplier partly depended on long-term trust	Restricted tendering for alternative designs organized; choice of suppliers influenced by previous pilot projects	Single-source procurement based on demonstration projects conducted before the initiation of national LED programme	Open tendering organized by Yangzhou city government for the local 'LED Transformation Programme – Phase 1'	Open tendering organized by STEC; choice of supplier influenced by previous experiments and long-term trust
Types of stakeholder interactions	Government-supplier; government-procurer; supplier-procurer	Supplier-procurer; procurer-user; supplier-user; procurer-expert	Supplier-government; supplier-procurer; government-procurer	Government-procurer/user; procurer/user-supplier; inter-government; procurer-expert	Government-procurer; procurer-supplier; procurer-user; supplier-user	Government-supplier; supplier-user; NEV supplier-infrastructure supplier	Supplier-government; others not very clear	Government-supplier; others not very clear	Supplier-procurer; supplier and procurer with government; inter-supplier
Types of IOPP (see Table 4.1)	Adaptive; commercial; direct; experimental	Adaptive procurement of customized solutions	Adaptive; pre-commercial; strategic; experimental	Adaptive; pre-commercial; experimental; direct	Adaptive; commercial; strategic	Adaptive; commercial; strategic	Adaptive; commercial; strategic	Adaptive; commercial; strategic	Adaptive procurement of customized innovative solutions

Source: Author

Table 7.2d Summary of IOPP cases – part 4 of 4

	Water recycling	E-classroom solutions	Tunnel engineering	Offshore wind turbines	Jinan in NEV case	Shenzhen in NEV case	Weifang in LED case	Yangzhou in LED case	Shanghai LED control
Outcomes and impacts	Supplier market expansion; accelerated diffusion of MBR technology countrywide; strengthened confidence for SMEs to deal with crisis; demonstration impacts of capital city	Loongson processor commercialization accelerated; supply chain strengthened; supplier gained further public contracts and expanded business; offered IOGP experience for other regions	Improved product performance; supply chain strengthened; supplier market expansion; lowered price; further contracts obtained; users awards	Domestic supply chain established; diffusion of offshore wind technology and industrial development; further contracts obtained by supplier companies; lowered turbine price	Improvement and maturation of product; lowered price; moderate improvement of the local transport system; awareness raising	Improvement of product design, public infrastructure and the local transport system; contributed to local new energy industry; achievements in standardization; diffusion of Shenzhen products to other regions	The numerous procurements of the supplier's products conducted by the local government formed a market to nurture a local LED industry; other firms were attracted to settle down; supply chain established	Innovative lighting for heritage was developed; the supplier obtained more contracts from the locality and beyond; procurements together with other innovation policies in Yangzhou contributed to the transformation of lighting industry	Higher energy efficiency was achieved as a result of the control system; better driving experience in the tunnel; improved LED light performance; supplier obtained new contract; demonstration effect
Problems, obstacles and tensions	For the supplier slight regionalism and procurers' unwillingness to procure	Unwillingness of actors to bear the risk; demanding after-sale services for the supplier; user capacity needed to be enhanced to fully benefit from the solution	Procurers' unwillingness to buy domestic equipment; competing departmental responsibilities in policy implementation	IPR dispute between the supplier and its previous foreign partner; controversies surrounding the supplier	Incapability of supplier to deliver contract on time; although open tendering was organized, regional protectionism was evident; hesitation about next moves	Although restricted tendering was organized, the procurement process was rather opaque	Old interest structures were broken down to give way to LED lighting; the development mode of 'exchanging local market for investment' is controversial	For the specific supplier not many difficulties; for Yangzhou the challenge lay in strengthening upper-stream technologies	Lack of standardized LED products; Shanghai's slow progress in programme implementation owing to risk aversion of officials

Source: Author

7.9 Conclusion

This chapter explored the IOPP dynamics in China down to the micro level. The six case studies elaborated on nine procurement processes carried out by practitioners in the five selected regions.

The roles of IOPP policies discussed in Chapter 6 in stimulating and shaping the dynamics have been evident. Different cases followed different policy channels. The Water and E-classroom cases were situated in policy Channel 1 based on innovation catalogues; both Beijing and Jiangsu articulated the national IOGP policies into regional initiatives which contributed to the emergence of cases; in particular, the Water case was only one of the numerous procurements achieved by Beijing through its local IOPP mechanism. The Tunnel case can be considered as following policy Channel 2 of MTE commercialization; although other factors might have served as critical driving forces, national policies did provide the justification for SHEITC to support the practice and subsidize equipment users. The NEV and LED Lighting cases certainly were situated in policy Channel 3, i.e. sectoral programmes; a few procurements were selected as examples to illustrate how regions tackle practical issues; this type of programmes proved to have great potential in stimulating large quantities of procurements; nevertheless, a number of problems emerged during implementation processes, notably regional protectionism. The Shanghai-LED case was situated in the LED programme channel, and can also be considered as an outcome of implementing policy Channel 2 underpinned by SHEITC's FEBP policies. The Wind Turbine case, which appeared to be outside any of the three channels, can be considered driven by the 'buy domestic' mandate from top-level officials; while indigenous turbines were delivered, IPR disputes between the supplier and its previous foreign partner made the 'indigenousness' of the innovation rather controversial.

Different cases followed different procedures, demonstrating special characteristics shaped by contextual factors. Other factors frequently played even stronger roles in stimulating IOPP than national or regional IOPP policies, such as proactive stakeholders (e.g. R2S_LED), and concentrated local demand created by large-scale events (e.g. Shanghai EXPO 2010). The cases did not all follow the implementation procedures stipulated by corresponding policies, e.g. the Water and the E-classroom cases would not have taken place if suppliers just waited for government procurers to select their products from innovation catalogues. ‘Procedures’ of most cases turned out to be outcomes of stakeholder interactions. Different from what was observed in the OECD context, the Chinese practitioners did not always follow the standard public procurement procedures as reviewed in Chapter 3. Competition was not always organized for selecting suppliers, especially in the cases where the suppliers played the role of initiators. Some common issues stood out, such as market fragmentation and duplicate investment owing to regional protectionism, and risk aversion of demand-side stakeholders.

On the basis of the reviews of IOPP dynamics and policy processes conducted in this chapter and Chapter 6, there is a need to bring different aspects and levels together, i.e. synthetic analysis, which is to be addressed in the following chapter.

Chapter 8: Synthetic Analysis

8.1 Introduction

By employing the conceptual framework proposed in Chapter 5, as well as perspectives reviewed in Chapters 2-4, this chapter seeks to synthesize the macro- and meso-levels of IOPP policy processes reviewed in Chapter 6 and the micro-level IOPP dynamics reviewed in Chapter 7. Section 8.2 analyses the micro-level IOPP dynamics through cross-case comparison based on perspectives regarding PPC. Section 8.3 then integrates findings from the three levels of policy process to evaluate the coherence between *goals*, *rationales*, *instruments*, *designed implementation structures*, *actual implementation processes* and *outcomes* of China's IOPP policies, i.e. the vertical coherence as defined in Table 5.1. Section 8.4 analyses horizontal coherence issues through contrasting China's IOPP practices with its context, including both the domestic and the international conditions. A variety of institutions have been identified heavily influencing IOPP in China; Section 8.5 provides a classification of them. Section 8.6 briefly compares China's IOPP practices with that of OECD countries reviewed in Chapter 4. Section 8.7 concludes the chapter.

8.2 Cross-case analysis: dynamics of implementation

8.2.1 Overview

An overview of key dimensions of the nine micro-level IOPP processes has been presented in Table 7.2. Corresponding to the sequential stages of procurement cycles, four broad aspects are analysed in this section in turn – background information including the driving forces, sectoral characteristics and governance structures; implementation mechanisms i.e. how *actors*, *institutions*, and their *interactions* from both innovation and procurement sides shaped the process of IOPP; outcomes and impacts that resulted from those IOPP cases; and other issues that emerged from the cases including obstacles and tensions encountered.

8.2.2 Background information

8.2.2.1 Driving forces

- **The demand**

A major reason why IOPP policies should be adopted is that there should be an unmet demand. Among the cases reviewed above, the demand for new technologies was largely generated by China's tremendous need to improve public services and infrastructures as a developing economy faced with an energy and environmental crisis. Technologies involved ranged from water recycling solutions to LED lighting and transportation equipment. A noteworthy 'engine of demand' has been the 'green' theme in various large-scale events organized by Chinese cities, e.g. the National Games 2009 hosted by Jinan and the Universiade 2011 hosted by Shenzhen brought about opportunities for the localities to improve public transport system, to implement the NEV programme, and to strengthen local NEV industries. The EXPO 2010 hosted by Shanghai served as a potent driving force for the Tunnel, the LED Control, and the Wind cases. Other examples included Beijing Olympics 2008 and Guangzhou Asian Games 2010 which led to public procurements of LED lighting and NEVs as well.

In the numerous case studies investigated in the EU context (Table 4.2), unsatisfied public needs calling for not-yet-existing solutions have been the main, if not the only, driving force for IOPP cases to take place. China's demand differs in that the demanded innovation is normally 'new to the country' rather than internationally 'not-yet-existing'; *indigenousness* of procured items and import substitution were emphasized in most of the cases (a vivid example was the Wind case where the international tendering process had failed and the 'buy Chinese' mandates led practitioners to seek domestic solutions). In China demand frequently results from the country's strategy to catch up, which sets clearer targets for IOPP practices than that of developed countries. In this sense, identifying and articulating public demand is much easier for catching-up countries than for developed ones, since the former can draw upon the latter's development experience, while the latter need to push technological frontiers which might appear highly uncertain.

It was observed that IOPP in China did not always start from the 'demand side' or from the procurement system (see the diagrams of procurement processes in Chapter 7);

rather, suppliers and the government frequently played the role of 'initiator'. Still the procured technologies were all in great need in the country – the 'national demand' has usually been identified and 'signalled' to innovation practitioners through formal instruments such as five-year plans and technology roadmaps. This is different from EU practices whereby it has normally been the role of specific procurers to identify the need.

Similarly to the national demand which is development-oriented, local demands elaborated in the cases were frequently accompanied by local governments' strong willingness to develop local industries through their purchasing power.

- **Innovation and sectoral policies**

Section 7.9 has briefly reviewed the link between IOPP cases and the three IOPP policy channels (also see Table 7.2a). The incentives and mandates provided by IOPP policies (see Chapter 6) served as another major driving force to bring innovation and procurement practices together.

Beyond the three channels, other policies related to innovation and sectoral development also contributed to the emergence of IOPP practices. For instance, several suppliers in the cases (e.g. Lemote in E-classroom and STEC in Tunnel) undertook 863 programmes (which is a supply-side policy) before the procurement took place. The R&D experience in government-funded programmes partly helped suppliers develop connections with MOST and local S&T departments; the connections further helped suppliers obtain government support to commercialize their R&D achievements. Sectoral policy examples included energy policies in the NEV, LED, and Wind cases, and environment policies in the Water case. Policies at lower levels of government also offered opportunities for IOPP, e.g. Jiangsu's education policies in the E-classroom case, Beijing's policy emphasis on commercializing local R&D outcomes, and participant cities' local industrial policies in the NEV and LED cases.

- **Proactive stakeholders**

Frequently it was observed that the emergence of cases was stimulated directly by proactive stakeholders with strong motivations rather than by explicitly perceived demand or stipulated policies. For instance, both the Tunnel and the LED Control cases partly followed policy Channel 2; however, the equipment user subsidies provided by SHEITC did not serve as the main incentive. It was the proactive suppliers (i.e. STEC in the Tunnel case and Baosight in the LED Control case) faced by commercialization challenges and seeking support from local governments or potential procurers that initiated the procurement processes. A similar example was Lemote in the E-classroom case.

Another type of proactive (and powerful) stakeholder was local government. Local governments in the E-classroom, Water, and NEV cases played multi-faceted roles including procurers, lead users and intermediaries. The motivation behind can be easily understood since development of local firms can contribute to the advancement of local economies. Section 8.2.3 will further reflect on the different roles played by stakeholders.

8.2.2.2 Sectoral characteristics, TLC and market stages

Although the selection of cases was not on the basis of technologies (Section 5.5.1), there has been convergence in terms of sectors. Involved sectors are mostly energy-saving, new energy and environment-friendly ones, i.e. the sectors of ‘green technologies’. Exceptions were the E-classroom and Tunnel cases, where both technologies were considered ‘strategic’ for China to catch up. The recurrent ‘green’ theme across cases is coherent with what has been observed in the EU context (Section 4.4.1). As nowadays many innovative solutions are targeted at overcoming grand challenges including environment pollution and energy shortage, they are frequently green products as well.

In terms of TLC timing (Section 4.3), most technologies procured were in the ‘growth’ stage at the global level, and in the stage of ‘introduction’ in China or in the region of procurement; the corresponding market stages were mostly ‘creation’ and ‘escalation’. In particular, the cases of Tunnel and Wind might be considered as PCP since the procured items were not commercialized or did not even exist before the procurements. One exception was again the Loongson case, where the CPU technology was in the maturation stage both internationally and domestically, but the development of customized e-classroom solutions involved incremental innovation and opened a promising niche market.

Within the NEV and LED programmes, procurements by different cities took place during different domestic and local market stages. Jinan’s case was in the initiation stage of the NEV programme when the local NEV industry was underdeveloped, and its choice of NEV type, i.e. hybrid coaches, reflected the caution taken by the local government faced with technological uncertainty by that time. Shenzhen's practice was in the middle stage of the NEV programme; its choice of various NEV models and ambitious procurement plan was backed by the strong NEV industry in the locality. For LED lighting, Weifang started procurements in 2006, well before the national programme, to support the only local supplier by that time; in 2009 when the LED programme was launched, the established local supply chain was competitive nationwide. Yangzhou on the other hand, kicked off on the basis of its strong traditional lighting industry after the launch of the national programme; the existence of many local suppliers made it possible to organize competition-based procurements to select suppliers with advantages in terms of core technologies. In all the four examples, the statuses of local industries, i.e. the technological and market stages in the locality, greatly influenced the processes and outcomes of procurements.

8.2.2.3 Levels and structures of governance

As summarized in Table 7.2b, most cases have crossed different government levels and departments and benefited from vertical and horizontal coordination. Cases that (largely) followed formally established governance structures include the Water case, Jinan and Shenzhen cases in the NEV programme, and Yangzhou in the LED programme. Governance of the Water case was led by the Beijing DRC, linking up vertical levels from ministries to districts, and horizontal departments covering S&T, finance and other related sectors. Beijing's systematic setup greatly enabled the implementation, although the actual opportunities to bring supply and demand together were created through technology exhibitions and contract-signing events. The NEV programme was better coordinated by ministries at the national level in comparison to the LED programme. Although Jinan and Shenzhen's procurements were mostly determined by the local governance structures, the control of the central government over regions was realized through an inter-ministerial coordination mechanism, regulations and considerable amounts of subsidies; lower-level governance was coherent with the national arrangement. Procurements that emerged from the LED programme, however, mainly followed local implementation plans; the absence of an inter-ministerial coordination mechanism weakened the central government's control over regions.

The rest of the cases, nevertheless, either followed temporarily coordinated governance structures (e.g. the E-classroom and the Wind cases, and Weifang in LED), or followed informal pathways led by other stakeholders than governments (e.g. the Tunnel and Shanghai LED Control cases). The E-classroom case was the very first practice of Changshu city and Jiangsu province; although provincial IOGP policies were announced by that time, the city government was not formally ready. A success factor was that the city government valued the possibility of conducting IOPP and established a temporary coordination mechanism engaging different government departments. The second, provincial contract followed Jiangsu's formal governance structure for 'first procurement'. The Wind case was an exception as it was outside the three IOPP policy channels, initiated by the Shanghai DRC, and resulted from a failed attempt to buy foreign products. The uniqueness of the case (i.e. being the first offshore wind farm directly regulated by NDRC's concession policy) drew attention from the NDRC, which led to the formation of a temporary, vertically coordinated governance structure. The procurement example in Weifang took place before the national programme and there were no formal institutional arrangements. The Tunnel and Shanghai LED Control cases, although considered as FEBP cases by SHEITC later on, were mainly coordinated through supplier-procurer interactions.

8.2.3 Procurement cycles and implementation mechanisms

The initiating body of IOPP practices in China proved to be diverse – other than procurers or users, suppliers and intermediaries played the role of initiators in several cases. As illustrated in the figures of procurement processes in Chapter 7, few cases followed the sequential phases of a typical PPC outlined in Figure 3.2. It is literally impossible to draw a 'cycle' for each case. Pre-procurement stages up to the awarding of contracts appeared rather flexibly conducted. Only the ones initiated by the demand side, e.g. the Wind case, Jinan and Shenzhen NEV cases and Yangzhou LED case, can be moderately considered as following the overall logic. For all the cases only three stages are distinguishable, i.e. *pre-procurement*, *contract awarding*, and *contract delivery* stages.

8.2.3.1 Pre-procurement stage: stakeholders, interactions and intermediation

As shown in Figure 3.2, four major tasks need to be fulfilled during the pre-procurement stage, i.e. the identification and articulation of demand, the gathering of market intelligence, the preparation of procurement strategy, and prequalification and dialogues. For the former two tasks there were formal approaches defined by policymakers at macro and meso levels. On the one hand, technological roadmapping and signalling policies/catalogues (Section 6.4.4) identify and articulate national and regional demand, and provide guidance to suppliers. For example, demand articulation in the Shenzhen NEV case was done by the local government through its Universiade implementation plan which was a rather formal instrument. On the other hand, catalogues of accredited products were designed to gather market intelligence and provide guidance to procurers, which could meanwhile contribute to the 'prequalification' task. For procurement strategies and procurer-supplier dialogue issues, national and regional IOPP policies also provided overall guidance for practitioners (see Chapter 6). As demonstrated in Chapter 7, the nine procurements did not all follow the defined approaches, but all of them fulfilled equivalent functions in adapted forms. Procurements were enabled to proceed, mainly through *stakeholder interactions*. Those interactions have been crucial in initiating and shaping procurement processes.

Five major types of stakeholders were identified from the cases, including: **procurers** who were sometimes the same as end-users (e.g. underground construction companies in the Tunnel case); **suppliers**, sometimes differentiated into various types of suppliers (e.g. supplier of LED lights in the Shanghai LED control case; infrastructure supplier in Shenzhen NEV case; supplier of construction work for the Wind case); **government agencies from multiple levels and departments**, who sometimes were procurers as well (e.g. Weifang and Yangzhou examples in the LED programme); **end-users**, who could be citizens or operating and construction companies (e.g. in the NEV cases); and **experts** who provided consultation services to government agencies. Interactions between any of them can contribute to IOPP processes (see figures of procurement processes in Chapter 7; also see Table 7.2c).

A distinction is made here between '*innovation'* and '*supply'*, and '*procurement'* and '*demand*'. This study considers that the supply side (i.e. suppliers) belongs to the innovation system but not all actors from the innovation system can be counted as the supply side (e.g. industrial alliances). Similarly it is considered that the demand side (i.e. procurers and users) belongs to the procurement system but not all actors from the procurement system can be counted as the demand side (e.g. MOF). The roles played by *intermediaries* are recognized, who might come from either system, and could be individuals or organizations. Interactive learning between stakeholders is the essence of IOPP, and stakeholder interactions are essentially interactions between innovation and procurement systems.

Along the procurement cycle, a distinction is made between *pre-procurement interactions* and *interactions in the contract delivery stage*. Section 4.5 argued that timing for stakeholder involvement is important and pre-procurement stages are crucial in stimulating IOPP cases. For the roles played in pre-procurement interactions, a distinction is made between *active* (i.e. the initiators) and *passive* roles. Nine idealized interaction modes between different sides during the pre-procurement stage, and their corresponding evidence from cases, are summarized in Table 8.1. It should be noted that *those idealized modes are not mutually exclusive*; they can exist in one IOPP process, simultaneously or in combined modes e.g. the demand-side and the intermediary might jointly interact with the supply-side.

Table 8.1 Idealized interaction modes during pre-procurement stages

<table>
<tr><th></th><th colspan="4">Passive</th></tr>
<tr><th rowspan="4">Active</th><th></th><th>Demand</th><th>Intermediary</th><th>Supply</th></tr>
<tr><th>Demand</th><td>D-D
E-classroom Solutions
Jinan NEV</td><td>D-I
E-classroom Solutions
Wind Turbines</td><td>D-S
Wind Turbines
Jinan NEV
Shenzhen NEV
Yangzhou LED</td></tr>
<tr><th>Intermediar</th><td>I-D
Water Recycling
Tunnel Engineering
Wind Turbines</td><td>I-I
Water Recycling
Wind Turbines</td><td>I-S
Water Recycling</td></tr>
<tr><th>Supply</th><td>S-D
E-classroom Solutions
Tunnel Engineering
Weifang LED
Shanghai LED Control</td><td>S-I
Tunnel Engineering</td><td>S-S
Shanghai LED Control
Shenzhen NEV</td></tr>
</table>

Source: Author

All the pre-procurement interactions by nature are to bring the two sides, i.e. demand (D) and supply (S), together; once the two sides reach an agreement to cooperate, the pre-procurement stage ends. Interactions between suppliers and procurers/users *after* the contracts (sometimes intents of procurement, e.g. in the Water case) are signed are discussed in Section 8.2.3.3. Evidence from the cases suggests that all the modes of interactions contributed to the initiating, proceeding and finishing of IOPP processes.

- **Demand-Supply (D-S) interaction mode**

This is the mode coherent with EU practices, where the demand side takes the initiative to seek suppliers for unmet public needs and the supply side responds to the call. Both sides can be brought together directly, e.g. in the form of public tendering as in the cases of Jinan NEV and Yangzhou LED; or in more interactive forms such as calling for alternative designs followed by dialogues and expert group evaluation, as in the cases of Wind and Shenzhen NEV. With respect to the four pre-procurement tasks, D-S interactions can contribute to demand articulation (letting the suppliers know better about user requirements), market intelligence gathering and prequalification (letting the procurers know better about what the suppliers can deliver and which design to choose). However, as pointed out by Edler et al. (2005), there is '*an inherent danger of privileging individual market actors whenever market intelligence becomes too interactive*'; this could be particularly true for the two NEV cases, where the long-term relationships between stakeholders influenced the choice of suppliers.

- **Demand-Demand (D-D) and Demand-Intermediary (D-I) interaction modes**

D-D and D-I interactions are the situations where the demand side takes the initiative but does not directly engage the supply side. These two modes can contribute to the tasks of 'demand articulation' and 'preparing procurement strategy'. A D-D interaction example is in the Jinan NEV case, where the Jinan government developed performance specifications together with the public transport company. A D-I interaction example is in the E-classroom case, where the Jiangsu Government Procurement Centre (a demand-side stakeholder) consulted specialized government agencies and experts (who can be considered as intermediaries) to develop the procurement strategy and to articulate technological specifications. In the Wind case, the interactions between the procurer and the expert group for product evaluation can be considered as D-I interactions as well.

- **Supply-Demand (S-D) and Supply-Intermediary (S-I) interaction modes**

From the cases there are situations where suppliers faced by commercialization challenges take the initiative, and seek a lead market by ‘persuading’ demand-side stakeholders (S-D interactions) or intermediaries (S-I interactions) to support them. Examples include the E-classroom, Tunnel, Weifang LED and Shanghai LED Control cases. It is worth noting that when the local government was the procurer, the suppliers succeeded rather smoothly e.g. in the E-classroom and Weifang cases. In cases of SOEs being the procurer, the process was more convoluted, e.g. in the Tunnel case, the supplier made several attempts including seeking help from the government and organizing pilot projects to obtain contracts; in the Shanghai LED control case, although an informal agreement was reached with the procurer, a tendering procedure was adopted after all. One explanation for this difference is that in China SOE procurement related to major projects is strictly regulated by the LTB, while local governments have more flexibility as procurers (Wang and Zhang, 2010). These interaction modes can be considered as contributing to the tasks of ‘market intelligence gathering’ and ‘prequalification and dialogues’. Nevertheless, there is again the danger of privileging certain suppliers over the others. These interaction modes are very different from that of EU practices, which are regulated by stricter institutions, and suppliers are not likely to take initiatives for public procurement.

- **Supply-Supply (S-S) interaction mode**

This interaction mode is applicable to cases where there is more than one supplier. For example, in the Shanghai LED control case, the control system supplier organized numerous experiments with products from various LED light suppliers. S-S interactions facilitated the improvement of control systems on the one hand, and improvement of LED light performance on the other. It can be considered as a form of stakeholder collaboration along the supply chain, and can potentially contribute to the gathering of market intelligence. Another example is the S-S interaction between NEV suppliers and charging infrastructure supplier in the Shenzhen NEV case, which contributed to the development of technological specifications and standards.

- **Intermediary-Intermediary (I-I), Intermediary-Supply (I-S), and Intermediary-Demand (I-D) interaction modes**

These are the interaction modes where intermediaries take the initiative and engage other stakeholders to enable the procurement. For example, in the Water case, the

Beijing government together with Zhongguancun Administration Committee played the role of intermediaries. With the objective of commercializing local R&D outcomes, they engaged various departments and levels of government (I-I interaction) to form a coordination mechanism for IOPP, and they also reached suppliers (I-S interaction) and potential procurers (I-D interaction) to seek opportunities to 'match' the two sides together. The contract-signing events organized by these intermediaries efficiently brought all stakeholders together and effectively stimulated the diffusion of new technologies produced by Zhongguancun. The roles of intermediaries played by local governments in this case can also be understood through the concept of 'policy entrepreneurs' (Flanagan et al., 2011); the Beijing government adopted somewhat interventionist approaches to promote IOPP as the solution for technology commercialization.

In the Wind case the Shanghai DRC was the initiator who recognized the need for offshore wind turbines. When the first round of procurement failed, it reported to the NDRC regarding the difficulty (I-I interaction), and later on it engaged with the procurer (I-D interaction) to select suppliers. WIND_P implied that the approach was rather interventionist as well, facilitating the procurement on the one hand while to an extent constraining the procurer's freedom of decision-making on the other.

Intermediaries also played important roles in the Tunnel case. The official from the Shanghai S&T Commission helped the supplier contact other stakeholders and obtain an opportunity for pilot operation (I-D interactions). Later on the mediation effort made by SHEITC contributed to the signing of contract between procurers and the supplier. In this case the intermediaries were *responsive* (see Edler and Yeow, 2013) and mediating, rather than proactive and intervening (as in the Water and Wind cases).

The cases suggest that through working in various ways, *intermediaries* can contribute to all aspects of IOPP processes, which echoes perspectives in Edler and Yeow (2013). A major difference of the intermediary roles presented in this thesis from that of Edler and Yeow (2013) is that, in the Chinese cases intermediaries were frequently *local governments* who could meanwhile be considered as *policy entrepreneurs* during the IOPP policy implementation process, while in the context of their paper, roles of intermediaries were played by external organizations providing management services.

The definition and features of innovation intermediaries as noted by Howells (2006) well suit the situation of Chinese local governments which can be considered as agencies situated at the meso level, integrating various functions (including both innovation and procurement functions) and resources. On the one hand they have a higher degree of authority than other types of stakeholders, and on the other they have more flexibility than the central government. Most importantly, local governments have strong motivations to intermediate – sometimes intervene – public procurement processes to seek economic, social and political benefits for the localities.

Most of the nine procurements featured very early involvement of stakeholders and dynamic interactions. Stakeholders from demand and supply sides as well as intermediaries can play the role of initiators, which indicates that it will be rewarding for IOPP policies to enhance all types of stakeholders' awareness and understanding of this instrument. It is worth noting that public procurers in these cases, unless they were local governments, remained rather passive and sometimes risk-averse. Proactiveness of other types of stakeholders to an extent compensated the inactiveness of procurers, but still incentives and resources proved to be lacking to engage procurers.

8.2.3.2 Contract awarding procedures

As addressed in Chapter 3, competition is supposed to be associated with the tendering process to guarantee compliance with regulations, and the delivery of the most satisfactory solutions. IOPP case studies in the EU context paid good attention to competitive tendering issues (see e.g. Tsipouri et al., 2010). Chinese IOPP policies also stipulated the necessity to organize formal tendering (see Sections 6.3.1, 6.4.1, 7.6.2, and 7.7.2 for the three policy channels' requirements respectively). Some special procurement techniques were introduced by policies, e.g. for bid evaluation methods life cycle costing was recommended by Caiku [2007]30.

However, the nine cases did not always follow the policy arrangement to have formal, competitive tendering processes organized. As summarized in Table 7.2c, the Water, E-classroom, Tunnel and Weifang LED can all be considered as having adopted single-source procurement procedures, where no competition was organized. Among the other five cases, Jinan NEV, Yangzhou LED and Shanghai LED adopted open tendering procedures, and Wind and Shenzhen NEV adopted restricted tendering procedures complemented with competitive dialogues.

Although the overall procedures can be categorized into single-source, restricted and open tendering, the actual pathways followed by practitioners were diverse and flexible. For some cases, the tendering process was more like a ritual step to go through than an actual process of selecting suppliers. For example in the cases of Jinan NEV, Shenzhen NEV and Shanghai LED, choice of suppliers was nearly decided before the tendering. The decision-making depended more on long-term relationships and mutual trust (which is informal), than on tendering procedures (which is formal). This phenomenon involves the role played by 'informal institutions' in China, as discussed in Section 8.2.6.2. This way of decision-making does not necessarily mean that the chosen suppliers were less competent than their competitors – after all, demanding evaluation criteria were adopted and alternative designs were compared. Nevertheless, this approach might create risks, e.g. the first procurement contract was not delivered on time in the Jinan NEV case. This initial failure and, perhaps more importantly, the lack of a strong local NEV industry caused Jinan's hesitation to conduct large-scale procurements later on.

Because most of the 'tendering' processes in the Chinese context turned out to be informal, the boundary between this stage and the 'evaluation and contract awarding' stage (as shown in Figure 3.2) is blurred. Equivalent functions were mostly fulfilled through pre-procurement stakeholder interactions, as explained in the preceding section.

8.2.3.3 Contract delivery stage: demand-supply interactive learning

Through various modes of interactions and mediations followed by contract awarding, the supply and demand sides eventually interact with and learn from each other to enable the delivery of innovative solutions. This mode differs from the D-S and S-D modes of interaction discussed in Section 8.2.3.1 in that the demand-supply relationship is already decided and the distinction between active and passive roles is ambiguous. This is even closer to the original notion of 'user-producer interaction' (Lundvall, 1985) whereby user-producer relationship is considered stabilized. Evidence from the cases suggests that although pre-procurement stages are crucial for IOPP, demand-supply interactions during the contract delivery stage also contributed to the accomplishment of IOPP. This echoes a major finding from Edler et al. (2005) that their case studies

> *'...showed the importance of* ***ongoing interaction*** *between suppliers and procurers and treating the project as* ***'an ongoing process', rather than a 'one off'****...' (p.6)*

Several functions of this interaction mode have been identified from the cases. The first is further articulating the demand through bilateral communications regarding technological specifications, and hence contributing to risk control and product delivery. For example in the Water case, intensive and formal demand-supply interactions started *after* contract-signing conferences, whereby the supplier could learn more about the user's exact requirements.

These communications are likely to fulfil a second function, i.e. to stimulate further, mostly incremental, innovation which leads to improved product performance. Several examples of this function emerged. In the Water case the supplier developed compact solutions at the request of users with distributed recycling needs. In the E-classroom case, feedback from users served as an input to improve the solution, and ongoing dialogues and experimentation activities contributed to product upgrading and development of accessories e.g. textbooks for the solution. In the Wind case, a routine user-supplier communication mechanism was established to implement maintenance, which meanwhile contributed to the improvement of the turbine control system. In the second contract of the Jinan NEV case, the user was more demanding and heightened its requirement, leading to product improvement in battery configuration. In the Shenzhen NEV case, the demand-supply relationship was established and stabilized long before the demonstration programme, featuring very frequent interactions. User feedback had been an essential driving force for incremental improvement of product performance, e.g. friendlier user interfaces.

Demand-supply interactions during the contract delivery stage can also realize a third function, i.e. accelerating the diffusion of innovations through training activities for users, who are the 'early adopters' as titled by Rogers (2003). For instance, in the E-classroom and Wind cases, during the prolonged periods of product warranty, users can improve their knowledge about the products and eventually become skilled to master them. The 'three-level training programme' (see Appendix 18) run by Lemote can be considered as a systematic approach to enhance user learning and potentially the integration of E-classroom solutions into various teaching modules. The wind turbine users aimed to build their own maintenance team through the five-year interactions with Sinovel, which will be promising in accelerating the diffusion of offshore technologies.

A fourth function is drawing experience for further practices, contributing to the 'evaluation and reflection' stage of the IOPP cycle (see Figure 3.2). As shown in the E-classroom and Jinan NEV cases, two procurements were conducted successively, and the first ones provided experience and lessons for the second time.

A special mode of demand-supply interactive learning occurred in the Tunnel case, where STEC was the supplier and meanwhile one of the users. This combined identity was considered the main competitive advantage of STEC. Very dynamic interactions between R&D (the supply side) and tunnel construction (the demand side) departments provided an internal channel to efficiently improve products by benefitting from user-producer interactions.

8.2.3.4 The handling of risks

Different types of risks are associated with various aspects of IOPP (Section 4.5). From the cases several types were evident. In the Jinan NEV case, the fact that the supplier failed to deliver indigenous products on time for the first contract can be considered as a result of *technological risk*. In the Wind case the initial open tendering failed as a result of *market risk from the supply side*, i.e. no suitable suppliers responded to the call. The lack of catalytic effect on private consumers in NEV cases can be considered as a result of *market risk from the demand side*. An example of high *financial risk* could be that of the Shenzhen NEV case, where large amounts of leading-edge NEVs and infrastructures were procured through a rather opaque process and the interviewee was unwilling to disclose the spending.

As reviewed in Section 4.5, all stages of the procurement cycle need to be dealt with carefully to realize risk control. In China at the macro level, the central government hoped to control risks in formal ways, e.g. as discussed in Chapter 6, accrediting products to produce guiding catalogues for procurers, public user subsidies, and other risk sharing and compensation mechanisms. These measures to an extent reduced the risks for practitioners at the micro level. Nevertheless, evidence from the nine procurements suggests that risks were not managed through explicit and systematic approaches. Rather, the following risk-control approaches were observed.

The most common one is suppliers gaining credibility through *experiments*, *prototype testing*, *pilot projects*, and *demonstration*, to deal with technological risks. This approach is evident in the Tunnel, Wind, Shenzhen NEV, Weifang LED and Shanghai LED control cases. In the E-classroom case the small-scale, city-level procurement could be considered as a pilot project as well as an accreditation process for the large-scale, provincial-level procurement. For the second contract in Jinan NEV case, the procurer learnt the lesson from the first contract and conducted stricter prototype testing and user-producer dialogues to control technological risks. *Dialogues and prequalification*, as evidenced by the Wind and Shenzhen NEV cases, can significantly contribute to risk control. *Mediations by powerful intermediaries* could be effective in controlling risks as well, e.g. the strong role played by the Beijing government in the Water case contributed to the control of organizational and market risks. *Extended product warranty* was adopted in the Wind and E-classroom cases to protect users from technological risks.

It is worth noting that the above mentioned approaches are mostly targeted at reducing procurers' and users' risks. The Chinese experience is coherent with the findings about EU practices by Tsipouri et al. (2010), that

> *'...procurers manage risk mainly through* ***political backing****,* ***pre-procurement intelligence gathering*** *and* ***an effort to shift technological risks to suppliers****, without using sophisticated contracts, specific tools or carefully planned stakeholder involvement and awareness raising…' (p.85)*

8.2.4 Outcomes and impacts

Several types of outcomes and impacts that IOPP can generate, as reviewed in Section 2.3.2, were evident from the cases, discussed in the following sections in turn.

8.2.4.1 Stimulation and diffusion of innovations

This is the direct objective of IOPP, and all the cases to an extent generated this outcome (see Chapter 7). As addressed the innovations were mostly 'new to the country' with an incremental feature rather than 'new to the world', although some of them represented the leading edge at the international level, e.g. the MBR recycling solutions, the EPB shield machines and the large-capacity offshore wind turbines. Import substitution was one of the motivations for China to adopt IOPP, and was realized in several cases through 'creative imitation' (Kim, 1997). Therefore, the IOPP practices presented in this thesis belong to the category of 'adaptive' rather than 'developmental' procurement (Edquist et al., 2000).

It should be noted that among the cases, public procurement did not always *stimulate* major innovations. Rather it served mostly as a *diffusion* policy, and key technology development was mostly achieved with the support of supply-side policies such as R&D programmes. What was *stimulated* was incremental innovation that led to product improvement or development of accessory solutions, e.g. wind turbine installation techniques. One reason for this could be that the Chinese IOPP policies were positioned to *follow* the R&D stage. All the three channels emphasized the 'commercialization' of existing new technologies, rather than 'creation' of even newer ones (see Chapter 6). Especially for the IOGP channel, accreditation criteria for innovation catalogues emphasized that the products should have entered the commercialization stage (Table 6.2). Interviewees' overall understanding of IOPP was 'buying new products' rather than buying something 'not-yet-existing'.

One consequence of the technology diffusion in several cases was reduction of product prices, which could in turn accelerate the diffusion process.

8.2.4.2 Development of suppliers, supply chains and local industries

Most of the cases resulted in development of suppliers' businesses, in terms of firm sizes as well as capabilities. Suppliers earned more contracts from either the procurer or from elsewhere, sometimes even from markets abroad as evidenced by the Tunnel and Wind cases. In terms of capabilities, some suppliers experienced rapid advancement during the course of delivering contracts. For example, Lemote had a systematic upgrading as a result of the second, larger-scale procurement (R5S_E); Sinovel's R&D progress on offshore turbines was accelerated greatly (WIND_S).

The impact of establishing and strengthening supply chains was also evident. In the cases of E-classroom, Tunnel, Wind, and Weifang LED, complete supply chains were established as a result of large-scale procurements. In the Yangzhou LED case, government procurement contributed to the transitioning of the supply chain from traditional lighting to an LED-based one.

Another impact was the nurturing and strengthening of local industries. This impact is most relevant to the cases of Shenzhen NEV, Weifang LED and Yangzhou LED. These cases belong to the policy channel of sectoral programmes, and the starting point of ministries was exactly to promote the development of emerging industries.

Procurements of this type feature very strong local integration, and are very likely to motivate local governments to exercise protectionism activities (Section 8.2.6.2).

It should be noted that larger procurement budgets played an important role in generating this type of impacts. The two procurements associated with the E-classroom case provided evidence demonstrating the difference between a small contract and a larger contract. Although the first, city-level procurement of 10,000 units of computers significantly encouraged the supplier, it did not lead to fundamental escalation of the company. It was the much larger, province-level procurement of 150,000 units that brought about the dramatic transition of the supplier’s business and full commercialization of Loongson-based e-classrooms. Another example has been the Jinan and Shenzhen NEV cases; the former, although involving two contracts, featured only a small scale of 200 hybrid vehicles which did not generate much impact on the local industry; while the latter featured a very large scale involving the procurement of 2011 NEVs based on diverse technologies, which significantly stimulated the development of the local NEV transport system and the local new-energy technology industry in general. This finding echoes the perspectives discussed in Section 2.2.2, that the size of demand can influence the creation and diffusion of innovation as large-scaled markets are more likely to provide the critical mass needed by suppliers than small-scaled ones.

8.2.4.3 Improvement of public infrastructures

This outcome was explicitly evident in NEV and LED cases, since public transport and lighting systems relate to citizens’ everyday life closely. Jinan and Shenzhen procurements to some extent eased the local transport situation, and LED lighting brought about better visual comfort. Both cases as well as the Water and Wind cases contributed to the ‘greening’ of public facilities. The E-classroom procurement brought about new modes of teacher-student interactions. The Tunnel procurement contributed to cost efficiency in the Chinese tunnel construction sector in general.

8.2.4.4 Demonstration effects

Demonstration effects of the cases were multifold, and by nature they can all be considered as enhanced public awareness. The first effect was ‘broadcasting’ new technologies and further stimulating public demand. For instance in the Water case, other regions became willing to procure MBR solutions after seeing Beijing’s practices. The second effect was easing consumers’ concerns over emerging technologies and spurring private demand. In general LED cases had wider impacts on private consumers than NEV cases. Several reasons account for private users’ risk aversion regarding NEVs, such as the lack of (unified) infrastructures countrywide, and much higher costs than traditional cars especially in the case that user subsidies did not apply to all regions. The third effect was encouraging practitioners to carry on with IOPP, and contributing to the building of innovation culture. Firms in Zhongguancun gained more confidence to deal with the economy crisis as a result of the contract-signing events; the E-classroom case encouraged procurers from other regions to better utilize IOGP; in the Tunnel case, lead users of Forerunner were recognized and praised, which might encourage other public users to use indigenous equipment.

8.2.5 Obstacles (system failures) encountered

As reviewed in Section 4.4.1, EU case studies reported some obstacles associated with IOPP in the European context; most frequently discussed ones included risk aversion, coordination deficiency, and EU’s strict procurement regulations hindering user-producer interactions (see e.g. Edler et al., 2005; Lember et al., 2007; Tispouri et al., 2010; Georghiou et al., 2010). The Chinese experience shared the former two, as discussed below; China’s experience in relation to the third one i.e. formal institutions turned out to be rather distinct, as will be discussed in Section 8.2.6.

Many obstacles were encountered during the course of conducting IOPP as documented in the case studies in Chapter 7. Those obstacles can be understood through the lens of ‘system failures’ (Section 2.3.1). For example, in the NEV case, the lack of standardized charging facilities can be considered as an infrastructure failure hindering the diffusion of NEV technologies; in the E-classroom, Jinan NEV and Wind cases, users’ and suppliers’ capability failures were evident, which caused slower adoption of new solutions or IPR disputes. The ‘stubborn’ obstacles identified in the Chinese context were mostly *institutional failures* by nature, arising from the procurement system, the innovation system, and from the broader context.

This section does not go through all of the obstacles one by one; rather it discusses the following obstacles which have been found particularly severe, including risk aversion, inter-departmental coordination problems, flawed regulatory system, and regional protectionism.

8.2.5.1 ***Risk aversion***

Risk aversion has been a recurrent obstacle hindering the IOPP processes. Unwillingness of actors to adopt innovation was evidenced by the cases of Water, E-classroom and Tunnel; also the implementation of NEV and LED programmes to an extent suffered from stakeholders' risk aversion. In particular, the longstanding attitude of 'discriminating' domestic products (Section 6.2.2.3) is an extreme example. As pointed out by interviewee R2O_2, equipment users 'feel more confident and responsible' if they buy imported products; also in Jinan case, that the practitioners decided to exchange the key components with imported ones is also an evidence of mistrust.

> *'…**in China we don't have the trust** (in domestic suppliers)… At least government procurement is a good signal… I might accept the products after the government has tried.* ***I believe…this 'gold rush' (i.e. LED programme) will eventually produce some gold****…' (NA_LED)*

Although the procurements were all conducted eventually, some suppliers were subject to high costs to deliver a product warranty. Based on the perspectives reviewed in Section 2.3.1, risk aversion can be considered as a *soft* institutional failure resulted from unfriendly informal institutions, which is related to the attitude of stakeholders and more broadly, the innovation culture (Herbig and Dunphy, 1998). Dealing with stakeholders' attitude of risk aversion, as pointed out by Tsipouri et al. (2010), is '*the major condition to manage risk*' (p.55). The analysis in Section 8.2.3 suggested that at least two types of roles are *not* risk-averse, i.e. initiators (played by proactive stakeholders) and intermediaries (played by proactive or responsive stakeholders).

From the cases some individuals essentially played the role of 'champion' (Yeow and Edler, 2012), the most vivid example being interviewee R2S_LED in the LED control case. R2S_LED had control of various resources including technological knowledge, business relations and human resources, and most importantly, he had the willingness and confidence to promote the development and diffusion of the LED control system. Through actively mobilizing available resources, R2S_LED implemented his idea, developed innovative LED control solutions, and earned initial contracts from the procuring company. R2S_LED's business partner (or friend) was open-minded enough to be a first user.

Both champions and intermediaries (especially when intermediaries are 'policy entrepreneurs') can contribute to overcoming risk aversion. High-level officials in local governments frequently play both roles. Local governments eager to promote local industries often put risk issues aside, which, however, might cause other problems (Section 8.2.6.2).

8.2.5.2 ***Poor inter-departmental coordination***

Inter-departmental coordination problems arose primarily owing to a lack of goal alignment, and can be considered as institutional (e.g. problematic division of labour resulting in competing departmental responsibilities) or interaction failures (e.g. the institutional setup is fine but communication and collaboration between departments are lacking). The design of the IOGP policy channel anticipated this problem and attempted to tackle it through clarified division of labor based on centralized innovation catalogues (see Figure 6.2); the effectiveness of this approach, however, would not be known due to the policy termination. Inter-departmental coordination during the course of regional implementation, as demonstrated in the cases of Water and E-classroom, was further strengthened through very strong leadership undertaken by local governments. For policy Channel 2 to which the Tunnel and Shanghai LED Control cases belong, there were disagreements between SHEITC and other departments (Section 7.4.4); although this was just the situation of Shanghai, this might have reflected the blurred boundary of responsibilities between the MIIT (supervising SHEITC), MOST (supervising S&T commissions) and MOF (supervising finance departments) regarding innovation policies (Section 2.5.3). For policy Channel 3, the smoothness of inter-ministerial coordination at the national level varied from programme to programme; inter-departmental coordination at the regional level was again strengthened through the leadership of local governments.

8.2.5.3 Flawed regulatory system

A major obstacle hindering IOPP in China has been the flawed regulatory system for public procurement (a type of *formal institutions*), which can be considered as *hard institutional failures* (Section 2.3.1). Examples of failures include that some innovation items were not procurable due to the fragmentation of the procurement system and correspondingly the absence of a unified procurement classification (R3F, R4F and R5F), and that regulations posed by the LGP and LTB are competing for micro-level practitioners who need to justify their decision making (R3O_LED). At the policy level, although some minor adjustments were made to support IOPP (see Chapter 6), fundamental flaws remain. At the micro level, the cases indicated that these failures were, again, largely mitigated by local governments. Nevertheless, too much autonomy and flexibility for local governments to perform as procurers led to regional protectionism and market fragmentation.

8.2.5.4 Regional protectionism

Barriers posed by regional protectionism hindering the diffusion of innovation were evidenced by the Water and Tunnel cases, and NEV and LED programmes. Regional protectionism exists in various aspects of the Chinese economy (Zhao and Zhang, 1999). This study argues that regional protectionism is fundamentally determined by problematic *formal* institutions (i.e. decentralization of Chinese fiscal system, ibid.), and the political and social norms resulting from regional protectionism can be considered as *informal* institutions; regional protectionism is further discussed in Section 8.2.6.2 through the lens of institutions.

8.2.6 The roles played by institutions

8.2.6.1 Formal institutions

From the cases it was observed that the Chinese IOPP experience was not short of interactions; on the contrary there was a risk of 'strong network failures' (Section 2.3.1) considering that procurement decisions were sometimes made based on close demand-supply relationships. Stakeholder interactions proceeded in diversified, unregulated patterns, rather than being shaped by well-established, formal institutions. Although significant development of formal institutions (notably legal regulations) in China has been witnessed since the launch of domestic economic reforms in the 1970s, especially since China's accession to the WTO in 2001, the power of formal institutions proved to be much weaker than that of developed countries (Clarke et al., 2007). This is coherent with the perspectives on developing countries in general, as reviewed in Section 2.4. Differently from the EU where formal institutions sometimes hinder the utilization of

IOPP because they are well implemented and powerful, China's formal institutions hinder IOPP because they appeared to be weak, unstable, and sometimes problematically established or absent. Based on Chapters 6 and 7, the main types of formal institutions involved in Chinese IOPP processes include, on the innovation system side, industrial standards and various regulations (e.g. on environment protection, market entry, and IPR issues); on the procurement system side, laws and implementation regulations aiming to realize primary objectives; and at the intersection of the two systems, regulations and measures promoting the innovation objectives of public procurement.

Standards can affect IOPP in a number of ways (OECD, 2011a; Blind, 2013). In the Shenzhen NEV case, IOPP and standardization were mutually reinforcing, which led to the establishment of unified standards in the locality. Nonetheless, in the Wind case the heightened national standards, which although could potentially stimulate innovation, posed challenges for suppliers to live up to the new rules only. In NEV and LED cases, the absence of unified, nationwide standards increased uncertainty for procurers to choose and for suppliers to develop products. In particular for the LED programme, some local governments exercised regional protectionism through producing standards 'tailored' to local suppliers. Regulations affected the cases in multiple ways as well. Environment-related regulations, although not fully developed or implemented either (Marks, 2010), partly stimulated the emergence of the Water, Wind, NEV and LED cases. This is also the situation at the global level, where tremendous public demand is being created by environment regulations, offering opportunities for eco-innovation (OECD, 2011b; Lanoie et al., 2011). Market entry regulations to an extent shaped the trajectories of NEV and LED programmes. The high market entry cost for the NEV industry discouraged some suppliers (e.g. R5S_NEV); in the LED industry where the entry cost was low, too many suppliers were motivated, resulting in duplicate investment and fierce competition. In the arena of IPR regulations, disputes between Sinovel and AMSC drew public attention to China's loosely implemented and frequently criticized IPR protection regulations (Smith et al., 2011; Peng, 2013).

Formal institutions from the procurement system affected IOPP processes in a more explicit way than that from the innovation system. The procurement regulatory system in China, as reviewed in Section 3.4, is rather fragmented as a result of two competing primary laws supervised by different authorities. The flaws of formal institutions created fundamental obstacles for conducting IOPP or even regular procurement practices, as indicated by the procurer interviewees.

> *'…Using procurement to promote development might be effective in some countries where the competition level is high and market is regulated;* ***in China the outcome is discounted****…* ***government procurement has turned into an arena for inter-departmental 'wrestling'****…' (R3O_LED)*

These obstacles can only be fully resolved through legislative reforms towards centralization (Wang and Li, 2013) rather than producing implementation regulations to complement the existing laws (which is what the Chinese government has been doing, see Chapter 6). The regulatory power of these institutions appeared to be stronger for SOEs than for local governments; meanwhile it is stronger at higher levels of the Chinese political system, while weakened at lower levels[38]. Local governments at the city level have more integrative authority than provincial governments and ministries. For example, in the LED programme, smaller cities (which are situated at a lower governance level than bigger cities such as provincial capitals and municipalities) appeared to be institutionally more flexible in conducting procurements than larger ones (Section 7.7.6.1); the cost of breaking down existing institutions to give way to adoption of new lighting technologies in smaller cities was lower, and practitioners were more incentivized.

Situated at the intersection of the innovation and procurement systems are various implementation measures promoting IOPP, adjusting procurement procedures and criteria to support a secondary objective i.e. innovation (corresponding to Stage 7 in Table 3.1). A most important 'vehicle' of these institutions, i.e. innovation catalogues, did not function in the way as designed. The 'procurability' of accredited products based on the narrow definition of government procurement is doubtful (see Chapter 6), which again pointed to the problematic legal system. In the Water and E-classroom cases, catalogues did not play the designed role to bring supply and demand together; rather they served as a formal justification for favouring innovation during the course of stakeholder interactions. The seemingly 'systemic' policy effort to promote innovation through procurement was significantly compromised due to the weak role played by

[38] Helmke and Levitsky (2004) pointed out that the regulatory power of Chinese formal institutions in rural area is even weaker; for a more comprehensive interpretation see Hu (2013).

innovation catalogues, which is one of the factors that made the IOPP implementation more like 'dots' rather than 'layers' (R5O_1). In addition, the procured items were tailored solutions rather than the exact products listed in catalogues. In this sense, even if not terminated, the catalogue system does not seem to be capable of capturing innovation. It is worth noting that interviewee R3O_LED (who normally worked as a procurer) did not approve 'innovation catalogues' as a reference when he evaluated alternative products.

> *'…**Indigenous innovativeness is not an exact criterion** and it will create **complications** in evaluating product quality. We focus on technological specifications. If you satisfy the specifications you will get the points, no other criteria.' (R3O_LED)*

Although the primary objectives (Section 3.2) of public procurement were ambiguously addressed, and the pathways followed were frequently different from that designed by the national IOPP policies, practitioners in the cases more or less achieved the objective of promoting innovation, which can be partly attributed to the 'mitigation' effect of informal institutions.

8.2.6.2 Informal institutions

From the cases the active role of *informal* elements (e.g. proactive individuals, temporary coordination mechanisms and stakeholder relationships) in stimulating and shaping IOPP activities was observed, which might be considered as manifestations of China's flawed and weak formal institutions. The typology of relationships between formal and informal institutions proposed by Helmke and Levitsky (2004) (Section 2.2.1) helps understand the various roles played by several types of informal institutions identified from the Chinese context of IOPP.

The first type is the *interventionist governance style* possessed by all levels of governments[39]. Analysis in Section 8.2.3 suggests that local governments were the most active stakeholders facilitating IOPP, serving as intermediaries, policy entrepreneurs or procurers. Most cases were heavily influenced by government decisions, except in the Tunnel and the Shanghai LED control cases where SOEs were procurers and the Shanghai government played limited roles. The interventionist governance style on one

[39] Interviews with NO_2, R3O, R4O_1, and R5F suggested that governments in different regions are interventionist to different degrees, influenced by regional culture and openness of local economy; Guangdong has a weak government, Shanghai in the middle, while Beijing, Shandong and Jiangsu have stronger governments.

hand helped achieve the desired outcomes, serving as a *complementary* force to put IOPP policies into practice. On the other it created 'administrative pressure' for potential procurers (R1S_OW), making them feel 'obligated' or 'expected by the government' to purchase (WIND_P). Interviewee R3O_LED even concluded that IOPP will not be an effective policy in China because

> *'…the government's role is too strong, and* ***the space left for the market is extremely limited****. Especially in recent years, it is always the government playing the main role…'*

The second type is the *informal norms followed by procurement practitioners*. As illustrated in Figure 3.1, laws/regulations are formal institutions, and other parts of the procurement system can be considered as informal elements. The Chinese procurement system is weak and flawed in formal institutions, thus the 'informal parts' played 'complementing' or 'substitutive' roles to fulfil system functions. Practitioners frequently needed to strike a balance among: *de jure* compliance with the LTB or the LGP, *de facto* operationality for implementation, the goal of procuring qualified products, and fulfilling political tasks such as promoting innovation. In sectors where the boundary between LTB and LGP is unclear, such as LED lighting, procurers' choice of which formal institution to follow was sometimes driven by operationality or 'practical convenience', as implied by R3O_LED. Beijing's systematic approach to overcoming the failures resulted from problematic procurement regulations (also adopted by East Lake innovation zone, Section 6.3) might be considered as 'adaptive informal institutions', defined by Tsai (2006) as '*creative responses to formal institutional environments that actors find too constraining*' (p.118). The emergence of adaptive informal institutions is sometimes in essence 'institutional experimentation' (Roland, 2004), producing justifications for formal institutional reforms (Tsai, 2006).

A third type of informal institutions is *guanxi*, often translated as 'connections' or 'relationships'. Guanxi has a complex, cultural connotation and exists pervasively in Chinese society (Gold et al., 2002; Ma, T., 2009; Wang, 2010). In short, guanxi refers to informal relationships based on mutual trust and reciprocity between different parties (ibid.). Guanxi that existed in the cases included that between individuals e.g. in the LED control case, between R2S_LED and the STEC manager; occasionally, old guanxi between stakeholders (e.g. interest groups centred on old technologies such as traditional lighting in the LED case) might hinder the diffusion of new technologies. Another important type of guanxi was the ones between local governments and local suppliers, as evidenced by the E-classroom, NEV, and LED cases. Local governments and firms share mutual interests as on the one hand, entrepreneurs need government provision of resources and support measures to develop business in the Chinese institutional context which features '*uncertainty, unpredictability and political sensitivity*' (Ma, T., 2009, p.92), and on the other, local government officials need local firms to contribute to economic growth which is an essential criterion for their performance evaluation by their superiors (ibid.). Guanxi's impacts proved to be contradictory (Ledeneva, 2008). One impact was that guanxi '*complement law, clarifying legal ambiguity and providing access to legal mechanisms of contract enforcement and dispute settlement*' (Wang, 2010, p.535). Taking IOPP as an example, guanxi to an extent mitigated the failures resulted from procurement regulations and motivated some stakeholders to support innovation. In this sense, guanxi is 'supportive' and provides a 'solution' to defects of formal institutions (Ledeneva, 2008). Interviewee R2S_LED considers using guanxi to gain contracts very reasonable:

> *'…if two business partners are familiar and satisfied with each other, why not cooperate? The key issue is to stick to the principle, to keep the quality high…'*

Nevertheless, there is a high risk of guanxi, and other informal institutions, to conduce clientelism and corruption (Helmke and Levitsky, 2004; Ledeneva, 2008).

In the context of this study, guanxi between local governments and firms was found intertwined with a fourth type of informal institutions, which is a stubborn force competing with formal institutions and hindering innovation, i.e. *regional protectionism*. There is a large body of literature on protectionism between Chinese regions (see e.g. Batisse and Poncet, 2004; Bai et al., 2004; Eberhardt et al., 2013). Regional protectionism exists pervasively in China owing to the fiscal decentralization reforms undertaken in the 1990s (Sections 2.5.3). It can be considered as a consequence of problematic formal institutions, which then forms a competing force against formal institutions, creating obstacles for the implementation of IOPP policies. A major 'rationale' for regional protectionism to hinder innovation is that it obstructs competition and the formation of critical mass by fragmenting the domestic market and turning demand structures into 'polypsony' (Section 4.3). If the Chinese IOPP policies were implemented according to the policy design, competitions should have been organized. Nevertheless, out of protectionism most of the regions did not introduce competition to their localities unless they had multiple local suppliers. Market conditions in China are not very innovation-friendly per se due to the legacy of a centrally-planned economy and unfinished institutional reforms (OECD, 2008; Golley and Song, 2010), and the fragmentation undoubtedly worsened this. Most of the interviewed regional procurers considered preferential treatment for local suppliers very 'natural' and 'understandable', but R3O_LED pointed out that:

> *'…I guess few people actually like regional protectionism… **even if it's the mayor of Weifang, if he goes to supermarket to buy LED products for his own use, he might not pick local ones – that is the real market system based on competition**, different from the government procurement market…'*

Opinions on the supply side were diverse. While most suppliers (including R1S_OW, R2S_T, R4S_SO R5S_SO and R5S_NEV) complained about barriers created by regional protectionism, interviewee R4S_LED was glad that '*at least there were some rules to follow*'. Firms with sufficient resources, e.g. the suppliers in the Water, Shenzhen NEV and Weifang LED cases, set up branches in different regions to break down inter-regional barriers. Indeed, 'localization' has increasingly become a strategy of Chinese firms to cope with regional protectionism (Batisse and Poncet, 2004). Although '*competition from foreign-invested firms operating in China and foreign imports*' and '*bureaucratic integration*' (i.e. concurrent appointment of local government officials in the central government) are considered as a counterforce to constrain regional protectionism (Bai et al., 2008), '*it seems unlikely that a marked lack of competition can be compensated for*' (OECD, 2010, p.262).

8.3 Cross-level analysis: vertical coherence

8.3.1 Overview

As implied in the preceding chapters and sections, interconnections existed between micro, meso and macro levels. This section attempts to bring different levels together to evaluate the vertical coherence of the three policy channels. Analytical lenses primarily involve perspectives on policy mix and policy implementation as introduced in Chapter 2 and deepened in Chapter 5. The dimensions for vertical mix defined by this study include goals, rationales, instruments, *designed* implementation structures, *actual* implementation processes and outcomes (see Table 5.1). For each channel these dimensions are briefly summarized in Table 8.2.

Table 8.2 Vertical coherence of the three IOPP policy channels

Channel	**1: IOGP mechanism based on catalogues**	**2: Major technological equipment (MTE) commercialization**	**3: Demonstration programmes for NEV and LED lighting**
Goals	To promote indigenous innovation based on the existing government procurement system	To promote the commercialization of ‘first (set of) MTE’	To promote the uptake and diffusion of NEV and LED lighting technologies
Rationales	Enhancing demand-supply communication; establishing a routine mechanism treating ‘innovation’ as an essential criterion (‘general procurement’)	Government signalling national demand; supporting organizational procurers’ procurement of newly developed domestic equipment (‘strategic procurement’; PCP)	Nurturing ‘lead markets’; encouraging public procurement as well as private consumption (‘strategic procurement’ and ‘state procurement in connection with private users)
Main instruments	Innovation and IOGP catalogues; pilot accreditation; raising public awareness; concrete measures regarding procurement management	Equipment catalogues; ‘experiment’ and ‘demonstration’ projects; user subsidies; risk compensation measures; user praises and awards	NEV: subsidies for public procurement and private consumption in selected cities; regulations and standards. LED: *ex-post* subsidies by MOST; public tendering by other ministries
Designed implementation structures	Inter-departmental mechanism engaging various levels and departments; S&T departments in charge of accreditation and finance departments in charge of procurement (Figure 6.2)	Projects conducted by all organizations can apply for the status of ‘experiment or demonstration projects’ to enjoy policy support from MIIT, MOST, NDRC, MOF and SASAC (Section 6.4.1)	NEV: implement city-level programme plans designed by participants and approved by MIIT, MOST, MOF, NDRC. LED: implement city-level plans designed by participants; no unified national implementation structure until 2013
Actual implementation processes	National implementation came to standstill (Section 6.3.2); regional autonomy in developing local mechanisms (Section 6.3.3); actual processes featured flexible stakeholder interactions	National implementation was not investigated; some regions designed local approaches; Shanghai experience implying that proactive suppliers and intermediaries rather than policy incentives were key drivers to success	Participant cities implemented with high degrees of autonomy (particularly in the LED programme), divergent pathways followed; local governments proactively played the roles of ‘policy entrepreneurs’; pervasive regional protectionism
Outcomes	Individual cases emerged; achieved ‘dots’ rather than ‘layers’ (R5O_1); awareness raised but government procurers’ behaviour did not change much	Successful examples emerged in regions; behavioural additionalities and increased awareness; nationwide progress reported and praised annually	Accelerated the diffusion of NEV and LED lighting technologies; nurtured some local industries; caused ‘high fever’ in certain regions; duplicate investment; chaotic picture for LED programme
Current statuses	Terminated at all levels in end 2011 in response to international concerns	Still in force, faced by challenges as well as opportunities	Both programmes should have ended by end 2012; both were ‘updated’ in 2013

Source: Author

The first four rows of the table lie primarily at the macro and meso levels of policy design and articulation, while the bottom three rows are more about the 'reality' at the meso and micro levels of policy implementation. The 'designed' vertical coherence (i.e. would the channels realize their goals if the implementation was carried out strictly according to the design?) can be evaluated through analysing the coherence between upper rows, while to evaluate the 'actual' vertical coherence all the rows need to be synthesized. Designed coherence is a prerequisite for realizing actual coherence. Even if vertical coherence is realized in terms of design, the actual implementation processes, as demonstrated in Chapters 6 and 7, can shape the policy trajectories in a rather inconsistent way. The following sections analyse the vertical coherence of each policy channel in turn.

8.3.2 Channel 1: IOGP mechanism based on catalogues

8.3.2.1 Vertical coherence – the designed

The goal of Channel 1 was explicitly stated in the MLP, i.e. to '*establish a coordination mechanism for government procurement of indigenous innovative products*' (State Council, 2006a, p.54). To realize the goal, the main rationale of Channel 1 was to enhance the communication and coordination between the supply and the demand sides through establishing a routinized procurement mechanism, which treats 'indigenous innovativeness' as an essential criterion, and can be considered as an approach to realizing 'general procurement' (Edler and Georghiou, 2007). The rationale was coherent with the goal. The designed mechanism, if effectively implemented, was expected to overcome market failures such as information asymmetries, and system failures such as interaction failures resulted from poor coordination, infrastructure failures e.g. lack of an IOPP e-platform, and institutional failures e.g. unfriendly regulations that discriminate immature products.

The main instruments adopted to 'bridge' the innovation and procurement systems were innovation and IOGP catalogues, complemented by a set of interdepartmental coordination, procurement management (including budgeting, evaluation, contracting and procedural regulations that were amended to favour innovation) and awareness-raising measures. Buying products listed in the IOGP catalogues was meant to be an obligation for government procurers. The instruments seemed fairly coherent with the rationale. Nevertheless, a major flaw had been the very rigid criteria to accredit a product as ‘indigenous innovation’ (see Table 6.2). It can be argued that the rigidness and inflexibility of the catalogue accreditation approach were the main factor affecting the designed vertical coherence of Channel 1, as they could potentially exclude some promising yet underdeveloped solutions, and considerably prolong the communication and coordination process between demand and supply.

According to the criteria announced in 2006 and 2009, innovation catalogues aimed to contain products that had ‘reliable quality’ and ‘passed tests’ by various authorities, which might end up with only including ‘off the shelf’ products. Empirical evidence, i.e. the Water and E-classroom cases, suggested that the listed products were not always satisfactory for procurers and often needed modifications to suit customers’ demand. In particular, the 2009 accreditation notice seemed rather self-contradictory – it required that indigenous innovation products should all have entered ‘the stage of commercialization’ (see Table 6.2), while a new product in need of ‘first procurement’ might not be able to satisfy this criterion. Moreover, criteria announced in some regions (e.g. in Guangdong) posed additional requirements about business sizes, which could be too restrictive for innovative SMEs. Interviewee R1O_2 indicated that Beijing noticed this flaw and the local IOPP policies treated ‘first procurement’ products separately from ‘normal’ indigenous innovation products; lower criteria in terms of business sizes and commercialization were posed for very new products. Again, this can be considered as a form of ‘institutional experimentation (Section 8.2.6.2), or what R1O_2 titled ‘policy breakthrough’, which could potentially provide implications for institutional change in the wider context. Affected by external pressure, the Notice 2010 adopted very ambiguous criteria which were arguably inconsistent with either the goal or the rationale of promoting ‘indigenous innovation’. This policy change can be considered as an outcome of *horizontal lack of coherence* (Section 8.4.3) affecting the vertical coherence of this channel. The significant deviation of the instruments from the original goal made it impossible to carry on with policy implementation that is coherent with the design.

Besides the problematic criteria, Chapter 6 discussed that the long period required by accreditation work (especially the period significantly prolonged by Notice 2010) might not be responsive enough to capture innovation. In addition, the time required to produce *IOGP catalogues* might as well prolong the implementation process. As shown in Table 6.4, the publication of IOGP catalogues (if different from innovation catalogues) was at least six months later than the publication of innovation catalogues; for Tianjin, the delay was as long as two years. The cases suggest that regional policy implementation appeared more flexible and efficient than that at the national level in China, thus it is hard to tell how long the nationwide IOGP catalogue would require to get published. Moreover, 2-4 years of validity of indigenous innovation products seemed too long as well, which might even hinder the diffusion of newer technologies.

The designed implementation structure (as illustrated in Figure 6.2) was that regional S&T departments organize local accreditation and recommend qualified products to MOST; MOST then organizes nationwide accreditation and produces initial versions of catalogues, followed by MOST, NDRC and MOF jointly publishing official versions; MOF then produces IOGP catalogue which serves as reference for government procurers nationwide. Such a multilevel, multi-sector implementation structure poses a very high requirement for coordination both vertically between levels of government, and horizontally between the innovation and the procurement systems. Although 'dynamic management' was emphasized several times in the policy documents, efficiency might hardly be realized considering the vast range of stakeholders involved and the high capabilities required. Not only would the publishing of catalogues be challenging, the use and coordination of various versions would be demanding as well. The fact that some government procurers 'welcomed' the policy termination (Section 6.3.4) indicated the complexity of its implementation. As implied by interviewees and the IOPP cases, alignment of interests, especially that between S&T and finance departments and that between central and local governments, would be another obstacle to hinder implementation even if the national IOGP catalogues were produced. In a nutshell, although the designed implementation structure seemed coherent with the rationale and instruments, 'implementability' would probably be a problem as the '*adequate resources for implementation*' and '*technical requirements of policy*' were not likely to be fulfilled (O'Toole, 1986, p.194).

8.3.2.2 Vertical coherence – the actual

The actual vertical coherence of Channel 1, as indicated by preceding sections and chapters, was apparently *not* realized since the implementation process was obstructed at a very early stage when the accreditation work was just initiated. The implementation type at the national level turned into a 'political' one (Matland, 1995) during 2009 –

July 2011, featuring a low level of 'policy ambiguity' and a high level of 'policy conflict' between the goal of promoting domestic innovation and the goal of complying with international 'rules of games'. 'Power' played the most important factor in determining the outcomes of 'political' implementation (ibid.), which turned out to be the termination of policies.

At the regional level, as illustrated in Figure 6.3, most regions responded actively to the national policies. Some regions issued IOGP policies, a few of which (mostly innovative and 'rich' ones) published local catalogues; eventually only a very limited number of regions put the approach into practice and carried on until end 2011. Some regions engaged broader range of government departments than the original design at the national level e.g. the involvement of specialized departments (such as construction authorities) and IPR and quality authorities in Beijing and Guangdong, which could potentially enable the building of common vision and wider public awareness. During the course of implementing the formal IOGP policies, coordination between S&T and finance departments was reported by some regional interviewees as being difficult (e.g. R2O_1, R4F and R5F); the alignment of priorities of different stakeholders proved to be challenging. It was observed that the accomplished implementation processes (i.e. Water and E-classroom cases, and some examples reviewed in Section 6.3.3.3) did not follow exactly what the formal policies defined; rather they featured the strong influence of informal elements (Section 8.2), including mitigation effects of informal institutions and leadership taken by other stakeholders than procurers. In this sense, the accomplished cases featured high ambiguity and low conflict, i.e. the implementation type turned into an 'experimental' one, whereby '*contextual conditions dominate the process*' and '*outcomes will depend largely on which actors are active and most involved*' (Matland, 1995, p.165).

The catalogue approach was meant to be a centralized one, which was expected to prevent regional protectionism (NO_1). During early 2006 – end 2011, the lack of centralized, national catalogues led to a high level of regional autonomy. Regional actions on the one hand appeared to be compliant with national initiatives, while on the other featured a strong intention of protectionism. IOGP trajectories diverged across different regions depending on their incentives backed by local conditions of supply and demand. Interviewee NO_2 pointed out that

> *'...barriers for technology diffusion would emerge if the regions carried on while the central government did not –* ***a supplier might need to apply for various local accreditations if it wants to enter markets nationwide****...'*

Entry and transaction costs for suppliers might become even higher if regional implementation was not suspended, and the result would not be beneficial for the country as a whole. Regional protectionism was likely to become a major obstacle hindering the vertical coherence, as implied by the experience of Channel 3.

Despite the winding and interrupted implementation process, some outcomes moderately coherent with the initial goal were achieved. The first type of outcomes has been a number of examples as reviewed in Section 6.3.3.3, which, although to an extent realized the objectives of promoting innovation (Section 8.2.4), just like what R5O_1 described, were 'dots' rather than 'layers'. Beijing, and perhaps also the city of Wuhan, realized 'layers' (i.e. routinized batches of procurements) through setting up coordination platforms, organizing promotion events, or even 'administrative pressure' (R1S_OW). Guangdong as the leading region in terms of economy advancement in China also realized 'layers' owing to its systematic institutional settings and advantages in terms of both supply and demand. The second type of outcomes, the signs of which perhaps seem rather weak though, has been the raised stakeholder awareness and, moderately, 'behavioural additionality' (Section 2.3.4) of certain groups of practitioners. The main target group, i.e. government procurers, did not play active roles although they were supposed to, but cases suggested that suppliers and local governments were greatly motivated, especially in Beijing and Guangdong where the local IOPP mechanisms were routinized. Nevertheless, the 'persistence' of the additionality (Gok and Edler, 2012) might be rather vulnerable to negative impacts as the policy termination especially the 'deep clean-up' notice (Section 6.3.4) sent strong signals to stakeholders to cut off the link between innovation and procurement.

8.3.3 Channel 2: MTE commercialization

8.3.3.1 Vertical coherence – the designed

The goal of Channel 2 was to stimulate the development and adoption of domestically made equipment that is much needed for the country's overall development (Section 6.4.1). In particular, the commercialization of 'first (set of) MTE' was highlighted. The rationale of this channel was consequently to facilitate the commercialization through incentivizing stakeholders, in particular enterprise procurers/users (primarily from the public sector), to interact with suppliers, and to play the role of 'early adopters' (Rogers, 2003) of indigenous innovation equipment. Equipment procurements associated with this channel can be considered as being 'strategic' i.e. highly encouraged by the government as '*a rule associated with sectoral policy*' (Edler and Georghiou, 2007, p.953). Meanwhile, the pre-commercial nature of this channel means that it also possesses the rationale of PCP, which is justified as being 'systemic' (Edler, 2013) as it is likely to integrate both demand-side and supply-side measures in order to match the two sides.

Instruments adopted included individual ones such as various catalogues. Section 6.4.2 reviewed the designed linkage between equipment and innovation catalogues, which aimed to feed the innovation outcomes stimulated by equipment catalogues to innovation catalogues so that government procurers can purchase them. Additional agencies, i.e. MIIT and (indirectly) SASAC, were involved, and the implementation structure appeared to be even more complex than the one illustrated by Figure 6.2. The rationale of this linkage per se was coherent with the goal and overall rationale of Channel 2. Nevertheless, the termination of Channel 1 made it impossible to evaluate the *actual* vertical coherence of this linkage. The *designed* coherence appeared to be rather problematic, given that procurers supervised by MOF (and correspondingly the LGP) are not likely to have the authority to procure 'MTE', the end users of which are SOEs rather than government-funded organizations.

A broader variety of *signalling* and *accrediting* catalogues was summarized in Table 6.6. Signalling catalogues/policies can be understood as a means to communicating the demand to the supply side (i.e. 'distributed IOPP', Section 4.3) and contributing to the system function of 'guidance of the search' (Hekkert et al., 2007), while accrediting catalogues communicate the supply to the demand side and contribute to the function of 'market formation' (ibid.). USCBC (2011d) pointed out the potential rigidness of the catalogue approach which might hinder innovation (Section 6.4.2). Nonetheless, for China being a catching-up country with limited resources, clear targeting at technological frontiers is considered necessary (Section 2.4); the key is to keep the target 'moving' (Nelson, 2004), and to avoid setting too rigid specifications – ideally in 'performance' rather than 'technological' terms to leave room for alternative designs (as argued by the IOPP literature reviewed in Chapter 4). Content analysis of equipment catalogues indicated that the annual updating by the central government is keeping the target 'moving'. Specifications outlined by the catalogues appeared to be mixtures of performance and technological ones; whether they are too rigid or not is yet to be investigated.

'Systemic' instruments centred on experiments and demonstration projects (Section 6.4.1) were also adopted for this channel. These projects can be considered as PCP and 'ordering procurement' (requiring additional R&D to deliver the contract), or 'first procurement' (entering the market for the first time without additional R&D), complemented with various measures such as user subsidies, tax reduction, certificates and praises, and risk compensation methods. In terms of implementation structure, the initiatives are expected to be taken by equipment users or suppliers; when intents of cooperation are agreed they can apply for the status of experiments or demonstration projects to gain policy support from ministries. The instruments and implementation structure appeared coherent with the rationale of incentivising equipment users.

Following the initiative, regions with strong equipment manufacturing capabilities carried on to support *locally* developed equipment with diversified policy instruments (Section 6.4.3). This study only looked at Shanghai's FEBP programme (Section 7.4), which was largely coherent with the central design of 'experiments and demonstration projects'. Instruments adopted by Shanghai included the above mentioned measures as well as supply-side measures such as R&D support. Application procedures were similar to that of national policies. The coordinating authority, however, was decided to be SHEITC after rounds of mediations by the municipal government as the departmental responsibility regarding equipment development was not clear. In general, the overall flow from goal to designed implementation structure appeared to be coherent.

8.3.3.2 Vertical coherence – the actual

At the national level, little data regarding the *actual* implementation processes is available; one of the reasons might be that the designed implementation structure is inherently a distributed one, replying on bottom-up initiatives taken by micro-level practitioners. There is a possibility of conflicts between regional goals with national ones, i.e. the risk of regional protectionism overwhelmingly favouring local suppliers. Nevertheless, the procurers are after all mainly SOEs who are not incentivised to favour local firms. Moreover, the entry threshold of the sector is high, and most regions did not announce measures that were active in protecting local industries as they had done in the LED programme. The Tunnel supplier encountered difficulties in selling products to other regions primarily owing to buyers' preference to imported, branded products, or other regional governments' demanding requirement for the firm to localize. In the context of Shanghai, intents of demand-supply cooperation in both Tunnel and LED Control cases were achieved through informal pathways before the official support measures were delivered. Being proactive and well-connected appeared to be a prerequisite for suppliers to gain support from potential users. Although the LED Control case can be considered as being situated at both Channel 2 and Channel 3, neither policy played a key role in stimulating IOPP. User subsidies were issued afterwards, which was coherent with the designed approach. The process cohered with what Matland (1995) titled 'administrative implementation', featuring 'low policy ambiguity' and 'low policy conflict' (p.160).

Shanghai's outcomes of this channel included, firstly, numerous FEBP projects that have been reported regularly by SHEITC, which facilitated local equipment suppliers in achieving first contracts for their newly developed products. Secondly, as indicated by interviewee R2O_2, stakeholders' awareness of this approach was enhanced, and behavioural additionality of SHEITC officials was achieved as the channel was routinized. Nationwide, an annual event supervised by MIIT, China Industrial Forum, reviews the outcomes of experiments and demonstration projects by calling for user/supplier applications for 'meritorious users' awards (the users in the Tunnel case were among the first batch of the award winners, Section 7.4.5). The Forum 2013 (see China Industrial Forum, 2013) reported that the award-winning users and corresponding suppliers in previous years obtained '*high-level attention from related ministries and policymakers, and received strong repercussions and various support from the society*'. It also reported that the barriers and problems encountered by the 'meritorious users' during the course of using domestic equipment provided references for policymakers to evaluate and improve the policies.

This policy channel in general realized vertical coherence. A major challenge identified was still to deal with users' risk aversion. In the cases, the incentives appeared to be too weak to effectively motivate procurers; *ex-post* subsidies valued 10% of the equipment price, which, as R2S_LED described, were 'ignorable', although the effects of enhancing 'reputation' proved to be very positive for the supplier. The same situation happened to other regions' implementation processes[40]. These problems cohere with the ones associated with 'administrative implementation' (Matland, 1995), which are primarily 'resource', 'capacity' and 'technical' ones (pp.160-163). These problems can be regarded as opportunities for further public interventions, e.g. strengthening the role of intermediaries to better manage the demand-supply interface.

8.3.4 Channel 3: procurement elements in NEV and LED lighting programmes

8.3.4.1 Vertical coherence – the designed

The goal of Channel 3 was to promote the uptake of emerging technologies which, if fully dependent on private demand, would face very high entry and diffusion barriers. The technologies investigated in this study are NEV and LED lighting technologies (Sections 7.6 and 7.7). The basic rationale of both programmes was to nurture 'lead markets' in selected cities through stimulating public as well as private demand, and improving framework conditions (e.g. standards and supply chains, and for the NEV programme, charging infrastructures and industrial regulations) for the diffusion of new technologies. Procurement elements of this channel have a feature of '*strategic procurement*' in the sense that demand is highly encouraged in selected sectors, as well as '*state procurement in connection with private users*' in the sense that both programmes aimed to 'catalyze' private consumption through demonstrating the use of new technologies in the public sector first (Edler and Georghiou, 2007). The rationale was coherent with the goal.

The two programmes adopted somehow different instruments and implementation structures. For the NEV programme, national-level instruments included procurer subsidies (complemented with additional subsidies provided by provincial and city governments), regulations regarding market entry, safety and infrastructure construction and catalogues of approved NEV models to guide procurers. A unified, cross-ministry coordinating mechanism was established and the overall implementation structure was defined from the beginning (Figure 7.6). Local agencies were expected to procure NEVs, catalyze private consumers, explore standards and operating modes, and in general contribute to the building of innovation-friendly markets. The design, although

[40] See BJX (2013) and Zhejiang Daily (2013); both news articles reported the difficulties of equipment manufacturers in entering into the market; in the described examples, contracts were gained after long and winding supplier-user negotiations; suppliers, similar to the supplier in the Tunnel case, had to bear the risks and demonstrate the use of equipment for free.

ambiguous compared to that of the other two channels, seemed coherent with the goal and rationale.

The implementation structure of the LED programme, however, was rather ambiguous and inconsistent primarily owing to the lack of a unified cross-ministry coordinating mechanism until recently. The main instrument adopted by MOST was *ex-post* subsidies for participants according to their achievements (Section 7.7.2). The tasks for local agencies were similar to that in the NEV programme, which seemed coherent with the MOST initiatives; nevertheless, the absence of a clearly-defined implementation structure or industrial regulations led to diverse implementation processes across different regions.

8.3.4.2 Vertical coherence – the actual

The actual implementation processes, as illustrated by the case studies, differed greatly from region to region as a result of the high autonomy authorized by ministries. They can be considered as 'experimental implementation' featuring 'high policy ambiguity and low policy conflict' whereby '…*the opportunities are excellent for bureaucratic entrepreneurs to create policies to deal with local needs*' (Matland, 1995, p.166). Indeed, the cases suggested that local governments actively exercised policy entrepreneurship to drive the implementation towards their target, i.e. developing local industries. This autonomy effectively motivated cities to set ambitious, quantitative targets to, on the one hand, over-fulfil the tasks issued from the central government, and on the other, to nurture and strengthen local supply chains while preventing the entry of products from other regions into local public procurement markets. Regional protectionism and the resulted duplicate production proved to be the main factor hindering the vertical coherence and overall quality of both programmes. The implementation processes of the NEV programme were better regulated and controlled by the central government than that of the LED lighting programme, primarily owing to the unified governance structure, considerable amounts of subsidies, presence of regulations, and the high threshold to enter into the industry (Sections 8.2.2.3 and 8.2.6.1). The LED programme, however, encountered a rather chaotic situation as indicated by interviewees:

> *'The programme unfolded way too fast. All of a sudden there were 21 cities participating. At the provincial level we have a 'one thousand kilometers, one hundred thousand of LED lights' programme… the programme has been amplified from level to level. Initially the temperature of*

the industry was a bit low, like 36 degree; MOST wanted to warm it up, through the central level effort it became 37 degree; through the provincial level, the industry was warmed to 38 degree; through the city level it was 39… and finally ***the industry is having a fever****.* ***The implemented policy is no longer the designed policy****; it is very likely that the firms take the policy signal in a wrong way. I think* ***once a policy is positive, the whole implementation process should stick to the plan****. Don't try more and more ambitious targets. The* ***evaluation approach is problematic as well*** *– some participants were criticized because they only finished 90% of their targets, while some participants were praised because they finished 120%; hence the cities are motivated to buy as many lights as possible...' (R3O_LED)*

*'…****100 fragmented demonstration projects are not as good as 10 large projects, and 10 large projects are not as good as 1 large, successful project****… Many firms are impetuous and haven't really concentrated on R&D. Sometimes they just form a company to gain funding and contracts.' (R2S_LED)*

'Still I think ***demonstration programme is a good approach to ease the concerns of private consumers, but the quality of programme should be kept high****. Once a good case is identified, the government should encourage and advertise the good practice. More effort should be spent on this and shouldn't be superficial.' (NA_LED)*

Outcomes generated by the two programmes included, firstly, numerous procurements carried out by local governments that to an extent facilitated the development and diffusion of (local) products (see Chapter 7). Nevertheless, some procurement might have turned into 'regular' ones rather than IOPP, especially in the LED lighting programme where local governments had too much autonomy in buying large amounts of local products in the absence of national-level standards. Moreover, several interviewees in the NEV and LED cases implied that even when local governments were 'buyers', it might be the suppliers who paid the money first. This echoes the recent international concerns over the extremely high debts of China's local governments which 'might be the next 'subprime'' (Magnus, 2013).

Other outcomes included moderate development of standards and infrastructure in the two sectors, although the picture still looks rather fragmented and the achievement remains unclear. Public awareness of the two technologies was greatly enhanced. Catalytic effects on private users, however, remained limited, especially for the NEV programme (Section 8.2.4.4).

Both programmes had reached their designed deadline by the end of 2012 without fulfilling the planned targets. Besides the above mentioned 'intended' outcomes, there were some 'unintended' consequences emerged e.g. the 'high fever', duplicate investment and market fragmentation as a result of local governments' eagerness and autonomy to push growth. It seems, just like interviewees NO_NEV and NA_LED admitted, that a major outcome of the programmes was the identification of various technological and institutional problems. This coincides with what Matland (1995) argued, that for 'experimental implementation', '*more important than a successful outcome is one that produces learning*' (p.167). The LED lighting programme has been 'updated' in 2013 with a unified governance structure and adjusted policy design (Section 7.7.2.2). The NEV programme is about to be continued with the support of adjusted policies as well, which, quoting the Minister of MIIT

> *'…will not differentiate support according to technological routes, but based on the oil-saving rate which will be classified into 16 tiers' (Xinhuanet[41], 2013).*

The effects of 'learning' produced by the implementation process during the past three years remain to be seen.

8.4 Cross-domain analysis: horizontal coherence

As a policy phenomenon situated at the 'intersection' of innovation and procurement systems, IOPP practices need to realize, besides the vertical coherence crossing multiple levels, horizontal coherence with circumstances of contextual domains (see Table 5.1). This means the design and implementation of the three IOPP policy channels, as reviewed in previous chapters and sections, should be coherent with the domestic innovation and procurement systems (Sections 2.5 and 3.4), as well as with their contexts, i.e. the international circumstances (Sections 2.4 and 3.3). On the basis of the characterization of IOPP policies outlined in Table 8.2, the coherence of each dimension is checked with that of the overall innovation and procurement policies/regulations as reviewed in Chapters 2 and 3; the dynamics of actors, institutions and interactions during the course of IOPP cycles are also reflected on, to identify major tensions resulted from lack of coherence with contextual issues. The case studies suggest that there have been other types of policies that interplayed with and enhanced the functioning of IOPP policies. A high degree of horizontal coherence or complementarity between IOPP policies and those policies has been observed. This finding is briefly discussed in Section 8.4.1, followed by two sections discussing the signs of lack of horizontal coherence with the domestic and the international contexts respectively.

[41] Xinhuanet is an official news agency supervised by the State Council.

8.4.1 Interplay and complementarity between IOPP policies and other policies

Despite the fact that this study is focused on IOPP policies only, it is worth noting that a high degree of interplay between other types of policies and IOPP policies has been observed in all of the cases. IOPP policies seem to have rarely been implemented in isolation from other policy instruments. In most of the cases, other types of policies served as complementary forces in shaping the functioning of IOPP policies. The interplay between those policies can be broadly categorized into three types according to what the other policies are, i.e. IOPP policies interplaying with other types of DSIP, IOPP policies interplaying with supply-side innovation policies, and IOPP policies interplaying with sectoral policies which are not primarily innovation-oriented.

Other types of DSIP interplaying with IOPP policies in the cases included regulations, standards, user subsidies and user praises/awards. In the Tunnel and the Shanghai LED Control cases, user subsidies to an extent incentivized the user companies to purchase newly developed machines/solutions; user awards confirmed the contributions by the lead users and enhanced public awareness of the innovative products as well as of IOPP policy channel 2. In the Shenzhen NEV case, various types of DSIP instruments were employed to create a lead market in the locality; industrial regulations and standards provided the prerequisites for articulating the needs of large amounts of NEVs and constructing public infrastructures compatible with the vehicles; the catalysing impacts of IOPP policies were enhanced as Shenzhen citizens were meanwhile incentivized by the private user subsidies from both the central and the local governments. The combination of IOPP policies with other DSIP measures has been recognized by Edler (2013) as a type of ‘systemic approach’ featuring ‘integrated demand measures’. In the context of the above mentioned cases, other DSIP measures and IOPP policies were in a mutually-reinforcing relationship. The successful implementation of IOPP policies in turn enhanced the functioning of other policies and the establishment of technological standards.

Supply-side innovation policies interplaying with IOPP policies included R&D support such as 863 programmes, and networking measures including science parks, industrial alliances, technology exhibits and contract-signing conferences. In the Water, E-classroom and Tunnel cases, the suppliers had benefitted from various types of R&D support from the central and/or local governments before the implementation of IOPP policies. They had managed to produce R&D outcomes and made the government aware of their achievements as well as commercialization difficulties. The use of IOPP policies then followed the use of R&D measures, to carry on supporting the development of those strategically important technologies. In this context, IOPP policies to provide the ‘demand pull’ complemented the ‘supply push’ provided by R&D support. The use of networking measures reinforced the functioning of IOPP policies as well. As elaborated in the Water case, Beijing’s different policy channels to implement IOPP were all centred on the science park, i.e. the Zhongguancun national innovation zone. IOPP policies were only one of the many types of policy instruments that influence simultaneously on tenant firms’ innovation performance. This type of combination of demand- and supply-side measures has been coined by Edler (2013) as another type of systemic approaches. Supported with intermediation tools including alliances, technology exhibits and contract-signing conferences, the implementation of IOPP policies had overcome some typical obstacles such as risk aversion and stakeholder interaction deficiency.

A third type of policies identified interplaying with IOPP policies has been sectoral policies which are not primarily innovation-oriented. For example, in the E-classroom case, the provincial-level policies promoting ‘education modernization’ provided a major driving force leading to the demand of new solutions; a similar role in the NEV and LED cases was played by China’s environment policies especially the carbon-reduction objectives. This type of sectoral policies can provide the prerequisites required by IOPP policies by contributing to the creation of demand, as well as better articulation of technological specifications. The combination of those policies with IOPP policies is inherently another type of ‘system approach’ in addition to the two types coined by Edler (2013).

8.4.2 Lack of coherence with the domestic context

8.4.2.1 Lack of coherence with the innovation system

Being innovation policies by nature, all of the three IOPP channels were largely coherent with other innovation policies under the umbrella of the ‘indigenous innovation’ strategy in terms of goals, rationales and instruments. A major inconsistency identified lies in the incompatibility between the designed implementation structures of IOPP policies with the existing, fragmented institutional setup of policy governance in the innovation system (Section 2.5.3).

For IOPP policy Channel 1, although inter-departmental and inter-policy coordination was taken into account during the policy design stage (Section 6.3.1), the implementation process suggested that in reality, coordination needed to be strengthened through additional, informal measures (Section 8.2.6). Interviewee R2O_1 complained that even though they could finish the accreditation work, they had no power to push the implementation further, given that the procurement agency, i.e. finance department, did not see innovation as a priority of their job. This viewpoint was echoed by interviewees from S&T departments of two other regions, who in general had no knowledge about downstream effects of the innovation catalogues. For Channel 2, the *Administrative Measures on First (set of) Major Technology Equipment Experiments and Demonstration Projects* (Section 6.4.1) adopted somehow ambiguous wording 'authorities in charge' to address division-of-labour issues. This sent unclear signals regarding institutional setup to regions. In Shanghai the lower-level department of MIIT 'fought' with S&T and finance departments and became the coordinator of the local FEBP programme. Other regions mostly centred the coordination of Channel 2 on lower-level departments of MIIT as well, while in Beijing the coordinator was fixed as the local DRC supervised by the NDRC to align all governmental departments. For the LED case of Channel 3, it was surprising to see that MOST and other ministries worked separately instead of in collaboration during the three years of implementation. According to NO_2, MOST firstly got the idea to conduct this programme, and they published the policy to their lower levels of departments and local governments. Nevertheless, afterwards they found that with the solo power of S&T departments it was impossible to implement the programme, given that traditionally public lights are regulated by other departments such as municipal construction authorities; concrete administration structures vary from city to city.

For all three channels, interdepartmental coordination (between S&T and other departments, as well as between innovation-related departments with overlapping responsibilities) proved to be a problem. The designed implementation structures (if clearly defined, as sometimes they were not) were to an extent incompatible with the existing institutional setup of China's innovation system. The existing institutional setup seems to still have followed a linear understanding of innovation, with MOST in charge of earlier stages of S&T development (narrow-sense innovation policies), leaving industrial and horizontal coordination issues to the MIIT and NDRC (Section 2.5.3). The fragmentation of innovation policy governance created ambiguity and barriers for the implementation of the three channels. At the lower levels as demonstrated by the cases (Section 8.2), the lack of coherence between IOPP policies and the existing institutional setup were mitigated through stakeholder interactions. Nevertheless, informal mediations and compensations might not be enough if China is to ‘systematically’ utilize ‘systemic’ instruments. The division of labour among ministries and levels of government, or even the formal institutional setup of the innovation system might need to be re-structured to suit the need of ‘systemic innovation’. This finding reconfirmed the argument made by OECD (2008) that China needs

> *‘a change from an uncoordinated, piecemeal style of STI policy making to a coordinated whole-of-government policy approach’ (p.46).*

As mentioned in Section 2.5, although ministries are all situated at the national level, their controlling power over lower levels of government and bargaining power with other ministries vary significantly. In general, horizontal (cross-sector) policy issuers are more powerful than vertical (focused on one sector only) policy issuers. Innovation policies nowadays are both horizontal and vertical. Considering the breadth of China’s innovation policy portfolio following the MLP, the authority of MOST as a leading agency in innovation policy making and implementation appears to be too limited. For instance, MOST offered *ex-post* rather than direct subsidies for local governments in the LED lighting programme as it did not have specialized funding for this type of demonstration programmes (Section 7.7.2). The experience of the three channels implied that MOST and its lower-level agencies did not play key roles in governing the processes of IOPP policies. This echoes what Liu et al. (2011) observed, that

> *‘…MOST’s exercise of power is largely* ***narrow*** *and* ***vertical*** *in nature; it can assert power over the various STI organizations at the local level, but* ***cannot exert a great deal of influence horizontally across the ministerial boundaries at the national or even local levels****’ (p.924).*

The making and implementation of *systemic* innovation policies require a more powerful agency to formally realize the integration of both vertical and horizontal authorities, such as the METI (formerly MITI) in Japan (Johnson, 1982). In China, the MIIT which was

> *'...positioned to become a super-ministry similar to Japan's MITI... has been conspicuously low profile and missing in the formulation of even sector-related innovation policies' (Liu et al., 2011, p.929).*

Although NDRC is performing as a 'Ministry of Ministries' (Section 2.5.3), its functions appear to be too broad (Vo ťa, 2008) and its role in relation to innovation policy is not clearly articulated based on the observation by this study. Institutional reforms, especially restructuring fragmented authorities into fewer and stronger 'super-ministries', have been an ongoing topic of research and practice in China throughout the years in order to realize better coordination and higher efficiency (Yeo, 2009; Shi, 2012). Nevertheless, stubborn obstacles remain, primarily owing to the existing interest structures associated with the current institutional setup (ibid.).

8.4.2.2 Lack of coherence with the procurement system

More horizontal inconsistencies were encountered by IOPP policies in the context of the procurement system, primarily owing to divergent goals and the institutional fragmentation (Sections 8.2.5.3 and 8.2.6.1). Goal conflicts between innovation and procurement practitioners arose from both the 'innovation' and the 'indigenous' requirements, the former being a common challenge for IOPP practices worldwide as a result of risk aversion against something new (Section 4.5) while the latter perhaps being a specificity for China as a result of risk aversion against 'something domestic' (Section 6.2.2.3).

Inconsistency with the procurement system in terms of *instruments* was encountered by Channel 1. The innovation catalogue approach, although designed with a systematic intention, seemed to be too 'one-size-fits-all' and inconsistent with China's fragmented procurement system. It sought to cover the procurement of all innovations in one system, while overlooked the reality that the public demand of innovations in China is distributed across sectors and levels (Section 3.4). Hindered by these operational barriers and probably goal conflicts, coordination difficulties between S&T and finance departments now seem to be inevitable. It is worth noting that Channels 2 and 3 realized relatively better horizontal coherence with China's fragmented procurement system, as they were both targeted at specific sectors (i.e. equipment manufacturing and emerging technologies) and specific levels (i.e. organizational and city levels). The interactions between innovation and procurement systems in these two channels are by nature interactions between *sectoral/regional* innovation systems and *sectoral/regional* procurement systems, which well suited the fragmented institutions in the Chinese context. This complementary relationship between sectoral policies and IOPP policy instruments in a sense highlighted again the importance of 'sectoral characteristics' as to IOPP (Section 4.5).

Horizontal lack of coherence with both innovation and procurement systems can be partly attributed to the fragmentation of institutional setups of both systems. 'Self-coherence' of China's innovation and procurement institutional setups were not realized yet. Implementation of IOPP policies was frequently associated with institutional failures (Sections 8.2.5 and 8.2.6), leading to some of the 'mismatches' between designed and actual implementation processes.

8.4.3 Lack of coherence with the international context

As reviewed in Sections 2.4 and 3.3, both innovation policies and public procurement are frequently intertwined with international issues regarding trade and competition in this increasingly globalized world. IOPP policies as mixes of innovation and procurement related interventions naturally are affected by international circumstances as well. The trajectory and termination of Channel 1, a once explicit and ambitious IOPP policy in China (Section 6.3), served as vivid evidence demonstrating the international impacts upon domestic 'policy space' (Section 3.3.3). This study found that the lack of coherence lies largely in three aspects, i.e. China's conspicuous national protectionism associated with both innovation and procurement policies, IPR disputes with developed countries owing to China's intention to catch up through 'imitation' (Section 2.4), and incompatibility between the Chinese procurement system and international norms. These three issues are in essence interlinked, reflecting the tensions between domestic development goals and interests of international trade stakeholders during the course of catching-up, in particular for China, whose companies '*began to encroach on to world markets*' (Nelson, 2004, p.369).

8.4.3.1 The emphasis on 'indigenousness' of innovation

A fundamental feature of China's recent innovation strategy has been its high-profile, explicit emphasis on 'indigenousness'. Review on policy measures in Section 2.5 and Chapter 6 suggested that both the overall, top-level mandate and lower-level policies measures claimed strong preferences for a Chinese 'nationality' of products. Import control and 'buy Chinese' were as important requirements as 'innovativeness' in China's IOPP scheme. The government's dissatisfaction with imported products regarding their high prices (as shown in the Water, Tunnel and Wind cases) and concerns over low added value as well as 'national security' (as shown in the E-classroom case) formed potent stimulus in China's innovation activities.

For IOPP Channel 1, a major controversy hindering horizontal coherence with the international context was – same as the factor hindering Channel 1's vertical coherence – the criteria for accrediting indigenous innovation products. Initial criteria announced in 2006 posed requirements such as 'ownership of indigenous IPRs' and 'substitute the import'; the 2009 criteria further tightened the requirement for 'indigenousness', demanding that '*the use, disposal and secondary development by the applicant is not restricted by others from abroad*' and that '*the initial registration place of the trademark is within the border of China, without restrictions from any foreign brands*' (see Table 6.2). Channel 2 had been very explicitly protectionist as well. The definition of 'first (set of) MTE' required exactly that it should feature 'indigenously developed core IPRs' and 'indigenous trademarks' (Section 6.4.1). Consequently 'experiments' and 'demonstration projects' are applicable to domestic products only. The initial versions of equipment catalogues frequently referred to 'import substitution' as a target for product development, which, in response to foreign concerns, was removed from later versions (Section 6.4.2). Sections 6.3.4 and 6.4.2 reviewed the actions taken by foreign countries (notably the US) against China's protectionism. The 'achievements' following these actions were firstly, termination of Channel 1, and secondly, elimination of discriminative requirements from China's IOPP policies in general; these achievements have been developed by USCBC (2012) into a 'case study' demonstrating how a 'dialogue' approach can help the US 'resolve issues with China'.

Technically speaking, since China has not joined the GPA, 'non-discrimination' as a 'rule of games' for IOPP in China is more an *informal* than a *formal* institution. This means that China would not be officially sanctioned according to GPA treaties. Nevertheless, it did offend *unwritten rules* (notably interest structures) associated with the international trade networks and was forced to make compromises to converge with 'international best practices' (USCBC, 2010a).

Channel 3, in contrast to the experience of the other channels, appeared to be fairly coherent with international formal and informal institutions. It can be argued that the main reason is that this channel targets at the uptake of emerging technologies for which there have not been imported, dominant designs to substitute and 'China is not a laggard' (NO_NEV). In other words, the goal and rationale of Channel 3 determine that China stands closer to global-level technological frontiers, and the challenge faced by both China and developed countries in those sectors is not dramatically different. Indeed, early involvement in emerging sectors has become one of the approaches by Chinese policymakers to accelerating catching-up. Quoting NO_NEV,

> *'...it is fair to say that we have been actively participating in global-level competition, working together with developed countries to* ***make the rules of games****'.*

This echoes what Nelson (2004) argued,

> *'...in the new regime of stronger protection of intellectual property, it is going to be increasingly important that countries trying to catch up develop their capabilities to revise and tailor manufacturing capabilities relatively* ***early in the game****' (p.371).*

Perspectives regarding catching-up through innovation, as reviewed in Section 2.4, suggest that the currently developed countries frequently adopted protectionist approaches during their catching-up stages (for a comprehensive review see Chang, 2002). Even nowadays, developed countries have been actively and flexibly exercising 'selective' or 'conditional' protectionism (Chorev, 2007; Stiglitz, 2009). Despite its concerns and criticisms over China's protectionism, interestingly, the US was titled '*the mother country and bastion of modern protectionism*' (Bairoch, 1993, p.30), and it continues emphasizing the 'nationality' of innovation (White House, 2011). Although USCBC portrayed China as the first and the only country adopting discriminative procurement, the US announced protectionist procurement measures in 2009 *before* China did so, primarily through reinforcing its *Buy American Act* (Section 3.3.1). Alongside this has been a 'resurgent' trend of 'global protectionism'[42] owing to the severe economic recession (Stiglitz, 2009; Liu and Cheng, 2011; Enderwick, 2011). Larch and Lechthaler (2011) explicitly criticized the US government's 'buy American' and the Chinese government's 'buy Chinese' schemes as 'beggar-thy-neighbour policies' which simply 'do not work' (p.838). Policymakers, however, still appear to 'like'

[42] Also on the rise has been 'reciprocal' trade protectionism between EU and China, see Jungbluth and Hauschild (2012).

protectionist approaches (ibid.), even though protectionism could be a double-edged sword, as demonstrated by Larch and Lechthaler (2011), as well as in several chapters in Cimoli et al. (2009a). This phenomenon echoes what Nelson (2004) observed, that as indigenous industries become stronger and try to get access to world markets, conflicts between the follower and the leader countries are likely to emerge, which brings further challenges to catching-up.

8.4.3.2 'Imitation to innovation' and IPR disputes

Another inconsistency with the international context, closely related to import substitution, has been China's explicit adoption of 'importing-digesting-absorbing-reinnovating' (Section 2.5) as one of its innovation approaches which easily leads to IPR disputes with leading countries. In essence this 'reinnovating' approach is the same as the 'imitation to innovation' pathway followed by some developed countries during their catching-up stages (Section 2.4). China intended to develop indigenous IPRs through 'creative imitation', and this intention was articulated into concrete policy measures including public procurement. As mentioned in Section 6.2.2.3, the 'buy Chinese' policy considers 'supporting indigenous innovation' as one principle and stipulated that procurement priority should be given to foreign companies offering IPR transfers. Policy Channel 2 emphasizes the 'digesting' of imported technologies. Alongside procurement of first (set of) MTE, taxation policies were flexibly adopted and adjusted to suit the need of developing indigenous equipment, e.g. to control import of unneeded equipment and to support the import of needed equipment or components (as in the Tunnel case).

Despite that the supplier interviewees all claimed firmly their ownership of indigenous IPRs for core technologies, secondary data sources suggested that Chinese suppliers still frequently need to collaborate with core technology suppliers, e.g. chips technologies in the LED programme. The currently unresolved IPR dispute between Sinovel (the wind turbine supplier) and AMSC was triggered by the failure to reach an agreement on responsibility between the two partners in response to the suddenly heightened national standard regarding turbine performance (Section 7.5). Ironically, one of the reasons why the procurer failed to find an international supplier in the first round of open tendering was suppliers' concern over potential IPR infringement by Chinese firms (WIND_P).

For IOPP Channel 3, tensions are increasingly being observed for emerging technologies especially the LED sector

> *'…IPR issues are currently the bottleneck of developing our LED lighting industry… Risks of trade frictions are higher and higher… Since 2008, more than thirty Chinese LED lighting firms suffered from four times of '337 investigation'*[43] *by the American government… Results were settlement with or compensation for the plaintiff, or the worst case, quitting from the American market…' (Yu and Zhang, 2013)*

China's weak regulations on IPR protection and active 'infringement' of foreign IPRs have been drawing international criticisms, again, primarily from the US (Athanasakou, 2007; USITC, 2010). Literature on catching-up has warned that catching-up through imitation inevitably suffers from IPR disputes; '*the arena of intellectual property is almost sure to become one of considerable international conflict in the immediate future*' (Nelson, 2004, p.369). Faced by this 'shrinking space' for catching-up through imitation (Wade, 2003), '*developing countries need to learn to be able to cope with this new problem*' (Nelson, 2004, p.369).

Although actively promoted by policymakers from developed countries, IPR protection is still subject to academic debates regarding its exact impacts on innovation, which still looks 'puzzling' (Lerner, 2009). For catching-up countries, too tight IPR protection would be '*slowing down the pace of technology adoption from the frontier*' (Manca, 2009, p.28), which certainly is the result demanded by policymakers in developed countries. For all countries in general, the positive side of IPR protection naturally is the effect of incentivizing innovators through 'expected benefit' (Gangopadhyay and Mondal, 2012), while the negative side is that IPR protection

> *'…may inhibit the free flow and diffusion of scientific knowledge and the ability of researchers to build cumulatively on prior discoveries' (ibid., p.82).*

IPR protection, similarly to the case of protectionism, is a double-edged sword.

8.4.3.3 Incompatibility between domestic and international procurement norms

Section 3.4 conducted a review on the Chinese public procurement system, detailing the distinctions between that and the shared norms among GPA signatories. Even without any discriminative preferences for domestic or innovative products, the Chinese *regular* procurement system itself is inconsistent with the international context. This has been

[43] Section 337 investigation by the United States International Trade Commission deals with IPR infringement issues.

increasingly considered as a barrier for China to integrate into the global economy (Chou, 2006b; Wang, 2013). Meanwhile in the domestic context, as argued in preceding chapters and sections, this inconsistency resulted in fragmentation which has been hindering the fulfilment of primary goals as well as the exploitation of secondary functions of public procurement.

Compared with the other two aspects leading to lack of coherence with the international context discussed above, this inconsistency lying in the regulatory system seems more 'formal' and pressing, and would become nonnegotiable owing to China's commitment to join the GPA (Section 3.4). Public procurers actively involved in China's IOPP processes, as elaborated in Chapter 7 and Section 8.2, included local governments and SOEs. The interest structures posed by these two groups of stakeholders, who 'figure prominently' in China's 'cosseted credit- and investment-centric growth model' (Magnus, 2013), are exactly the main barrier hindering reforms towards centralization and coherence with international institutions (Wang, 2009).

8.5 Institutions affecting IOPP activities – a classification

Section 8.2.6 reviewed the roles of formal/informal institutions within the boundary of China. Nevertheless, Section 8.4 suggested that international institutions also heavily influence China's IOPP policy trajectories. Based on institution-related perspectives reviewed in Chapters 2 and 4, this section classifies institutions affecting IOPP activities into four categories, divided according to two dimensions, i.e. formal/informal and domestic/international. The boundary of this classification can vary, e.g. for a region or sector, the 'domestic/international' dimension can be adapted to 'internal/external'. Institutions of each category interact with others and generate various impacts depending on the context. Table 8.3 maps the range of institutions affecting China's IOPP identified by this study.

Domestic, formal institutions can play dual roles by *enabling* or *constraining* IOPP, while domestic, informal institutions play multifold roles by *complementing*, *accommodating*, *substituting*, and *competing* with formal ones. International, formal institutions, as reviewed in Chapter 3, are likely to constrain the space for IOPP in a country. In the context of China, international institutions directly affecting IOPP have been informal and constraining; the impact of this type of institutions in other contexts especially in developed countries can be very different. Applying this classification, it may be seen that the policy space (Section 3.3.3) for IOPP in a country/region/sector is defined by the intersections and interactions of those institutions.

Table 8.3 Institutions affecting China's IOPP

	Domestic/Internal	International/External
Formal	**Dual roles: enabling or constraining** • Procurement regulations • Industrial regulations • Standards	**Constraining:** • Applicable regulations by WTO (not necessarily GPA; some multilateral treaties involve procurement issues as well, Kattel and Lember, 2010)
Informal	**Multifold relationships with formal ones: complementing, substituting, accommodating, competing** • Guanxi (reciprocal connections between stakeholders) • Governance styles • Procurement norms **Competing:** • Regional protectionism	**Constraining:** • Interest structures of international trade and competition

Source: Author

8.6 Comparing China with OECD countries

IOPP practices by representative OECD countries (see Section 4.4 and Appendix 4) have been frequently referred to throughout the analysis of China's IOPP processes. This section attempts to bring the Chinese and OECD experiences together, to summarize their major differences and similarities, which could serve a basis to draw implications for better utilization of this innovation policy instrument.

8.6.1 Substantial differences existing

Difference in strategic goals: The strategic goal of China has been, undoubtedly, to catch up with developed countries through the OEM-ODM-OBM and 'imitation to innovation' pathway to develop indigenous capabilities rather than relying on FDI (Fagerberg and Godinho, 2005), while the strategic goal of developed countries, in the context of this study the US in particular, has been to maintain its competitive advantages and 'kick away the ladder' (Chang, 2002). This difference has been the fundamental factor leading to the conflicts of interest between China – and more generally catching-up countries – and major stakeholders from the camp of developed countries.

Difference in institutional contexts: Both domestically and internationally, the contextual situation in terms of institutions is very different for China and for OECD countries. Section 2.4 reviewed briefly the institutional characteristics of developing countries in terms of their innovation systems, which 'normally feature weak and unstable (formal) institutions' and 'high heterogeneity in terms of social, political and economic structures'. The preceding chapters and sections suggested that this holds true for China's domestic procurement system, and consequently true for the Chinese IOPP experience. Developed countries' innovation and procurement systems feature a higher level of stabilization, regularization and capacity owing to their better integration and dominance in the global political economy. This integration to an extent guaranteed the compliance of their domestic institutions with international orders, thus some of the horizontal coherence problems encountered by China (e.g. fragmentation of institutional setups, and incompatibility with GPA regulations) is not likely to be an obstacle for IOPP in OECD countries.

Difference in policy instruments: Major types of policy measures taken by OECD countries were summarized in Table 4.3. It appeared that OECD (more specifically the EU) countries, rather than setting up a universal, routinized procurement system such as IOPP policy Channel 1, put greater emphasis than China did on capacity building (e.g. procurer training), networking, and dissemination of IOPP guidance and 'good practice' (see Appendix 4 for details). Differently from the US and China who adopted very controversial, protectionist procurement measures, EU countries did not announce explicit measures to protect EU suppliers, although individual practitioners called for a programme to 'buy European' (Marsh, 2012) in response to other countries' procurement protectionism.

Difference in governance styles and implementation processes: It was observed that the Chinese government, in particular local governments during the course of IOPP policy implementation, frequently appeared as 'big governments' (Rose, 1981) pursuing economic growth with an interventionist style, while developed countries mostly feature 'small governments' which emphasize the predominant role of the market and minimize public interventions (Hood, 1995). EU countries made policies to encourage IOPP practices rather than requiring public agencies to procure innovation mandatorily (see Appendix 4). A higher level of accountability was realized in the EU through the engagement of a wider range of stakeholders from the arenas of policy, business and academia. Regulated by highly-developed formal institutions, public procurers in OECD countries, unlike those in China who have more flexibility in exercising 'informal practices' (Ledeneva, 2008), have to stick to transparency and non-discrimination as primary principles and follow competition-based procedures. IOPP cycles more or less followed the stages illustrated in Figure 3.2, as elaborated in various case studies (see publications listed in Table 4.2).

Difference in barriers and challenges: Although barriers such as risk aversion and horizontal coordination difficulties are common (Sections 4.5 and 8.2.5), some different barriers are faced by China and OECD countries. For China fundamental barriers, as argued in preceding sections, lie in its formal institutions in relation to innovation as well as procurement. It is because of the weaknesses and flaws of formal institutions that regional protectionism exists pervasively, and that the environment in terms of market and competition is not IOPP-friendly. For developed countries this is not a problem, but perhaps a major challenge lies in how to identify and boost public demand.

8.6.2 Signs of policy convergence

Despite the existence of substantial differences, some early signs of 'policy convergence', i.e. the '*coming together*' in terms of policy '*goals'*, '*content'*, '*instruments'*, '*outcomes'* and '*style'* across different nations or regions (Bennett, 1991), were observed.

The first is convergence across China and OECD countries and other developing countries such as Brazil in the choice of public procurement, and more broadly of DSIPs, as a complementary approach of supply-side measures to promoting innovation. The rising interest on IOPP internationally influenced the Chinese academia. Appendix 1 reviewed Chinese publications on IOPP, a considerable amount of which were focused on policy learning based on analysis of international policies and practices. Moreover, the announcement of IOPP in MLP was originally based on policy learning from the US and Korea (Edler et al., 2008).

The second is, closely related to the first, convergence in rationales and (moderately) in concrete instruments employed to utilize IOPP. The enhancement of communications and interactions was commonly emphasized although different instruments were employed (e.g. in China through various catalogues, while in the EU through procurer networks). Common instruments included sector-focused measures and PCP (as with Channel 2), LMI-type measures (as with Channel 3), user incentives and risk-control measures, and adjusting procurement regulations, methods and procedures (as with Channels 1 and 2, although fundamental flaws of the procurement system were not overcome). China's policy change, i.e. the termination of Channel 1 and announcement of procurement support for SMEs in late 2011, suggested that rather than bent on its previous approach China picked up an approach commonly shared by OECD countries (Section 4.4 and Appendix 4). Arguably this trend of adaptation and convergence would carry on, and instruments increasingly similar with that of OECD countries would be employed by China, given that China encountered tremendous difficulties and failed in its initial attempts to use protectionist innovation catalogues.

The third is convergence in terms of the ultimate goals of innovation nowadays, i.e. to overcome grand challenges and realize sustainable socioeconomic development. It is exactly because of these common challenges and goals shared by all countries that 'beggar-thy-neighbour policies' such as national protectionism are not likely to work (Meléndez-Ortiz et al., 2012).

Finally, convergence of China with OECD countries in the building of formal institutions related to its innovation as well as procurement systems is expected. The NIS model pursued by the Chinese government, as outlined in the MLP and illustrated in Figure 2.4, is coherent with that of the OECD countries. The convergence with international public procurement practices is even more certain as China's accession to the GPA has become 'a key priority for both [the U.S. and the EU]' (Anderson et al., 2012, p.4) and currently the negotiations are ongoing (Section 3.4).

8.7 Conclusion

This chapter has, on the basis of the preceding conceptual and empirical chapters, brought multiple levels and multiple aspects together to gain a deeper understanding of the Chinese IOPP policy process. The cross-case analysis enabled comparative investigation into the IOPP dynamics at the micro-level through the lenses of procurement cycles, innovation processes, stakeholders, interactions and institutions. It was observed that three factors, i.e. the demand, innovation and sectoral policies, and proactive stakeholders served as major forces driving China's IOPP practices. The key to creating opportunities for IOPP was to bring demand- and supply-sides together, either through *formal* ways such as public tendering, or through *informal* ways of stakeholder interactions. This chapter characterized idealized modes of stakeholder interactions and elaborated on their contributions to fulfilling functions throughout the procurement process, including functions of demand articulation, market intelligence gathering, dialogues, risk control, and qualification. Institutional failures (both hard and soft) including risk aversion, coordination difficulties, flawed regulatory system for procurement, and regional protectionism have been identified as major obstacles encountered by practitioners. The roles played by various institutions were discussed. It was found that in the context of the weak and flawed formal institutions regulating China's public procurement activities, informal institutions such as an interventionist governance style, unwritten procurement norms, and guanxi to an extent mitigated the flaws and contributed to the emergence of IOPP cases. Nevertheless, the roles of informal institutions proved to be multifold; they might play as forces 'competing' with formal institutions and hindering policy implementation.

This chapter then moved on to cross-level analysis concerning the vertical coherence of the IOPP policies. Diversified trajectories were observed from channel to channel. Channel 1 during its initial stage up to 2010 moderately realized designed coherence between goals, rationales, instruments and designed implementation structures. A problem identified was its *implementability* since it adopted very rigid criteria and lengthy procedures to accredit innovation products. The actual implementation process of Channel 1 turned into a 'political' one featuring low ambiguity yet high conflict owing to tensions with major international stakeholders. Although some regions carried on implementing Channel 1 and to an extent achieved outcomes coherent with the original design, the implementation processes were rather 'experimental' and the outcomes were individual IOPP examples rather than systematic IOPP activities. The vertical coherence of Channel 2 in Shanghai was more or less realized in terms of both design and implementation, although the equipment catalogues drew tensions from international stakeholders as well. Shanghai's experience suggested that the implementation turned into an 'administrative' type for which both ambiguity and conflict were low, while the provision of resources, capacities and techniques might need to be enhanced. The design of both programmes situated in Channel 3 appeared to be more ambiguous compared with that of the other two channels. The implementation structure, i.e. selected cities implementing the programme according to their local plans, determined that regional autonomy played a key role in shaping the dynamics. The NEV programme realized better vertical coherence than the LED programme due to its better national control over regions through a unified ministerial-level governance structure, larger amounts of subsidies and industrial regulations. The implementation type of both programmes was also an ‘experimental’ one, producing diversified outcomes as well as lessons for further policymaking. A common problem identified, perhaps more for Channels 1 and 3, less for Channel 2, was again local protectionism, hindering the vertical coherence of policy implementation for the country as a whole.

Horizontal coherence was appraised through identifying major factors leading to ‘lack of coherence’ with the domestic as well as the international contexts. The current institutional setup of China’s innovation system appeared to be too fragmented to deal with ‘systemic’ innovation policies; the implementation structures required by the three IOPP policy channels were inconsistent with this fragmentation. Channel 1 also suffered from the fragmentation of the Chinese procurement system since it was by rationale a centralized approach aiming to intervene across sectors and levels. An advantage of the other two channels has been attributed to their relative coherence with China’s fragmented procurement system, as they were both ‘fragmented’ policies, targeting at specific sectors and levels of governance. Their horizontal coherence with international institutions was also better realized than that of Channel 1, in the sense that the tendency of protectionism was less explicit and fewer controversies were drawn. Lack of coherence with the international context can be largely considered as conflicts of interests between catching-up and leading countries in the domains of international trade and competition.

Through comparing China’s IOPP practices with that of OECD countries, this chapter found that substantial differences exist in terms of their respective institutional contexts, choice of IOPP policy instruments, governance styles and implementation processes. Nevertheless, some signs of ‘policy convergence’ have been noticed. China has been converging both actively, e.g. through policy learning from developed countries (‘emulation’, Bennett, 1991), and passively, e.g. through ‘harmonization’ (ibid.) by international commitments and ‘penetration’ (ibid.) by international stakeholders.

The forthcoming chapter will reflect on these findings, draw policy implications, and conclude the thesis.

Chapter 9: Concluding the Thesis

9.1 Review of the study – approach and limitations

Driven by the fact that public procurement has been gaining ground internationally as a potent yet under-investigated innovation policy, and the paradoxical fact that China adopted a seemingly systemic, very ambitious yet controversial IOPP policy approach about which little academic knowledge was available, this thesis set out to *explore* the policy implementation processes, *evaluate* the policy's appropriateness, and *explain* key issues identified.

Despite the significant progress made during the past decade or so, the research area on IOPP remains underdeveloped especially in that a coherent conceptualization is lacking to facilitate policy analysis and evaluation. This gap made it a prerequisite for this study to develop a novel conceptual framework before moving on to purposive investigation. Drawing upon three major strands of literature, i.e. innovation systems and policies (Chapter 2), public procurement (Chapter 3), and IOPP (Chapter 4), Chapter 5 proposed a tentative conceptualization of IOPP and IOPP policies (see Figure 5.2):

- Concrete IOPP processes are dynamics situated at the intersection of innovation and public procurement systems ('system mix'), and shaped by the contexts, institutions, actors and interactions of the two systems;
- IOPP policies are horizontal mixes of innovation and public procurement related interventions, and vertical mixes of goals, rationales, instruments, designed implementation structures, actual implementation processes, and outcomes;
- IOPP policies impact on concrete IOPP processes through implementation, and IOPP processes, shaped by various factors in the context, are meanwhile manifestations of IOPP policy implementation.

Through this conceptualization, *multiple aspects* of the IOPP processes (institutions, actors, interactions and contexts) and *multiple levels* of IOPP policy processes (micro-level of IOPP cycles and implementation, and meso- and macro-levels of policy design, articulation and implementation) are connected. Embedded throughout the study, this conceptual framework facilitated the articulation of research questions, the design of methodology, and the analysis and synthesis of data.

The key research question of this study has been structured as: ***How was the use of public procurement as an innovation policy mediated by innovation and procurement systems in China?*** The question was then articulated into seven sub-questions which were illustratively located in the research framework (see Figure 5.3). The research framework, developed from the conceptual framework, provided direct guidance to answer the research question. Methodologically, a multi-level approach integrating policy analysis (focused on the design, articulation and implementation processes) and case studies (focused on procurement cycles) was justified and employed (Section 5.4).

This study is, like any other studies, subject to limitations. Firstly, some important concepts and perspectives this study draws from the literature, including the notions of 'policy mix' and 'appropriateness', are still conceptually underdeveloped and/or ambiguous. This study has proposed definitions and delineation of them, and attempted to contribute to the field in addressing those gaps; nevertheless, this is only an initial effort, which should be considered open-ended rather than conclusive. Secondly, the limitations related to research design discussed in Chapter 5 apply. As an initial attempt to explore and seek a qualitative understanding of China's previous IOPP policies and practices, this study is far from being comprehensive. Although a broader picture of IOPP practices in China was uncovered, it is believed to still be partial owing to the vastness of the subject. Thirdly, the situation in China being researched has been constantly changing during the course of this study, influenced by unstable (political) factors. Owing to this complexity, this study might not have been able to capture some issues that would turn out influential on the dynamics later on.

9.2 Review of key findings

9.2.1 The contextual situation for IOPP in China

The current institutional setup of the innovation system, which seems to still have followed a linear understanding of innovation, was found insufficient to support IOPP. MOST together with its lower-level agencies as the nominal leader for IOPP policymaking lacked the authority to enhance horizontal coordination across policy domains. This has been an institutional barrier hindering the implementation of IOPP policies.

The fragmented public procurement system is inconsistent with international norms. A high degree of departmental/regional autonomy has been evident. Micro-level procurers implied pragmatic attitudes in choosing what regulations to follow depending on practical convenience and priority. Concrete procedures thus differ from one context to another. Policy capacity for IOPP is significantly constrained by this institutional fragmentation. Minor adjustments have been made to suit the need of procuring ‘innovative’ or ‘green’ products, but fundamental legislation remains unchanged.

Both systems are intertwined with trade and competition issues. This study considers that it is because this is a ‘knowledge-based’ economy that ‘innovation’, now considered to be the main driver of economic growth, became a key issue related to country competitiveness; and it is because this is a ‘globalized’ economy that ‘public procurement’, a substantial share of the global market, became a key issue related to international trade. Conflicts of both innovation and procurement systems with the international context were evident. The former lay in the protectionist emphasis on *indigenousness* of innovation, and IPR disputes with leading countries caused by ‘importing-digesting-absorbing-reinnovating’. The latter lay in incompatibility with international regulations and discrimination against non-Chinese suppliers. In this context, China’s IOPP practices situated at the *intersection* of both systems, stood out as a controversial topic.

9.2.2 The Chinese IOPP policy process

This study found that *de facto* policy initiatives moved beyond the explicit policy channel based on innovation catalogues (Channel 1), to sector-specific policies such as MTE commercialization projects (Channel 2) and demonstration programmes promoting emerging technologies (Channel 3). A related policy has been the *buy domestic* mandate, which proved to have the potential in triggering indigenous development of ‘new to the country’ products. The existence of multiple policy channels suggested that the actual scope of IOPP in China moved beyond the narrow-sense government procurement regulated by the LGP.

Channel 1 as the most explicit IOPP approach was designed to be a centralized mechanism to enhance supplier-procurer and inter-departmental coordination through the use of innovation and IOGP catalogues. Protectionist criteria adopted to accredit products caused tremendous controversy from major trade partners notably the US.

While implementation at the national level came to a standstill, proactive regions exercised their autonomy and demonstrated diverse trajectories. Implementation outcomes appeared to be individual ‘dots’ shaped by contextual circumstances rather than systematic ‘layers’ as planned by national policies. Diffusion of technologies was accelerated in some localities as a result of procurement, but further diffusion was often hindered by *regional protectionism*.

Channel 2 is an implicit, PCP-like approach targeted at the equipment sector. Equipment catalogues are employed to signal the national demand to potential suppliers, and experiment/demonstration projects serve as vehicles to commercialize newly developed technologies. Proactive regions with strong equipment industries exercised their own approaches. Two cases from Shanghai suggested that incentives provided for users remained rather weak. The implementation type was considered as an ‘administrative’ one, whereby provision of resources and capacities is critical in determining policy effectiveness.

Channel 3 aims to promote the uptake of emerging technologies through government procurement and ideally catalyse demand from private consumers. The two programmes demonstrated that the implementation type of this channel easily turned ‘experimental’ featuring a very high degree of regional autonomy and diversity. The central government’s authority over regions appeared to be too weak (in particular for the LED programme) to control the scope of implementation. Regional protectionism stood out as a stubborn barrier hindering the channel’s vertical coherence, causing duplicate investment and consequently homogeneous competition.

9.2.3 Stakeholders, interactions, and institutions

A key finding from the cross-case analysis has been that micro-level practices, although partly encouraged by upper-level IOPP policies, might not have been primarily stimulated or shaped by those policies; it was the local contexts that served as more powerful forces in doing so. Unlike the EU cases summarized in Table 4.4.1, the Chinese ones were not always initiated by the actual ‘demand’ side. Initiatives were often taken by proactive local governments who wanted to promote local economic growth, or by suppliers faced with commercialization challenges. In particular, the roles played by the former can be understood through the lenses of ‘policy entrepreneurs’ as well as ‘intermediaries’, and the latter through the lens of ‘champions’.

This study abstracted ten idealized modes of stakeholder interaction, nine of which were *pre-procurement interactions* as illustrated in Table 8.1, and the tenth mode was *demand-supply interactive learning* after the demand-supply relationship is established. The key to IOPP is to bring the demand and supply together followed by interactive learning, regardless of the concrete pathways followed. All ten modes of interactions contribute to IOPP through, for instance, demand articulation and market intelligence gathering. Chinese IOPP processes were not short of interactions; in particular interactions between local governments and local suppliers appeared very dynamic, leading to a danger of 'strong network failures' as procurers tended to privilege certain suppliers driven by interests beyond innovation or procurement, to economic incentives and interpersonal relationships.

Formal/informal and domestic/international institutions were distinguished. Informal institutions, both domestic and international ones, played powerful roles in shaping China's IOPP policy processes. Pathways adopted by practitioners did not always follow the designed procedures. This study attributes this procedural flexibility to China's weak and fragmented formal institutions regulating public procurement. Informal institutions sometimes served as 'complementary' and 'substitutive' forces that compensated the flaws of China's formal institutions and contributed to the implementation of IOPP policies, while sometimes they appeared to be 'competing' with formal institutions and hindered the implementation process, an extreme case being regional protectionism. Regional protectionism significantly constrained the establishment and functioning of an IOPP-friendly market mechanism based on open competition. Internationally China has not been subject to formal institutions related to GPA; nevertheless, the informal 'rules of the game' determined by international interest structures forced China to give up its conspicuously protectionist stipulations.

9.2.4 Appropriateness of the three IOPP policy channels

This study adopted vertical and horizontal coherence as a criterion to evaluate the 'appropriateness' of an IOPP policy. The conclusion is that the three IOPP policy channels realized different degrees of appropriateness owing to their respective characteristics and institutional contexts.

This study considers that Channel 1, the seemingly most 'systemic' approach, was the *least appropriate* among the three channels. Despite the feasibility of its rationale, and the designed vertical coherence, its *implementability* is considered very low. The design appeared to be rather 'one-size-fits-all' counting on centrally-controlled coordination across multiple levels of government, and across innovation and procurement systems, which was incompatible with the domestic institutional fragmentation and regional autonomy. Time-consuming accreditation procedures and fragmented responsibilities of promoting innovation and conducting procurement across a wide range of agencies made the *actual* vertical coherence unlikely to be achieved, even if there were no external obstructions from international players. Horizontal *lack of coherence* with the international context, as elaborated in Section 6.3.4, goes without saying.

Based on documentation and experience of Shanghai, this study found that Channel 2 realized a higher degree of vertical coherence, despite the fact that implementation of the linkage between equipment and innovation catalogues was aborted owing to the termination of Channel 1. Higher horizontal coherence with the procurement system was realized as Channel 2 targets at the equipment sector only. Lack of coherence with the international context was diminished after the equipment catalogues removed explicit requirements of 'indigenousness' and import substitution. However, the understanding of Channel 2 was constrained by the limited amount of data available.

Channel 3, differed from the other two channels which featured a strong protectionist and catching-up intention, has been an increasingly popular instrument internationally, which implies that the appropriateness judged according to international 'rules of the game' is less controversial. Domestically it was better supported by the procurement system owing to its sector- and region-specific characteristics which were in line with the institutional fragmentation. Horizontal coherence with the innovation system, however, depended very much on the institutional settings of the specific programme.

This study also partially appraised the short-term effectiveness of the three channels based on data available. Four major outcomes/impacts were observed from the cases, i.e. promoting innovation, improving public infrastructure, development of supply chains, and demonstration effects. These effects, however, were largely limited to the localities rather than spilling over to elsewhere. It was found that IOPP in China appeared to be mostly *adaptive* procurement that facilitated the diffusion of incremental innovation rather than *developmental* procurement that stimulates radical innovation. IOPP policies have been positioned as an instrument to follow supply-side policies and support the commercialization of *existing* R&D outcomes, rather than an instrument to trigger the creation of *not-yet-existing* solutions. Very moderate behavioural additionalities of target groups were observed in regions such as Beijing and Shanghai. Owing to the financial autonomy, local governments can be easily motivated by central-level IOPP initiatives if they see the potential of levering procurement to drive local GDP growth. Nevertheless, unintended consequences such as protectionism and duplicate production are very harmful for the country as a whole. The three channels have arguably failed to address this problem.

This study believes that the irreconcilability in strategic goals between leading countries and China has been the fundamental cause leading to conflicts with the international context. Differences in terms of institutional contexts, policy instruments, and governance styles were other factors that powerfully shaped the distinct IOPP pathways of the two camps. Meanwhile, some early signs of *policy convergence* were observed, owing to factors including China's policy learning from developed countries, harmonization by international commitments, and penetration by international stakeholders such as the US.

9.3 Contributions to knowledge

9.3.1 Theoretical and conceptual contributions

The main theoretical contribution of this study has been the 'system mix' – 'policy mix' conceptualization of IOPP as elaborated in Section 5.2, the lack of which was identified at the outset of this study (Section 1.3). The area of IOPP research has been underdeveloped in terms of theorization; this conceptual framework can be considered as an initial attempt. The conceptual framework is heavily influenced by perspectives on innovation systems, policy mix, implementation, TLC, PPC, and public procurement as a multi-functional policy. Underpinned by the conceptualization, a qualitative criterion for evaluating IOPP policies' appropriateness and implementation was set as vertical and horizontal 'coherence' (Section 5.4.2). The experience of this study suggests that this conceptualization, although appearing rather complex and broad, can deal with the difficulty of analysing cross-domain, multi-level and multi-actor policies, and facilitate the diagnostic analysis of IOPP policy processes. Findings underpinned by this conceptualization helped understand and explain the trajectories of IOPP in China. The conceptualization is not confined to the Chinese context as it stands on the shoulders of established literature strands on innovation and public procurement in general. More generically, the applicability of 'system mix' and 'policy mix' thinking to other policies with a cross-domain nature is highly possible.

To develop the conceptual framework, this study further characterized the concept of 'policy mix', especially the *vertical mix* linking up elements of 'policy design' and elements of 'policy implementation'. This offers an approach to conceptualizing the 'under-conceptualized' notion of policy mix (Flanagan et al., 2011; OECD, 2010).

This study adds to existing literature by deepening the understanding of stakeholder *interactions* in IOPP processes. Although interactive learning has been highlighted, discussions have been mostly limited to user/procurer-supplier interactions (see e.g. Edquist et al., 2000; Uyarra and Flanagan, 2010). This study looked at the broader scope of stakeholders from innovation and procurement systems, and abstracted interactions between *demand*, *supply*, and *intermediaries* into ten idealized modes (Section 8.2.3). Various combinations of those modes can realize the 'connecting' of 'demand and supply' (Edler and Yeow, 2013) and shape the PPC in diversified ways.

Also deepened has been the understanding of *institutions* associated with IOPP. Although the importance of institutions has been acknowledged (Section 4.5), understanding of their varieties and roles has been limited. This study elaborated on the range of institutions influencing IOPP in China and proposed a fourfold classification of institutions affecting IOPP activities in general (Section 8.5). The formal/informal dimension echoes Edquist et al. (2000)'s views, and moves further by articulating the varieties and causal mechanisms (Section 8.2.6). The domestic/international (internal/ external) dimension echoes Rolfstam (2012a)'s endogenous/exogenous dichotomy but extends it by capturing broader boundaries of countries, regions, and sectors (Section 8.4). The classification can be employed as an analytical tool to assess the institutional environment for IOPP.

9.3.2 Empirical and practical contributions

The policy analysis method adopted by this study, featuring iterations and interactions between documentation and fieldwork, and bridging 'top-down' and 'bottom-up' approaches (Section 2.3.5), can contribute to a more comprehensive approach to implementation analysis. Furthermore, the multi-level methodology integrating policy analysis and case studies enabled a contextual, systematic and in-depth investigation, offering a means to addressing the gap of evaluating IOPP policy appropriateness and implementation (Sections 1.3 and 2.3.4).

Descriptive texts derived from stakeholder interview data, supplemented with secondary data from multiple sources, took a major part of Chapters 6 and 7 in order to reconstruct the IOPP phenomenon in the Chinese context. This part itself offers an empirical contribution by adding a significant amount of evidence to international knowledge base on public procurement, IOPP, and innovation policy.

Evidence collected by this study verified and enriched some significant perspectives reviewed in early chapters, notably those on characteristics of policy implementation (Section 2.3.5) especially ‘implementation types’ (Matland, 1995), those on conditions and challenges for catching-up (Section 2.4), and those on issues associated with IOPP (Section 4.5). On the other hand, the Chinese evidence challenges some existing perspectives. The sequential PPC model (Figure 3.2) derived from contexts regulated by solid formal institutions based on well-functioning markets appears to be not suitable enough to be directly adopted by transitional economies which feature unstable formal institutions. Meanwhile, this study suggests that IOPP in China has more often possessed the nature of ‘adaptive’ procurement, and the Chinese IOPP policies have been positioned as instruments ‘responsive’ to existing innovations rather than ‘triggering’ new ones. The current body of literature, however, has mostly debated about ‘developmental’ procurement (as reviewed in Chapter 4), while the understanding of responsive procurement remains rather limited; this is a gap that this study identified.

This study offers implications for future IOPP policies and practices in China, and some more general implications for other countries/contexts seeking socioeconomic development through public procurement, as elaborated in Section 9.4.

9.4 Implications for policy and practice

9.4.1 Reforming and tuning institutions

The fact that hard institutional failures were pervasive indicates the strong need for China to (re-)establish appropriate formal institutions and enhance the functioning of them in order to facilitate IOPP, and more generally, innovation (Lundvall, 1992; Metcalfe, 1995) and catching-up (Manca, 2009; Cimoli et al., 2009a). Major hard institutional failures identified include the *fragmented public procurement regulatory system* owing to the flawed legislation underpinned by the two competing laws (as evidenced by the Water, Tunnel, NEV and LED cases), the *lack of industrial regulations and standards* to regulate and facilitate the development of emerging technologies (as evidenced by the Wind, NEV and LED cases), and *regional protectionism* owing to the financial decentralization and consequently lack of central government's control over regions (as evidenced by the NEV and LED cases). All of the three types of failures significantly hindered the establishment and functioning of a stabilized and competition-based market mechanism, and created barriers against the diffusion of innovations across sectors, levels of governance, and regions.

As reviewed in Section 2.2.1 and Section 3.2, market conditions built upon sufficient competition form an essential part of the framework conditions needed by a firm-centred NIS and the conduct of public procurement activities. A competition-based market mechanism can contribute to the realization of primary (e.g. transparency and efficiency) and secondary goals of procurement. Consequently the 'match' between the innovation and public procurement systems would be enhanced, contributing to vertical and horizontal coherence. A well-functioning market can better engage private players (e.g. catalysing private demand), thus realize wider diffusion of innovations. The consequently higher institutional capacity can potentially enlarge the 'shrinking' policy space for development.

The current underdevelopment of formal institutions in China might be excused as the feature of an unavoidable stage during the course of transition from a centrally-planned economy to a market-based one. Nevertheless, the transition is far from being complete while vested interest structures and corruption, notably that of local governments and SOEs (Gong, 2006), are standing in the way. The current Premier described the tackling of existing interest structures as '*harder than stirring the soul*' (Magnus, 2013); yet he still put the deepening of institutional reforms high on the agenda since '*reform is the biggest bonus for China*'. This study reaffirms this. Findings generated by this study suggest, corresponding to the three hard institutional failures mentioned above, three major policy directions to improve China's market conditions for IOPP, i.e. revising and centralizing the procurement legislation, strengthening the use of regulations and standardization especially for emerging sectors, and breaking down the barriers posed by regions' financial autonomy.

Informal institutions complementary to policy objectives should be encouraged and utilized. For instance, the coordination mechanism in Zhongguancun innovation zone, which engages various departments and levels of government and underpins all of the three IOPP policy channels, might be taken as initial steps towards a broad-sense *public procurement* system. This study also would like to appeal for a more friendly *culture* for innovation, based on the observation that risk aversion proved to still be a common barrier hindering the diffusion process. An issue related to this but in particular for China is to enhance people's confidence in domestic products; neither protectionism for nor discrimination against 'indigenous' products will actually benefit innovation.

9.4.2 Strengthening actor capabilities

This study calls for good attention to the building of actor capabilities which, although well emphasized by EU countries, seemed to be lacking in China's previous IOPP policies. What China needs urgently for catching-up is now perhaps less about 'technological congruence' but more about 'social capabilities' (Section 2.4). The first type of capability is related to the 'centre' of the innovation system, i.e. suppliers. Suppliers' capability failures were observed in several cases, leading to higher risks associated with IOPP. If suppliers' capabilities are enhanced and better-quality products are delivered, soft institutional failures such as risk aversion and discrimination against domestic products are likely to be overcome gradually. The building of users' capability in adopting new technologies should be paid attention too. Rather than being totally a burden on suppliers who struggle with commercialization already, training and education for users should be supported with public policies and resources (as discussed in Edler, 2013). Issues regarding procurers' capability, however, are less pronounced due to: the interventionist and direct involvement of local governments, the passiveness of procuring agencies in conducting IOPP, and the diversified, informal procurement 'procedures' followed. Capability building for professional public procurers is likely to stand out as a necessity in the light of China's accession to the GPA, as implied by the IOPP policy focus of OECD countries (Section 4.4.2).

A type of actor that this study found in great need of capability enhancement is the *central government*, represented by its wide range of ministries. Some *government* *failures* were observed. Arguably the protectionist, one-size-fits-all policy Channel 1 was a manifestation of poorly justified policy design without taking horizontal coherence issues into account; the poorly coordinated governance of the LED lighting programme caused wasteful activities. Government failures and 'trial and error' caused by limited government capability are common for developing countries (Krueger, 1990; Cimoli et al., 2009a). To deal with this, a careful *ex-ante* justification of policy design assisted with multi-source information gathered on the basis of *transparency* (the lack of which has been long denounced as a problem of China's political system) is a prerequisite (OECD, 2010). The evaluation criterion adopted by this study, i.e. vertical and horizontal coherence, can contribute to *ex-ante* policy justification (the designed coherence) as well as *ex-post* evaluation (the *actual* coherence).

9.4.3 Interaction and intermediation

Interaction failures resulted primarily from lack of coordination and stakeholder engagement. Following Edler and Yeow (2013), this study found that *intermediaries* played the role of 'brokers', contributing to interface management and consequently to better awareness, goal alignment, coordination, and interactions of stakeholders. The variety of interaction modes identified from the Chinese context is enlightening for IOPP practices in general. The implementation of IOPP as a demand-side policy instrument is not necessarily initiated by the demand side. The design of innovation policies should then consider providing intermediary channels for suppliers faced by commercialization challenges to report their difficulties, demonstrate their innovative solutions, and seek government support.

Interactions between intermediaries and suppliers can effectively realize *accreditation* of new products and reduction of uncertainty; assisted with effective communication methods, engagement of demand-side stakeholders can be enhanced. This is, interestingly, the very rationale of the terminated Channel 1. This study argues that the same rationale can be carried on, but more flexible and responsive instruments should be employed. The rationale of the designed linkage between equipment (signalling) and innovation (accrediting) catalogues (Figure 6.4) is enlightening as well. Through the intermediation function of linkage, forward-looking policy design can be realized, directing demand-driven innovation towards long-term socioeconomic goals. Again the challenge is to design adequate instruments to implement the linkage. For the 'signalling' function, strategic intelligence tools such as technology foresight will be of crucial importance to avoid government failures.

Intermediaries observed from the cases were mostly 'temporary' or 'voluntary' rather than formally introduced; this can be considered as a policy gap to be addressed. The intermediary agency established in Zhongguancun innovation zone, i.e. the Working Group for New Technology/Product Government Procurement and Promotion, and the annually organized China Industrial Forum which disseminates good practices identified from the implementation of Channel 2, can both be referred to for future IOPP policymaking. Much wider forms of intermediation are believed to exist out there in need of further exploration (Howells, 2006; Edler and Yeow, 2013). Considering the issues related to other types of actors, this study believes that as intermediaries with multiple functions emerge as additional types of actors involved in IOPP, corresponding institutional adjustment, capability building, and monitoring/evaluation measures should be taken into account in future IOPP policy design as well.

9.4.4 Policy differentiation and complementarity

Findings of this study imply that the implementation of a one-size-fits-all IOPP approach such as Channel 1 is hardly possible; Channels 2 and 3 realized better horizontal coherence with the fragmented procurement system as both were targeted at specific sectors and levels. In the Chinese cases studied, demand and supply were brought together through somewhat *occasional* factors leading to 'dots'. In order to realize 'layers', IOPP policies should attempt to systematically and *sophisticatedly* align the two sides, not through using a universal instrument, but through exploiting the potential of *differentiated* and *distributed* ones. Even for developed countries where procurement systems are not fragmented, the diversity of types and rationales of IOPP reviewed in Section 4.3 suggests that policy differentiation is needed to suit specific circumstances in various contexts. A key dimension of differentiation this study emphasizes here, echoing perspectives reviewed in Section 4.5, is *sectoral characteristics*, which by nature is technological and market specificities. Sectoral differences are so crucial that even 'general procurement' should be tailored to certain sectors so that criteria of *innovativeness* can be better defined and routinized. Differentiation of IOPP policies across sectors might be especially beneficial for developing countries since, as argued by Malerba and Nelson (2011), that catching-up policies should be sector-specific as well.

Opportunities for designing *complementary* policies on the basis of sectoral differentiation were observed. The problems (notably duplicate investment) encountered by NEV and LED lighting programmes suggested that, as local governments are encouraged to procure innovative solutions, complementary national-level regulations have to be in place to *control* the pace, scope and quality of programmes. Another finding was a strong overlap between 'green procurement' and IOPP, implying that an integration of innovation and the objective of 'sustainable development' is promising (i.e. driving 'eco-innovation' through DSIPs, see OECD, 2011b). Integrating IOPP into green sectors can contribute to a clearer articulation of innovativeness into performance requirements, e.g. in terms of energy-saving and recycling rates.

9.4.5 Globalization of IOPP – challenges and opportunities

This study did not set out to emphasize the impact of 'globalization' upon IOPP. However, the globalization of both innovation and procurement activities made the globalization of IOPP an inevitable trend, bringing benefits as well as tensions to the Chinese context. Benefits included, as evidenced by the cases, that returnee students from abroad served as entrepreneurs contributing to China's technological development, and that globalized supply chains allowed Chinese suppliers to use international resources for indigenous innovation and to learn quickly from foreign technologies. Tensions included IPR disputes between domestic and foreign suppliers, disputes related to trade and protectionism, and incompatibility between domestic institutions with international ones.

Future trajectories of China's IOPP policies appear to be rather uncertain and confusing. There is a risk of moving away from IOPP after the termination of key policies. This study argues that China as well as other developing countries should seek appropriate approaches to utilizing rather than avoiding this promising instrument, given that these countries have increasingly tremendous public demand for 'new to the country' goods, which indicates great opportunities to lever economic growth and societal development. Moreover, IOPP is an increasingly popular instrument internationally (Section 4.4). One challenge faced by policymakers in developing countries is how to utilize IOPP for catching-up and meanwhile maintain (at least *de jure*) conformity with international rules and interests.

Despite that policy space is shrinking, opportunities still exist as implied in the previous sections. Developing countries will need to learn how to deal with international ‘rules of the game’ in a more intelligent and sophisticated way, enhancing their bargaining power and utilizing flexibility. This again requires a high level of institutional capacity and actor capabilities. Although China was ‘forced’ by American players to terminate its ambitious policies, it has been a good lesson. In this increasingly globalized political economy of development (Cimoli et al., 2009a), arguably there are no purely isolated, ‘domestic’ systems any more, be they innovation systems or procurement systems. The making and implementation of domestic policies might always need to consider compatibility issues with international institutions (formal as well as informal), in order to avoid direct confrontation on the one hand, and benefit from integration into the global economy on the other.

Better horizontal coherence of China’s innovation and procurement systems with international norms, and convergence of instruments with that of OECD countries if China carries on with IOPP policies, are expected. The accession to GPA poses tremendous challenges for Chinese practitioners; but it will contribute to the elimination of institutional failures embedded in the domestic context. International conflicts and pressure can help tackle some of China’s stubborn problems, and accelerate the process of transitioning and catching-up. In this sense, institutional reforms in China, *if implemented*, can kill two birds with one stone, resolving problems from both the domestic and international contexts.

9.5 Further research

This exploratory study points to a range of topics worth further research.

Firstly, as this study only conducted research on five provincial-level regions selected through purposive sampling, further empirical study in the context of China will be beneficial to extend and deepen the understanding. Different geographical, sectoral, and governance boundaries and levels might be considered. For instance, research into lower-level localities is promising as cases in Chapter 7 suggest that local governments are the main body implementing IOPP. The fact that many IOPP examples emerged from ‘green’ sectors indicates an avenue for further IOPP research concerning eco-innovation. Evidence regarding the implementation of Channel 2 collected by this study was only from Shanghai; research into equipment-related IOPP policies in other regions will contribute to a more comprehensive evaluation.

Secondly, although this study touched briefly upon issues of policy complementarity, it only evaluated IOPP as an *individual* instrument. Study on IOPP as part of a policy portfolio will enhance the understanding of the horizontal dimension of ‘policy mix’. In particular for policy Channels 2 and 3, other instruments such as regulations and subsidies were employed; the interactions and interdependencies between them and IOPP are yet to be better appreciated.

Thirdly, the conceptual and evaluation frameworks constructed by this study are only very initial attempts to integrate multiple aspects and multiple levels of IOPP, and will benefit from further application and adaptation. Testing of the frameworks can, for example, take the form of an *ex-ante* assessment regarding the potential of IOPP policies in a certain country/region/sector. Further sharpening of the frameworks is needed alongside the advancement of key concepts and perspectives in the broader area of research. The role played by intermediaries and institutions can be more clearly characterized and conceptualized through drawing upon evidence from contexts beyond the one where this study is situated.

References

Abramovitz, M. (1986). Catching Up, Forging Ahead, and Falling Behind. *The Journal of Economic History*, 46(02), pp.385–406.

Adach, Y. (2011). The Process of Policy Design. *Policy Design Research*, 5, pp.61–74.

Aho, E., Cornu, J., Georghiou, L. and Subira, A. (2006). *Creating an Innovative Europe*. Luxembourg. [online]. Available from: http://www.eua.be/Libraries/Page_files/aho_report.sflb.ashx [Accessed August 6, 2013].

Ahrens, N. (2010). *Innovation and the Visible Hand*. Washington. [online]. Available from: http://carnegieendowment.org/files/indigenous_innovation.pdf [Accessed August 18, 2013].

Allman, K., Edler, J., Georghiou, L., Jones, B., Miles, I., Omidvar, O., Ramlogan, R. and Rigby, J. (2011). *Measuring Wider Framework Conditions for Successful Innovation - A System's Review of UK and International Innovation Data*. London. [online]. Available from: http://www.nesta.org.uk/library/documents/Measuring_Framework_web_v2.pdf [Accessed August 17, 2013].

Anderson, R.D. (2008). China's Accession to the WTO Agreement on Government Procurement: Procedural Considerations, Potential Benefits and Challenges, and Implications of the Ongoing Re-negotiation of the Agreement. *Public Procurement Law Review*, (4), pp.161–174.

Anderson, R.D. and Kovacic, W. (2009). Competition Policy and International Trade Liberalisation: Essential Complements to Ensure Good Performance in Public Procurement Markets. *Public Procurement Law Review*, 67(2), pp.67–102.

Anderson, R.D. and Arrowsmith, S. (2011). The WTO Regime on Government Procurement: Past, Present and Future. In Sue Arrowsmith & R. D. Anderson, eds. *The WTO Regime on Government Procurement: Challenge and Reform*. Cambridge: Cambridge University Press, pp. 3–58.

Anderson, R., Schooner, S. and Swan, C. (2012). WTO's Revised Government Procurement Agreement - An Important Milestone Toward Greater Market Access and Transparency in Global Public Procurement Markets. *The Government Contractor*, 54(1), pp.1–6.

Apostol, A.R. (2012). Public Procurement of Innovation - A Structural Approach. *Public Procurement Law Review*, (4), pp.179–186.

Arbolino, R. (2011). Innovation in China: Evidence From the Provincial Data. *Chinese Business Review*, 10(10), pp.855–867.

Arnold, E. (2004). Evaluating Research and Innovation Policy: A Systems World Needs Systems Evaluations. *Research Evaluation*, 13(1), pp.3–17.

ARRA. (2009). *The American Recovery and Reinvestment Act*. Washington, D.C. [online]. Available from: http://www.gpo.gov/fdsys/pkg/BILLS-111hr1enr/pdf/BILLS-111hr1enr.pdf [Accessed August 6, 2013].

Arrowsmith, S. (2003). *Government Procurement in the WTO*. The Hague: Kluwer Law International.

Arrowsmith, S. (2004). Public Procurement: An Appraisal of the Uncitral Model Law as a Global Standard. *International & Comparative Law Quarterly*, 53(01), pp.17–46.

Arrowsmith, S. (2010). Horizontal Policies in Public Procurement: A Taxonomy. *Journal of Public Procurement*, 10(2), pp.149–186.

Arrowsmith, S. (2012). Modernising the EU's Public Procurement Regime: A Blueprint for Real Simplicity and Flexibility. *Public Procurement Law Review*, (21), pp.71–82.

Arrowsmith, S., Linarelli, J. and Wallace, D.J. (2000). *Regulating Public Procurement - National and International Perspectives*. The Hague: Kluwer Law International.

Aschhoff, B. and Sofka, W. (2009). Innovation on Demand - Can Public Procurement Drive Market Success of Innovations? *Research Policy*, 38(8), pp.1235–1247.

Athanasakou, K.K. (2007). China IPR Enforcement: Hard as Steel or Soft as Tofu? Bringing the Question to the WTO under TRIPs. *Georgetown Journal of International Law*, 39(1), pp.217–245.

Baark, E. (2001). The Making of Science and Technology Policy in China. *International Journal of Technology Management*, 21, pp.1–21.

Bacaria-Colom, J., Casanova, L. and Rullán, S. (2010). The European Supranational Innovation System: Advantages and Challenges. In *European Consortium for Political Research (ECPR) Graduate Conference*. Dublin, pp. 1–30.

Bai, C.-E., Du, Y., Tao, Z. and Tong, S.Y. (2004). Local Protectionism and Regional Specialization: Evidence from China's Industries. *Journal of International Economics*, 63(2), pp.397–417.

Bai, C.-E., Tao, Z. and Tong, Y.S. (2008). Bureaucratic Integration and Regional Specialization in China. *China Economic Review*, 19(2), pp.308–319.

Bairoch, P. (1993). *Economics and World History: Myths and Paradoxes*. Brighton: Harvester Wheatheaf.

Barnard, H., Bromfield, T. and Cantwell, J. (2009). The Role of Indigenous Firms in Innovation Systems in Developing Countries: The Developmental Implications of National Champion Firms' Response to Underdeveloped National Innovation Systems. In B. Å. Lundvall et al., eds. *Handbook of Innovation Systems and Developing Countries: Building Domestic Capabilities in a Global Context*. Cheltenham: Edward Elgar Publishing, Inc., pp. 241–279.

Barrett, S.M. (2004). Implementation Studies: Time for a Revival? Personal Reflections on 20 Years of Implementation Studies. *Public Administration*, 82(2), pp.249–262.

Batisse, C. and Poncet, S. (2004). Protectionism and Industry Location in Chinese Provinces. *Journal of Chinese Economic and Business Studies*, 2(2), pp.133–154.

Beamer, G. (2002). Elite Interviews and State Politics Research. *State Politics & Policy Quarterly*, 2(1), pp.86–96.

Beijing Bureau of Finance. (2009). *Implementation Measures for Government First and Ordering Procurement in Beijing (Trial) (in Chinese)*. Policy code Jingcaicaigou[2009]370. Beijing. [online]. Available from: http://www.bjeit.gov.cn/zdzttj/zdxmld/zchz/201107/t20110708_15311.htm [Accessed August 17, 2013].

Beijing Government. (2008). *Measures on Conducting Experimental Government Procurement of Indigenous Innovation Products in Zhongguancun Science Park (in Chinese)*. Policy code Jingzhengfa[2008]46. Beijing. [online]. Available from: http://58.30.2.212/bjgov/751614002.jhtml [Accessed August 18, 2013].

Beijing Government. (2009a). *Measures on Constructing Zhongguancun National Innovation Demonstration Zone (in Chinese)*. Beijing. [online]. Available from: http://www.gov.cn/gzdt/2009-04/03/content_1276937.htm [Accessed August 18, 2013].

Beijing Government. (2009b). *"Science and Technology Beijing" Action Plan (2009 - 2012) (in Chinese)*. Beijing. [online]. Available from: http://zhengwu.beijing.gov.cn/ghxx/qtgh/t1036696.htm [Accessed July 29, 2013].

Beijing S&T Commission, Beijing DRC, Beijing Municipal Construction Committee, Beijing Municipal Bureau of Industrial Development and Zhongguancun Science Park Management Committee. (2009). *Measures for Accrediting Indigenous Innovation Products in Beijing (Revised) (in Chinese)*. Beijing. [online]. Available from: http://www.bjkw.gov.cn/n8785584/n8904761/n8904870/n8917796/9005010.html [Accessed August 18, 2013].

Beise, M. (2004). Lead Markets: Country-specific Drivers of the Global Diffusion of Innovations. *Research Policy*, 33(6-7), pp.997–1018.

Bennett, C.J. (1991). Review Article: What Is Policy Convergence and What Causes It? *British Journal of Political Science*, 21(2), pp.215–233.

Bergek, A., Jacobsson, S., Hekkert, M. and Smith, K. (2010). Functionality of Innovation Systems as a Rationale for and Guide to Innovation Policy. In R. E. Smits, Stefan Kuhlmann, & P. Shapira, eds. *The Theory and Practice of Innovation Policy: An International Research Handbook*. Cheltenham: Edward Elgar Publishing Ltd, pp. 115–144.

Berman, P. (1978). The Study of Macro and Micro Implementation. *Public Policy*, 26(2), pp.157–184.

Bertalanffy, L. Von. (1968). *General Systems Theory: Foundations, Development, Applications*. New York: George Braziller.

BJX. (2013). Domestic 'First-set' Equipment Including Power Generators Encountered Difficulties in 'Getting Married' (in Chinese). Beijing. [online]. Available from:

http://news.bjx.com.cn/html/20130603/437786.shtml [Accessed August 19, 2013].

Blanchard, O. and Shleifer, A. (2000). Federalism with and without Political Centralization: China versus Russia. pp.1-16. National Bureau of Economic Research. [online]. Available from: http://www.nber.org/papers/w7616 [Accessed August 6, 2013].

Blind, K. (2009). Standardization: a Catalyst for Innovation. pp.1–27. Erasmus Research Institute of Management (ERIM). [online]. Available from: http://hdl.handle.net/1765/17558 [Accessed August 18, 2013].

Blind, K. (2013). *The Impact of Standardization and Standards on Innovation*. Manchester/London. [online]. Available from: http://www.innovation-policy.org.uk/share/14_The%20Impact%20of%20Standardization%20and%20Standards%20on%20Innovation.pdf [Accessed August 18, 2013].

Boekholt, P. (2010). The Evolution of Innovation Paradigms and their Influence on Research, Technological Development and Innovation Policy Instruments. In R. E. Smits, S. Kuhlmann, & P. Shapira, eds. *The Theory and Practice of Innovation Policy: An International Research Handbook*. Cheltenham: Edward Elgar Publishing Ltd, pp. 333–362.

Boon, W., Moors, E., Kuhlmann, S. and Smits, R. (2011). Demand articulation in emerging technologies: Intermediary user organisations as co-producers? *Research Policy*, 40(2), pp.242–252.

Borrás, S. and Edquist, C. (2013). The choice of innovation policy instruments. *Technological Forecasting and Social Change*, in press.

Brammer, S. and Walker, H. (2011). Sustainable Procurement in the Public Sector: An International Comparative Study. *International Journal of Operations & Production Management*, 31(4), pp.452–476.

Breschi, S. and Malerba, F. (1997). Sectoral Innovation Systems: Technological Regimes, Schumpeterian Dynamics and Spatial Boundaries. In C. Edquist, ed. *Systems of Innovation: Technologies, Institutions and Organizations*. London and Washington: Pinter A Cassell Imprint, pp. 130–156.

Cabral, L., Cozzi, G., Denicolò, V., Piga, G., Spagnolo, G. and Zanza, M. (2006). Procurement and innovation. In N Dimitri, G Piga, & G Spagnolo, eds. *Handbook of Procurement*. Cambridge: Cambridge University Press, pp. 483–528.

Cao, F. (2010). *China Public Procurement Law (in Chinese)*. Beijing. [online]. Available from: http://law.cufe.edu.cn/manageedit/UploadFile/2011117174011990.pdf [Accessed August 17, 2013].

Carlsson, B. ed. (1997). *Technological Systems and Industrial Dynamics*. Dordrecht: Kluwer Academic Publishers.

Carlsson, B. and Jacobsson, S. (1997). In Search of Useful Public Policies - Key Lessons and Issues for Policy Makers. In B Carlsson, ed. *Technological systems and industrial dynamics*. Dordrecht: Kluwer Academic Publishers, pp. 299–316.

CATARC (China Automotive Technology and Research Centre). (2010). *The 2010 Yearbook on New Energy Vehicles (in Chinese)*. Beijing: China Economic Publishing House.

Cave, J. and Frinking, E. (2007). Public Procurement for R&D. pp.1–24. RAND Europe. [online]. Available from: http://www2.warwick.ac.uk/fac/soc/economics/staff/academic/cave/publications/pp_for_rd.pdf [Accessed August 7, 2013].

CCGP. (2011). All Aspects of Government Procurement Have Been Going Well After Indigenous Innovation Stipulations Were Terminated (in Chinese). *China Government Procurement*. [online]. Available from: http://www.ccgp.gov.cn/zzcx/hgzc/201111/t20111107_1859180.shtml [Accessed August 17, 2013]

Chaminade, C. and Edquist, C. (2006). Rationales for Public Policy Intervention From A Systems of Innovation Approach: the Case of VINNOVA. *Centre for Innovation, Research and Competence in the Learning Economy (CIRCLE), Lund University*, pp.1–25. [online]. Available from: http://www.circle.lu.se/upload/CIRCLE/workingpapers/200604_Chaminade_Edquist.pdf [Accessed August 18, 2013]

Chaminade, C., Lundvall, B.Å., Vang, J. and Joesph, K.J. (2009). Designing Innovation Policies for Development: Towards A Systemic Experimentation-based Approach. In B. Å. Lundvall, K. J. Joseph, & Cristina Chaminade, eds. *Handbook on Innovation Systems and Developing Countries: Building Domestic Capabilities in a Global Context*. Cheltenham: Edward Elgar Publishing Ltd, pp. 360–379.

Chang, H.-J. (2002). *Kicking Away the Ladder: Development Strategy in Historical Perspective*. London: Anthem Press.

Chang, H.-J. (2003). Kicking Away the Ladder: Infant Industry Promotion in Historical Perspective. *Oxford Development Studies*, 31(1), pp.21–32.

Chang, H.-J. (2006). Policy Space in Historical Perspective with Special Reference to Trade and Industrial Policies. *Economic and Political Weekly*, 41(7), pp.627–633.

Chapman, J. (2004). *System Failure: Why Governments Must Learn to Think Differently*. 2nd ed. London: Demos.

Chen, J. (1994). From Technology Import to Indigenous Innovation - a Learning Mode (in Chinese). *Science Research Management*, 15(2), pp.31–34.

Chen, J.J. (2011). Development of Offshore Wind Power in China. *Renewable and Sustainable Energy Reviews*, 15(9), pp.5013–5020.

Chen, L. and Lao, Z. (2010). Analysis of the Legal System of Governmental Procurement for Indigenous Innovation Products - Review on Guangdong's Policy Measures (in Chinese). *China Science Forum*, (1), pp.14–18.

Chen, X. (2010). The Domestic Equipment Underground "Forerunner" - Shanghai Tunnel Engineering Corporation as a Member of the <Beijing Declaration> (in Chinese). *Equipment Manufacturing*, (5), p.68.

Chen, X.Y. (2009). When Will the Law on Tendering and Bidding and the Law on Government Procurement Stop Conflicting With Each Other (in Chinese). Beijing. [online]. Available from: http://article.chinalawinfo.com/Article_Detail.asp?ArticleID=48118 [Accessed August 19, 2013].

Chen, Z. and Yu, N. (2010). The Fast-growing Champion Sinovel Wind Energy - the Perfect Innovation Story in China Has Been Questioned (in Chinese). Beijing. [online]. Available from: http://finance.people.com.cn/GB/12719383.html [Accessed August 19, 2013].

Cheung, T.M. (2011). The Chinese Defence Economy's Long March from Imitation to Innovation. *Journal of Strategic Studies*, 34(3), pp.325–354.

China Industrial Forum. (2013). Demonstration Projects of First (Set of) Major Technological Equipment in China 2012 (in Chinese). Beijing. [online]. Available from: http://www.cinn.cn/zggylt/2012stt/index.shtml [Accessed August 19, 2013].

Chinacity. (2011). *China Cities Innovation Report 2011 (in Chinese)*. Beijing. [online]. Available from: http://www.chinacity.org.cn/cscx.html [Accessed August 18, 2013].

Chorev, N. (2007). *Remaking U.S. Trade Policy: From Protectionism to Globalization*. Ithaca: Cornell University Press.

Chou, B. (2006a). Challenges for China's Reform of Government Procurement. *Journal of Contemporary China*, 15(48), pp.533–549.

Chou, B. (2006b). China's Economic Integration into Global Regulatory Frameworks: A Study of Government Procurement. *Communist and Post-Communist Studies*, 39(4), pp.431–445.

Cimoli, M., Dosi, G. and Stiglitz, J.E. eds. (2009a). *Industrial Policy and Development - The political economy of capabilities accumulation*. Oxford: Oxford University Press.

Cimoli, M., Dosi, G. and Stiglitz, J.E. (2009b). The Future of Industrial Policies in the New Millennium: Toward a Knowledge Centreed Development Agenda. In M. Cimoli, G. Dosi, & J. E. Stiglitz, eds. *Industrial Policy and Development: The Political Economy of Capabilities Accumulation*. Oxford: Oxford University Press, pp. 541–560.

Clarke, A. and Dawson, R. (1999). *Evaluation Research: An Introduction to Principles, Methods and Practice*. London: Sage Publications Ltd.

Clarke, D.C., Murrell, P. and Whiting, S.H. (2007). The Role of Law in China's Economic Development. In L. Brandt & T.G. Rawski , eds. *China's Great Economic Transformationpp*. Cambridge: Cambridge University Press. pp. 375–428.

CLPEA (China Logistics and Procurement Education Association). (2010). New Products Added to the Catalogue of Government Procurement of Indigenous Innovation Products in Guangdong (in Chinese). Beijing. [online]. Available from: http://news.clpp.org.cn/newss/content/201004/201017939.html [Accessed August 19, 2013].

Cooke, P., Uranga, M.G. and Etxebarria, G. (1997). Regional Innovation Systems: Institutional and Organisational Dimensions. *Research Policy*, 26(4-5), pp.475–491. [online].

Creswell, J.W. (2007). *Qualitative Inquiry and Research Design: Choosing Among Five Approaches*. 2nd ed. London: Sage Publications.

Creswell, J.W. (2009). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. 3rd ed. Los Angeles: Sage Publications.

CRGSTDS (China Research Group on Science and Technology Development and Strategy). (2011). *China Regional Innovation Capabilities Report 2011 (in Chinese)*. Beijing. [online]. Available from: http://theory.gmw.cn/2011-12/18/content_3199457.htm [Accessed August 6, 2013].

CSES (Centre for Strategy and Evaluation Services) and Oxford Research. (2011). *Final Evaluation of the Lead Market Initiative Final Report*. Kent. [online]. Available from: http://ec.europa.eu/enterprise/policies/innovation/policy/lead-market-initiative/files/final-eval-lmi_en.pdf [Accessed July 20, 2013].

Dahmén, E. (1988). "Development Blocks" in Industrial Economics. *Scandinavian Economic History Review*, 36(1), pp.3–14.

Dalpe, R. (1994). Effects of Government Procurement on Industrial Innovation. *Technology in Society*, 16(1), pp.65–83.

Danermark, B., Ekstrom, M., Jakobsen, L. and Karlsson, J.C. (2002). *Explaining Society: Critical Realism in the Social Sciences*. Abingdon: Routledge.

Datta-Chaudhturi, M. (1990). Market Failure and Government Failure. *The Journal of Economic Perspectives*, 4(3), pp.25–39.

Davies, A. (2011). The National Treatment and Exceptions Provisions of the Agreement on Government Procurement and the Pursuit of Horizontal Policies. In Sue Arrowsmith & R. D. Anderson, eds. *The WTO Regime on Government Procurement Challenge and Reform*. Cambridge: Cambridge University Press, pp. 429–443.

DCMS (Department for Culture Media and Sport). (2009). *Innovation Procurement Plan*. London. [online]. Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/78346/InnovationProcurementPlan.pdf [Accessed August 17, 2013].

Defra (Department for Environment Food and Rural Affairs). (2007). *UK Government Sustainable Procurement Action Plan - Incorporating the Government Response to the Report of the Sustainable Procurement Task Force*. London. [online]. Available from: http://www.thenbs.com/PublicationIndex/DocumentSummary.aspx?PubID=169&DocID=281704 [Accessed August 17, 2013].

DeLeon, P. (2008). The Historical Roots of the Field. In R. E. Goodin, M. Moran, & M. Rein, eds. *The Oxford Handbook of Public Policy*. Oxford: Oxford University Press, pp. 39–57.

Deng, X. (1978). *Speech on the Opening Ceremony of the National Science Conference (in Chinese)*. Beijing. [online]. Available from: http://www.most.gov.cn/ztzl/qgkjdh/qgkjdhbjzl/qgkjdhbjkjdh/bjzl-dh-7801.htm [Accessed August 19, 2013].

Dimitri, N., Dini, F. and Piga, G. (2006). When should procurement be centralized? In Nicola Dimitri, Gustavo Piga, & Giancarlo Spagnolo, eds. *Handbook of Procurement*. Cambridge: Cambridge University Press, pp. 47–81.

DIUS (Department for Innovation Universities & Skills). (2008). *Innovation Nation*. London. [online]. Available from: http://www.bis.gov.uk/assets/BISCore/corporate/MigratedD/ec_group/18-08-C_b.pdf [Accessed August 17, 2013].

DIUS and OGC (Office of Government Commerce). (2007). *Finding and Procuring Innovative Solutions*. London. [online]. Available from: http://www.dfpni.gov.uk/index/procurement-2/cpd/cpd-policy-and-legislation/pp-innovation/ogc-finding_and_procuring_innovative_solutions__3_.pdf [Accessed August 17, 2013].

Easton, G. (2010). Critical Realism in Case Study Research. *Industrial Marketing Management*, 39(1), pp.118–128.

Easton, K.L., McComish, J.F. and Greenberg, R. (2000). Avoiding Common Pitfalls in Qualitative Data Collection and Transcription. *Qualitative Health Research*, 10(5), pp.703–707.

Eberhardt, M., Wang, Z. and Yu, Z. (2013). Intra-National Protectionism in China: Evidence from the Public Disclosure of “Illegal” Drug Advertising. pp.1–19. Centre for the Study of African Economies. [online]. Available from: http://www.nottingham.ac.uk/gep/documents/papers/2013/2013-04.pdf [Accessed August 22, 2013].

EC (European Commission). (2006). *Pre-Commercial Procurement of Innovation A Missing Link in the European Innovation Cycle*. [online]. Available from: ftp://ftp.cordis.europa.eu/pub/fp7/ict/docs/pcp/precommercial-procurement-of-innovation_en.pdf [Accessed July 22, 2013].

EC (European Commission). (2007). Guide on Dealing with Innovative Solutions in Public Procurement - 10 Elements of Good Practice. pp.1–32. Luxembourg. [online]. Available from:

http://www.ukmin.lt/uploads/documents/Viesieji%20pirkimai/inovatyvus_Nr1.pdf [Accessed July 22, 2013].

Edler, J. (2010). Demand-Based Innovation Policy. In R. E. Smits, S. Kuhlmann, & P. Shapira, eds. *The Theory and Practice of Innovation Policy An International Research Handbook*. Cheltenham: Edward Elgar, pp. 275–301.

Edler, J. (2013). *Review of Policy Measures to Stimulate Private Demand for Innovation. Concepts and Effects*. Manchester. [online]. Available from: http://www.innovation-policy.org.uk/share/12_Review%20of%20Policy%20Measures%20to%20Stimulate%20Private%20Demand%20for%20Innovation.%20Concepts%20and%20Effects.pdf [Accessed August 22, 2013].

Edler, J., Rigby, J., Hommen, L. and Tsipouri, L. (2005). *Innovation and Public Procurement–Review of Issues at Stake. Study for the European Commission (No ENTR/03/24). Final Report*. [online]. Available from: http://cordis.europa.eu/innovation-policy/studies/full_study.pdf [Accessed August 17, 2013].

Edler, J. and Georghiou, L. (2007). Public Procurement and Innovation—Resurrecting the Demand Side. *Research Policy*, 36(7), pp.949–963.

Edler, J., Corvers, S. and Liu, X. (2008). Public Procurement and Innovation: OECD Experience and Reflections on China. In *OECD Reviews of Innovation Policy: China*. OECD Publishing, pp. 563–594.

Edler, J., Georghiou, L., Blind, K. and Uyarra, E. (2012). Evaluating the Demand Side: New Challenges for Evaluation. *Research Evaluation*, 21(1), pp.33–47.

Edler, J. and Yeow, J. (2013). Connecting Demand and Supply: The Role of Intermediation in Public Procurement of Innovation. In *R&D Management Conference*. Manchester, pp. 1–29.

Edquist, C. (1997). *Systems of Innovation: Technologies, Institutions, and Organizations*. London: Routledge.

Edquist, C. (2001). The Systems of Innovation Approach and Innovation Policy: An Account of the State of the Art. In *DRUID Conference*. Aalborg, pp. 1–24.

Edquist, C. (2011). Design of Innovation Policy through Diagnostic Analysis: Identification of Systemic Problems (or Failures). *Industrial and Corporate Change*, 20(6), pp.1725–1753.

Edquist, C. and Hommen, L. (1999). Systems of Innovation: Theory and Policy for the Demand Side. *Technology in Society*, 21(1), pp.63–79.

Edquist, C. and Hommen, L. (2000). Public Technology Procurement and Innovation Theory. In C. Edquist, L. Hommen & L. Tsipouri, eds. *Public Technology Procurement and Innovation*. Dordrecht: Kluwer Academic Publishers, pp. 5–70.

Edquist, C., Hommen, L. and Tsipouri, L. eds. (2000). *Public Technology Procurement and Innovation*. Dordrecht: Kluwer Academic Publishers.

Edquist, C. and Zabala-Iturriagagoitia, J.M. (2012). Public Procurement for Innovation as Mission-Oriented Innovation Policy. *Research Policy*, 41(10), pp.1757–1769.

Eliadis, P., Hill, M.M. and Howlett, M. eds. (2005). *Designing Government - from Instruments to Governance*. Montreal: McGill-Queen's University Press.

Enderwick, P. (2011). Understanding the Rise of Global Protectionism. *Thunderbird International Business Review*, 53(3), pp.325–336.

Ernst, D. (2002). Global Production Networks and the Changing Geography of Innovation Systems. Implications for Developing Countries. *Economics of Innovation and New Technology*, 11(6), pp.497–523.

EU SME Centre. (2012). *Understanding China's Procurement Processes*. Beijing. [online]. Available from: http://www.eusmecentre.org.cn/content/understanding-china's-procurement-processes [Accessed August 15, 2013].

EUCCC. (2011). *Public Procurement in China: European Business Experiences Competing for Public Contracts in China*. Beijing. [online]. Available from: http://www.publictendering.com/pdf/PPStudyENFinal.pdf [Accessed August 15, 2013].

EUCCC. (2012). Another Disappointing and limited Chinese Offer to Join the Government Procurement Agreement. Beijing. [online]. Available from: http://www.euccc.com.cn/en/press-releases/1739 [Accessed August 19, 2013].

Fagerberg, J., Mowery, D.C. and Nelson, R.R. eds. (2005). *The Oxford Handbook of Innovation*. Oxford: Oxford University Press.

Fagerberg, J. and Godinho, M.M. (2005). Innovation and Catching-up. In J. Fagerberg, D. Mowery, & R. Nelson, eds. *The Oxford Handbook of Innovation*. Oxford: Oxford University Press, pp. 514–542.

Fan, Y. (2002). Questioning Guanxi: Definition, Classification and Implications. *International Business Review*, 11(5), pp.543–561.

Federal Ministry of Education and Research. (2006). *The High-Tech Strategy for Germany*. Bonn. [online]. Available from: http://www.umic.pt/images/stories/publicacoes200801/bmbf_hts_lang_eng.pdf [Accessed August 17, 2013].

Feng, J. (1996). *Ten Years of Madness: Oral Histories of China's Cultural Revolution*. 1st ed. San Francisco: China Books and Periodicals.

Fiorentino, L. (2006). Public Procurement and Competition. In *International Public Procurement Conference Proceedings*. Rome, pp. 847–868.

Flanagan, K., Uyarra, E. and Laranja, M. (2011). Reconceptualising the "Policy Mix" for Innovation. *Research Policy*, 40(5), pp.702–713.

Fleetwood, S. (2005). Ontology in Organization and Management Studies: A Critical Realist Perspective. *Organization*, 12(2), pp.197–222.

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

Freeman, C. (1991). Networks of Innovators: A Synthesis of Research Issues. *Research policy*, 20(5), pp.499–514.

French German and UK Governments. (2004). *Towards An Innovative Europe*. A Paper by the French, German and UK Governments.

Gangopadhyay, K. and Mondal, D. (2012). Does Stronger Protection of Intellectual Property Stimulate Innovation? *Economics Letters*, 116(1), pp.80–82.

GAO (General Accounting Office of the US). (1990). *Case Study Evaluations*. [online]. Available from: http://www.gao.gov/products/PEMD-10.1.9 [Accessed August 17, 2013].

Geng, Y. and Doberstein, B. (2008). Greening Government Procurement in Developing Countries: Building Capacity in China. *Journal of environmental management*, 88(4), pp.932–938.

Georghiou, L. (1998). Issues in the Evaluation of Innovation and Technology Policy. *Evaluation*, 4(1), pp.37–51.

Georghiou, L. (2006). *Effective Innovation Policies for Europe–the Missing Demand-Side*. Helsinki. [online]. Available from: http://vnk.fi/hankkeet/talousneuvosto/tyo-kokoukset/globalisaatioselvitys-9-2006/artikkelit/Georghiou_06-09-20.pdf [Accessed August 18, 2013].

Georghiou, L. (2008). Europe's Research System Must Change. *Nature*, 452(April), pp.935–936.

Georghiou, L. and Roessner, D. (2000). Evaluating Technology Programs: Tools and Methods. *Research Policy*, 29(4-5), pp.657–678.

Georghiou, L., Rigby, J., Amanatidou, E., Belitz, H., Cruz, L. and Edler, J. (2003). *Raising EU R & D Intensity. Improving the Effectiveness of Public Support Mechanisms for Private Sector Research and Development*. Brussels. [online]. Available from: http://ec.europa.eu/invest-in-research/pdf/download_en/report_directmeasures.pdf [Accessed August 18, 2013].

Georghiou, L., Clarysse, B., Steurs, G., Bilsen, V. and Larosse, J. (2004). *"Making the Difference" - The Evaluation of "Behavioural Additionality" of R&D Subsidies*. Brussels. [online]. Available from: http://www.iwt.be/english/iwt-content/iwt-study/48-making-difference-evaluation-behavioural-additionality-rd-subsidies [Accessed August 18, 2013].

Georghiou, L., Li, Y., Uyarra, E. and Edler, J. (2010). *Public Procurement for Innovation in Small European Countries*. Manchester. [online]. Available from: http://ec.europa.eu/environment/gpp/pdf/Public%20Procurement%20for%20Innovation%20in%20Small%20European%20Countries.pdf [Accessed August 17, 2013].

Georghiou, L., Edler, J., Uyarra, E. and Yeow, J. (2013). Policy Instruments for Public Procurement of Innovation: Choice, Design and Assessment. *Technological Forecast and Societal Change*, (forthcoming), pp.1–22.

Geroski, P.A. (1990). Procurement Policy as A Tool of Industrial Policy. *International Review of Applied Economics*, 4(2), pp.182–198.

Gok, A. and Edler, J. (2012). The Use of Behavioural Additionality Evaluation in Innovation Policy Making. *Research Evaluation*, 21(4), pp.306–318.

Golafshani, N. (2003). Understanding Reliability and Validity in Qualitative Research. *The Qualitative Report*, 8(4), pp.597–606.

Gold, T., Guthrie, D. and Wank, D. eds. (2002). *Social Connections in China, Institutions, Culture and the Changing Nature of Guanxi*. Cambridge: Cambridge University Press.

Golley, J. and Song, L. (2010). Chinese Economic Reform and Development: Achievements, Emerging Challenges and Unfinished Tasks. In R. Garnaut, J. Golley, & L. Song, eds. *China: the Next Twenty-Years of Reform and Development*. Canberra: Australian National University E Press, pp. 1–15.

Gong, H., Wang, M.Q. and Wang, H. (2013). New Energy Vehicles in China: Policies, Demonstration, and Progress. *Mitigation and Adaptation Strategies for Global Change*, 18(2), pp.207–228.

Gong, T. (2006). Corruption and Local Governance: the Double Identity of Chinese Local Governments in Market Reform. *The Pacific Review*, 19(1), pp.85–102.

Gore, C. (2000). The Rise and Fall of the Washington Consensus as A Paradigm for Developing Countries. *World Development*, 28(5), pp.789–804.

GPA. (1994). *The Plurilateral Agreement on Government Procurement. World Trade Organization*. [online]. Available from: http://www.wto.org/english/tratop_e/gproc_e/gp_gpa_e.htm [Accessed August 18, 2013].

Grand, J. (1991). The Theory of Government Failure. *British journal of political science*, 21(4), pp.423–442.

Granstrand, O. (1984). *Technology Procurement as a Special Form of Buyer-seller Interaction in Industrial Marketing*. Department of Industrial Management, Chalmers University of Technology.

Gu, S. and Lundvall, B. (2006). *China's Innovation System and the Move Toward Harmonious Growth and Endogenous Innovation*. Danish Research Unit for Industrial Dynamics (DRUID), Aalborg. [online]. Available from: http://www3.druid.dk/wp/20060007.pdf [Accessed August 18, 2013].

Gu, S., Lundvall, B.Å., Liu, J., Malerba, F. and Serger, S.S. (2009). China's System and Vision of Innovation: An Analysis in Relation to the Strategic Adjustment and the Medium- to Long-Term S&T Development Plan (2006–20). *Industry & Innovation*, 16(4-5), pp.369–388.

Guangdong Provincial Government. (2009). *Plan on Adjustment and Revitalisation of Automobile Industry in Guangdong Province (2009-2015) (in Chinese)*. Policy code Yuefu[2009]77. Guangzhou. [online]. Available from: http://www.gdei.gov.cn/zwgk/jmzk/gdjm/200910/200910/t20091023_80476.html [Accessed August 18, 2013].

Guangdong Provincial Government. (2010). *Guangdong Action Plan on Electric Vehicles (in Chinese)*. Policy code Yuefuhan[2010]50. Guangzhou. [online]. Available from: http://zwgk.gd.gov.cn/006939748/201003/t20100324_11790.html [Accessed August 18, 2013].

Guo Y. (2013). Zhongguancun Government Procurement Solves Problems Faced by Firms (in Chinese). *Economic Information*, pp.1–2. Beijing. [online]. Available from: http://dz.jjckb.cn/www/pages/webpage2009/html/2013-03/28/content_72905.htm?div=-1 [Accessed August 6, 2013].

Guy, K., Boekholt, P., Cunningham, P., Hofer, R., Nauwelaers, C. and Rammer, C. (2009). *Designing Policy Mixes - Enhancing Innovation System Performance and R&D Investment Levels*. Brussels. [online]. Available from: http://ec.europa.eu/research/policymix/userfiles/file/uploadeddocs/task3-methodology deliverable-26.03.091.pdf [Accessed August 9, 2013].

Hakansson, H. and Snehota, I. (1989). No Business Is An Island: the Network Concept of Business Strategy. *Scandinavian Journal of Management*, 5(3), pp.187–200.

Hamwey, R.M. (2005). *Expanding National Policy Space for Development: Why the Multilateral Trading System Must Change*. The South Centre. [online]. Available from: http://www.southcentre.org/index.php?option=com_content&task=view&id=336 [Accessed August 19, 2013].

Hanley, A., Liu, W. and Vaona, A. (2011). *Financial Development and Innovation in China: Evidence from the Provincial Data*. Kiel Institute for the World Economy, Kiel.

Harrison, A. (2002). Case Study Research. In D. Partington, ed. *Essential Skills for Management Research*. London: Sage Publications, pp. 158–180.

Hartley, J. (2004). Case study research. In C. Cassell & G. Symon, eds. *Essential Guide to Qualitative Methods in Organizational Research*. London: Sage Publications, pp. 323–333.

Heimer, M. and Thogersen, S. eds. (2006). *Doing Fieldwork in China*. Honolulu: University of Hawaii Press.

Hekkert, M.P., Suurs, R.A.A., Negro, S.O., Kuhlmann, S. and Smits, R.E.H.M. (2007). Functions of Innovation Systems: A New Approach for Analysing Technological Change. *Technological Forecasting and Social Change*, 74(4), pp.413–432.

Helmke, G. and Levitsky, S. (2004). Informal Institutions and Comparative Politics: A Research Agenda. *Perspectives on Politics*, 2(04), pp.725–740.

Herbig, P. and Dunphy, S. (1998). Culture and Innovation. *Cross Cultural Management: An International Journal*, 5(4), pp.13–21.

Hill, M. (1997). *The Policy Process in the Modern State*. 3rd ed. Essex: Prentice Hall.

Hill, M. and Hupe, P. (2009). *Implementing Public Policy: An Introduction to the Study of Operational Governance*. 2nd ed. London: Sage Publications.

Hjern, B. and Porter, D. (1981). Implementation Structures: A New Unit of Administrative Analysis. *Organization Studies*, 2(3), pp.211–227.

Hoekman, B. (2004). Operationalizing the Concept of Policy Space in the WTO: Beyond Special and Differential Treatment. In *Third Annual Conference on Preparing the Doha Development Round – WTO Negotiators Meet the Academics*. Fiesole. [online]. Available from: http://www.ycsg.yale.edu/focus/gta/operationalizing.pdf [Accessed August 19, 2013].

Hommen, L. and Rolfstam, M. (2009). Public Procurement and Innovation: towards A Taxonomy. *Journal of Public Procurement*, 9(1), pp.17–56.

Hood, C. (1995). The "New Public Management" in the 1980s: Variations on a Theme. *Accounting, Organizations and Society*, 20(2-3), pp.93–109.

Howells, J. (2006). Intermediation and the Role of Intermediaries in Innovation. *Research policy*, 35, pp.715–728.

Howlett, M. (2005). What is A Policy Instrument? Policy Tools, Policy Mixes, and Policy-Implementation Styles. In P. Eliadis, M. M. Hill, & M. Howlett, eds. *Designing Government: From Instruments to Governance*. Montreal: McGill-Queen's University Press, pp. 31–50.

Howlett, M. and Rayner, J. (2007). Design Principles for Policy Mixes: Cohesion and Coherence in "New Governance Arrangements". *Policy and Society*, 26(4), pp.1–18.

Hu, B. (2013). *Informal Institutions and Rural Development in China*. Abingdon: Routledge.

Hu, J. (2006). *Work Hard to Build an Innovative Nation Through the Pathway of Indigenous Innovation with Chinese Characteristics - Speech at the National Science Conference (in Chinese)*. Beijing. [online]. Available from: http://www.chinamil.com.cn/site1/images/2006-01/10/jfjb02b110b.pdf [Accessed August 12, 2013].

Huang, C., Amorim, C., Spinoglio, M., Gouveia, B. and Medina, A. (2004). Organization, Programme and Structure: An Analysis of the Chinese Innovation Policy Framework. *R&D Management*, 34(4), pp.367–387.

Huang, S., Wu, Z. and Hong, L. (2012). *The 2011 Annual Report on New Energy Coaches Demonstration Programme in China (in Chinese)*. Beijing. [online]. Available from: http://www.d1ev.com/news-10333/ [Accessed August 17, 2013].

Huang, X., Xiao, K. and Shen, Y. (2010). Recent Advances in Membrane Bioreactor Technology for Wastewater Treatment in China. *Frontiers of Environmental Science & Engineering in China*, 4(3), pp.245–271.

ICTSD (International Centre for Trade and Sustainable Development). (2012). China to Table New Government Procurement Agreement Offer by Year's End. *Bridges Weekly Trade News Digest*, 16(29). [online]. Available from: http://ictsd.org/i/news/bridgesweekly/139008/ [Accessed August 18, 2013].

ISA (International Solid-state-lighting Alliance). (2012). *Global Solid State Lighting Outlook 1*. Beijing. [online]. Available from: http://www.efchina.org/csepupfiles/news/20134321446436.267596294614.pdf/GSO report 20130403 en.pdf [Accessed August 17, 2013].

Izsak, K. and Edler, J. (2011). *Trends and Challenges in Demand- Side Innovation Policies in Europe*. Thematic Report 2011 under Specific Contract for the Integration of INNO Policy TrendChart with ERAWATCH (2011- 2012). Brussels.

Jiangxi Government. (2006). *Supporting Policies for Implementing the Provincial Medium- and Long-term Programme for Science and Technology Development (2006-2020) in Jiangxi (in Chinese)*. Policy code Ganfufa[2006]16. Nanchang. [online]. Available from: http://www.jxstc.gov.cn/ReadNews.asp?NewsID=1836 [Accessed August 15, 2013].

Jin, Y. (2007). Transitions in China's Economic Growth: Realities and Challenges. *Journal of the Washington Institute of China Studies*, 2(2), pp.1–11.

Jinan Government. (2009a). *Plan on Adjusting and Revitalizing Automobile Industry in Jinan City (2009-2011) (in Chinese)*. Jinan. [online]. Available from: http://www.jinan.gov.cn/art/2009/7/7/art_76_190243.html [Accessed July 17, 2013].

Jinan Government. (2009b). *Plan on Development of New Energy Industry in Jinan (2009-2011) (in Chinese)*. Jinan. [online]. Available from: http://www.jinan.gov.cn/art/2009/7/13/art_76_190765.html [Accessed July 17, 2013].

Johnson, B.H. (1992). Institutional Learning. In B.-Å. Lundvall, ed. *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning*. London: Anthem Press, pp. 23–44.

Johnson, C.A. (1982). *MITI and the Japanese Miracle*. Stanford: Stanford University Press.

Jordan, G.B. (2010). A Theory-based Logic Model for Innovation Policy and Evaluation. *Research Evaluation*, 19(4), pp.263–273.

JSRSRC (Jiang Su Ren Shi Ren Cai). (2006). Rail Transport - Human Resources Development Catches up with "Metro Speed" (in Chinese). *Newspaper of Talent Market*. [online]. Available from: http://www.jsrsrc.gov.cn/html/2006-9/11093.html [Accessed August 19, 2013].

Jungbluth, C.F. and Hauschild, H. (2012). Don't Go Protectionist! Trade and Investment Relations between the EU and China. *Asia Policy Brief*, 1, pp.1–8.

Kalvet, T. and Lember, V. (2010). Risk Management in Public Procurement for Innovation: the Case of Nordic-Baltic Sea Cities. *Innovation - The European Journal of Social Science Research*, 23(3), pp.241–262.

Kashap, S. (2004). Public Procurement as a Social, Economic and Political Policy. In *International Public Procurement Conference Proceedings*. Florida, pp. 133–147.

Kattel, R. (2010). Trade, Innovation, Finance: Towards a Taxonomy of Knowledge Governance Regimes. In *Trade, Innovation Policy and Small States: A Professional Training Programme*. Barbados, pp. 1–30. [online]. Available from: http://hum.ttu.ee/failid/misc/kattel knowledge governance barbados.pdf [Accessed August 18, 2013].

Kattel, R. and Lember, V. (2010). *Public Procurement as an Industrial Policy Tool – an Option for Developing Countries?* Tallinn University of Technology, Tallinn.

Khorana, S. and Subramanian, S. (2012). Potential Accession to the WTO Government Procurement Agreement: A Case-Study on India. *Journal of International Economic Law*, 15(1), pp.287–309.

Kim, L. (1997). *Imitation to Innovation: Dynamics of Korea Technological Learning*. Boston: Harvard Business School Press.

King, N. (2004a). Using Interviews in Qualitative Research. In C. Cassell & G. Symon, eds. *Essential Guide to Qualitative Methods in Organizational Research*. London: Sage Publications, pp. 11–22.

King, N. (2004b). Using Templates in the Thematic Analysis of Text. In C. Cassell & G. Symon, eds. *Essential Guide to Qualitative Methods in Organizational Research*. London: Sage Publications, pp. 256–270.

Kline, S. and Rosenberg, N. (1986). An Overview of Innovation. In R. Landau & Natha, eds. *The Positive Sum Strategy: Harnessing Technology for Economic Growth*. Washington D.C.: National Academy Press, pp. 275–306.

Kline, S.J. (1985). Innovation Is Not A Linear Process. *Research Management*, 28(4), pp.36–45.

Knapp, L. (1961). The Buy American Act: A Review and Assessment. *Columbia Law Review*, 61(3), pp.430–462.

Kok, W., Bausch, R., FitzGerald, N., Vegara, A.G., Hutton, W., Idrac, A.-M., Lundby-Wedin, W., Mirow, T., Moldan, B., Paganetto, L., Rosati, D., Sundbäck, V. and Verzetnitsch, F. (2004). *Facing the Challenge - The Lisbon strategy for growth and employment. Report from the High Level Group*. Luxembourg.

Kono, D.Y. and Rickard, S.J. (2010). Buying National: Preferential Trade Agreements and Public Procurement. In *Workshop on The Politics of Preferential Trade Agreements: Theory, Measurement, and Empirical Applications*. Princeton, pp. 1–43.

Krueger, A. (1990). Government Failures in Development. *The Journal of Economic Perspectives*, 4(3), pp.9–23.

Kvale, S. (1983). The Qualitative Research Interview. *Journal of Phenomenological Psychology*, 14(1), pp.171–196.

Kvale, S. (2007). *Doing Interviews*. London: Sage Publications.

Lanoie, P., Laurent-Lucchetti, J., Johnstone, N. and Ambec, S. (2011). Environmental Policy, Innovation and Performance: New Insights on the Porter Hypothesis. *Journal of Economics and Management Strategy*, 20(3), pp.803–842.

Lao, Z., Chen, L. and Yang, R. (2009). *Operational Guidance of the Indigenous Innovation Products Government Procurement Mechanism (in Chinese)*. Guangzhou: Nanfang Daily Press.

Larch, M. and Lechthaler, W. (2011). Why "Buy American" is a Bad Idea but Politicians Still Like It. *Canadian Journal of Economics*, 44(3), pp.838–858.

Ledeneva, A. (2008). Blat and Guanxi: Informal Practices in Russia and China. *Comparative Studies in Society and History*, 50(01), pp.118–144.

Lee, K., Jee, M. and Eun, J.-H. (2011). Assessing China's Economic Catch-Up at the Firm Level and Beyond: Washington Consensus, East Asian Consensus and the Beijing Model. *Industry & Innovation*, 18(5), pp.487–507.

Lember, V., Kalvet, T., Kattel, R., Penna, C. and Suurna, M. (2007). *Public Procurement for Innovation in Baltic Metropolises*. Tallinn: Tallinn University of Technology.

Lerner, J. (2009). The Empirical Impact of Intellectual Property Rights on Innovation: Puzzles and Clues. *The American Economic Review*, 99(2), pp.343–348.

LGP. (2002). *The Government Procurement Law of the People's Republic of China*. Order of the President No.68. Beijing. [online]. Available from: http://www.gov.cn/english/laws/2005-10/08/content_75023.htm [Accessed August 11, 2013].

Li, J., Shi, P. and Hu, G. (2010). *China Wind Power Outlook 2010*. Beijing/Brussels. [online]. Available from: http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:CHINA+WIND+POWER+OUTLOOK+2010#0 [Accessed August 6, 2013].

Li, L. (2008). The Evolution of China's Science and Technology Policy, 1975-2007. In *OECD Reviews of Innovation Policy: China*. OECD Publishing, pp. 381–394.

Li, X. (2009). China's Regional Innovation Capacity in Transition: An Empirical Approach. *Research Policy*, 38(2), pp.338–357.

Li[a], Y. (2011). Public Procurement as A Demand-side Innovation Policy Tool in China - A National Level Case Study. In *DRUID Society Conference 2011 on Innovation, Strategy, and Structure*. Copenhagen.

Li[a], Y. and Georghiou, L. (2013). *Accrediting and Signalling New Technology – Use of Procurement for Innovation in China (work in progress)*. Manchester.

Li[a], Y., Georghiou, L. and Rigby, J. (2013). Public Procurement for Innovation Elements in the Chinese New Energy Vehicles Programme. In C. Edquist, N. S. Vonortas, & J. M. Zabala-Iturriagagoitia, eds. *Public Procurement for Innovation (forthcoming)*.

Li[b], Y. (no relation). (2011). Zhongguancun Innovation Platform is Leading a New Mode of Government Procurement (in Chinese). *Invest Beijing*, pp.75–76.

Lieberthal, K. and Oksenberg, M. (1988). *Policy Making in China: Leaders, Structures, and Processes*. Princeton: Princeton University Press.

Lin, J. and Wang, X. (2012). A Research on Automobile Industry Innovation Capability in China. In *IEEE International Conference on Computer Science and Automation Engineering (CSAE)*. Zhangjiajie: IEEE, pp. 600–603.

Linarelli, J. (2011). Global Procurement Law in Times of Crisis: New Buy American Policies and Options in the WTO Legal System. In Sue Arrowsmith & R. D. Anderson, eds. *The WTO Regime on Government Procurement: Challenge and Reform*. Cambridge: Cambridge University Press, pp. 773–802.

Lipsky, M. (1978). Standing the Study of Public Policy Implementation on its Head. In W. D. Burnham & M. W. Weinberg, eds. *American politics and public policy*. MIT Press, pp. 391–402.

Liu, F., Simon, D.F., Sun, Y.-T. and Cao, C. (2011). China's Innovation Policies: Evolution, Institutional Structure, and Trajectory. *Research Policy*, 40(7), pp.917–931.

Liu, X. and White, S. (2001). Comparing Innovation Systems: A Framework and Application to China's Transitional Context. *Research Policy*, 30(7), pp.1091–1114.

Liu, X. (2009). National Innovation Systems in Developing Countries: The Chinese National Innovation System in Transition. In B.-Å. Lundvall et al. eds. *Handbook of Innovation Systems and Developing Countries - Building Domestic Capabilities in a Global Setting*. Cheltenham: Edward Elgar Publishing, pp. 119–139.

Liu, X. and Cheng, P. (2011). *Is China's Indigenous Innovation Strategy Compatible with Globalization?* Honolulu: East-West Centre. [online]. Available from: http://www.eastwestcentre.org/sites/default/files/private/ps061.pdf [Accessed August 16, 2013].

Liu, Y. and Kokko, A. (2010). Wind Power in China: Policy and Development Challenges. *Energy Policy*, 38(10), pp.5520–5529.

Lorenz, O., Lange, M., Blind, K., Weber, M. and Krohn, W. (2009). *The "Purchasing State" as a Driver of Innovation - Development potential and necessities relative to more-innovative procurement in Germany's public procurement sector*. Berlin.

LTB. (1999). *The Tendering And Bidding Law Of The People's Republic Of China*. Decree No.21 of the President of the People's Republic of China. Beijing. [online]. Available from: http://www.chinabidding.org/law/860522 [Accessed August 16, 2013].

Luckey, J.R. (2009). *The Buy American Act: Requiring Government Procurements to Come from Domestic Sources*. Washington, D.C. [online]. Available from: http://digital.library.unt.edu/ark:/67531/metacrs10532/ [Accessed August 19, 2013].

Lundvall, B.-Å. (1985). *Product Innovation and User-producer Interaction*. Aalborg University. [online]. Available from: http://vbn.aau.dk/files/7556474/user-producer.pdf [Accessed August 14, 2013].

Lundvall, B.-Å. (1988). Innovation as An Interactive Process: From User-Producer Interaction to the National System of Innovation. In G. Dosi et al., eds. *Technical Change and Economic Theory*. Pisa: Laboratory of Economics and Management (LEM), Sant'Anna School of Advanced Studies, pp. 349–369.

Lundvall, B.-Å. (1992a). Introduction. In B.-Å. Lundvall, ed. *National Systems of Innovation - Towards a Theory of Innovation and Interactive Learning*. London: Anthem Press, pp. 1–19.

Lundvall, B.-Å. ed. (1992b). *Natinal Systems of Innovation - Towards a Theory of Innovation and Interactive Learning*. London: Anthem Press.

Lundvall, B.-Å. and Borrás, S. (2005). Science , Technology and Innovation Policy. In J. Fagerberg, D.C. Mowery, & R.R. Nelson, eds. *The Oxford Handbook of Innovation*. Oxford: Oxford University Press, pp. 599–631.

Lundvall, B.-Å., Joseph, K.J., Chaminade, C. and Vang, J. eds. (2009). *Handbook of Innovation Systems and Developing Countries - Building Domestic Capabilities in a Global Setting*. Cheltenham: Edward Elgar Publishing.

Luo, Z. (2009). Jiangsu and Shandong Published <Indigenous Innovation Product Catalogue', Not Confined to Government Procurement Areas (in Chinese). *Government Procurement Information*. [online]. Available from: http://www.caigou2003.com/law/llr/20090211/llr_128341.html [Accessed August 18, 2013].

Lv, H. and Lu, L. (2012). The Third Offer Submitted - Regional Government Procurement Market Opened (in Chinese). *Economic Monthly*, 11, pp.164–165.

Ma, G. (2009). Say "No" to Domestic Products Discrimination. *Global Times*. [online]. Available from: http://www.globaltimes.cn/opinion/editorial/2009-06/436447.html [Accessed August 19, 2013].

Ma, T. (2009). China's Informal Institutions: the Case of Private Enterprise in Wenzhou. *Journal of the Washington Institute of China Studies*, 4(3), pp.85–94.

Magnus, G. (2013). China's National Problems Start in Local Government. *Financial Times*. [online]. Available from: http://www.ft.com/cms/s/0/e898e1c0-bef2-11e2-87ff-00144feab7de.html#axzz2VANYHRPr [Accessed August 18, 2013].

Malerba, F. and Nelson, R. (2011). Learning and Catching up in Different Sectoral Systems: Evidence from Six Industries. *Industrial and Corporate Change*, 20(6), pp.1645–1675.

Malerba, F., Nelson, R., Orsenigo, L. and Winter, S. (2007). Demand, Innovation, and the Dynamics of Market Structure: The Role of Experimental Users and Diverse Preferences. *Journal of Evolutionary Economics*, 17(4), pp.371–399.

Manca, B.F. (2009). Technology Catching-up and the Role of Institutions. pp.1–40. Research Institute of Applied Economics. [online]. Available from: http://www.ub.edu/irea/working_papers/2009/200912.pdf [Accessed August 17, 2013].

March, J. and Olsen, J. (2008). The Logic of Appropriateness. In M. Moran, M. Rein, & R. E. Goodin, eds. *The Oxford Handbook of Public Policy*. Oxford: Oxford University Press, pp. 689–708.

Marks, D. (2010). China's Climate Change Policy Process: Improved but Still Weak and Fragmented. *Journal of Contemporary China*, 19(67), pp.971–986.

Marsh, P. (2012). Mittal Urges "Buy European" Programme. *Financial Times*. [online]. Available from: http://www.ft.com/cms/s/0/32c8497a-9a96-11e1-9c98-00144feabdc0.html#axzz2X3BPX9XS [Accessed August 18, 2013].

Martin, M.F. (2010). *Understanding China's Political System*. Congressional Research Service.[online]. Available from: http://assets.opencrs.com/rpts/R41007_20100414.pdf [Accessed August 16, 2013].

Matland, R.E. (1995). Synthesizing the Implementation Literature: The Ambiguity-Conflict Model of Policy Implementation. *Journal of Public Administration Research and Theory*, 5(1986), pp.145–174.

Maxwell, J.A. (2005). *Qualitative Research Design: An Interactive Approach*. 2nd ed. London: Sage Publications.

Mayer, J. (2009). Policy Space: What, for What, and Where? *Development Policy Review*, 27(4), pp.373–395.

Mazmanian, D.A. and Sabatier, P.A. (1983). *Implementation and Public Policy*. Glenview: Scott Foresman.

McCleery, R.K. and De Paolis, F. (2008). The Washington Consensus: A Post-Mortem. *Journal of Asian Economics*, 19(5-6), pp.438–446.

McCrudden, C. (2004). Using Public Procurement to Achieve Social Outcomes. *Natural Resource Forum*, 28(4), pp.257–267.

McCrudden, C. (2007). *Buying Social Justice: Equality, Government Procurement and Legal Change*. Oxford: Oxford University Press.

McDonald, S., Daniels, K. and Harris, C. (2004). Cognitive Mapping in Organizational Research. In C. Cassell & G. Symon, eds. *Essential Guide to Qualitative Methods in Organizational Research*. London: Sage Publications, pp. 73–85.

McGregor, J. (2010). *China's Drive for "Indigenous Innovation" - A Web of Industrial Policies*. APCO Worldwide. [online]. Available from: http://www.uschamber.com/sites/default/files/reports/100728chinareport_0.pdf [Accessed August 17, 2013].

Meléndez-Ortiz, R., Bellmann, C. and Mendoza, M.R. eds. (2012). *The Future and the WTO: Confronting the Challenges - A Collection of Short Essays*. Geneva: International Centre for Trade and Sustainable Development (ICTSD).

Metcalfe, J.S. (1995). Technology Systems and Technology Policy in an Evolutionary Framework. *Cambridge Journal of Economics*, 19(1), pp. 25-46.

METI (Ministry of Economy Trade and Industry Japan). (2010). *Announcement of Master Plans for the Demonstration of Next-Generation Energy and Social Systems*. [online]. Available from: http://www.meti.go.jp/english/press/data/20100811_01.html [Accessed August 19, 2013].

MIIT, MOST, MOF and SASAC. (2009). *Guiding Catalogue for Indigenous Innovation in Major Technological Equipment (version 2009) (in Chinese)*. Beijing. [online]. Available from: http://www.miit.gov.cn/n11293472/n11293832/n11293907/n11368223/12937690.html [Accessed August 19, 2013].

MIIT, MOST, MOF and SASAC. (2012). *Guiding Catalogue for Indigenous Innovation in Major Technological Equipment (version 2012) (in Chinese)*. Beijing. [online]. Available from: http://www.miit.gov.cn/n11293472/n11293832/n11293907/n11368223/14458181.html [Accessed August 19, 2013].

Miles, M.B. and Huberman, A.M. (1994). *Qualitative Data analysis: An Expanded Sourcebook*. 2nd ed. London: Sage Publications.

Ministry of Commerce. (2010). MOST Welcomes Foreign-invested Enterprises to Apply for Accreditation of National Indigenous Innovation Products (in Chinese). Beijing. [online]. Available from: http://www.mofcom.gov.cn/article/zt_chanyejishu/other/201007/20100707049862.shtml [Accessed August 18, 2013].

MOF, NDRC, MIIT, General Administration of Customs of the People's Republic of China and State Administration of Taxation and National Energy Board. (2009). *Circular on Adjusting Import Taxation Policy for Key Technological Equipment (in Chinese)*. Policy code Caiguanshui[2009]55. Beijing. [online]. Available from: http://gss.mof.gov.cn/zhengwuxinxi/zhengcefabu/200909/t20090904_203868.html [Accessed August 17, 2013].

MOF, MOST, MIIT and NDRC. (2010a). *Circular on Conducting Pilot Projects for Private Consumer Subsidies of New Engery Vehicles (in Chinese)*. Policy code Caijian[2010]230. Beijing. [online]. Available from: http://www.sdpc.gov.cn/zcfb/zcfbqt/2010qt/t20100603_351147.htm [Accessed August 17, 2013].

MOF, MOST, MIIT and NDRC. (2010b). *Circular on Increasing the Number of Cities for Demonstration and Promotion of New Energy Vehicles in the Public Section (in Chinese)*. Policy code Caijian[2010]434. Beijing. [online]. Available from: http://www.jscz.gov.cn/pub/jscz/zfxxgk/zfxxgkml/ywgz/dwgnywwj/201104/t20110422_20461.html [Accessed August 18, 2013].

MOF. (2011). *Notice on Terminating the Implementation of Three Policy Measures Including <Administrative Measures on Budget Management for Government Procurement of Indigenous Innovation Products> (in Chinese)*. Policy code Caiku[2011]85. Beijing. [online]. Available from: http://gks.mof.gov.cn/redianzhuanti/zhengfucaigouguanli/201106/t20110628_567649.html [Accessed August 18, 2013].

MOF and MIIT. (2011). *Interim Measures on Government Procurement Promoting the Development of SMEs (in Chinese)*. Policy code Caiku[2011]181. Beijing. [online]. Available from: http://gks.mof.gov.cn/zhengfuxinxi/guizhangzhidu/201112/t20111231_620727.html [Accessed August 18, 2013].

MOF and MOST. (2009). *Circular on Conducting Pilot Projects for Demonstration and Promotion of NEVs (in Chinese)*. Policy code Caijian[2009]6. Beijing. [online]. Available from: http://jjs.mof.gov.cn/zhengwuxinxi/zhengcefagui/200902/t20090205_111617.html [Accessed August 18, 2013].

Morlacchi, P. and Martin, B.R. (2009). Emerging Challenges for Science, Technology and Innovation Policy Research: A Reflexive Overview. *Research Policy*, 38(4), pp.571–582.

Mosoti, V. (2004). The WTO Agreement on Government Procurement: A Necessary Evil in the Legal Strategy for Development in the Poor World? *University of Pennsylvania Journal of International Economic Law*, 25(2), pp.593–638.

MOST. (2009). Pilot Projects for “Ten Cities, Ten Thousand of Lights” Semiconductor Lighting Application Have Started by the Ministry (in Chinese). Beijing. [online]. Available from: http://www.most.gov.cn/kjbgz/200905/t20090507_69046.htm [Accessed August 19, 2013].

MOST. (2013). The Number of New Energy Vehicles Promoted in Our Country is Expected to Reach 40,000 by March (in Chinese). *S&T Daily*. [online]. Available from: http://www.most.gov.cn/ztzl/kjzjbxsh/kjzjbxmt/201302/t20130204_99599.htm [Accessed August 19, 2013].

MOST, NDRC and MOF. (2011). *Notice on Terminating the Implementation of <Administrative Measures on the Accreditation of National Indigenous Innovation Products (Trial)> (in Chinese)*. Beijing. [online]. Available from: http://www.zfcg.sz.gov.cn/zxtz/szfcgtz/201107/t20110715_1677073.htm [Accessed August 19, 2013].

Motohashi, K. and Yun, X. (2007). China’s Innovation System Reform and Growing Industry and Science Linkages. *Research Policy*, 36(8), pp.1251–1260.

Mowery, D., and Rosenberg, N. (1979). The Influence of Market Demand Upon Innovation: a critical review of some recent empirical studies. *Research Policy*, *8*(2), 102–153.

Muchhala, B. (2007). *The Policy Space Debate: Does a Globalized and Multilateral Economy Constrain Development Policies?* Washington, D.C. [online]. Available from: http://www.wilsoncentre.org/sites/default/files/asia_136FINAL.pdf [Accessed August 15, 2013].

Myoken, Y. (2010). Demand-orientated Policy on Leading-edge Industry and Technology: Public Procurement for Innovation. *International Journal of Technology Management*, 49(1/2/3), pp.196–219.

Mytelka, L.K. and Smith, K. (2002). Policy Learning and Innovation Theory: an Interactive and Co-evolving Process. *Research Policy*, 31(8-9), pp.1467–1479.

Müller, A. (2011). Special and Differential Treatment and other Special Measures for Developing Countries under the Agreement on Government Procurement: the Current Text and New Provisions. In S. Arrowsmith & R. D. Anderson, eds. *The WTO Regime on Government Procurement: Challenge and Reform*. Cambridge: Cambridge University Press, pp. 339–376.

NDRC. (2005). *Interim Measures for Inter-Ministry Coordination of Public Tendering and Bidding (in Chinese)*. Policy code Fagaifagui[2005]1282. Beijing. [online]. Available from: http://www.sdpc.gov.cn/zcfb/zcfbtz/zcfbtz2005/t20050721_37698.htm [Accessed August 17, 2013].

NDRC. (2013). *Deepen the Reforms with More Courage and Wisdom (in Chinese)*. Beijing. [online]. Available from: http://www.gov.cn/gzdt/2013-05/30/content_2415313.htm [Accessed August 17, 2013].

NDRC, MOST, MOF and COSTIND. (2008). *Administrative Measures on First (set of) Major Technology Equipment Experiments and Demonstration Projects(in Chinese)*. Policy code Fagaigongye[2008]224. Beijing. [online]. Available from: http://www.gov.cn/ztzl/kjfzgh/content_883867.htm [Accessed August 17, 2013].

NDRC and the Ministry of Environment Protection. (2010). *Catalogue of Recommended Environment Protection Device (Products) 2010 (in Chinese)*. Beijing. [online]. Available from: http://www.sdpc.gov.cn/zcfb/zcfbgg/2010gg/t20100507_345480.htm [Accessed August 17, 2013].

NDRC, Ministry of Housing and Urban-Rural Development and Ministry of Transport. (2010). *Notice on Organizing the Application for Semiconductor Lighting Products Demonstration Projects (in Chinese)*. Policy code Fagaibanhuanzi[2010]2082. Beijing. [online]. Available from: http://www.sdpc.gov.cn/zcfb/zcfbtz/2010tz/t20100901_369038.htm [Accessed August 17, 2013].

NDRC, MOST, MIIT, MOF, Ministry of Housing and Urban-Rural Development and General Administration of Quality Supervision Inspection and Quarantine.

(2013). *Semiconductor Lighting Industry Plan (in Chinese)*. Policy code Fagaibanhuanzi[2013]188. Beijing. [online]. Available from: http://www.gov.cn/zwgk/2013-02/17/content_2333127.htm [Accessed August 17, 2013].

Nelson, R.R. (1981). Research on Productivity Growth and Productivity Differences: Dead Ends and New Departures. *Journal of Economic Literature*, 19(3), pp.1029–1064.

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

Nelson, R.R. (2004). The Challenge of Building An Effective Innovation System for Catch-up. *Oxford Development Studies*, 32(3), pp.365–374.

Nelson, R.R. (2008). What Enables Rapid Economic Progress: What Are the Needed Institutions? *Research Policy*, 37(1), pp.1–11.

Nelson, R.R. and Winter, S.G. (1974). Neoclassical vs. Evolutionary Theories of Economic Growth: Critique and Prospectus. *The Economic Journal*, 84(336), pp.886–905.

Nelson, R.R. and Winter, S.G. (1977). In Search of Useful Theory of Innovation. *Research Policy*, 6, pp.36–76.

Nelson, R.R. and Sampat, B.N. (2001). Making Sense of Institutions as A Factor Shaping Economic Performance. *Journal of Economic Behaviour & Organization*, 44(1), pp.31–54.

Nelson, R.R. and Winter, S.G. (1982). *An Evolutionary Theory of Economic Change*. Cambridge: Harvard University Press.

Nilsson, H. (1994). *Technology Procurement for Market Transformation – A Customer Tool for Sustainable Design and Manufacturing*. Stockholm.

North, D.C. (1991). Institutions. *The Journal of Economic Perspectives*, 5(1), pp.97–112.

NWV. (2011). *Electric Vehicle Demonstration Projects in the United States*. Leesburg. [online]. Available from: http://www.tekes.fi/fi/gateway/PTARGS_0_201_403_994_2095_43/http%3b/tekes-ali2%3b7087/publishedcontent/publish/programmes/eve/documents/us_study_on_ev_demonstration.pdf [Accessed August 16, 2013].

Nyiri, L., Osimo, D., Özcivelek, R., Centeno, C. and Cabrera, M. (2007). *Public Procurement for the Promotion of R&D and Innovation in ICT*. Luxembourg. [online]. Available from: http://ftp.jrc.es/EURdoc/eur22671en.pdf [Accessed August 5, 2013].

ODI (Overseas Development Institute). (2007). *Policy Space: Are WTO Rules Preventing Development*. London. [online]. Available from: http://dspace.cigilibrary.org/jspui/handle/123456789/22836 [Accessed August 12, 2013].

OECD. (1999). *Managing National Innovation Systems*. Luxembourg: OECD Publishing.

OECD. (2005a). *Governance in China*. Luxembourg: OECD Publishing.

OECD. (2005b). *Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data*. 3rd ed. Luxembourg: OECD Publishing.

OECD. (2008). *OECD Reviews of Innovation Policy: China*. Luxembourg: OECD Publishing.

OECD. (2010). The Innovation Policy Mix. In *OECD Science, Technology and Industry Outlook 2010*. Luxembourg: OECD Publishing, pp. 251–279.

OECD. (2011a). *Demand-side Innovation Policies*. Luxembourg: OECD Publishing.

OECD. (2011b). *Driving Eco-Innovation: The Role of Demand-Side Policies*. [online]. Available from: http://www.fca.be/NL/Downloads/Documents/2011_OESO_DemandSideEcoInnovation_EN.pdf [Accessed August 19, 2013].

OGC. (2004). *Capturing Innovation - Nurturing Supplier's Ideas in the Public Sector*. London. [online]. Available from: http://www.dfpni.gov.uk/index/procurement-2/cpd/cpd-policy-and-legislation/pp-innovation/ogc-_capturing_innovation.pdf [Accessed August 19, 2013].

OGC. (2008). *An Introduction to Public Procurement*. London. [online]. Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/62060/introduction-public-procurement.pdf [Accessed August 19, 2013].

OGC/HMT. (2008). *Competitive Dialogue in 2008 OGC/HMT Joint Guidance on Using the Procedure*. Norwich. [online]. Available from: http://webarchive.nationalarchives.gov.uk/20110601212617/http:/ogc.gov.uk/documents/OGC_HMT_2008_Guidance_on_Competitive_Dialogue.pdf [Accessed August 19, 2013].

OMC-PTP. (2009). *Exploring Public Procurement as a Strategic Innovation Policy Mix Instrument*. [online]. Available from: http://www.technopolis-group.com/resources/downloads/reports/public_procurement.pdf [Accessed August 19, 2013].

Orb, A., Eisenhauer, L. and Wynaden, D. (2000). Ethics in Qualitative Research. *Journal of Nursing Scholarship*, 33(1), pp.93–96.

O'Brien, R. (2010). China's Indigenous Innovation - Origins, Components and Ramifications. *China Security*, 6(3), pp.51–65.

O'Toole, L.J. (1986). Policy Recommendations for Multi-Actor Implementation: An Assessment of the Field. *Journal of Public Policy*, 6(02), pp.181–210.

Palumbo, D.J. and Calista, D.J. eds. (1990). *Implementation and the Policy Process: Opening Up the Black Box*. Greenwood Press.

Papaconstantinou, G. and Polt, W. (1997). Policy Evaluation in Innovation and Technology: An Overview. In *Policy Evaluation in Innovation and Technology: Towards Best Practices*. Luxembourg: OECD Publishing, pp. 9–14.

Patel, P. and Pavitt, K. (1994). National Innovation Systems: Why They Are Important, and How They Might Be Measured and Compared. *Economics of innovation and new technology*, 3(1), pp.77–95.

Patton, D. (2013). The Rise and Stall of Sinovel. [online]. Available from: http://www.rechargenews.com/magazine/article1302268.ece [Accessed August 19, 2013].

Patton, M.Q. (1987). *How to Use Qualitative Methods in Evaluation*. London: Sage Publications.

Peng, H. (2011). Performance Evaluation and Countermeasures of Government Procurement Supporting Independent Innovation in China (in Chinese). *Science-Technology and Management*, 13(3), pp.1–4.

Peng, M.W. (2013). An Institution-based View of IPR Protection. *Business Horizons*, 56(2), pp.135–139.

Peter, V., Izsak, K., Bruno, N., Castel, J. and Roman, L. (2013). *Developing an Evaluation and Progress Methodology - Final Report*. Technopolis. [online]. Available from: http://ec.europa.eu/enterprise/policies/innovation/files/action-plan-methodology-final-report_en.pdf [Accessed August 19, 2013].

Peters, G. (1998). Managing Horizontal Government: The Politics of Co-Ordination. *Public Administration*, 76(2), pp.295–311.

Piga, G. (2011). A Fighting Chance against Corruption in Public Procurement? In S. Rose-Ackerman & T. Soreide, eds. *International Handbook on the Economics of Corruption, Volume Two*. Cheltenham: Edward Elgar, pp. 141–181.

Pimputkar, S., Speck, J.S., DenBaars, S.P. and Nakamura, S. (2009). Prospects for LED Lighting. *Nature Photonics*, 3(4), pp.180–182.

Poel, M. and Kool, L. (2009). Innovation in Information Society Policy: Rationale, Policy Mix and Impact in The Netherlands. *Info*, 11(6), pp.51–68.

Pressman, J.L. and Wildavsky, A. (1973). *Implementation*. Berkeley: University of California Press.

Punch, K.F. (2005). *Introduction to Social Research: Quantitative and Qualitative Approaches*. 2nd ed. London: Sage Publications.

Qian, Y. (2009). Coping with the Global Economy Recession, Supporting Indigenous Innovation: Proposal on Promoting Loongson based Computers in Education Sector (in Chinese). [online]. Available from: http://tech.qq.com/a/20090305/000155.htm [Accessed August 18, 2013].

Reichardt, C.S. and Cook, T.D. (1979). Beyond Qualitative versus Quantitative Methods. In T. D. Cook & C S Reichardt, eds. *Qualitative and Quantitative Methods in Evaluation Research*. Beverly Hills: Sage Publications, pp. 7–32.

Reiter, B. (2013). The Epistemology and Methodology of Exploratory Social Science Research: Crossing Popper with Marcuse. pp.1–17. [online]. Available from: http://scholarcommons.usf.edu/gia_facpub/99 [Accessed August 19, 2013].

Rigby, J., Boekholt, P., Semple, A., Deuten, J. and Apostol, R. (2012). *Feasibility Study on Future EU Support to Public Procurement of Innovative Solutions: Obtaining Evidence for a Full Scheme*. Manchester. [online]. Available from: http://ec.europa.eu/enterprise/policies/innovation/policy/lead-market-initiative/files/meeting-procurement-feb2012/study-eu-support-public-procurement-innovative-solutions_en.pdf [Accessed August 14, 2013].

Rigby, J. (2013). *Review of Pre-commercial Procurement Approaches and Effects on Innovation*. Manchester. [online]. Available from: http://www.innovation-policy.org.uk/share/13_Review%20of%20Pre-commercial%20Procurement%20Approaches%20and%20Effects%20on%20Innovation.pdf [Accessed August 7, 2013].

Ringeling, A.B. (2005). Instruments in Four: The Elements of Policy Design. In P. Eliadis, M. M. Hill, & M. Howlett, eds. *Designing Government From Instruments to Governance*. Montreal: McGill-Queen's University Press, pp. 185–202.

Robson, C. (2002). *Real World Research: A Resource for Social Scientists and Practitioner-Researchers*. 2nd ed. Oxford: Blackwell Publishing.

Rogers, E.M. (2003). *Diffusion of Innovations*. 5th ed. New York: The Free Press.

Roland, G. (2004). Understanding Institutional Change: Fast-moving and Slow-moving Institutions. *Studies in Comparative International Development*, 38(4), pp.109–131.

Rolfstam, M. (2010). A Tentative Model of A Demand System For Public Procurement of Innovation. In *Proceedings of the International Public Procurement Conference*. Seoul, pp. 1–29.

Rolfstam, M. (2012a). An Institutional Approach to Research on Public Procurement of Innovation. *Innovation: The European Journal of Social Science Research*, 25(3), pp.303–321.

Rolfstam, M. (2012b). Understanding Public Procurement of Innovation: Definitions, Innovation Types and Interaction Modes. *SSRN Electronic Journal*, pp.1–16. [online]. Available from: http://www.ssrn.com/abstract=2011488 [Accessed August 27, 2013].

Rose, R. (1981). What if Anything is Wrong with Big Government? *Journal of Public Policy*, 1(01), pp.5–36.

Rothwell. R. (1983). Creating a Regional Innovation-Oriented Infrastructure: The Role of Public Procurement. In *Conference on Public Procurement and Regional Policy*, Neuchâtel, pp.159-172.

Rothwell, R. (1984). Technology-Based Small Firms and Regional Innovation Potential: The Role of Public Procurement. *Journal of Public Policy*, 4(4), pp.307–332.

Rothwell, R and Zegveld, W. (1981). *Industrial Innovation and Public Policy: Preparing for the 1980s and the 1990s*. London: Francis Pinter Publications.

Rothwell, R. and Zegveld, W. (1985). *Reindustrialization and Technology*. London: Longman Group Limited.

Russell, C. (2010). China Drops "70% Home-Made" Rule for Wind Turbines. *Bloomberg News*. [online]. Available from: http://www.bloomberg.com/apps/news?pid=newsarchive&sid=a6Py.AvPnWu8 [Accessed August 18, 2013]

Sabatier, P.A. (1986). Top-Down and Bottom-Up Approaches to Implementation Research: a Critical Analysis and Suggested Synthesis. *Journal of Public Policy*, 6(01), pp.21–48.

Sabatier, P.A. (1991). Toward Better Theories of the Policy Process. *PS: Political Science and Politics*, 24(2), pp.147–156.

Saetren, H. (2005). Facts and Myths about Research on Public Policy Implementation: Out-of-Fashion, Allegedly Dead, But Still Very Much Alive and Relevant. *Policy Studies Journal*, 33(4), pp.559–582.

Saidur, R., Islam, M.R., Rahim, N.A. and Solangi, K.H. (2010). A Review on Global Wind Energy Policy. *Renewable and Sustainable Energy Reviews*, 14(7), pp.1744–1762.

Sayer, R.A. (1992). *Method in Social Science: A Realist Approach*. 2nd ed. Abingdon: Routledge.

Schapper, P., Malta, J.N.V. and Gilbert, D.L. (2006). An Analytical Framework for the Management and Reform of Public Procurement. *Journal of Public Procurement*, 6(1&3), pp.1–26.

Schmookler, J. (1966). *Invention and Economic Growth*. Cambridge: Harvard University Press.

Schumpeter, J.A. (1934). *The Theory of Economic Development*. Cambridge: Harvard University Press.

Scriven, M. (1994). Types of Theory in Evaluation. *Theories of Evaluation (Newsletter of the AEA Topical Interest Group on Theories of Evaluation)*, 2, pp.1–4.

SEI (Shaanxi Economy Information). (2012). *Review of Provincial/Municipal Economic Achievements 2011 (in Chinese)*. Xi'An. [online]. Available from: http://www.sei.gov.cn/ShowArticle2008.asp?ArticleID=220986 [Accessed August 18, 2013].

Shandong Provincial Government. (2009a). *Administrative Measures on Financial Support of NEV Demonstration Programme in Shandong (Trial) (in Chinese)*. Policy code Luzhengbanfa [2009]130. Jinan. [online]. Available from: http://www2.shandong.gov.cn/art/2009/12/24/art_3883_1406.html [Accessed August 18, 2013].

Shandong Provincial Government. (2009b). *Measures on Accelerating the Development of NEV Industry in Shandong (in Chinese)*. Policy code Luzhengbanfa[2009]64. Jinan. [online]. Available from: http://www.shandong.gov.cn/art/2009/9/7/art_956_3181.html [Accessed August 18, 2013].

Shandong Provincial Government. (2009c). *Measures on Accelerating the Development of New Energy Industry in Shandong (in Chinese)*. Policy code Luzhengfa[2009]140. Jinan. [online]. Available from: http://www.shandong.gov.cn/art/2009/12/24/art_956_3622.html [Accessed August 16, 2013].

Shandong Provincial Government. (2009d). *Plann on Adjusting and Revitalizing Automobile Industry in Shandong (2009-2011) (in Chinese)*. Policy code Luzhengfa[2009]44. Jinan. [online]. Available from: http://www2.shandong.gov.cn/art/2009/4/25/art_3883_1531.html [Accessed August 16, 2013].

Shanghai Government. (2007a). *Shanghai Administrative Measures for Identifying First Major Technology Equipment Programmes (Trial) (in Chinese)*. Shanghai. [online]. Available from: http://www.most.gov.cn/kjzc/kjzcdfgz/dfzcsh/200804/t20080407_60373.htm [Accessed August 16, 2013].

Shanghai Government. (2007b). *Shanghai Implementation Measures on Encouraging the Commercial Breakthrough of First Major Technology Equipment (Trial) (in Chinese)*. Shanghai. [online]. Available from: http://www.most.gov.cn/kjzc/kjzcdfgz/dfzcsh/200804/t20080407_60375.htm [Accessed August 16, 2013].

Sharif, N. (2006). Emergence and Development of the National Innovation Systems Concept. *Research Policy*, 35(5), pp.745–766.

SHEITC. (2007). *Expert Evaluation Results for Shanghai First Major Technological Equipment Breakthrough Programme (Year 2007) (in Chinese)*. Shanghai. [online]. Available from: http://www.sheitc.gov.cn/cyfz/615695.htm [Accessed August 8, 2013].

SHEITC. (2009). *Project List of Shanghai's First Major Technological Equipment Breakthrough Programme (Year 2009) (in Chinese)*. Shanghai. [online]. Available from: http://www.sheitc.gov.cn/res_base/sheitc_gov_cn_www/upload/upload/35587/附件.doc [Accessed August 11, 2013].

Shenzhen Government. (2009a). *Implementation Measures of Building Public Charging Infrastructure for NEVs in Shenzhen (2009-2012) (in Chinese)*. Shenzhen. [online]. Available from: http://paper.ce.cn/jjrb/html/2012-06/12/content_214246.htm [Accessed August 19, 2013].

Shenzhen Government. (2009b). *Plann on Revitalizing and Developing the New Energy Industry in Shenzhen (2009-2015) (in Chinese)*. Policy code Shenfu[2009]240. Shenzhen. [online]. Available from:

http://www.sz.gov.cn/zfgb/2010/gb681/201001/t20100112_1424099.htm [Accessed August 18, 2013].

Shenzhen Government. (2011). *The 12th Five-year Plan on NEV Industry Base in Shenzhen (in Chinese)*. Shenzhen. [online]. Available from: http://news.xinhuanet.com/2010-10/22/c_12688380.htm [Accessed August 19, 2013].

Shi, H. (2012). Superministry Reforms - Analysis Based on Perspectives of Economics (in Chinese). *Journal of Chinese Academy Of Governance*, 5, pp.49–52.

Shields, P. and Tajalli, H. (2006). Intermediate Theory: The Missing Link to Successful Student Scholarship. *Journal of Public Affairs Education*, 12(3), pp.313–334.

SIGMA (Support for Improvement in Governance and Management - a joint initiative of the OECD and the EU). (2011). *Defence Procurement*. [online]. Available from: http://www.oecd.org/site/sigma/publicationsdocuments/49102610.pdf [Accessed August 18, 2013].

Silva, V.G. d. L. e. (2011). Treatment of Small Businesses in Public Procurement in Brazil. *Public Procurement Law Review*, (4), pp.123–133.

SLETA (Shanghai LED Engineering and Technology Association). (2010). *Seminar Organized to Review Shanghai's Progress in LED Demonstration Programme (in Chinese)*. Shanghai. [online]. Available from: http://sleta.shled.org.cn/Item/487.aspx [Accessed August 17, 2013].

Smeds, R. (1994). Managing Change towards Lean Enterprises. *International Journal of Operations & Production Management*, 14(3), pp.66–82.

Smith, K. (2000). Innovation as a Systemic Phenomenon: Rethinking the Role of Policy. *Enterprise & Innovation Management Studies*, 1(1), pp.73–102.

Smith, T., Mcwhirter, J. and Adams, B. (2011). Behind The AMSC/Sinovel Dispute: A Look at IP Law In the U.S. Vs. China. *North American Windpower*. [online]. Available from: http://www.nawindpower.com/e107_plugins/content/content.php?content.8757 [Accessed August 18, 2013].

Smith, T.B. (1973). The Policy Implementation Process. *Policy Sciences*, 4(2), pp.197–209.

Smits, R. and Kuhlmann, S. (2004). The Rise of Systemic Instruments in Innovation Policy. *International Journal of Foresight and Innovation Policy*, 1(1/2), pp.4–32.

Smyth, R. (2004). Exploring the Usefulness of a Conceptual Framework as A Research Tool: A Researcher's Reflections. *Issues In Educational Research*, 14, pp.1–10.

Snyder, B. and Kaiser, M.J. (2009). Ecological and Economic Cost-Benefit Analysis of Offshore Wind Energy. *Renewable Energy*, 34(6), pp.1567–1578.

Soete, L. (2007). From Industrial to Innovation Policy. *Journal of Industry, Competition and Trade*, 7(3-4), pp.273–284.

Song, H., Mu, R. and Ren, Z. (2011). Study on Correlation Between the Government Procurement Policy and the Related Implemented Rules (in Chinese). *Studies in Science of Science*, 29(2), pp.291–299.

SSCTHA (Shanghai Services Centre for Transformation of High-tech Achievements). (2010). *Report on Shanghai's Science, Technology and Innovation Policies (Year 2009) (in Chinese)*. Shanghai.

SSCTHA. (2011). *Report on Shanghai's Science, Technology and Innovation Policies (Year 2010) (in Chinese)*. Shanghai. [online]. Available from: http://www.shtic.com/structure/xwzx/bg_137_1.htm [Accessed August 15, 2013].

State Council. (2004). *Advice on Further Regulating Tendering and Bidding Activities (in Chinese)*. Policy code Guofaban[2004]56. Beijing. [online]. Available from: http://www.gov.cn/gongbao/content/2004/content_62892.htm [Accessed August 17, 2013].

State Council. (2006a). *The National Medium- and Long-Term Programme for Science and Technology Development (2006-2020) - An Outline*. Policy code Guofa[2005]44. Beijing. [online]. English translation is available from: http://www.cstec.org/service/detail.aspx?id=1887 [Accessed August 17, 2013].

State Council. (2006b). *Supporting Policies for the Implementation of the MLP (2006 – 2020) (in Chinese)*. Policy code Guofa[2006]6. Beijing. [online]. Available from: http://www.gov.cn/zwgk/2006-02/26/content_211553.htm [Accessed August 17, 2013].

State Council. (2006c). *Advice on Accelerating the Revitalization of Equipment Manufacturing Industry (in Chinese)*. Policy code Guofa[2006]8. Beijing. [online]. Available from: http://www.gov.cn/jrzg/2006-06/29/content_322286.htm [Accessed August 17, 2013].

State Council. (2009). *Advice on Restraining the Over-production in Certain Industries and Guiding Healthy Industrial Development (in Chinese)*. Policy code Guofa[2009]38. Beijing. [online]. Available from: http://www.sdpc.gov.cn/zcfb/zcfbqt/2010qt/t20100513_346554.htm [Accessed August 17, 2013].

State Council. (2010). *Exposure Draft of Implementation Regulations of the Law on Government Procurement in the PRC (in Chinese)*. Beijing. [online]. Available from: http://www.china.com.cn/policy/txt/2010-01/11/content_19215879.htm [Accessed August 17, 2013].

State Council. (2011a). *China's Policies and Actions for Addressing Climate Change*. Beijing: Foreign Languages Press. Beijing. [online]. Available from: http://www.gov.cn/english/official/2011-11/22/content_2000272.htm [Accessed August 17, 2013].

State Council. (2011b). *National-level Implementation Regulations for the Law on Tendering and Bidding (in Chinese)*. Beijing. [online]. Available from: http://www.gov.cn/zwgk/2011-12/29/content_2033184.htm [Accessed August 17, 2013].

State Council. (2012). *Programme for the Development of Energy-saving and New-energy Vehicles Industry (2012-2020) (in Chinese)*. Policy code Guofa[2012]22. Beijing. [online]. Available from: http://www.gov.cn/zwgk/2012-07/09/content_2179032.htm [Accessed August 17, 2013].

Stebbins, R.A. (2001). *Exploratory Research in the Social Sciences*. Thousand Oaks: Sage Publications.

Stefano, G. D., Gambardella, A. and Verona, G. (2012). Technology Push and Demand Pull Perspectives in Innovation Studies: Current Findings and Future Research Directions. *Research Policy*, 41(8), pp.1283–1295.

Stenbacka, C. (2001). Qualitative Research Requires Quality Concepts of Its Own. *Management Decision*, 39(7), pp.551–556.

Stern, P., Hellman, J., Rijnders-nagle, M., Terrell, M., Åström, T. (2011). *How Public Procurement can Stimulate Innovative Services*. Brussels. [online]. Available from: http://www.technopolis-group.com/resources/downloads/nl/2011_Report_Public_Procurement_NICE.pdf [Accessed August 18, 2013].

Stiglitz, J. (2009). The Global Crisis, Social Protection and Jobs. *International Labour Review*, 148(1), pp.1–13.

Strickland, E. (2012). A Test Case for Intellectual Property in China: Will Chinese Courts Finally Protect Foreign IP? *IEEE Spectrum*. [online]. Available from: http://spectrum.ieee.org/green-tech/wind/a-test-case-for-intellectual-property-in-china [Accessed August 19, 2013].

Sun, L. (2012). Development and Policies of New Energy Vehicles in China. *Asian Social Science*, 8(2), pp.86–94.

Sutcliffe, H. (1996). Tunnel Boring Machines. In J. Bickel, T. Kuesel, & E. King, eds. *Tunnel Engineering Handbook*. Springer US, pp. 203–219.

Tayob, R.K. (2010). *Inside Views: Flexibility In Government Procurement Needed For Developing Countries*.

Telgen, J., Harland, C. and Knight, L. (2007). Public Procurement in Perspective. In L. Knight et al., eds. *Public Procurement: International Cases and Commentary*. Abingdon: Routledge, pp. 16–24.

Thai, K. V. (2009). International Public Procurement: Concepts and Practices. In K. V. Thai, ed. *International Handbook of Public Procurement*. Boca Raton: Auerbach Publications, pp. 1–26.

Thomas, A.G. (1919). *Principles of Government Purchasing*. New York, London: D. Appleton and company.

Todtling, F. and Trippl, M. (2005). One Size Fits All? Towards A Differentiated Regional Innovation Policy Approach. *Research Policy*, 34, pp.1203–1219.

Trionfetti, F. (2000). Discriminatory Public Procurement and International Trade. *The World Economy*, 23(1), pp.57–76.

Tsai, K.S. (2006). Adaptive Informal Institutions and Endogenous Institutional Change in China. *World Politics*, 59(01), pp.116–141.

Tsao, J.Y., Coltrin, M.E., Crawford, M.H. and Simmons, J.A. (2010). Solid-State Lighting: An Integrated Human Factors, Technology, and Economic Perspective. *Proceedings of the IEEE*, 98(7), pp.1162–1179.

Tsipouri, L., Edler, J., Rolfstam, M. and Uyarra, E. (2010). *Risk Management in the Procurement of Innovation - Concepts and Empirical Evidence in the European Union*. Brussels. [online]. Available from: http://ec.europa.eu/invest-in-research/pdf/download_en/risk_management.pdf [Accessed August 14, 2013].

Turner, D.W. (2010). Qualitative Interview Design: A Practical Guide for Novice Investigators. *The Qualitative Report*, 15(3), pp.754–760.

Tushman, M. and Nadler, D. (1986). Organizing for Innovation. *California Management Review*, 28(3), pp.74–92.

U.S.-China Joint Commission on Commerce and Trade. (2010). *China Agrees to Significant IP Rights Enforcement, Market Opening, and Revisions to Indigenous Innovation Policies That Will Help Boost U.S. Exports*. [online]. Available from: http://www.ustr.gov/about-us/press-office/press-releases/2010/december/us-china-joint-commission-commerce-and-trade-2010 [Accessed August 12, 2013].

UNCITRAL (United Nations Commission for the International Trade Law). (1994). *Model Law on Procurement of Goods, Construction and Services, with Guide to Enactment*. [online]. Available from: http://www.uncitral.org/uncitral/en/uncitral_texts/procurement_infrastructure/1994Model.html [Accessed August 12, 2013].

US Department of the Treasury. (2010). *Second Meeting of the U.S. –China Strategic & Economic Dialogue Joint U.S.-China Economic Track Fact Sheet*. [online]. Available from: http://www.treasury.gov/press-centre/press-releases/Pages/tg722.aspx [Accessed August 14, 2013].

US Department of the Treasury. (2011). *The 2011 U.S.-China Strategic and Economic Dialogue U.S. Fact Sheet – Economic Track*. [online]. Available from: http://www.treasury.gov/press-centre/press-releases/Pages/TG1172.aspx [Accessed August 12, 2013].

USCBC[44]. (2009). *PRC Government Procurement Policy*. [Not available online any more].

USCBC. (2010a). *International Innovation Best Practices: Recommendations for China's Innovation*. Washington, DC. [Not available online any more].

USCBC. (2010b). *Issue Brief: New Developments in China's Domestic Innovation and Procurement Policies*. [Not available online any more].

[44] This series of USCBC reports regarding China's IOPP initiatives used to be downloadable from https://www.uschina.org/; however, they have been removed from the website lately and most of them are no longer available online.

USCBC. (2010c). *USCBC's Suggestions on Modifying the Notice on Initiating Accreditation Work for National Indigenous Innovation Product in 2010 (exposure draft) (in Chinese)*. [online]. Available from: http://wenku.baidu.com/view/03ddb56aaf1ffc4ffe47ace2 [Accessed August 16, 2013].

USCBC. (2011a). *China's Innovation and Government Procurement Policies: Next Steps*. [online]. Available from: http://www.uschina.org/policy/china%E2%80%99s-innovation-and-government-procurement-policies-next-steps [Accessed August 16, 2013].

USCBC. (2011b). *Intellectual Property and Import Substitution References in China ' s Provincial and Local-Level Accreditation Criteria for Indigenous Innovation Products*. [Not available online any more].

USCBC. (2011c). *Issues Brief: China's Domestic Innovation and Government Procurement Policies*. [online]. Available from: http://www.chinabusinessreview.com/domestic-innovation-and-government-procurement-policies/ [Accessed August 17, 2013].

USCBC. (2011d). *Letter to Minister Miao Wei*. [Not available online any more].

USCBC. (2011e). *PRC Government Actions to Meet Bilateral Commitments on Indigenous Innovation and Government Procurement*. [Not available online any more].

USCBC. (2011f). *Provincial and Local Indigenous Innovation Product Catalogues*. [Not available online any more].

USCBC. (2012). *How Dialogue Helps Resolve Issues with China*. [online]. Available from: https://www.usaita.com/pdf_files/USCBC-paper.pdf [Accessed August 17, 2013].

USCBC. (2013). *Status Report on China's Government Procurement and Indigenous Innovation Policies*. [Not available online any more].

USITC (U.S. International Trade Commission). (2010). *China: Intellectual Property Infringement, Indigenous Innovation Policies, and Frameworks for Measuring the Effects on the U.S. Economy*. Washington, DC. [online]. Available from: http://www.usitc.gov/publications/332/pub4199.pdf [Accessed August 17, 2013].

Uyarra, E. (2003). *Innovation, Knowledge and Regional Development: Implications for Innovation Policies in Less Favoured Regions, Using a Case Study of Castilla Y Leon (Spain)*. Manchester: The University of Manchester.

Uyarra, E. (2012). *Review of Measures in Support of Public Procurement of Innovation*. Manchester. [online]. Available from: http://www.innovation-policy.org.uk/share/16_Review%20of%20Measures%20in%20Support%20of%20Public%20Procurement%20of%20Innovation.pdf [Accessed August 14, 2013].

Uyarra, E. and Flanagan, K. (2010). Understanding the Innovation Impacts of Public Procurement. *European Planning Studies*, 18(1), pp.123–143.

VINNOVA (the Swedish Governmental Agency for Innovation Systems). (2007). *Public Procurement as a Driver for Innovation and Change*. Stockholm. [online]. Available from: http://www.vinnova.se/upload/EPiStorePDF/vp-07-03.pdf [Accessed August 11, 2013].

Von Hippel, E. (1988). *The Sources of Innovation*. New York: Oxford University Press.

Vo ťa, T. (2008). Reform of the NDRC or Mutations in Central Planning. *China Perspectives*, 2, pp.106–107.

Vorley, T. and Nelles, J. (2010). Innovation Policy as Industrial Policy: Some Lessons from Hamburg's Regional Innovation System. *Local Economy*, 25(8), pp.631–649.

Wade, R. (1990). *Governing the Market*. Princeton: Princeton University Press.

Wade, R. (2003). What Strategies Are Viable for Developing Countries Today? The World Trade Organization and the Shrinking of "Development Space". *Review of International Political Economy*, 10(4), pp.621–644.

Wang, C. and Li, X. (2013). Centralizing Public Procurement In China. *Public Management Review*, pp.1–22.

Wang, H. (2010). Informal Institutions and Foreign Investment in China. *The Pacific Review*, 13(4), pp.525–556.

Wang, P. (2007). Coverage of the WTO's Agreement on Government Procurement: Challenges of Integrating China and other Countries with a Large State Sector into the Global Trading System. *Journal of International Economic Law*, 10(4), pp.887–920.

Wang, P. (2009). China's Accession to the WTO Government Procurement Agreement - Challenges and the Way Forward. *Journal of International Economic Law*, 12(3), pp.663–706.

Wang, P. (2013). *Public Procurement in China: A Long March Towards Integration into the Global Trading System*. Abingdon: Routledge.

Wang, P. and Zhang, X. (2010). *Chinese Public Procurement Law - An Introductory Textbook*. EU Asia Inter University Network for Teaching and Research in Public Procurement Regulation.

Watermeyer, R. (2003). Implementing Preferential Procurement Policies in the Public Sector in South Africa. *Journal of the South African Institution of Civil Engineering*, 45(3), pp.1–20.

Weiss, L. and Thurbon, E. (2006). The Business of Buying American: Public Procurement as Trade Strategy in the USA. *Review of International Political Economy*, 13(5), pp.701–724.

Westring, G. (1994). Multilateral and Unilateral Procurement Regimes: to which Camp does the Model Law Belong? *Public Procurement Law Review*, 3, p.142.

White House. (2011). *A Strategy for American Innovation: Securing Our Economic Growth and Prosperity*. Washington D.C. [online]. Available from: http://www.whitehouse.gov/innovation/strategy [Accessed August 19, 2013].

Wilkinson, R., Georghiou, L. and Cave, J. (2005). *Public Procurement for Research and Innovation - Developing Procurement Practices Favourable to R&D and Innovation*. Brussels. [online]. Available from: http://ec.europa.eu/invest-in-research/pdf/download_en/edited_report_18112005_on_public_procurement_for_research_and_innovation.pdf [Accessed August 17, 2013].

Williamson, J. (1990). What Washington Means by Policy Reform. In J. Williamson, ed. *Latin American Adjustment: How Much Has Happened?* Washington D.C.: Institute for International Economics.

Woolthuis, R.K., Lankhuizen, M. and Gilsing, V. (2005). A System Failure Framework for Innovation Policy Design. *Technovation*, 25(6), pp.609–619.

World Bank. (2011). *The China New Energy Vehicles Programme - Challenges and Opportunities*. Washington D.C. [online]. Available from: http://documents.worldbank.org/curated/en/2011/04/14082658/china-new-energy-vehicles-programme-challenges-opportunities [Accessed August 15, 2013].

Wu, Y. (2002). Regional Disparities in China: An Alternative View. *International Journal of Social Economics*, 29(7), pp.575–589.

Wuhan S&T Bureau. (2010). 300 Million Yuan Needed to Match Local Demand and Supply for 292 Indigenous Innovation Projects Through Government Platform (in Chinese). *Yangtze River Daily*. [online]. Available from: http://www.whst.gov.cn/Default_71_12678,1.html [Accessed August 15, 2013].

Xinhuanet. (2013). Industrial Development Will be Accelerated as Subsidy Policies for New-energe Vehicles Renewed (in Chinese). *Xinhuanet*. [online]. Available from: http://news.xinhuanet.com/energy/2013-05/24/c_124756713.htm [Accessed August 19, 2013].

Xu, R. and Pan, L. (2011). The Promotion Effects of Government Procurement on High-speed Railway Technology Development in Our Country (in Chinese). *Kehai Gushi Bolan*, 9, pp.129–130.

Xue, L. (1997). A Historical Perspective of China's Innovation System Reform: A Case Study. *Journal of Engineering and Technology Management*, 14(1), pp.67–81.

Yang, G. (2010). *The Cost of Offshore Wind Energy is Twice as High as that of Onshore Wind Energy (in Chinese)*. Shanghai. [online]. Available from: http://www.chuandong.com/publish/report/2010-4/7141.html [Accessed August 15, 2013].

Yang, W., Cicek, N. and Ilg, J. (2006). State-of-the-art of Membrane Bioreactors: Worldwide Research and Commercial Applications in North America. *Journal of Membrane Science*, 270(1-2), pp.201–211.

Yang, X., Jiang, Y., Wu, P. and Wang, F. (2011). Government Procurement Policies Supporting Indigenous Innovation - the Case of East Lake Innovation Zone in Wuhan City (in Chinese). *Local Finance Research*, 3(3), pp.69–76.

Yeo, Y. (2009). Remaking the Chinese State and the Nature of Economic Governance? The Early Appraisal of the 2008 "Super-ministry" Reform. *Journal of Contemporary China*, 18(62), pp.729–743.

Yeow, J. and Edler, J. (2012). Innovation Procurement as Projects. *Journal of Public Procurement*, 12(4), pp.488–520.

Yin, R.K. (2009). *Case Study Research: Design and Methods*. 4th ed. London: Sage Publications.

Yu, M. and Zhang, W. (2013). *The Imminent IPR Crisis in the LED Lighting Sector (in Chinese)*. Beijing. [online]. Available from: http://scitech.people.com.cn/n/2013/0417/c1007-21167925.html [Accessed August 19, 2013].

Yuan, X. (2013). Overdependent on Government Support, Sinovel Performance Dramatically Declined After Being Listed (in Chinese). *Sina Finance*. [online]. Available from: http://finance.sina.com.cn/chanjing/gsnews/20130411/161615117896.shtml [Accessed January 1, 2013].

Yukins, C.R. and Anderson, R.D. (2012). Opening Procurement Markets Internationally: An Update , and the Road Ahead. In *West Government Contracts Year In Review Covering 2011 Conference Briefs*. Washington: Thomson Reuters.

Yukins, C.R. and Piga, G. (2013). Dialogue (in Part IV Set-asides for Small and Medium Firms, as in the USA System with the Small Business Act that Reserves Shares of Tenders to SMEs Only). In Gustavo Piga & S. Treumer, eds. *The Applied Law and Economics of Public Procurement*. London: Routledge.

Yunnan Government. (2005). *Decision to Promote the Socioeconomic Development of Yunnan Through Indigenous Innovation (in Chinese)*. Policy code Yunfa[2005]16. Kunming. [online]. Available from: http://www.most.gov.cn/kjzc/kjzcdfgz/dfzcyn/200804/t20080410_60614.htm [Accessed August 1, 2013].

Zhang, K.H. ed. (2006). *China as the World Factory*. Abingdon: Routledge.

Zhao, X. and Zhang, L. (1999). Decentralization Reforms and Regionalism in China: A review. *International Regional Science Review*, 22(3), pp.251–281.

Zhejiang Daily. (2013). Technological Bottlenecks are Overcome but Market Ones are Not - Why Domestic Major Equipment is Not Welcome (in Chinese). [online]. Available from: http://biz.zjol.com.cn/05biz/system/2013/05/23/019356028.shtml [Accessed August 18, 2013].

Zhejiang S&T Department. (2009). *Notice on Organizing the Application for Accreditation of 2009 National Indigenous Innovation Products (in Chinese)*.

Policy code Zhekefaji[2009]251. Hangzhou. [online]. Available from: http://www.zjkjt.gov.cn/news/node02/detail0201/2009/0201_17282.htm [Accessed August 5, 2013].

Zheng, J. (2011). *Strategic Policies and Demonstration Programme of Electric Vehicle in China*. University of Wisconsin-Madison.

Zheng, Y. (2007). *De Facto Federalism in China: Reforms and Dynamics of Central-Local Relations*. Singapore: World Scientific Publishing.

Zhongguancun. (2010a). *Building the Zhongguancun National Indigenous Innovation Demonstration Zone - Action Plan (2010-2012) (in Chinese)*. Beijing. [online]. Available from: http://zhengwu.beijing.gov.cn/ghxx/qtgh/t1117789.htm [Accessed August 9, 2013].

Zhongguancun. (2010b). *Conference Organized to Commend Government Procurement of Zhongguancun Indigenous Innovation Products in 2009, and to Conduct the First Contract-signing Event in 2010 (in Chinese)*. Beijing. [online]. Available from: http://www.zgc.gov.cn/jztd1/wqhdsc/zfcgzgczzcxcp/58787.htm [Accessed August 10, 2013].

Appendices

Appendix 1: Overview of Chinese literature on IOPP

1.1 Search details, research themes and findings

Rounds of literature search were conducted during 2009 – 2013, with the latest update in January 2013. Keywords and databases used for search included:

- **Keywords:**

  Government/public (technology) procurement 政府/公共(技术)采购
  (Indigenous) innovation (自主)创新

- **Search engines:**

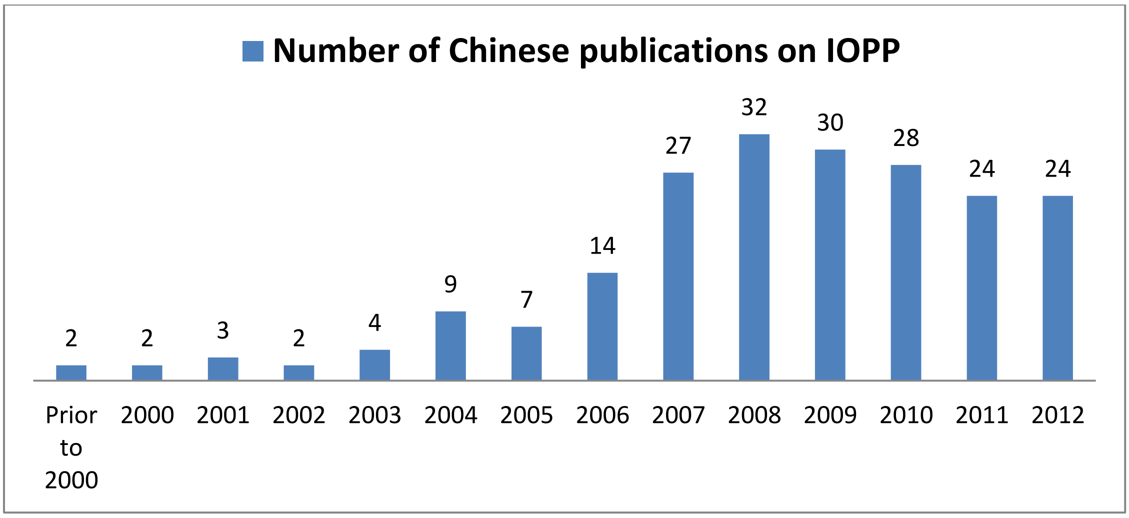
  Vip Professional Search Engine www.cqvip.com
  Wanfang Internet Library www.ilib.cn
  Wanfang Data www.wanfangdata.com.cn
  Chinese National Knowledge Infrastructure (CNKI) www.cnki.net
  Google Scholar http://scholar.google.co.uk

- **Search results:**

  - **208** publications closely related to this topic (judged from the titles) were found;
  - Literature types include journal articles, Masters and PhD dissertations;
  - Full texts of **139** publications were accessible and downloaded, and analysed to inform this study.
  - See Appendix 1.2 for the list of publications

As illustrated in Figure App.1 the number of publications has been growing fast since the launch of MLP; peak in 2008, followed by a slight decline in the past two years.

Figure App.1 Number of Chinese publications on IOPP



Source: Author's search results by January 2013

A range of research themes have been covered, as summarized in Table App.1, including rationale justification for employing government procurement as an innovation policy, policy learning by drawing upon foreign countries' IOPP experiences, advice on legislation, policy design and implementation, and more recently, how to carry on with IOPP in China in the light of policy termination and US-China disputes.

Table App.1 Main research themes addressed by Chinese IOPP literature

Research theme	Main content	Example publications
Rationale justification	Explaining the rationales of government procurement to stimulate innovation	Justifying from the perspectives of economics (Zhao and Cai, 2007; Xu et al., 2007); political science (Yang, 2006; Xu, 2004; Li, 2004; Zhang, 2004; Kang, 2009); and empirical testing (Sun and Yang, 2009)
Legislative issues	Discussing how to develop a more innovation-friendly legal system for IOPP	How to adjust legislation to support innovation in a more powerful way (He et al., 2010; Dong, 2009; Hu, 2001); how to cope with China's accession to GPA (Li et al., 2009)
IOPP policy learning	Introducing foreign IOPP experience to China	Discussing good practices and lessons from abroad (Gong and Yu, 2010; Chen, 2008; Jiang, 2007; Jiang, 2010)
Regional IOPP initiatives	Introducing what has been done in different regions	Reporting local legislative settings for IOPP (Chen and Lao, 2010); describing how they designed regulatory measures to respond to the themes from central government; suggestions for local implementation of IOPP (Tang et al., 2007)
General advice on policies and practices	Discussing how to implement public procurement effectively to promote innovation	Advice on policy implementation and coordination between stakeholders (Dai and Zhou, 2009; Liu, 2008), IOPP project management (Zhou, 2008; Peng and Luo, 2008), procedural issues (Feng and Huang, 2007; Dai, 2008; Xiao et al., 2010; Zhang and Gu, 2010); Song et al. (2011) touched upon policy articulation and investigated the correlationship between higher- and lower-level IOPP policies
Advice on conducting IOPP after the policy termination 2011	Discussing how to cope with international tensions and utilize IOPP in future	Advice on dealing with disputes related to IOPP with major trade partners (Zhang and Liu, 2011); advice on supporting indigenous innovation through public procurement in the context of WTO-GPA (Deng and Zhang, 2012)

Source: Author based on content analysis of Chinese literature

Chinese literature up to 2010 helped this study develop a background understanding of China's situation prior to the fieldwork; later publications offered opportunities for verifying data collected and some initial findings. In particular, pre-interview questionnaires (see Appendix 7) were designed based on findings of Chinese publications, which had pointed out a range of problems existing in China in relation to the use of IOPP. Major problems identified by those publications included: the small amount of expenditure on government procurement as a proportion of GDP (Guan, 2009; He et al., 2010); lack of clarified definitions for 'domestic products' and 'innovative products' (Peng and Luo, 2009; Zhang, 2002); poor coordination between departments and regions (Jiang, 2010); lack of professional procurers (Peng, 2000); and the absence of external monitoring mechanisms (Peng and Luo, 2009).

The literature review suggested that existing Chinese literature in general is subject to two major shortcomings compared with international publications. Firstly, the overall quality is questionable given that the majority of the publications were neither built upon well-justified methodologies, nor on sufficient evidence. Numerous authors made their arguments and advice without referring to empirical evidence. Length of journal articles is considerably shorter than that of international ones, ranging from 1 to 9 pages (mostly 2-5 pages). One reason could be that the Chinese language is more condensed than English; but still the very short length considerably limited the depth of articles. Secondly, there has been severe duplication of contents among journal articles. Some of them adopted similar structures, made similar arguments, and came up with similar conclusions, e.g. Qiu (2010), Ma (2009), and Li et al. (2009).

Ai (2009) has been the only doctoral thesis focused on this topic. It built a mathematical model to idealize the mechanism that underpins the functioning of public procurement to promote innovation. It then conducted one case study based on secondary data to verify the model. Although this thesis deepened the understanding of IOPP's functioning rationales and preconditions, it did not touch upon the actual processes of IOPP in China.

In summary, a contextual, in-depth understanding of IOPP in China is still lacking, which is one of the gaps this study addresses.

1.2 List of Chinese publications

The listed publications do not always have English titles originally; English titles in *Italics* were translated by the author.

PART 1 of List of Chinese publications

Year	Author(s)	Publication Name (in English)	Publication Name (in Chinese)
2012	Jianing Han, Jingchen Zhang	*Research on Functioning Mechanisms of Government Procurement to Promote Indigenous Innovation*	促进自主创新的政府采购机制的探究
2012	Wen Guo	Research on Rationality of Public Procurement for Promoting Indigenous Innovation	政府采购激励自主创新的合理性辨析
2012	Wanjun Deng, Huanzhao Zhang	Suggestions on China Protecting Indigenous Industries and Supporting Indigenous Innovation Under the GPA	《政府采购协议》下中国保护本国产业和支持本土创新的建议
2012	Bing Ai	*Government Procurement to Promote Indigenous Innovation – Lessons and Experience Drawn from Practices of European Countries and the US*	欧美国家政府采购促进自主创新的经验与启示
2012	Bing Ai	On the Characteristic Method of Japan and Republic of Korea in Government Procurement's Promotion to Independent Innovation	日韩政府采购促进自主创新特色研究
2012	Yanfeng Bai, Sheng Xu	Analysis on the Role of the Government Procurement in Promoting Domestic Independent Innovation	中国政府采购促进自主创新的角色分析
2012	Hui Wang	*Research on Government Procurement Measures to Promote Technology Innovation*	政府采购促进科技创新的对策研究
2012	Ruijun Wang, Lingling Shang	The Influence of Entering into GPA upon China's Science and Technology Innovation and Industrial Development and China's Coping Strategies	加入 GPA 对我国科技创新和产业发展的影响和应对策略
2012	Chunhui Wang, Ping Li	The Policy Effect of Government Supporting Enterprise Technology Innovation	政府扶持企业技术创新的政策效应分析
2012	Hong Wang	*Research on Government Procurement Decision-making Strategy based on Industry Life Cycle Theory*	基于产业生命周期理论的政府技术采购决策研究
2012	Qiyue Xiong, Yiru Zhang	Study on Suppliers Optimal Bidding Price under Incentive Policy in the Process of Government Procurement	自主创新激励下企业政府采购最优出价行为研究
2012	Heyuan Pan	*Research on the First Procurement of Indigenous Innovation Products in the Defence Sector*	国防采购中自主创新产品首购研究
2012	Jie Lin	*Study on Enterprise Indigenous Innovation-based Government Procurement Policy*	基于企业自主创新的政府采购政策探析
2012	Rui Li, Ping Zhou	Government Behaviour and Independent Innovation – Based on the Perspective of Supply and Demand	政府行为与自主创新-供求视角
2012	Zhe Li	Review on the Coordination between S&T Innovation Policies and WTO Rules after China's Entry to WTO	入世十年来我国科技创新政策与 WTO 规则的协调及展望
2012	Runlin Cao	*Study on Government Procurement to Promote the Development of Infant industries*	论政府采购促进幼稚产业的发展
2012	Qiwei Wan	*Empirical Research on Government Procurement and Indigenous Innovation*	政府采购与自主创新的实证研究
2011	Yi Liu, Jianhua Chen	*Research On The Interaction Between Defence Procurement and the Innovation Development of SMEs in the US*	美国国防采购与中小企业发展创新互动研究

PART 2 of List of Chinese publications

Year	Author(s)	Publication Name (in English)	Publication Name (in Chinese)
2011	Haozhen Tang	*Indigenous Innovation Does Not Equal to Government Procurement*	自主创新不等于政府采购
2011	Aihua Jiang, Fei Wang	*Practices and Experience of Utilizing Government Procurement to Promote Indigenous Innovation in Typical Countries and Regions*	典型国家和地区利用政府采购政策促进科技创新的实践及经验
2011	Hefa Song, Rongping Mu, Zhongbao Ren	Study on Correlation Between the Government Procurement Policy and the Related Implemented Rules	促进自主创新的政府采购政策与实施细则关联性研究
2011	Jun Zhang, Liming Chang, Yongjun Zhao	*Utilizing the Function of Government Procurement to Promote Supplier Indigenous Innovation*	以政府采购政策功能促进供应商自主创新
2011	Huangzhao Zhang, Guannan Liu	The Conflict of Homeland-innovative Product First Policy and the Coping Strategies	自主创新产品优先政策引发的争议及应对策略
2011	Rui Zhang	*Empirical Analysis on the Relationship Between Government Procurement and Technological Innovation*	政府采购与科技创新关系的实证分析
2011	Hongguang Peng	Performance Evaluation and Countermeasures of Government Procurement Supporting Independent Innovation in China	我国政府采购扶持自主创新政策效果评估与对策
2011	Renying Xu, Lei Pan	*Study On Government Procurement To Promote The Indigenous Innovation Of Chinese High-Speed Rail Technology*	论政府采购对我国高铁科技自主创新的促进
2011	Guanglei Zhu	*On Five Aspects Of Government Procurement To Promote Indigenous Innovation*	政府采购政策力推企业自主创新的五个方面
2011	Chunjing Li	*The Impacts Of GPA On Indigenous Innovation in China*	《政府采购协议》对我国自主创新的影响
2011	Yan Li	*Zhongguancun Innovation Platform To Lead The New Model Of Government Procurement*	中关村创新平台引领政府采购新模式
2011	Zhen Li	Research On The Influence Of Government Procurement In Supporting Auto-Industry Independent Innovation	政府采购对汽车产业自主创新影响研究
2011	Xicai Yang, Yuxiang Jiang, Ping Wu, Fen Wang	*Research On Government Procurement Policies To Support Indigenous Innovation – a Case Study On Wuhan East Lake National Innovation Demonstration Area*	支持自主创新政府采购政策探析-以武汉东湖国家自主创新示范区为例
2011	Wei Shen	*Government Procured Indigenous Innovation Products Are Serving Shanghai World EXPO*	政府采购自主创新产品助力上海世博会
2011	Hong Wang, Shangfu Zheng	Research on the Relationship of Government Procurement and Technology Innovation Based on the Provincial Panel Data	基于省际面板数据分析的政府采购与技术创新关系研究
2011	Yanfeng Bai, Min Liu, Jian Gao	*Empirical Analysis On Government Procurement Promoting Indigenous Innovation*	政府采购促进自主创新的实证分析
2011	Bing Ai	*Mechanisms of US Government Procurement Promoting Indigenous Innovation And Implications for China*	美国政府采购促进自主创新机制及启示
2011	Wanjun Deng, Huanzhao Zhang	*Government Procurement Systems Of Developed Countries*	发达国家的政府采购制度
2011	Xin Deng	*Research On Government Procurement System Promoting SME Innovation In China*	我国促进中小企业技术创新的政府采购政策研究
2011	Jing Wu, Man Zhou, Zhiyuan Bai	*Literature Review of the Research on Government Procurement To Support Innovation*	政府采购扶持自主创新研究文献综述

PART 3 of List of Chinese publications

Year	Author(s)	Publication Name (in English)	Publication Name (in Chinese)
2011	Wen Guo, Yu Cheng, Zhongbao Ren	*Implications Drawn From Foreign Governments' Policy of Public Procurement for Innovation*	国外政府采购激励创新的政策研究及启示
2011	Yuling Han	The Government Procurement Promote Service Innovation in the Background of Low-carbon Economy	低碳经济背景下利用政府采购促进服务业创新
2011	Li Ma, Jianmin Liu, Yong Niu	*A Fuzzy Screening Approach to Evaluating Indigenous Innovation Capabilities of Emerging Industries in Government Procurement*	政府采购中新兴产业自主创新资质的模糊甄别
2011	Lili Zhai	An Empirical Research Of Government Procurement Impact Of Complex Product System Innovation Performance	政府采购对复杂产品系统创新绩效影响的实证研究
2011	Junying Huang	Public Procurement of Innovation in Selected Countries and its Policy Implications for China	发达国家利用政府采购支持创新的政策及启示
2011	Yuhong Jiang, Yong Huang	Indigenous Innovation, IPR and Competition Policy – Comments on 332 Investigation Against Chinese Indigenous Innovation Policy	自主创新、知识产权和竞争政策的协调兼评 USITC 对我国自主创新政策的 332 调查报告
2010	Jinsheng He, Lingzhi Zhang	Bottleneck Restraints of Independent Innovation Supplier in Government Procurement	自主创新产品供应商在政府采购中的瓶颈研究
2010	Donghui Tang	Study on Bid Time of Procurement Enhancing Independent Innovation	政府采购促进自主创新招标时机研究
2010	Baoquan Song	*Utilizing Government Procurement Policies to Support Domestic Products and Indigenous Innovation Products*	发挥政府采购政策功能支持本国产品和自主创新产品
2010	Linlin Cui	*Analysis of Government Procurement Promoting High-tech Industry Development*	政府采购促进高新技术产业发展探讨
2010	Zhen Li	*Empirical Analysis of Government Procurement Promoting STI in China*	我国政府采购对科技创新的促进作用实证分析
2010	Wentao Li	*Government Procurement Should Give Priority to Indigenous Innovation Products*	政府采购应优先采购国内自主创新成果
2010	Jiyang Lin	*Research on Countermeasures to Employ Government Procurement Policy to Enhance the Indigenous Innovation Capability of Fujian Province*	运用政府采购政策提升福建省自主创新能力的对策研究
2010	Wenting Wang	*Research on Government Procurement and the Issue of Promoting Enterprise Indigenous Innovation*	政府采购与促进企业自主创新问题研究
2010	Ji Wang	*Establishing a Government Procurement of Domestic Product System to Strengthen Indigenous Innovation Capabilities*	建立政府采购国货制度加强自主创新能力
2010	Ning Luo	*Study on the Important Role of Government Procurement in Promoting Enterprise Indigenous Innovation*	谈政府采购对企业自主创新的重要扶持作用
2010	Weimin Dong	*Government Procurement and Technology Innovation*	政府采购与科技创新
2010	Ruirui Guo, Yihao Chen	*Research on Government Procurement Promoting the Development of Indigenous Innovation Enterprises*	政府采购促进自主创新企业发展研究

PART 4 of List of Chinese publications

Year	Author(s)	Publication Name (in English)	Publication Name (in Chinese)
2010	Lijia Chen, Zhijian Lao	Analysis of the Legal System of Governmental Procurement for Indigenous Innovation Products-Review on Guangdong's Policy Measures	自主创新产品政府采购法律制度分析-兼评广东省相关政策
2010	Di Xiao, Yunhong Hao, Bo Wu	Study on the Mode of Government Technology Procurement to Promote Technology Innovation	政府技术采购促进技术创新的模式研究
2010	Yingli Gong, Jingtao, Yu	Research on Government Procurement to Promote Technology Innovation – Taking the United States and Korea as Examples	促进技术创新的政府采购研究—以美国与韩国为例
2010	Kai Zhang, Xiaoyan Hao	*Research on Government Procurement to Promote Technology Innovation in Inner Mongolia*	内蒙古政府采购与技术创新激励的研究
2010	Liguo He, Yuliang Su, Cong Chen	Study on Enterprise Independent Innovation Protection and Enhancement in the Respect of Law of Government Procurement	从政府采购法的完善角度谈保护和提高企业自主创新能力
2010	Qinhong Zhang, Xiaowen Gu	Study on Two Stage Government Procurement Policy to Support Independent Innovation	支持自主创新的两阶段政府采购政策
2010	Hong Cai	*Thoughts on Implementing Independent Innovation Government Procurement Policy*	对落实自主创新产品政府采购政策的思考
2010	Dayang Jiang	Is Public Procurement Policy an Innovative Policy? - A Case of the Public Procurement Policy of EU	公共采购是一项创新政策吗 - 从欧盟的采购政策谈起
2009	Xiaohua Sun, Bin Yang	*The Mechanisms of Government Procurement to Promote Technology Innovation – Empirical Evidence from Nine Countries in EU*	政府采购驱动技术创新的机制及实证-来自欧盟 9 国的经验证据
2009	Yongtao Du	*Empirical Research on the Function of Government Procurement to Promote Indigenous Innovation*	政府采购政策对企业技术创新作用的实证研究
2009	Ziyang Qi	*The Function of Government Procurement to Promote Indigenous Innovation – the Example of Shanghai*	政府采购对企业自主创新的促进作用——以上海市为例
2009	Yishun Tian	Research on the Government Procurement Institution of Supporting Independent Innovation Products	扶持自主创新产品的政府采购制度研究
2009	Bing Ai	The Study of the Mechanism and Effectiveness of the Government Procurement's Promotion to Independent Innovation	政府采购促进自主创新的关系及效果研究
2009	Yuhong Kang	Analysis of the Effect from Government Procurement to Support Technology Innovation	政府采购在支持科技自主创新中的功效分析
2009	Jianwen Luo, Xiaowen Gu, Hongguang Peng	Research On Government Procurement Strategy To Promote Independent Innovation In High Technology Industry	政府采购促进高技术产业自主创新策略研究
2009	Yinyan Dai, Hongqiang Zhou	*Implementation Progress of Government Procurement Policies Supporting Indigenous Innovation Products and Implications*	自主创新产品政府采购政策落实情况及启示
2009	Hongguang Peng, Jianwen Luo	Conflict, Incompletion and Reconstruction: Analysis on Government Procurement Policies to Inspire Independent Innovation	冲突、缺失与重构——自主创新产品政府采购政策探析

PART 5 of List of Chinese publications

Year	Author(s)	Publication Name (in English)	Publication Name (in Chinese)
2009	Ping Zou	A Study of the Government Purchasing System for Encouraging Independent Innovation – A Case Study of Yunnan Province	鼓励自主创新的政府采购制度研究——以云南省为例
2009	Jichun Gan, Haiping Lv, Aijun Wang	The Function Loss of Our Country Government Procurement Policy and Analysis	我国政府采购政策功能的缺失及原因分析
2009	Yaqin Song	Problems of Government Procurement's Promotion to Independent Innovation	政府采购促进自主创新的几个问题
2009	Juan Wang	*Research on the Rationales and Bottlenecks of Government Procurement Promoting Independent Innovation*	政府采购促进自主创新的作用机理及瓶颈研究
2009	Juan Ma	Research on the Policy Function of Government Procurement	政府采购政策功能的探析
2009	Chenghui Dong	Government Procurement System of Independent Innovation Products Based on the Economic Law	自主创新产品政府采购制度的经济法基础
2009	Hongjun Li, Xiaopeng Li, Chunguang Li	Strategy of Implementation of Independent Innovation Government Procurement	自主创新政府采购实施对策
2009	Xiaoming Li	Policy Recommendations on Patent System for Independent Innovation Government Procurement	专利制度用于自主创新政府采购的政策建议
2009	Wenqi Li	Research on Policy of Government Procurement's Promotion to Independent Innovation	促进自主创新的政府采购政策研究
2009	Yanqin Zheng	*Research on Government Procurement Promoting SMEs Technology Innovation*	政府采购促进中小企业技术创新问题研究
2008	Yue Dai	Research on Government Procurement Policies Improving Independent Innovation	促进自主创新的政府采购政策研究
2008	Lei Dai	Research on the Standard of Changchun Government Procurement Oriented by Self-directed Innovation	长春市自主创新导向型政府采购标准研究
2008	Hongzhao Li	Study on Local Government Technology Buying Policy	地方政府技术采购政策研究
2008	Jing Bian	*Research on Demand-based Government Procurement Promoting Indigenous Innovation*	基于需求侧的自主创新政府采购问题研究
2008	Jun Yang	The Research of Government Procurement System Promoting the Development of High-tech Industry in China	促进我国高新技术产业发展的政府采购制度研究
2008	Hedong Liu	Governance of Government Procurement for Independent Innovation	自主创新中政府采购的治理机制
2008	Bao Liu	Project Management and the Role of Government in Public Technology Procurement	公共技术采购的项目管理及政府角色定位
2008	Yanmei Peng, Jiaxi Hu	Analysis of Government Procurement as the Tool of Innovation Policy	解析作为创新政策工具的政府采购
2008	Hang Zhou, Wenjing Xu	Government Procurement and Performance Management for Independent Innovation-oriented Products	自主创新产品的政府采购及其绩效管理
2008	Donghui Tang	Study on the Mechanism of Government Procurement's Promotion to Independent Innovation	政府采购促进自主创新的机理探析
2008	Ruihua Sun, Lan Zhang	Thinking of Using Government Procurement to Promote China's Industrial Technology Innovation	利用政府采购推动中国产业技术创新的思考

PART 6 of List of Chinese publications

Year	Author(s)	Publication Name (in English)	Publication Name (in Chinese)
2008	Jingzhong Zhang, Fen Huang	*Operational Procedures for Government Procurement Policies Supporting Independent Innovation*	政府采购扶持自主创新政策操作规程探讨
2008	Guijin Liang	Study on the Role and Strategy of Government Procurement to Promote Enterprise Independent Innovation	政府采购促进企业自主创新的作用及对策研究
2008	Shengquan Xu	On the System of Government Procurement Promoting Self-innovation in China	我国促进自主创新的政府采购制度探析
2008	Jiang Chen	Procurement Related Policies and Measures for SMEs by the U.S. Government	美国联邦政府采购对中小企业的扶持政策与措施
2008	Hongjun Li	Thoughts on Public Procurement Policy to Promote Independent Innovation	推动自主创新的公共采购政策思考
2008	Tieshan Wang, Zongxian Feng	Research on the Rationales of Government Procurement to Support Self-innovation	政府采购对产品自主创新的激励机制研究
2008	Weimin Dong	Study on Quantitative Identification and Evaluation Method of Government Procurement Independent Innovation Products	政府采购自主创新产品的量化认定与评价方法研究
2008	Ruili Hao	Our Government Stock Accelerates Self-Independent Innovation	政府采购对我国自主创新的促进作用
2008	Hongguang Peng, Jianwen Luo	Independently Innovative Products	生命周期成本-政府采购自主创新产品的新视角
2008	Kai Hu, Jidong Yin	Study on Government Procurement Policy Supporting Enterprise Innovation Activities	支持企业创新活动的政府采购政策研究
2007	Yanjun Ma, Junlin Li	*Utilizing the Policy Functions of Government Procurement to Promote Firm Innovation*	发挥政府采购政策功能促进企业自主创新
2007	Jiani Ouyang	*Study on the Promotion Effects of Government Procurement upon Independent Innovation*	论政府采购政策对企业自主创新的激励
2007	Aihua Jiang	*Study on Government Procurement Policy to Promote Small Enterprise Independent Innovation - Experience from U.S. ETIP Project*	促进小企业自主创新的政府采购政策探析-美国 ETIP 项目的经验与借鉴
2007	Shuyun Wang	Study on Government Procurement Policy and Independent Innovation	政府采购政策与自主创新研究
2007	Guoniao Jia	Study on Government Procurement Promoting Independent Innovation	促进自主创新的政府采购研究
2007	Jingzhong Zhang, Wenhong Cao, Fen Huang	*Experience of Developed Countries in Using Government Procurement to Support Indigenous Innovation*	发达国家政府采购扶持自主创新的经验借鉴
2007	Xiaojie Zhang	Analysis of U.S. Government Procurement System Supporting Technology Innovation and Implications for China	美国政府采购支持科技创新的体制分析及启示
2007	Zhenpeng Tang, Wei Lin, Jinlin Xu	Study on Government Procurement Strategies in Fujian Province to Promote the Development of High-tech Enterprises	促进福建省高新技术企业发展的政府采购对策研究
2007	Jingzhong Zhang, Fen Huang	Approaches to Implementing Government Procurement Policies Supporting SME Innovation	政府采购促进中小企业自主创新的实现途径
2007	Pingjun He	*Improving Government Procurement System to Support Independent Innovation*	论支持自主创新的政府采购制度的完善
2007	Li Ma	Independent Innovation, Government Procurement and Public Auction Design	自主创新、政府采购与招投标机制设计
2007	He Huang	American Governmental Procurement for SMEs – Policies and Suggestions	美国政府采购中的中小企业政策及其启示

PART 7 of List of Chinese publications

Year	Author(s)	Publication Name (in English)	Publication Name (in Chinese)
2007	Weiwei Ye, Jinyi Zheng	Develop a Government Procurement System to Promote High-Tech Enterprise Indigenous Innovation	激发高技术企业自主创新的政府采购制度研究
2007	Peng Zhang	The Study of Functions of Government Procurement in Technology Innovation and Policy Implications	浅谈政府采购在促进技术创新中的作用及对我国政府的启示
2007	Hongguang Peng	*Government Procurement Supporting Indigenous Innovation Products – an evaluation system*	政府采购扶持的自主创新产品的评价指标体系
2007	Hong Zhao, Weixing Cai	Economic Analysis on Government Procurement Supporting Independent Innovation	政府采购支持自主创新的经济学分析
2007	Bei Xu, Lianghua Chen, Lijing Shen	Economic Analysis on the Promotion of Government Procurement to Self-innovation	政府采购促进自主创新的经济学分析
2007	Mei Hong, Lijing Shen, Lianghua Chen	International Experience and Implications of Government Procurement's Promotion Independent Innovation	政府采购促进自主创新的国际经验借鉴与启示
2007	Chunhua Feng, Peiqing Huang	Government Technology Procurement and Its Application Environment	政府技术采购模式及其情境分析
2006	Kaijian Zhang, Ruyan Cheng	To Make Public Procurement a real 'Innovation Procurement' – Review of the EU Report 'Public Procurement of R&D and Innovation'	使公共采购成为真正的“创新采购”——对欧盟《研发与创新的公共采购》报告的述评
2006	Changlin Gao, Yue Zhang, Zhaohui Xuan, Aimin Li	Suggestions on the Improvement of Buying Domestic Products to Promote Enterprise Technological Innovation	完善购买国货原则促进企业技术创新的政策建议
2006	Muzhu Shen	*Research on Government Procurement Policies Promoting Indigenous Innovation*	促进技术创新的政府采购政策研究
2006	Yanhua Liang	Study on Policy to Encourage Enterprise Independent Innovation	鼓励企业自主创新政策解读
2006	Zhanwu Yang	Government Procurement as an Innovation Policy	科技创新中的政府采购政策问题
2006	Conghu Wang	On Government Procurement to Promote Indigenous Innovation in China	论我国政府采购促进自主创新
2005	Zhou Xu	*Policy Measures to Use Government Procurement to Support Domestic High-tech Industries*	政府采购扶持国内高新产业促进技术创新的对策思考
2004	Zhou Xu	Theoretical Analysis of Government Procurement to Support High-tech Industry to Promote Technology Innovation	政府采购扶持高新产业促进技术创新理论的分析
2004	Xuejing Li	Theoretical Analysis of Government Procurement Promoting Technological Innovation in our Country	政府采购促进我国技术创新的理论分析
2004	Leyuan Deng	*Government Procurement for Technological Innovation (Dissertation)*	技术创新取向的政府采购
2004	Aihua Zhang	Developing Government Procurement to High-tech Industry	政府采购如何扶持高新技术产业的发展
2003	Leyuan Deng, Liangbin Cheng	*Government Procurement for Technological Innovation (Journal Article)*	技术创新取向的政府采购

PART 8 of List of Chinese publications

Year	Author(s)	Publication Name (in English)	Publication Name (in Chinese)
2003	Aifang Guo, Jianzhong Zhou	Practices of U.S. Government Procurement Promoting Technological Innovation and Its Significance	美国政府采购支持技术创新的做法及其借鉴意义
2002	Zhixue Zhang	Research on Public Procurement Policy and Implementing Measures to Support the Development of High-tech Industry	通过政府采购支持高新技术产业发展及其配套政策探讨
2001	Chaoyang Hu	Measures to Improve the Legal System Supporting Public Procurement for Technology Innovation	政府采购促进科技创新的法律对策
2000	Jisheng Peng	The Function of Government Procurement in Advancing Technological Innovation and Thoughts Regarding Practice	政府采购在推进技术创新中的功能及实践思考
1996	Ke Bao	*Use Government Procurement to Stimulate Technological Innovation of Firms*	用政府采购激励企业技术创新
1996	Ke Bao	*On the Necessity of Stimulating Technological Innovation Through Government Procurement*	通过政府采购刺激企业技术创新是必要的

Appendix 2: Non-linear innovation perspectives and the role of demand

Perspective	Author/Literature	Explanation of innovation processes	Implications regarding demand
Evolutionary theory	Nelson and Winter (1974); Nelson and Winter (1977); Nelson (1981); Nelson and Winter (1982)	Three main components lead to technical changes, i.e. the existence and reproduction of entities, novelty-introducing mechanisms and selecting mechanisms (market or political/institutional); innovations are like mutations in biology, introducing novelty and diversity; technological change is open-ended and path-dependent.	Interventions can target at any of the three components, e.g. to strengthen resource bases and institutional setups, to enhance scientific research systems, and to improve selecting mechanisms through regulations or demand articulation.
'Chain-linked' model	Kline (1985) Kline and Rosenberg (1986)	Innovations should be viewed as 'changes in a complete system' of many elements and factors; the central-chain-of-innovation is design-development-production-marketing, with feedbacks and loops connected to potential market and scientific knowledge.	Different types of firms and innovations are introduced; public interventions can target at the building or strengthening of any of the linkages or components.
'Interactive learning'	Lundvall (1985) Lundvall (1988)	Innovation must be based on an economy structure; it results from interactive learning processes between stakeholders (especially producer-user interactions) within a certain institutional setup which includes not only the market but also organizational and social mechanisms.	Markets are not perfect and need to be 'organized' to enhance information flow and induce innovation; the 'establishment and restructuring of user-producer relationships' is necessary.
'Development blocks'	Dahmen (1988)	Innovation processes as 'collective entrepreneur', requiring extensive mobilization of resources, including information, raw materials, skilled people and well-informed markets; linkages and coordination are needed to address 'gaps' in technological development.	Public agencies should identify and address 'gaps' hindering innovation processes; they should also play an entrepreneurial role when necessary; 'critical mass' can be achieved.
'Distributed innovation process'	von Hippel (1988)	Product innovations can arise from at least three distinct sources, i.e. suppliers, producers and users; 'shifting sources of innovation' can potentially modify incentive structures which would be more conducive for innovations.	Governments could intervene (directly or indirectly) in various segments of the innovation process, e.g. to alter incentive structure or to perform as 'lead users'.
Network analysis	Hakansson (1989) Freeman (1991)	Innovation processes are heavily affected by external information networks, which include 'vertical (e.g. user-producer)' and 'horizontal (e.g. inter-firm co-operation)' relations.	Public agencies can facilitate demand articulation; a focal organization providing vertical linkage is needed to overcome a 'low-level equilibrium trap'.

Source: Author derived from Edquist and Hommen (1999), Edquist (1997), Sharif (2006) and the literature listed in the table

Appendix 3: Evolution of China's national innovation system

Key dimensions of the five development stages of China's NIS are summarized in Table App.3 below.

Table App.3 Evolution of China's NIS in terms of policy milestones

Years	Background	Main measures	Actors and Interactions	Impacts
1975-1978 **Incubation**	Termination of Cultural Revolution; Imperative of economic development.	'Bring order out of chaos' for the role of STI; remove ideological and cultural barriers.	Public research institutes as the only R&D means; barely any interactions within the 'NIS'.	Emancipated people's mind for economic and STI development.
1978-1985 **Experimentation**	'Open-door' decision; Unfolding experimental economic and education reforms.	Learning by doing; addressing the shortcomings of Soviet STI model.	Universities became involved; R&D abilities of firms recognized; weak science-industrial link established.	Successful spin-off firms; better innovation diffusion.
1985-1995 **Structural reform**	Rapid international STI development; the need of complementing economic reform.	Institutional reforms: personnel reform; commercializing PRIs; launching key STI programmes.	Stronger firm R&D; university-firm link initiated; stronger science-industrial link.	Systemic structure formed; confidence for further reform.
1995-2005 **Deepening the reform**	Fast economic growth; severe STI competition; globalization.	Deepening the reform; systemic measures; specialized STI programmes.	Connections between actors strengthened: firm-PRI; university-firm; university-PRI.	More efficient policymaking; more dynamic NIS.
2006- **Indigenous innovation**	Sustainability of development highlighted; imperative of social development	Towards a harmonious society and indigenous NIS; catching up with OECD countries	Firm-centred, stronger interactions between innovative actors; the role of government adjusted from top-down to an interactive component of NIS	To develop a firm-centred NIS with various policy tools; impacts remain to be seen.

Source: Author derived from Baark (2001), Gu and Lundvall (2006), Xue (1997), OECD (2008), published in adapted form in Li[a] *(2011).*

- **1975-1978: the incubation stage**

The period of 1975-1978 was a time of recovery for many aspects in the Chinese society, as the Cultural Revolution during 1966-1976, described as the '*ten years of madness*' in Feng (1996), finally terminated. After the rehabilitation of Deng Xiaoping, he initiated 'rectification' measures to promote the recovery and development of economic, STI and education systems. Economic development was put back as the focus, and STI reforms were also brought on the agenda (Deng, 1978). Deng's 'open-door' initiative of this period had far-reaching impacts on China's development in various areas. Different from the Cultural Revolution that denied the value of knowledge, Deng's reform initiatives featured the emphasis that '*science and technology are the primary productive forces*'[45]. Supposed NIS actors of this phase were far from being 'active'. Universities were damaged seriously during Cultural Revolution and just started to recover. Firms, as a result of the centrally-planned economic mode, had little R&D input and their potential to innovate was neglected by the government (Xue, 1997). PRIs were the only innovating body, enjoying direct funding and undertaking research programmes. In this sense, universities and firms could hardly be called as 'actors'. This top-down STI policy approach, although not systemic, worked in certain high-tech core areas in early years of new China, to concentrate limited resources on key breakthrough missions, such as nuclear weapons and space technology.

- **1978-1985: the experimentation phase**

In 1978, the *Outline of a National Plan for the Development of Science and Technology (1978-1985 Draft)* was launched in line with the *Outline of the Ten-Year Plan for the Development of the National Economy (1976-1985 Draft)*. The two plans both proved to be too ambitious and got adjusted later (Xue, 1997). Still, the Outline implied that another era was coming, i.e. a groping phase to pursue STI strategies that were suitable for China. In this phase, the overall theme of China's economic development was '*open door*' and '*emancipating the mind and seek truth from facts*'. Bottom-up and '*learning by doing*' approaches of policymaking were gaining ground, aiming to address the shortcomings of the soviet model with an emphasis on science-industry links (Motohashi and Yun, 2007). Meanwhile, reforms of universities widely unfolded under

[45] Speech given by Deng Xiaoping when he met the Czech President Husak in 1988; later on included into *Selected Works of Deng Xiaoping (Volume III)*.

the guidance of the government. The government started to pay attention to the research potential of universities, but there was barely any official collaboration between universities and PRIs or firms. Linkage between PRIs and firms was initiated, mainly in the form of spinoffs to commercialize the research results of PRIs through business channels (Liu and White, 2001). A well-known spinoff example of this period was Lenovo founded by the CAS (OECD, 2008). Although many reformative measures were promulgated at this stage, large-scale, systemic and substantial reforms were still in the shell until the launch of *Decision on Reforming the Science and Technology System in 1985* (hereafter Decision 1985).

- **1985-1995: the phase of systemic reforms**

The motivation underpinning the reforms during this phase, according to Li (2008), lies in both internal and external aspects. The internal motivation was that a complementary, STI system reform was necessary for the overall, market-oriented economic reform (ibid.). A key problem to resolve was the structural deficiency of the previous, centrally-planned system (Xue, 1997). The deficiency can be understood through the lens of *system failures*, including the *deficiency of interaction between main actors* (e.g. poor science-industrial linkage led to separation of the R&D function from production processes), the *deficiency of innovation-friendly framework conditions* (such as the poor IPR protection system), and *the deficiency of mobility of STI personnel* (ibid.). The external motivation lies primarily in the rapid development of global STI and the rise of newly industrialized countries (Li, 2008). The Chinese government identified the imperative of developing STI to stimulate economic growth. Based on these motivations, the Chinese government issued Decision 1985, which marked the official start of a systemic reform of the STI system. In particular, it pointed out three dimensions in which reforms were most imperative, namely ‘operating mechanism’, ‘institutional structure’ and ‘STI personnel management’. Several R&D programmes were launched in this phase of reforms, e.g. 863 programme (supporting high-tech R&D), Spark and Torch Programme (supporting SMEs and commercialization), and National Natural Science Foundation (supporting basic research). The conversion of applied-research-PRIs into business entities was encouraged (Xue, 1997). Interactions and linkages between main actors became increasingly dynamic during this phase, and market forces were introduced to the system (Xue, 1997; Li, 2008).

- **1995-2005: deepening the reforms**

The positive impacts of Decision 1985 together with its complementary measures on economic and STI development encouraged the Chinese government to deepen the reforms in the following decade (Li, 2008). Meanwhile, considering the new conditions in the international context and new domestic problems that emerged, the government made further adjustment to deal with the more complex and challenging situation. Inefficient industrial structure, low technological levels, low labour productivity and poor quality of economic growth were identified as the main problems (ibid.). In order to achieve policy goals more efficiently and coherently, the then Premier Zhu Rongji established the State Leading Group for Science, Technology and Education, which has been playing an important role in coordinating various STI agencies and policies. Interactions between main actors were reinforced based on the framework set in the previous phase. The main feature of this phase could be described as '*steady deepening of reforms*', with a rapid growth of R&D investment by both the government and business players.

Appendix 4: Details of IOPP policy initiatives by OECD countries

4.1 The European Union

A series of initiatives related to IOPP have been taken in the EU since the early 2000s. In 2002 the EC set the ‘Barcelona target’ of spending 3% of EU GDP on R&D by the year 2010, with industry expected to contribute two thirds of the spending. In this context, in 2003 the expert group report for the EC *Raising EU R&D Intensity – Improving the Effectiveness of Public Support Mechanisms for Private Sector Research and Development: Direct Measures* (Georghiou et al., 2003) made a set of policy recommendations covering supply-side, demand-side and framework measures and coordination issues to realize this target. They argued that

> *‘...public technology procurement is probably the policy instrument with the largest potential to contribute to the 3% target’*
>
> and that
>
> *‘…the boost to innovation derived from defence spending in the US could be matched in Europe by innovation-oriented procurement in sectors such as health and public security’ (ibid. p. xi).*

In 2004 the French, German and UK governments jointly published a paper *Towards an Innovative Europe* (French, German, UK Governments, 2004), which identified main barriers hindering innovation in Europe and priorities for action to tackle them. Public procurement is one of the priorities and the paper called for attention from the Commission and other Member States to analyse EU’s existing procurement systems and taking appropriate actions to utilize IOPP. Later in that year, the Kok report *Facing the Challenge – the Lisbon Strategy for Growth and Employment: Report from a High Level Group* (Kok et al., 2004) explicitly pointed out that

> *‘Member States and the Commission should look at ways in which public procurement could be used to provide a pioneer market for new research and innovation-intensive products and services’ (p.21)*

An expert group report on IOPP but more targeted at the practical issues associated with procurement is *Public Procurement for Research and Innovation – Developing procurement practices favourable to R&D and innovation* (Wilkinson et al., 2005). It analysed the possibility of embedding IOPP into regular procurement cycles conducted by government agencies. Recommendations were made to direct procurement to stimulate innovation, including: reviewing EC Directives 2004/17/EC and 2004/18/EC by 2010 to see whether or not these supranational-level institutions are enabling R&D and innovation; requiring Member States to implement the Directives 2004 into national legislation and initiate training for procurement personnel; enhancing awareness and capacity of various stakeholders; setting up monitoring mechanisms especially with regard to IPR and standards issues.

Another expert group report with even more far-reaching impacts on EU's IOPP policymaking was the Aho report *Creating an Innovative Europe* (Aho et al., 2006), which recognized that *market fragmentation* has been a major disadvantage of EU in promoting innovation and proposed to create a EU-wide lead market. Main policy recommendations included strengthening DSIPs (regulations, standards, public procurement and culture building) and combining them with supply-side measures. Following this initiative, the EC published *Pre-commercial Procurement of Innovation – a missing link in the European innovation cycle* (EC, 2006), pointing out that there is tremendous potential in adopting PCP to stimulate innovation, since

> *'...due to their pre-competitive nature,* ***pre-commercial R&D services are by definition an exception case in the WTO-GPA****' (p.7).*

EU countries should then provide preferential treatment for European firms during the stage of PCP and open up competition during later stages of commercialization (ibid.). This PCP regime has been carried on since then[46] as part of the EU's effort to utilize IOPP. Meanwhile, the Commission published a practical guide to dealing with IOPP and offered implications derived from 'good practices' (EC, 2007).

A more systemic action triggered by the Aho report has been the LMI launched in 2007, which selected six strategically important sectors (eHealth, protective textiles, sustainable construction, recycling, bio-based products and renewable energies) and employed demand-side measures (standardization, legislation, public procurement and complementary actions) in order to remedy development barriers and stimulate innovation. An important achievement resulted from the LMI has been the establishment of a network of procurers across the continent, in order to enhance communication and collaboration among practitioners (OECD, 2011a).

---

[46] See http://cordis.europa.eu/fp7/ict/pcp/overview_en.html for details [accessed June 30th 2013].

A recent expert group report *Feasibility Study on Future EU Support to Public Procurement of Innovative Solutions* (Rigby et al., 2012) addresses a number of research questions regarding future options of IOPP available for the EU. By analysing possible scenarios they proposed that the future IOPP regime in the EU should embed three strands of activities, i.e. a '*support mechanism defined by EU policy objectives* (e.g. societal challenges, industrial policy)', a '*support mechanism based on a response mode facility to assist public buyers meet their needs for innovative procurement*', and developing '*capabilities amongst all relevant parties to the procurement of innovation* (e.g. Strand 1 & 2 networks)' (ibid. p. 5). The first strand can be considered as a 'top-down' approach driven by innovation gaps in the EU; the second strand can be considered as a 'bottom-up' approach driven by contracting authorities' demand; and the third strand can be considered as a 'horizontal' approach to supporting all types of stakeholders (ibid.).

4.2 Individual European countries

The United Kingdom adopted both targeted programmes and horizontal initiatives to implement IOPP. In 2004, the Office of Government Commerce (OGC) published the report *Capturing Innovation* (OGC, 2004) to encourage the public sector to '*think innovation and become intelligent procurers*' (p.1), and meanwhile to provide practical guidance for practitioners regarding when and how to capture innovation through public procurement. Stimulated by this initiative, the UK Environmental Innovations Advisory Group (2003-2008) developed the *forward commitment procurement* (FCP) model together with OGC in 2006. The rationale of FCP is to reduce suppliers' (especially SMEs') risk and stimulate innovation by adopting such a procedure that public authorities provide advance information regarding their future needs (in performance terms rather than technological specifications), interact with suppliers during the innovation processes, and eventually if the solutions are developed, procure them. A number of IOPP cases were stimulated by this approach[47]. In 2007, OGC and the then Department for Innovation, Universities and Skills published a joint guidance *Finding and Procuring Innovative Solutions* (DIUS and OGC, 2007), which demonstrated practical issues of IOPP through case studies. In 2008, the UK government published the White Paper *Innovation Nation* (DIUS, 2008), whereby every government

[47] See http://www.bis.gov.uk/innovation/procurement_policy/forward_commitment_procurement [accessed June 30th 2013].

department was committed to embed 'an innovation procurement plan as part of their commercial strategy' (p.4). Meanwhile, the UK government decided to review the Small Business Research Initiative (SBRI)[48] by drawing upon successful experience of the US SBIR programme (OMC-PTP, 2009). SBRI organizes competitions of business ideas to suit public needs with the aim to stimulate firms especially SMEs to innovate. Efforts have also been made to incorporate innovation and sustainability into the UK public procurement system. Various government departments and agencies have made their action plans to implement sustainable and innovation procurement, e.g. *Sustainable Procurement Action Plan* (Defra, 2007), and *Innovation Procurement Plan* by Department for Culture, Media and Sport (DCMS, 2009).

Germany initiated its High-Tech Strategy since 2006, aiming to become the 'most research friendly nation in the world' (Federal Ministry of Education and Research, 2006). Creating lead markets in targeted sectors (for the period 2009-2013, sectors of health/nutrition, climate protection and energy, mobility, security, and communication) was announced as one priority of action, and public procurement is one important policy element to realize it. Meanwhile, the German government has been calling for a change in terms of procurement practices, e.g. the Federal Ministry of Economics and Technology and the German Association Materials, Management Purchasing and Logistics jointly published a brochure about how to embed the objective of stimulating innovation into the public procurement system (OMC-PTP, 2009); electronic procurement platforms have also been built to facilitate more efficient public purchasing (ibid.). Six federal ministries (Interior, Economics, Defence, Transport, Environment, and Research) reached an agreement to work together on possible approaches to orienting public procurement towards innovation and sustainability (Lorenz et al., 2009). Following this ministerial-level initiative, in early 2009, the *Act Against Restraints on Competition* was passed and innovation was included as part of the procurement criteria in addition to traditional requirements (ibid.).

Sweden, although nurtured numerous IOPP cases historically (Edquist et al., 2000), took its explicit, national initiatives of IOPP at a similar time with Germany. In 2006, the Swedish Agency for Economic and Regional Growth and the Swedish Governmental Agency for Innovation Systems (VINNOVA) were commissioned

[48] See http://www.innovateuk.org/deliveringinnovation/smallbusinessresearchinitiative.ashx for details [accessed June 30th 2013].

collaborate with the National Board for Public Procurement to investigate the functioning mechanisms and potential of public procurement to stimulate innovation (VINNOVA, 2007). A major finding was that some public authorities were already acting as demanding consumers (primarily in infrastructure sectors) long before the national initiative was launched (ibid.). Some sectoral agencies implemented technology-specific mix of policy instruments, e.g. in the energy sector, public procurement was used as an *ice-breaker* and *catalyst*, followed by complementary measures such as procurer and private consumer subsidies (Stern et al., 2011). VINNOVA (2007) proposed that IOPP should be taken as a general procurement form in Sweden, that all public authorities should engage in IOPP and 1% of Sweden's procurement budget should be targeted at stimulating innovation, and that a reliable information source (including statistics) should be established to monitor and evaluate IOPP. In 2008, the Swedish government issued the *Research and Innovation Government Bill*, which emphasized the necessity of developing implementation approaches and building competence for IOPP; it meanwhile commissioned VINNOVA to carry out pilot projects (OMC-PTP, 2009). These pilot projects should investigate issues such as procurement methods (criteria, procedures and bundling of demand), risk management, SMEs, and IPR, and further demonstrate different functioning mechanisms of various types of IOPP (ibid.).

4.3 Other OECD countries

Although the US has not been active in implementing explicit DSIPs in recent years (OECD, 2011a), it has a sophisticated IOPP system and a long history of utilizing it. The Department of Defence has triggered numerous innovations through its procurement of R&D services, well-known examples of those including transistors, jet engines and the Internet (ibid.). Although defence procurement is not the focus of this thesis, and might not be suitable for other countries (e.g. EU countries with relatively smaller defence expenditure and fragmented markets) as an IOPP approach, it is still enlightening for procurement in other sectors (ibid.). Another IOPP approach in the US is the SBIR programme which targets at facilitating SMEs through systemic support including procurement. Nowadays SBIR is a 'role model' in the domain of IOPP; many countries initiated 'SBIR-type' programmes, e.g. SBIR in the Netherlands and SBRI in the UK. At a more general level, the *Buy American* regime (see Section 3.3.3) provides support for indigenous firms.

Japan initiated its SBIR-type programme in the early 2000s at the central level, followed by further implementation from 2004 at local levels (Myoken, 2010). This initiative drew attention from government agencies to the significance of IOPP (ibid.). Meanwhile, the METI has been working on an integrated and horizontal procurement strategy to engage various departments in IOPP (VINNOVA, 2007).

Korea initiated a *New Technology Purchasing Assurance Programme* supervised by the Small and Medium Business Administration in 1996, aiming to stimulate SME innovation through procurement (OECD, 2011a). However, the programme was rather flawed and the implementation was not smooth due to a lack of incentives and capacity (ibid.). In 2005 a major revision of the programme was conducted to further clarify policy details, reduce suppliers’ and buyers’ risks, and enhance the implementation mechanism. A performance insurance system was introduced to certify products, and qualified products have the priority to be procured through restricted tendering (ibid.).

Appendix 5: Details of data collection

Given that this is an exploratory study, two fieldwork trips to China were taken. The first round (December 2010 to January 2011) served as a scoping trip to gather opinions from national and regional government officials, identify micro-level cases, and 'snowball' further interviewees; the second round (late April to early June 2011) was the main stage of data collection, gathering opinions from suppliers, procurers, government officials, users and some researchers in this field. Before the fieldwork, pre-interview questionnaires[49] were sent out to potential interviewees as a case/interviewee selection as well as a data collection approach; after the fieldwork, follow-up interviews via telephone were conducted in late 2011 and early 2012 to track new changes after the policy termination in July 2011.

The sampling process started with an initial selection of regions based on documentation available on the Internet. After initial contacts with two national-level officials (who are among the key interviewees for this study, working in MOST) were established prior to the fieldwork[50], the selection of regions was refined based on interviewees' advice and their estimated accessibility of further interviewees. The selection of cases and interviewees went on hand in hand, as access to further interviewees determines whether a case could be selected or not; while cases in turn determined what interviewees should be chosen.

It is noteworthy that the China Railway High-speed (CRH) programme, which was considered as a potential national programme case study, was screened out after one interview during the first fieldwork trip, due to its political sensitivity and complexity[51].

---

[49] Pre-interview questionnaires were designed based on the sampling strategy, type of potential interviewees and Chinese IOPP literature. Questionnaires were sent out to all potential interviewees except researchers via email or in person together with a one-page introduction to this topic and operational issues in Chinese. Researchers were approached directly since their work on IOPP was available online and they were all knowledgeable. Questionnaires were all anonymized and coded correspondingly to interviewees.

[50] Contacts with interviewees are perceived very difficult to establish in China (which has been well documented in Heimer and Thøgersen, 2006). Initial attempts to establish contacts through emails arguably failed; only two researchers and one government official respondent replied. Contacts with most of the interviewees were established through interpersonal relationship, or 'Guanxi' (Fan, 2002), as well as snowballing. It was important that the starting point of snowballing was national and regional government officials from S&T and finance departments; they are well-connected with suppliers and public procurers (sometimes also users).

[51] Beyond the government procurement system, the then Ministry of Railway (MOR) also announced in 2007 that it would encourage organizations from the railway system to apply for accreditation of indigenous innovation products; and it would procure indigenous innovation products once the catalogues were published (see http://www.gov.cn/jrzg/2007-10/05/content_768770.htm) [accessed April 30th 2013].

Nevertheless, the 2.5-hour interview with a high-level manager in the company was an in-depth one which provided rich information about public infrastructure procurement in China; it helped gain a better understanding of the Chinese procurement system. There were some other interviews conducted but not used explicitly to build cases, including R1S_HV (originally for Havon case), R4S_SP (originally for Spandex case), and two interviews regarding Solar energy (originally for Solar case but also related to LED lighting). The Havon case was eliminated as it had a 'regular procurement' nature rather than IOPP; the Spandex one was related to defence and access to further data was limited; the Solar one was too broad to define a clear boundary. Those interviews contributed to the author's overall understanding of IOPP, public procurement, and innovation in China from the viewpoints of suppliers.

The selected interview approach was face-to-face rather than electronic ones. Although interviews in the field were time and money consuming, it proved to have greater potential in snowballing more interviewees and digging more data out. Telephone interviews were employed as a subsequent method after face-to-face interviews were finished while further information was needed; it was very useful after the IOPP policy got abolished and an update was needed. Still, there were 4 interviews turned out to be done via telephone and email (see Appendix 10), when face-to-face interviews were impossible due to distance and scheduling issues.

Interviewees of a certain level or cases were asked about their perspectives regarding other levels. For instance, suppliers were asked, other than issues related to the concrete procurement cycle, about their experience and opinions regarding innovation policies issued by different levels of government, so that downstream impacts of policies could partially be understood. Meanwhile it was desired that different types of interviewees can be consulted to a similar degree of depth with some common issues covered, to enable data analysis in a converging fashion. Some interviewees played multiple roles in IOPP processes, and they were asked more questions accordingly by integrating questions concerning all the roles.

The promotion impacts of MOR procurements on indigenous innovation through the CRH programme have been tremendous (see Xu and Pan, 2011). However, the ministry was dissolved on March 10th 2013, and its responsibilities were taken over by the Ministry of Transport, State Railways Administration, and China Railway Corporation. Numerous controversial issues surrounded the development of CRH, one of which being the corruption scandals of high-level officials including the previous minister.

After interviews are done, transcribing is a crucial yet 'tiresome' process to turn oral conversations into analysable texts and this process itself is '*an initial analysis*' (Kvale, 2007, p.94). Language is an issue as well; translating between two languages is no less tiresome than transcribing, and could potentially lead to information loss and misunderstanding of the interview data (see e.g. Heimer and Thøgersen, 2006 where the translation issues associated with fieldwork in China are elaborated). Other issues that need to be taken into account include ethical issues to protect interviewees (Kvale, 2007), operational issues such as choosing the interview sites, recording, wording of concrete questions, and techniques during interviews e.g. bridging and probing (Easton et al., 2000; Robson, 2002; Turner, 2010).

Interviews are anonymized and coded as the majority of the interviewees preferred this way (this is also the case for most researchers conducting fieldwork in China, see Heimer and Thøgersen, 2006). Interviews were all recorded with notes taken except one with a Chinese researcher in a public place which was too noisy; the choice of site was not ideal but it was following the request of the interviewee. Most of the recorded interviews were transcribed except the two with EU researchers; they provided very helpful insights for the author to understand the context of EU in terms of IOPP policy and research, but it was not considered very necessary to transcribe word by word, since, on the one hand a large amount of time was required to transcribe the four-hour long recordings and on the other, the data collected would not be directly involved in the analysis (this decision is supported by Robson, 2002). Chinese interviews were not all translated due to the large amount of data – the word count of the transcripts is around 360,000 Chinese words. The Chinese data were analysed directly without being translated except for the direct quotes, then written up into descriptive pieces, and then further structured to build IOPP case studies or fed into other analysis in English.

Appendix 6: Information page sent out to interviewees

Translated Example (R5O_2)

The University of Manchester
Manchester Business School

Information Page for Interviewees Participating in Doctoral Research Projects

You have been invited to participate in a Doctoral Research Project. This is an introduction to the Project to facilitate you to decide whether to take part or not. Please spend some time reading through the items below. You can consult third parties to help you make the decision if necessary. Should you have any doubts or questions, please do not hesitate to contact me (see contact details below). Thank you very much for your cooperation!

Q1: Who will carry out this Project?
Yanchao Li (please see attachment for my CV), 2nd year PhD student, Manchester Institute of Innovation Research (MIOIR)

Q3: Research Objectives?
In the light of the launch of policies supporting indigenous innovation with public procurement by the State Council, this Project investigates the making and implementation of those policies, and details regarding micro-level processes undertaken by practitioners.

Q5: What am I asked to do if I participate?
You will need to provide information regarding this policy instrument based on your knowledge, in the form of face-to-face interviews. You opinions will be treated as your personal ones rather than official ones representing your department. No questions violating your privacy will be asked. If any questions made you feel unpleasant, you can refuse to answer them.

Q7: How do you guarantee data confidentiality?
Interview data will be stored in the researcher's encrypted computer, for the researcher's personal use only. You can choose to keep your identity anonymous by ticking corresponding items in the Consent Form (which will be presented to you before the interview).

Q10: Will the results of this Project be published?
Yes, very likely. You can decide whether to stay anonymized or not. You can also clarify during the interview regarding which part of information you would rather keep confidential and unpublished.

Q12: What if I do not want to participate, or if I change my mind?
It is completely up to you to choose whether or not to participate, and to decide when to quit. If you do want to be an interviewee, please sign the two copies of Consent Form, keep one copy of that, and keep this information page as a record.

Q2: Title of the Project?
<Potential in China for Demand-side Innovation Policy Including Public Procurement>

Q4: Why am I chosen as a participant?
(Example for R5O_2) Jiangsu has been a pioneer in promoting indigenous innovation through government procurement. During the course of implementation, S&T departments played a very important role. As an official in charge, your understanding, experience and opinions regarding this topic will be invaluable for this study. Other informants approached by the researcher include officials from other departments, procurers, users, and suppliers etc., in Jiangsu and in other regions.

Q6: How do you deal with the data collected?
Interview data will be processed through template analysis, comparative analysis, and system failure analysis. In general, they will form the empirical foundation for the thesis that the researcher is working on.

Q8: How long will the interview last?
Normally 0.5-2 hours, depending on your availability. If necessary, and if you agree, you might be approached later on for further information or interview.

Q9: Will I be paid?
No, but your cooperation is very much appreciated ☺. If you are willing to, you will be thanked in the publications that this research produces.

Q11: Where is this Project being conducted?
Primary data collection mainly takes place in China, while data analysis and writing-up will take place in the UK.

Q13: Contact details
Email: Yanchao.li@postgrad.mbs.ac.uk
Telephone (China): 0086-13811649257
Telephone (UK): 0044(0)7879291944
Address: Manchester Business School, Booth Street West, Manchester M15 6PB

Appendix 7: Pre-interview questionnaire

Translated Example (Finance official)

The objective of using this questionnaire is to gain overall information about your experience and opinions with respect to 'government procurement supporting indigenous innovation' (innovation oriented government procurement, IOGP).

1. Which of the following activities have you been involved in regarding innovation oriented government procurement? (You can select more than one answer.)
   （ ）A. Building legislation and regulations, and policymaking;
   （ ）B. Organizing and coordinating tender processes;
   （ ）C. Acting as an expert/advisor for innovation procurement;
   （ ）D. Acting as a procurer of innovation procurement;
   （ ）E. Acting as an end-user of innovative solutions;
   （ ）F. Other forms, please specify: ______________________________

2. From your own opinion, do you agree or disagree with the following statements?

Y	N	Neither	Statements
			Our country's legal system is well established for government procurement and IOGP.
			Policies and regulations on IOGP are sufficient enough to guide practice.
			China's accession to WTO-GPA is good for innovation and IOGP.
			Finance departments are supportive in procuring innovation.
			Enough budgets have been allocated for procurement of innovation.
			We have a large domestic market, and this indicates great potential for IOGP.
			Procurement centralization is not enough; regional protectionism is common.
			There is a lack of professional procurers in China.
			'Supporting innovation' should be a priority in government procurement activities.
			Government procurers refer to innovation catalogues to buy products in practice.
			Government procurement in China is lack of equality.
			Government procurement in China is lack of transparency.
			Finance departments work closely with S&T departments to implement IOGP.

3. Do you know any examples where government procurers favour innovative solutions rather than cost-effective solutions? Or can you name any examples where innovative solutions on the catalogues have been procured? Or do you know any examples whereby innovative technologies/products/solutions have been produced *as a result of* government procurement?

4. Can you provide any statistics/reports about government procurement in your locality? In particular, can you provide statistics/reports about government procurement supporting innovation?

Appendix 8: Unstructured interviews – key issues covered

Interviews	Key issues covered
NO_1	• Based on information provided in the questionnaire, interviewee was asked to describe his experience as a policymaker for STI policies including IOPP; interviewee introduced the broad landscape of innovation policy making and implementation in China, including his understanding of the innovation systems of the regions selected by the author; he also introduced the rationales, procedures, organization, and coordination issues related to policymaking in his department; • Interviewee commented on the appropriateness and effectiveness of IOPP as an innovation policy; he highlighted a range of problems associated with this policy instrument in China, including some 'conceptual problems' (NO_1); • Interviewee recommended the E-classroom case; he also commented on the procurement elements of the Chinese Railway High-speed programme.
NO_2	• Interviewee suggested that NEV, LED, and Solar Energy programmes were important policy instruments with IOPP features; he recommended the author to investigate further into those programmes, and helped contact further informants from different regions; he also discussed briefly the role of Zhongguancun in Beijing, and potential cases he knew about; • Interviewee discussed his understanding of regional implementation of policies and programmes; he considered that regional implementation achievements relate highly to regional governance styles and culture; • Interviewee described various aspects of the LED programme in detail.
Researcher_1	• Interviewee shared his experience and observation as a junior researcher on IOPP in China; he commented on the design of this study, and explained his concerns over difficulties to access primary, qualitative data related to policy implementation processes.
Researcher_2	• Interviewee introduced the functions of his institute and described his and his colleagues' experience of facilitating the government in policymaking for DSIPs including IOPP; • Interviewee discussed his opinions on some crucial factors affecting IOPP, including issues related to WTO-GPA; he as an 'insider' of the policymaking process expressed concerns over US-China dispute and its pressure on IOPP.
Researcher_3	• Interviewee provided a detailed introduction to his institute in facilitating IOPP policy design and implementation, and collaboration with technological practitioners; • Interviewee commented on the potential of IOPP in China and other developing countries; he suggested the author to look at development literature; he discussed the differences between developed and developing countries in using IOPP, and pointed out some potentially tricky issues.
Researcher_4	• Interviewee introduced his observation of IOPP research and practices in the EU context especially regarding actions taken by individual member countries; • Interviewee provided an in-depth discussion on the roles played by institutions in shaping IOPP.

Appendix 9: Semi-structured interview protocols

9.1 Semi-structured interview protocol – STI and sectoral innovation officials

Section I: Overall issues

- On the basis of questionnaire answers, clarifying key issues related to the interview;
- Consent form signing;
- Main objectives:
  - To understand China's IOPP policy processes from the standpoint of the innovation side;
  - To understand the process of particular IOPP cases;
  - And/or to snowball IOPP examples.

Section II: About the IOPP policy process

- How do you position the innovation system in your region in the context of the broader national and/or provincial innovation systems? What are the special characteristics, advantages, and weaknesses of your region in terms of innovation performance?
- What special considerations has your department taken when designing the local IOPP setup?
- Does your region have any routinized IOGP mechanism corresponding to the national-level 'innovation catalogues' scheme?
  - If yes, could you please provide details about the design and implementation of this mechanism? How were the catalogues produced and used?
  - If no, could you please introduce the setup of other IOPP policies in your region?
- Do you consider the government procurement elements associated with the NEV and LED lighting programmes appropriate and effective in stimulating the emergence and diffusion of innovation (define innovation for interviewee)? Please provide more details.
- How have issues such as inter-departmental and inter-level coordination, product evaluation, risk control, policy implementation, monitoring, and evaluation been handled? What difficulties are there hindering the implementation of IOPP policies?
- Among the various types of STI policy instruments adopted by your department, do you consider IOPP (including any policy channels that link government/public procurement with innovation) as an appropriate and effective one?
- In your opinion, what deficiencies do you think the IOPP policies that your department is involved in address?
- In the questionnaire you considered that…(raising the issues identified from the questionnaire); could you please explain why?

Section III: About the particular IOPP case(s)

- In cases that the official has also played the role of 'procurer' or 'user', refer to corresponding interview designs and ask questions related to other roles.
- I have been collecting data to build a case study about the procurement of…(introducing the IOPP cases selected); I would like to know more about the case(s) from your point of view; could you please discuss your opinions on issues such as…(asking questions related to the background, process, impacts, and barriers etc. related to the IOPP case, depending on what earlier data have been collected).
- If you have been involved in the IOPP process, could you please discuss your own experience and opinions, especially regarding your interactions with other parties (e.g. finance departments,

procurers, suppliers, and users)?

- Do you consider the policies issued by your department, and the ones by other government departments, effective in stimulating and affecting this IOPP case?

Section IV: Other cases and other issues

- Do you recommend any IOPP examples that you think are worth investigation? Could you provide a brief introduction to the examples? Could you please provide data sources and further contacts?
- Do you have any other information/materials/contacts that you think might be useful for the conduct of this study?
- Do you have any comments or criticisms for the design of this interview?
- Do you have any questions/concerns? Please feel free to let me know. Thank you!

9.2 Semi-structured interview protocol – finance officials

Section I: Overall issues

- On the basis of questionnaire answers, clarifying key issues related to the interview;
- Consent form signing;
- Main objectives:
  - To understand China's IOPP policy processes from the standpoint of the procurement side;
  - To understand the process of particular IOPP cases;
  - And/or to snowball IOPP examples.

Section II: About the IOPP policy process

- Could you please introduce briefly the main tasks and objectives of the government procurement function of your department?
- Could you please discuss your own opinions on the current legislative and institutional setups for government and public procurement in China? Do you consider the current procurement system as a well-established one?
  - If yes, are there any barriers, bottlenecks, or other factors hindering the use of government/public procurement as an innovation policy? Do you consider government procurement as an (potentially) appropriate and effective innovation policy?
  - If no, what are the problems/deficiencies/weaknesses? (Then ask the above sub-question).
- Have objectives such as transparency, efficiency, and equality been achieved by the current regulatory system for government procurement? How were these objectives achieved?
- What procedures, techniques, evaluation criteria, and other measures (such as risk control) has your department adopted to implement IOPP? Any different ones from that for 'regular' government procurement?
- Other than the innovation catalogue-based approach, what other IOPP policy measures have your department been involved in, e.g. NEV and LED lighting programmes, or equipment-related IOPP? How have those policies been implemented?
- What deficiencies do you think the IOPP policies address for the beneficiaries e.g. suppliers and users?
- What are the overall attitudes of your department and related procurement agencies for domestic and imported products, and for products from suppliers located in other regions? Do you have any preferences, either personally or organizationally (or politically)?
- What are your opinions on the potential of IOPP in the light of China's accession to WTO-GPA?
- Does your department have any statistics or reports for government procurement targeted at innovation?
- In the questionnaire you considered that…(raising the issues identified from the questionnaire); could you please explain why?

Section III: About the particular IOPP case(s)

- In cases that the official has also played the role of 'procurer' or 'user', refer to corresponding interview designs and ask questions related to other roles.
- I have been collecting data to build a case study about the procurement of…(introducing the IOPP cases selected); I would like to know more about the case(s) from your point of view; could you please discuss your opinions on issues such as…(asking questions related to the background, process, impacts, and barriers etc. related to the IOPP case, depending on what earlier data have been

collected).

- If you have been involved in the IOPP process, could you please discuss your own experience and opinions, especially regarding your coordination/interaction with other parties (e.g. STI departments, procurers, suppliers, and users)?
- Do you consider the policies issued by your department, and the ones by other government departments, effective in stimulating and affecting this IOPP case?

Section IV: Other cases and other issues

- Do you recommend any IOPP examples that you think are worth investigation? Could you please provide a brief introduction to the examples? Could you provide data sources and further contacts?
- Do you have any other information/materials/contacts that you think might be useful for the conduct of this study?
- Do you have any comments or criticisms for the design of this interview?
- Do you have any questions/concerns? Please feel free to let me know. Thank you!

9.3 Semi-structured interview protocol – supplier

Section I: Overall issues

- On the basis of questionnaire answers, clarifying key issues related to the interview;
- Consent form signing;
- Main objectives:
  - To understand the process of the particular IOPP case;
  - To gain knowledge about the supplier's experience related to IOPP, and the influence of IOPP on the supplier.

Section II: About the supplier's experience related to IOPP

- Could you please briefly introduce your company?
- What has your company's experience been, and what are your personal opinions, regarding the innovation policies issued by different levels of government in China? What types of policies has your company enjoyed? From which level?
- Among those policy instruments, do you consider government/public procurement as an effective one in terms of stimulating the creation and diffusion of innovation of your company (new products, solutions, and organizational methods etc.)? Has this instrument addressed any bottlenecks, or deficiencies, faced by your company? How often has your company benefitted from this instrument? Has IOPP influenced your company's effort in innovation activities e.g. increased R&D spending?
- What do you think about the effectiveness of other instruments such as standards, industrial regulations, and user subsidies (what we term as 'demand-side innovation policy' instruments), compared with traditional measures such as R&D grants?
- Could you please introduce your company's overall experience in government/public procurement market? What public authorities have been your customers? What products/solutions have you provided to them?
- Generally speaking, do you consider the government/public procurement in China well regulated? Have issues such as transparency, efficiency, and equality, been handled well?
- Has your company encountered regional protectionism, or other kinds of discrimination, in the government/public procurement market? If yes, please provide more details.
- What products/solutions produced by your company have been listed in (national and regional) innovation catalogues?
- Is your company's innovation activities influenced by the national equipment catalogues? If yes, how? If not, why?
- With respect to the IOPP example we focus on today, is it the only case that your company experienced, or is it only one of the many IOPP cases experienced by your company?
- In the questionnaire you considered that…(raising the issues identified from the questionnaire); could you please explain why?

Section III: About the IOPP case

- **Details of the IOPP process**
  - Could you introduce briefly the timeline of the procurement?
  - How did you get the information about the procurement?
  - Was public tendering organized? What procedure was adopted? What were the evaluation criteria, e.g. performance-based, or price-based? Was 'innovativeness' a criterion?
  - Was there competition? If not, why? If yes, what companies were the competitors? Why, in your

opinion, did your company win the contract?

- How much was the contract value? What products/solutions were procured?
- What was the innovativeness of the products/solutions? Does your company own the IPRs for core technologies? If not, could you please discuss in more detail regarding IPR issues?
- How were the performance and design specifications of the products/solutions decided? Were the requirements demanding? Did your company have the space to explore alternative designs?
- Were the products/solutions developed specially for this public contract (a), or were they developed already before the IOPP (b)?
  (a) If they were developed specially for this contract, did your company obtain any new IPRs as a result of the procurement?
  (b) If they had been developed already, were they listed in an innovation catalogue at any level? Was it the title of 'indigenous innovation products' that led to the procurement? If not, what were the driving forces for this IOPP case to emerge?
- Can you provide any documentation regarding the procurement, e.g. bidding documents?

• **Interactions with procurers, users, and other parties**
  - What were the channels of communications, or dialogues, or interactions between your company and your customers?
  - When did that occur? Was it before, or during, or after the contract was signed?
  - Were there any other parties involved in enhancing the communication, and promoting the emergence of this IOPP case? If yes, please provide more details.
  - Did those stakeholders contribute to the improvement of your products/solutions? If yes, how?

• **Difficulties and barriers**
  - Did your company encounter any difficulties and barriers during the course of obtaining and delivering this contract? If yes, please provide more details.
  - Were there any difficulties that your company had before but addressed by this IOPP case?

• **Outcomes and impacts**
  - Could you please describe, in your opinion, the impacts of this IOPP case on your company? E.g. the emergence and diffusion of new products/solutions/methods and the expansion of market share.
  - In your opinion, what have been the experience and lessons gained by your company through this IOPP case?

Section IV: Other issues

• Do you have any other information/materials/contacts that you think might be useful for the conduct of this study?
• Do you have any comments or criticisms for the design of this interview?
• Do you have any questions/concerns? Please feel free to let me know. Thank you!

9.4 Semi-structured interview protocol – procurer

Section I: Overall issues

- On the basis of questionnaire answers, clarifying key issues related to the interview;
- Consent form signing;
- Main objectives:
  - To understand the process of the particular IOPP case;
  - To gain knowledge about the procurer's opinions and experience related to IOPP.

Section II: About the procurer's opinions and experience related to IOPP

- Could you please introduce briefly the procurement function of your organization? What have been the principles and priorities guiding this function, e.g. cost-effectiveness?
- Does your organization favour any of those types of products: domestic, imported, local, non-local?
- Beyond the particular IOPP case we focus on today, has your organization been involved in any other IOPP activities? Did you voluntarily decide to purchase new products/solutions?
- In the questionnaire you considered that…(raising the issues identified from the questionnaire); could you please explain why?

Section III: About the IOPP case

- **Details of the IOPP process**
  - What procedures did you adopt for the procurement? What rules and regulations did you follow? Was there competition (public tendering) organized? If not, why? Did you look up innovation catalogues when conducting this procurement? Why?
  - Why did you choose the products/solutions? Was 'innovativeness' a criterion in evaluating the products? Any other reasons (e.g. political driving forces)? Did you stick to any standards/regulations when choosing the products? How were the requirements (i.e. technological or performance specifications) decided?
  - Can you provide any documentation regarding this procurement, e.g. invitation to tender?
- **Interactions with suppliers, users, and other parties**
  - What were the channels of communications, or dialogues, or interactions between your organization, the supplier, and (if applicable) end users? How did those interactions facilitate the implementation of this IOPP case?
  - Were there any other parties involved in enhancing the communication, and promoting the emergence of this IOPP case? If yes, please provide more details.
- What difficulties and barriers did you encounter during the course of this procurement?
- What outcomes and impacts have been produced by this case? Have the related public infrastructures/services (e.g. user experience and energy-saving rate) been improved?

Section IV: Other issues

- Do you have any other information/materials/contacts that you think might be useful for the conduct of this study?
- Do you have any comments or criticisms for the design of this interview?
- Do you have any questions/concerns? Please feel free to let me know. Thank you!

9.5 Semi-structured interview protocol – user

Section I: Overall issues

- On the basis of questionnaire answers, clarifying key issues related to the interview;
- Consent form signing;
- Main objectives:
  - To understand the process of the particular IOPP case;
  - To gain knowledge about the user's opinions and experience related to IOPP.

Section II: About the user's opinions and experience related to IOPP

- Does your organization favour any of those types of products: domestic, imported, local, non-local?
- Beyond the particular IOPP case we focus on today, has your organization been acting as an early user or procurer of other new products/solutions? Did you voluntarily decide to purchase new products/solutions? If yes, why? If not, what has been the driving force?
- In the questionnaire you considered that…(raising the issues identified from the questionnaire); could you please explain why?

Section III: About the IOPP case

- **Details of the IOPP process**
  - Did you choose the procured products/solutions by yourself? If yes, why did you choose the particular products? If no, how were the products/solutions chosen?
- **Interactions with suppliers, procurers, and other parties**
  - What were the channels of communications, or dialogues, or interactions between your organization, the supplier, and (if applicable) procurers? How did those interactions influence you as a user of innovative products?
  - Did you provide any feedback/advice/criticisms for the supplier to improve its products?
- What difficulties and barriers did you encounter during the procurement/contract delivery stages?
- What problems did you encounter during the process of using the procured products/solutions?
- What outcomes and impacts have been produced by this case? Have the related public infrastructures/services (e.g. user experience and energy-saving rate) been improved?
- Have you been more willing to buy innovative products/solutions as a result of this procurement?

Section IV: Other issues

- Do you have any other information/materials/contacts that you think might be useful for the conduct of this study?
- Do you have any comments or criticisms for the design of this interview?
- Do you have any questions/concerns? Please feel free to let me know. Thank you!

Appendix 10: Summary of interviews

PART 1 of Summary of interviews

No.	Code (A – Z)	Date	Location	Interviewees' working roles	Stakeholder roles
1	CRH	Dec.2010	Qingdao	Manager of a department in China Southern Railway Co. Ltd.	Supplier; SOE procurer
2	NA_LED	May 2011	Beijing	One of the directors of China Semi-conductor Alliance (CSA)	STI official
3	NO_1	Dec.2010	Beijing	Vice head of a department in the MOST	STI official
4	NO_2	Dec.2010	Beijing	Director of an office in the High-tech Department in the MOST	STI official
5	NO_NEV	May 2011	Beijing	One of the officials in charge of the NEV programme, MOST	STI official
6	R1O_1	May 2011	Beijing	One of the vice directors of the Beijing S&T Commission	STI official
7	R1O_2	May 2011	Beijing	Head of one office in the Beijing S&T Commission	STI official
8	R1O_3	May 2011	Beijing	Official knowledgeable of Zhongguancun issues	STI official
9	R1S_HV	May 2011	Beijing	One manager in Havon electronics company situated in Zhongguancun	Supplier
10	R1S_OW	May 2011	Beijing	One manager in Origin Water water-recycling technology company	Supplier
11	R2O_1	Dec.2010	Shanghai	Head of one office in Shanghai S&T Commission	STI official
12	R2O_2	Dec.2010	Shanghai	Head of one office in Shanghai Commission of Economy and Informatization	STI official
13	R2O_3	May 2011	Shanghai	Vice head of one office in Shanghai S&T Commission	STI official
14	R2O_4	May 2011	Shanghai	Vice head of one office, Shanghai Commission of Economy and Informatization	STI official
15	R2S_LED	May 2011	Shanghai	One manager from the Baosight Company	Supplier, SOE procurer
16	R2S_M	May 2011	Shanghai	Chief engineer of an underground construction company	SOE procurer
17	R2S_T	May 2011	Shanghai	Chief engineer of Shanghai Tunnel Engineering Co. Ltd.	Supplier, SOE procurer

PART 2 of Summary of interviews

No.	Code (A – Z)	Date	Location	Interviewees' working roles	Stakeholder roles
18	R3F	May 2011	Guangzhou	One official from Guangdong government procurement centre	Finance official, procurer
19	R3O	May 2011	Guangzhou	Vice head of one office, Guangdong S&T Department	STI official
20	R3O_LED	May 2011	Shenzhen	One director from Shenzhen Lighting Environment Administration Centre	Procurer
21	R3S_NEV_1	May 2011	Shenzhen	One manager from BYD Co. Ltd.	Supplier
22	R3S_NEV_2	May 2011	Shenzhen	One manager from Wuzhoulong Co. Ltd.	Supplier
23	R3U_NEV	May 2011	Shenzhen	One employee of the public transport operating company	User
24	R4F	May 2011	Jinan	One official from Shandong Department of Finance	Finance official, procurer
25	R4O_1	Dec.2010	Jinan	Head of one office, Shandong Department of S&T	STI official
26	R4O_2	May 2011	Jinan	Vice head of one office, Shandong Department of S&T	STI official
27	R4O_NEV	May 2011	Jinan	One of the vice directors of Jinan S&T Bureau	STI official
28	R4S_LED	May 2011	Weifang	One manager from AODevices	Supplier
29	R4S_NEV	June 2011	-	Vice Chair, Company A	Supplier
30	R4S_SO	May 2011	Jinan	One manager from a solar-LED technology company	Supplier
31	R4S_SP	May 2011	-	One manager of a high-tech textile (specialized in spandex) company	Supplier
32	R4P_NEV	May 2011	Jinan	One of the managers in Jinan Public Transport Group	SOE procurer, user
33	R5F	May 2011	Nanjing	One vice director of procurement office, Jiangsu Department of Finance	Finance official, procurer
34	R5O_1	May 2011	Nanjing	A high-level official in Jiangsu Province in charge of STI issues	STI official
35	R5O_2	May 2011	Nanjing	Head of one office, Jiangsu Department of S&T	STI official
36	R5O_CS	May 2011	Changshu	A high-level official from Changshu Bureau of S&T	STI official

PART 3 of Summary of interviews

No.	Code (A – Z)	Date	Location	Interviewees' working roles	Stakeholder roles
37	R5O_YZ	May 2011	Yangzhou	Head of one office, S&T Bureau of Yangzhou	STI official
38	R5S_LED	May 2011	Yangzhou	Two managers from an LED lighting company	Supplier
39	R5S_NEV	May 2011	Yangzhou	A manager from an NEV company in Yangzhou	Supplier
40	R5S_E	May 2011	Changshu	A manager from Lemote Co. Ltd.	Supplier
41	R5S_SO	May 2011	Yangzhou	Two managers from a solar-LED company based in Yangzhou	Supplier
42	R5U_E	May 2011	Changshu	A director in charge of ICT procurement issues from a primary school in Changshu	User; procurer
43	Researcher_1	Dec. 2010	Shanghai	A researcher on the topic of IOPP in a university in Shanghai	Researcher
44	Researcher_2	Dec. 2010	Beijing	A researcher from China Academy of S&T for Development (CASTED)	Researcher
45	Researcher_3	May 2012	Manchester	A researcher/project manager in the area of IOPP	Researcher
46	Researcher_4	June 2012	-	A researcher in the area of IOPP	Researcher
47	WIND_P	May 2011	Shanghai	One manager from Shanghai Donghai Wind Power Co. Ltd.	Procurer/operator
48	WIND_S	June 2011	-	One manager from Sinovel Co. Ltd.	Supplier
49	WIND_U	May 2011	Shanghai	A technician, Shanghai Donghai Wind Power Co. Ltd.	User

Notes:

- Unstructured interviews: NO_1, NO_2, Researcher_1, Researcher_2; Researcher_3; Researcher_4.
- Electronic interviews: R4S_NEV; R4S_SP; Researcher_4; WIND_S.
- Interview not recorded: Researcher_1.
- Interviews in English: R5S_LED; Researcher_3; Researcher_4.
- Interviews recorded but not transcribed: Researcher_3; Researcher_4.
- Informant quoted but did not count as interviewees: Weifang S&T informant, working in the local S&T Bureau.

Appendix 11: Information of national-level policies listed in Table 6.1

For English names and issuing bodies of the policies see Table 6.1.

Policy Code/Short Name	Chinese Names	Web links (accessed March 19th 2013)
Guofa[2006]8	关于加快振兴装备制造业的若干意见	http://www.gov.cn/jrzg/2006-06/29/content_322286.htm
Caiku[2006]47	关于实施促进自主创新政府采购政策的若干意见	http://www.ccgp.gov.cn/gzdt/201009/t20100929_1284150.shtml
Guokefajizi[2006]539	国家自主创新产品认定管理办法(试行)	The original document was not found; MOST's elaboration on it is available at http://www.most.gov.cn/ztzl/cxqygzhy/cxqyhydt/200702/t20070226_41506.htm
Caiku[2007]29	自主创新产品政府采购预算管理办法	http://www.gov.cn/ztzl/kjfzgh/content_883710.htm
Caiku[2007]30	自主创新产品政府采购评审办法	http://www.gov.cn/ztzl/kjfzgh/content_883671.htm
Caiku[2007]31	自主创新产品政府采购合同管理办法	http://www.gov.cn/ztzl/kjfzgh/content_883701.htm
Caiku[2007]120	自主创新产品政府首购和订购管理办法	http://www.gov.cn/ztzl/kjfzgh/content_883647.htm
Caiku[2007]119	政府采购进口产品管理办法	http://www.gov.cn/ztzl/kjfzgh/content_883643.htm
Fagaigongye[2008]224	首台(套)重大技术装备试验、示范项目管理办法	http://www.gov.cn/ztzl/kjfzgh/content_883867.htm
Guokefaji[2009]618	关于开展 2009 年国家自主创新产品认定工作的通知	http://www.most.gov.cn/tztg/200911/t20091115_74197.htm
Equipment catalogues (2009), updated versions in 2010, 2011 and 2012	重大技术装备自主创新指导目录(2009) 重大技术装备自主创新指导目录(2010) 重大技术装备自主创新指导目录(2011) 重大技术装备自主创新指导目录(2012)	http://www.miit.gov.cn/n11293472/n11293832/n11293907/n11368223/12937690.html http://www.miit.gov.cn/n11293472/n11295006/n13554930/n13557611.files/n13557617.pdf http://www.miit.gov.cn/n11293472/n11293832/n11293907/n11368223/14317806.html http://www.miit.gov.cn/n11293472/n11293832/n11293907/n11368223/14458181.html
Notice 2010	关于开展 2010 年国家自主创新产品认定工作的通知(征求意见稿)	http://www.most.gov.cn/tztg/201004/t20100409_76710.htm
Administrative Measures for 'Buying Domestic'	政府采购本国产品管理办法(征求意见稿)	http://www.chinalaw.gov.cn/article/cazjgg/201005/20100500254720.shtml

Appendix 12: Regional IOGP Policies

Not all the policies are policies about 'accreditation; some just mentioned the regional intention to use government procurement to support innovation. Explicit accreditation policies are marked with 'Y', others marked with 'N'.

PART 1 of List of regional IOGP policies

	Regions	Title of the policy (English titles are brief translations from the Chinese ones)	Web Links (accessed March 28th 2013)
Y	**Anhui**	安徽省自主创新产品认定管理办法（试行） Anhui Measures on Accrediting Indigenous Innovation (Trial)	http://www.ahkjt.gov.cn/back/eWebEditor/uploadfile/20090922111532162.doc
Y	**Beijing**	北京市自主创新产品认定办法（修订） Beijing Measures on Accrediting Indigenous Innovation (Revised)	http://www.bjkw.gov.cn/n8785584/n8904761/n8904870/n8917796/9005010.html
N	**Chongqing**	2009 年国家自主创新产品申报培训会 Workshop for 2009 National Accreditation of Indigenous Innovation	http://www.ctin.ac.cn/View.aspx?id=13167
Y	**Fujian**	福建省自主创新产品认定管理办法（试行） Fujian Measures on Accrediting Indigenous Innovation (Trial)	http://old.xmsme.gov.cn/2008-1/200812995217361.htm
N	**Gansu**	政府强制采购节能产品优先采购环保和自主创新产品的实施意见 Mandatory Government Procurement of Green and Innovation Products	http://www.ccgp-gansu.gov.cn/web/148/5252.html
Y	**Guangdong**	关于自主创新产品认定的管理办法（试行） Administrative Measures on Accrediting Indigenous Innovation (Trial)	http://www.gdstc.gov.cn/HTML/zwgk/zcfg/sfggz/1224138717718625775775925130 1494.html
N	**Guangxi**	转发财政部关于自主创新产品政府采购的一系列办法 A Series of Measures Issued by MOF on Procurement of Innovation	http://222.216.4.8/view/staticpags/sjfgzd/8ab8814e3d19c528013d1eafc54175ac.html
N	**Guizhou**	举全省之力建设创新型社会 Mobilizing the Province's Resources and Building an Innovative Society	http://www.most.gov.cn/ztzl/qgkjgzhy/2007/2007ybs/200701/t20070124_39950.htm
N	**Hainan**	关于推进科技创新的实施意见 Implementation Advice on Promoting S&T Innovation	http://hnkjonline.net/CPF/News_ShowContent.asp?Seq=2006000041
Y	**Hebei**	河北省自主创新产品认证管理办法（试行） Hebei Measures on Accrediting Indigenous Innovation (Trial)	http://www.hebstd.gov.cn/xxgk/content_23573.htm

PART 2 of List of regional IOGP policies

	Regions	Title of the regulation (English titles are brief translations from the Chinese ones)	Web Links (accessed March 28th 2013)
N	**Heilongjiang**	关于开展 2011 年度政府采购自主创新产品认定工作的通知 Notice on Conducting Innovation Accreditation for Procurement 2011	http://www.hljkjt.gov.cn/zwgk/bsgf/bsjggsgg/nblgs/201105/t20110505_188873.htm
N	**Henan**	河南省出台意见自主创新产品政府可优先采购 Policies by Henan Supporting Innovation with Procurement Priority	http://henan.people.com.cn/news/2010/04/20/470707.html
Y	**Hubei**	湖北省自主创新产品认定管理办法（试行） Hubei Measures on Accrediting Indigenous Innovation (Trial)	http://www.hbstd.gov.cn/info.jsp?id=43128
Y	**Hunan**	湖南省自主创新产品认定管理办法（试行） Hunan Measures on Accrediting Indigenous Innovation (Trial)	http://www.hnst.gov.cn/zcfg/gfxwj/kjtgfxwj/201112/t20111207_316504.htm
N	**Inner Mongolia**	贯彻落实国家有关促进自主创新、节能环保政府采购政策的通知 Implementing National Policies on Green and Innovation Procurement	http://www.nmgp.gov.cn/read.asp?id=29114&typename=&typeid=14
Y	**Jiangsu**	江苏省自主创新产品认定管理办法（试行） Jiangsu Measures on Accrediting Indigenous Innovation (Trial)	http://www.most.gov.cn/fggw/dffggw/dffgjs/200703/t20070320_53546.htm
Y	**Jiangxi**	江西省自主创新产品政府采购管理办法（试行） Jiangxi Measures on Government Procurement of Innovation (Trial)	http://www.jxstc.gov.cn/ReadNews.asp?NewsID=3611
N	**Jilin**	深化启动政府采购功能机制，强化完善本土自主创新产品扶持政策 Enhancing Government Procurement Functions to Support Innovation	http://www.jl.gov.cn/zwgk/yatabl/zxwylmta2010/2011/201106/t20110628_1020493.html
Y	**Liaoning**	辽宁省自主创新产品认定管理办法（试行） Liaoning Measures on Accrediting Indigenous Innovation (Trial)	http://www.lninfo.gov.cn/kjzx/show.php?itemid=11867
N	**Ningxia**	财政法规惠民政策（十）政府采购类 Finance Policies Benefitting Citizens (Ten) Government Procurement	http://www.nxcz.gov.cn/WebSiteOut/010000//LSPD/LSPDsub10/
Y	**Qinghai**	青海省自主创新产品认定管理办法 Qinghai Administrative Measures on Accrediting Indigenous Innovation	http://cjzx.xining.gov.cn/html/3380/237285.html
N	**Shaanxi**	实施科技规划纲要增强自主创新能力建设创新型陕西若干政策 Policies to Implement MLP and Build an Innovative Shaanxi	http://www.most.gov.cn/kjzc/kjzcdfgz/dfzcshanx/200804/t20080409_60600.htm

PART 3 of List of regional IOGP policies

	Regions	Title of the regulation (English titles are brief translations from the Chinese ones)	Web Links (accessed March 28th 2013)
Y	**Shandong**	山东省自主创新产品认定管理办法（试行） Shandong Measures on Accrediting Indigenous Innovation (Trial)	http://www.lskj.gov.cn/OA/AttachmentsFile/633192274474843750.pdf
Y	**Shanghai**	上海市自主创新产品认定管理办法（试行） Shanghai Measures on Accrediting Indigenous Innovation (Trial)	http://soco.hitec.net.cn/zcxx.do?method=detail&id=577
Y	**Shanxi**	山西省自主创新产品认定管理办法 Shanxi Measures on Accrediting Indigenous Innovation	http://www.sxinfo.gov.cn/zcfgc/686.jhtml
Y	**Sichuan**	四川省自主创新产品认定实施管理办法（试行） Sichuan Measures on Accrediting Indigenous Innovation (Trial)	http://jscx.scst.gov.cn/newscontent.aspx?NewsID=240&current=%E6%94%BF%E7%AD%96%E6%96%87%E4%BB%B6
Y	**Tianjin**	天津市自主创新产品认定管理办法（试行） Tianjin Measures on Accrediting Indigenous Innovation (Trial)	http://www.tstc.gov.cn/zhengwugongkai/zcfg/kjgf/zhcx/200902/t20090220_12928.htm
N	**Tibet**	西藏自治区 2007 年工作安排 2007 Work Plan for the Tibet Autonomous Region	http://www.ccgp-xizang.gov.cn/detail.jsp@condition=10000022072&difang=xizang
Y	**Xinjiang**	新疆维吾尔自治区自主创新产品认定管理办法（试行） Xinjiang Measures on Accrediting Indigenous Innovation (Trial)	http://www.xjkjt.gov.cn/AffixDownload.do?identifier=010183322/2010-00041&fileorder=0
Y	**Yunnan**	云南省自主创新产品认定暂行办法 Yunnan Interim Measures on Accrediting Indigenous Innovation	http://www.ynstc.gov.cn/tzgg/xgwd/rdgz/5-云南省自主创新产品认定暂行办法.htm
N	**Zhejiang**	关于建立政府优先强制采购节能环保和自主创新产品制度的通知 Mandatory Government Procurement of Green and Innovation Products	http://www.dyzfcgw.gov.cn/powercms/html/zcfgszfwj/66168.htm

Appendix 13: Regional catalogues of indigenous innovation products

PART 1 of List of regional innovation catalogues

Region	Catalogue info	Web links (accessed March 28th 2013)
Anhui	Version 2010	http://www.ahkjt.gov.cn/rootfiles/2011/02/23/1291106712445942-1291106712447231.xls
Beijing	1st batch	http://ftkw.gov.cn/filedown/cxcpml/%E5%8C%97%E4%BA%AC%E5%B8%82%E9%A6%96%E6%89%B9%E8%87%AA%E4%B8%BB%E5%88%9B%E6%96%B0%E4%BA%A7%E5%93%81%E7%9B%AE%E5%BD%95.doc
	2nd – 10th batches	http://www.bjjs.gov.cn/publish/portal0/tab1794/
	11th	http://www.bjjs.gov.cn/publish/portal0/tab662/info63761.htm
	12th	http://www.bjkw.gov.cn/n8785584/n8904761/n8904870/n8917796/n9007328.files/n9007329.doc
Fujian	1st batch	www.fujian.gov.cn/zwgk/tzgsgg/200905/P020090522406865129997.xls
	2nd batch	www.fujian.gov.cn/zwgk/tzgsgg/200908/P020090812379757185105.xls
	3rd batch	www.fjkjt.gov.cn/info/image/38709.xls
	4th batch	www.fjkjt.gov.cn/info/image/39272.xls
Guangdong	1st batch, 2009	www.gdstc.gov.cn/HTML/zwgk/spgg/1243735296865-1629765023466186964.html
	2nd batch, 2009	www.gdstc.gov.cn/HTML/zwgk/spgg/12619703651671824336551954741254.html
	2010	http://stc.dabu.gov.cn/Article/kjgg/201009/2153.html
Hebei	1st	http://www.zfcg.hd.gov.cn/portal/documentView.do?method=downloadAttachment&id=2578689
	2nd	http://www.hebgp.gov.cn/upnews/upAttachs/20110113091004.pdf
Hubei	2010	http://govinfo.nlc.gov.cn/hbsfz/xxgk/hbskxjst/201111/t20111121_1100100.html?classid=423
Hunan	2010	www.hnst.gov.cn/tzgg/sttzgg/201010/P020101026574906356477.xls

PART 2 of List of regional innovation catalogues

Region	Catalogue info	Web links (accessed March 28th 2013)
Jiangsu	1st – 3rd batches	http://zfcgzx.huaian.gov.cn/filedown?file=%2Fupload%2F201003%2F306250.attach%7C%BD%AD%CB%D5%CA%A1%B5%DA%C8%FD%C5%FA%D7%D4%D6%F7%B4%B4%D0%C2%B2%FA%C6%B7%C3%FB%B5%A5.doc
	4th batch	http://www.jstd.gov.cn/zwgk/tzggg/20090619/165302575.html
	5th batch	http://www.jstd.gov.cn/zwgk/tzggg/20091030/10393763966.html
	6th batch	www.jiangsu.gov.cn/shouye/gsgg/533/201009/t20100916_495254.html
	7th batch	http://www.ccgp-jiangsu.gov.cn/pub/jszfcg/zcfg/fgzc/xzfg/201101/t20110117_41563.html
Jiangxi	1st batch, 2009	www.jxstc.gov.cn/ReadNews.asp?NewsID=3683
	2nd batch, 2009	www.ccgp-jiangxi.gov.cn/manage/datemange/jpg/FJ_3894.doc
Shandong	2008	http://www.ccgp-shandong.gov.cn/fin_info/site/read.jsp?colcode=02&id=2077
Shanghai	2009	www.stcsm.gov.cn/uploads/Notice/downloads/090827-01.doc
Sichuan	Official website not found	http://www.maipu.cn/new.aspx?id=1540
Tianjin	2009	www.ccgp.gov.cn/loadfile/2009716584717345580377.doc
Yunnan	2010	http://www.ynstc.gov.cn/tzgg/201002090016.htm

Appendix 14: Regional IOGP catalogues

Region	Catalogue info	Web links (accessed April 9th 2013)
Tianjin	1st IOGP catalogue on medical equipment	http://www.tjcs.gov.cn/tnetcms/u/cms/www/201102/151640019u5j.doc
	2nd IOGP catalogue on biochemical engineering and lighting equipment	http://www.tjjj.gov.cn/upload/File/20110607162849096.pdf
Beijing	1st - 7th catalogues of *first procurement* of indigenous innovation	http://www.hdzfcg.gov.cn/viewPublish.do?file_id=2847
	8th catalogue of *first procurement* of indigenous innovation	http://www.caigou2003.com/news/innovation/news/20110410/news_180440.html
	9th catalogue of *first procurement* of indigenous innovation	http://www.bjhd.gov.cn/zt/hdcxpt/zzcxcpml/201106/t20110614_262789.htm
Shanghai	Same as Shanghai's innovation catalogue in 2009, Hucaiku [2009]39	http://www.shzfcg.gov.cn:8090/2004_year/yuandi/zcxc/zcxc-6.htm
Guangdong	November 16th 2009: 1st IOGP catalogue	http://www.hpedu.gov.cn/Article/ShowArticle.asp?ArticleID=21852
	December 28th 2010: 2nd IOGP catalogue	http://www.hpedu.gov.cn/Article/ShowArticle.asp?ArticleID=24915
	March 21st 2011: 3rd IOGP catalogue	http://www.gdczt.gov.cn/adminfo/gp/201109/t20110913_29841.htm

Appendix 15: Regional policies related to IOPP policy Channel 2 MTE Commercialization

Regions	Title of the policy (English titles are brief translations from the Chinese ones)	Web Links (accessed March 28th 2013)
Anhui	安徽省首台（套）重大技术装备认定管理暂行办法 Anhui Interim Measures on Accrediting First (set of) MTE	http://www.hfgj.gov.cn/n7216006/n18905487/n18909807/n18913287/19644875.html
Beijing	在中关村科技园区开展政府采购自主创新产品试点工作的意见 Conducting Pilot Work of Innovation Procurement in Zhongguancun	http://www.gov.cn/zwgk/2009-01/05/content_1196327.htm
Guizhou	2009 年贵州省装备制造业重点装备产品推荐目录(第一批) Guizhou 2009 Catalogue of Recommended Equipment Products (1st batch)	http://www.gzgov.gov.cn/xxgk/gggs/55277.shtml
Heilongjiang	黑龙江省重点领域首台（套）产品认定和扶持办法（试行） Heilongjiang Measures on Accrediting First (set of) MTEs (Trial)	http://202.97.193.28/zwgk/zfwj/szfbgtwj/200909/t20090907_182729.htm
Hunan	湖南省首台（套）重大技术装备认定及奖励实施办法 Hunan Measures on Accrediting and Rewarding First (set of) MTEs	http://www.yygyjw.gov.cn/News_View.asp?NewsID=3502
Jiangsu	首台（套）重大装备及关键部件认定管理实施细则（2012 年修订） Jiangsu Measures on Accrediting First (set of) MTE (Revised in 2012)	http://www.cz.gov.cn/getNewsByid.action?newsid=1855&typeid=66
Shaanxi	支持经济结构调整加快经济发展方式转变若干财税政策措施 A Set of Measures Facilitating the Transition of Development Mode	http://www.shaanxiinvest.gov.cn/zsfg/show.asp?id=4476&page=2
Shandong	山东省重点领域首台（套）技术装备财政扶持办法（试行） Shandong Supporting Measures for Key First (set of) MTEs (Trial)	http://www.wheitc.gov.cn/art/2012/2/17/art_2166_172325.html
Shanghai	上海市鼓励重大技术装备首台业绩突破实施办法 Shanghai Measures on Encouraging First MTE Breakthrough	http://www.most.gov.cn/kjzc/kjzcdfgz/dfzcsh/200804/t20080407_60375.htm

Appendix 16: Regional notices on termination of IOPP policy Channel 1

PART 1 of List of regional termination notices

Region	Title of the notice (English titles are brief translations from the Chinese ones)	Web links (accessed March 29th 2013)
Anhui	转发财政部停止执行《自主创新产品政府采购预算管理办法》等三个文件的通知 Forwarding MOF's Notice to Terminate Caiku [2007]29, Caiku [2007]30 and Caiku [2007]31	http://www.ahcz.gov.cn/portal/zwgk/zbcg/1321546398264922.htm
Beijing	关于停止执行本市创新政策与提供政府采购优惠挂钩相关政策措施的通知 Notice on Terminating the Policies Linking Procurement with Innovation in This City	http://govfile.beijing.gov.cn/Govfile/ShowNewPageServlet?id=5980
Chongqing	转发财政部停止执行《自主创新产品政府采购预算管理办法》等三个文件的通知 Forwarding MOF's Notice to Terminate Caiku [2007]29, Caiku [2007]30 and Caiku [2007]31	http://www.cqgp.gov.cn/portal/documentView.do?method=view&id=478226
Fujian	关于停止执行自主创新产品政府采购政策的通知 Notice on Terminating Government Procurement Policies Supporting Indigenous Innovation	http://www.fjcz.gov.cn/article.cfm?f_cd=59&s_cd=456&id=D1D2920F-D605-5850-C028A8A4236DB8CB
Gansu	转发财政部停止执行《自主创新产品政府采购预算管理办法》等三个文件的通知 Forwarding MOF's Notice to Terminate Caiku [2007]29, Caiku [2007]30 and Caiku [2007]31	http://www.gszfcg.gansu.gov.cn/web/147/110287.html
Guangdong	关于停止执行《广东省自主创新产品政府采购的若干意见》的通知 Notice on Terminating Guangdong's Government Procurement Policies Supporting Innovation	http://www.gpcgd.com/zcfgc/492125.htm
Guangxi	转发财政部停止执行《自主创新产品政府采购预算管理办法》等三个文件的通知 Forwarding MOF's Notice to Terminate Caiku [2007]29, Caiku [2007]30 and Caiku [2007]31	http://www.baisecaigou.gov.cn/article/view.aspx?id=9728
Guizhou	关于停止执行有关创新政策与提供政府采购优惠挂钩相关措施的通知 Notice on Terminating Policies Linking Government Procurement with Innovation Policies	http://www.caigou2003.com/news/notice/20111209/notice_214101.html
Hebei	转发财政部关于停止执行《自主创新产品政府采购预算管理办法》等三个文件的通知 Forwarding MOF's Notice to Terminate Caiku [2007]29, Caiku [2007]30 and Caiku [2007]31	http://www.hebgp.gov.cn/upnews/upfiles/zfcg_zcfg/TS_LX20111222162415jg@ng.htm
Henan	《自主创新产品政府采购预算管理办法》等三个文件停止执行 Termination of Caiku [2007]29, Caiku [2007]30 and Caiku [2007]31	http://www.hngp.gov.cn/henan/gzdt/jqyw/webinfo/2011/07/1308651908762497.htm

PART 2 of List of regional termination notices

Region	Title of the notice (English titles are brief translations from the Chinese ones)	Web links (accessed March 29th 2013)
Hubei	转发关于停止执行《自主创新产品政府采购预算管理办法》等三个文件的通知 Forwarding MOF's Notice to Terminate Caiku [2007]29, Caiku [2007]30 and Caiku [2007]31	http://www.ecz.gov.cn/wzlm/zwdt/bmgzdt/gkjzsf/20692.htm
Hunan	关于做好涉及创新政策与提供政府采购优惠挂钩的规范性文件清理工作的通知 Conducting the Deep Cleanup of Policies Linking Government Procurement with Innovation	http://www.changsha.gov.cn/xxgk/szfgbmxxgkml/szfgzbmxxgkml/szffzb/tzgg_1966/201201/t20120104_299869.html
Inner Mongolia	关于清理创新政策与提供政府采购优惠挂钩相关文件的通知 Notice on Terminating Government Procurement Support for Innovation	http://www.nmfzb.gov.cn/information/fzb17/msg548586222.html
Jiangsu	关于停止执行《江苏省自主创新产品认定管理办法（试行）》等文件的通知 Notice on Terminating Jiangsu Measures on Accrediting Indigenous Innovation (Trial)	http://www.jscz.gov.cn/pub/jscz/zfxxgk/zfxxgkml/zfcg/11/201112/t20111231_22292.html
Jiangxi	关于停止执行〈江西省自主创新产品认定管理办法（试行）〉的通知 Notice on Terminating Jiangxi Measures on Accrediting Indigenous Innovation (Trial)	http://www.ncinfo.gov.cn/Newsite/content_detail.asp?id=40904
Liaoning	关于停止执行有关政府采购优惠政策的通知 Notice on Terminating Certain Government Procurement Policies Favouring Innovation	http://www.fd.ln.gov.cn/web/detail.jsp?id=8a98819d34cfac22013540d6d25b02d1
Ningxia	关于修订宁夏回族自治区政府采购货物项目综合评分法评分标准的通知 Notice on Amending the Evaluation Criteria for Government Procurement in Ningxia	http://www.ccgp-ningxia.gov.cn/iezcInfoIssuanceAction.public?p=publicForBrowseInfoIssuance&ID=1c9c4e2M134557bf616Mf528764d624db129b32c21fbca0cb8d6
Qinghai	关于印发青海省人民政府决定取消的非行政审批项目目录（44项）的通知 Notice on Government Decision to Terminate 44 Policy Projects in Qinghai	http://xxgk.qh.gov.cn/html/1670/179043.html
Shandong	转发关于停止执行《自主创新产品政府采购预算管理办法》等三个文件的通知 Forwarding MOF's Notice to Terminate Caiku [2007]29, Caiku [2007]30 and Caiku [2007]31	www.ccgp-shandong.gov.cn/fin_info/servlet/attach?type=site&id=832
Shanghai	关于停止执行《上海市 2009 年政府采购自主创新产品目录》的通知 Notice on Terminating the Implementation of Shanghai's IOGP Catalogue 2009	http://www.czj.sh.gov.cn/zcfg/gfxwj/zfcg/201107/t20110708_128211.html
Shanxi	转发财政部关于停止执行《自主创新产品政府采购预算管理办法》等三个文件的通知 Forwarding MOF's Notice to Terminate Caiku [2007]29, Caiku [2007]30 and Caiku [2007]31	http://www.ccgp-shanxi.gov.cn/view.php?nid=43025

PART 3 of List of regional termination notices

Region	Title of the notice (English titles are brief translations from the Chinese ones)	Web links (accessed March 29th 2013)
Sichuan	关于取消招标文件评标标准中关于自主创新产品加分的通知 Abolishing Extra Points Enjoyed by Indigenous Innovation Products in Tendering Process	http://www.cd-procurement.gov.cn/zfcgsite/Secondary/BulletinInfo.aspx?nav_id=03010000&id=611
Tianjin	转发关于停止执行《自主创新产品政府采购预算管理办法》等三个文件的通知 Forwarding MOF's Notice to Terminate Caiku [2007]29, Caiku [2007]30 and Caiku [2007]31	http://www.tjjj.gov.cn/upload/File/20111215162157833.pdf
Xinjiang	关于停止执行《新疆维吾尔自治区自主创新和节能环保产品政府采购实施意见》的公告 Notice on Terminating Measures Regarding Innovation and Green Procurement in Xinjiang	http://xb.xjzfcg.gov.cn/mos/cms/html/1/59/201112/13956.html
Yunnan	转发财政部停止执行《自主创新产品政府采购预算管理办法》等三个文件的通知 Forwarding MOF's Notice to Terminate Caiku [2007]29, Caiku [2007]30 and Caiku [2007]31	http://www.ynwscz.gov.cn/show.asp?id=1925
Zhejiang	关于停止执行《自主创新产品政府采购预算管理办法》等三个文件的通知 Notice to Terminate Caiku [2007]29, Caiku [2007]30 and Caiku [2007]31	http://www.zjzfcg.gov.cn/new/sysej/313845.html

Appendix 17: Water Recycling case – other details

17.1 Zhongguancun Innovation Zone in Beijing

Beijing ranked the 2nd (after Shanghai) among medium and large cities in China in terms of overall innovativeness (Chinacity, 2011), and the 3rd (after Shanghai and Shenzhen) in terms of the capability of commercializing innovative solutions. According to interviewee R1O_1, compared to other regions Beijing is a place with '*active and concentrated endogenous innovation resources*', featuring numerous high-level universities, research institutes, engineering centres and advanced laboratories.

Compared with Shanghai and Shenzhen where enterprises play a more important role in R&D in the innovation systems, Beijing's core player for R&D is still mainly state-owned universities, research institutes and large SOEs, though private firms and SMEs are becoming more active and better supported by STI policies recently. Large amounts of R&D investments have been continuously allocated by the national and local governments during decades, leading to considerable accumulation of R&D results in the public research sector.

The Zhongguancun National Innovation Demonstration Zone originated from the 'Zhongguancun electronics street' in the early 1980s[52] with multiple science parks spread across Beijing, has been an engine for Beijing's high-tech development for over two decades. In the geographical area of Zhongguancun, there are numerous universities (representatives of which are Tsinghua University and Peking University) and public research institutes (representatives of which are China Academy of Sciences, and China Academy of Engineering). By 2011, there have been around 20,000 enterprises nurtured by or attracted to Zhongguancun, covering a range of sectors including energy and environmental technologies, new materials, biomedicine, equipment manufacturing, astronautics, ICT, and culture/entertainment. Firms in Zhongguancun are involved in around one quarter of the 863 programmes of the whole country; its amount of high-tech trade, venture capital and entrepreneurship cases take up one third of the national quantity[53]. At least 50 SMEs from Zhongguancun got listed on the SME board of Shenzhen Stock Exchange by 2011. Total income of Zhongguancun firms in 2011

[52] See http://www.zgc.gov.cn/sfqgk/55179.htm for the history of Zhongguancun [accessed June 4th 2013].
[53] Source: Zhongguancun statistics, available at http://www.zgc.gov.cn/tjxx/nbsj/ [accessed June 4th 2013].

reached 1920 billion Yuan with a growth rate of 20% from 2010, contributing to 24% of the annual economic growth of Beijing.

In Zhongguancun, favourable policies, high-quality human resources, funds and services are all concentrated to conduce the emergence and diffusion of innovation. Internal administration is conducted by the Zhongguancun Administration Committee that has specialized offices for each key policy area. R1O_3 explained that:

> *'…for instance we offer better incentive mechanisms – one approach is that we support the research bodies to cofound* ***technology transformation centres*** *with our city. They provide human and intelligence resources and we provide funds; they explore how to exploit the resources they have and submit proposals to us… Another approach is that, governmental departments such as S&T Commission, DRC, Commission of Economy and Information Technology, and the Administrative Office of Zhongguancun,* ***go to the research institutes to investigate potentially transformable R&D results and then make investments****…* ***Zhongguancun is not only a high-tech zone but also a policy experimental zone****; you can find all kinds of incentive regulations there, covering issues like equity, IPR, and financing…'*

17.2 IOPP policies in Beijing

The *Measures on Conducting Experimental Government Procurement of Indigenous Innovation Products in Zhongguancun Science Park* (Beijing Government, 2008) clearly stated under what conditions each type of procurement applies, and from where the procurers should select relevant products/services. Besides innovation catalogues, this policy also stated that the government will publish '*catalogue of innovative products for first procurement*' (as mentioned in Chapter 6), which provides direct reference for procurers to buy new products. Following this detailed measures for accrediting products (Beijing S&T Commission et al., 2009)[54] and conducting first and ordering procurement (Beijing Bureau of Finance, 2009) were published.

A policy milestone targeted at escalating Zhongguancun is *Approval for Building a National Innovation Demonstration Zone in Zhongguancun Science Park*, policy code Guohan[2009]28. It confirmed a set of policy experimentations (equity incentive, STI financing reform, funds for service agencies, supporting new forms of industrial organizations taxation and innovative governance) in Zhongguancun and approved the idea of constructing an inter-ministry coordinating group for policy implementation.

[54] In February 2009 the Beijing government published *Measures for Indigenous Innovation Accreditation (revision)*, policy code Jingkegaofa[2009]186, to replace the previous *Measures for Indigenous Innovation Accreditation (trial)* issued in 2006, policy code Jingkegaofa[2006]731. The trial version adopted the *narrow* concept of government procurement and the revised version *expanded* it.

Following the approval, in April 2009 the Beijing government issued *Measures on Constructing Zhongguancun National Innovation Demonstration Zone* (Beijing Government, 2009a), further clarifying the scope of government procurement of innovation, from office products to other areas that require government (city level or district level) investment including municipal infrastructure, construction, water/energy saving, environment protection and recycling, transport administration, public security, healthcare, agriculture, education and R&D infrastructure.

Besides STI policies, a legislative regulation, *Regulations for Zhongguancun National Innovation Demonstration Zone*, was issued by the 13th People's Congress of Beijing in 2010. Articles 27-30 of the regulation clarified the responsibilities of procurers and the suppliers, and scope of procurable products/services.

Being situated in Zhongguancun does not guarantee a firm to enjoy favourable policies definitely. Firms need to obtain the title of 'High-tech or New Technology Enterprise' in order to benefit from policy support. Firms need to prove that they have certain quantity of R&D employees, R&D expenditure, and the key requirement is that they have to hold *indigenous* IPRs. To suit the needs of high-tech SMEs, Zhongguancun has been exploring new policy solutions:

> *'…there are many start-up high-tech firms with great potential in the zone, who don't have any patents yet; we introduced the concept of* ***technological secrets****, which is a* ***policy breakthrough****… we jointly published a modified version of accreditation measures especially for them with related ministries… this provides strong support for them, and* ***more than 3000 SMEs now qualify the title*** *and can access to favourable policies…' (R1O_3)*

Technology exhibition organized by government: Governmental departments of Beijing city including DRC, Commission of Transport, Bureau of Finance and Water Authority jointly organized a promotion event for indigenous innovation products of Zhongguancun[55] in January 2009. It exhibited innovation outcomes of Zhongguancun in the areas of water management, municipal construction and transport. Various stakeholders including high-tech firms, procurers, project operators, sub-science parks and industrial alliances attended the event and communicated with each other. Products of Origin Water were strongly recommended to potential procurers by the Beijing government during the event.

---

[55] See http://www.zgc.gov.cn/bzccfz/zfcg/41872.htm for more details [accessed June 7th 2013].

A recent move to strengthen inter-departmental communication is the establishment of *Zhongguancun Acceleration Centre for STI Innovation and Industrialization* at the end of 2010, a better-known name of which is the '*Capital Platform of Innovation Resources*'. It aims at integrating STI resources and improving implementation efficiency, especially paying attention to inter-level (vertical) and inter-departmental (horizontal) collaborations. It consists of members from around 30 departments of Beijing city and at least 100 members from the 10 sub-parks of Zhongguancun, and officials from 19 national level ministries directly participate in decision-making processes. By May 2011, eight working groups had been set up based on the platform, and the '*Working Group for New Technology/Product Government Procurement and Promotion*' [56] is one of them. Firms in Zhongguancun can enjoy 'one-stop' services from relevant working groups.

Related interviewees (R1O_1, R1O_2 and R1O_3) were all very optimistic about the potential of IOPP in Beijing; there has been a trend towards *systemic policy mix*, an emphasis on *culture building* and *stakeholder communication*, and a *strengthened role played by SMEs*.

> *'…**We spent 6 billion Yuan on procurement of innovations in 2010**… it is **crucial for many firms, better than any other kinds of funding**…that's why we say different STI policies including procurement, apply in different stages, and produce different effects… **we are trying to integrate the defence sector as well** – actually we already covered it in policy documents, but practical work is still in need – a top official of the city is coordinating this… **I expect a wider scope for procurement** (of innovation in Beijing)…' (R1O_1)*

17.3 More information about the supplier

Founded in 2001, Origin Water was a construction company for MBR plants initially. The founder has been one of the pioneers in MBR technologies in China. He used to work as an official in MOST in the 1990s. In 1998 he went to Australia to pursue a PhD degree in the area of municipal water resources management. The Sydney Olympics in 2000 adopted MBR technology to process wastewater, which inspired him (who was working as a volunteer) that MBR might become popular in China as well. In 2001 after graduation he did not go back to the previous position, but commenced entrepreneurship in Zhongguancun.

[56] See the working group's official website http://zfcg.zgc.gov.cn/index.php [accessed June 7th 2013].

Membrane units are the core segments of MBR systems and take up around one third of the total cost. According to R1S_OW, they initially needed to spend 40% of their income on imported materials. Therefore their business focus in early years was to develop indigenous membrane technology. Tsinghua University started MBR-related R&D in the early 1990s and already obtained some IPRs. Origin Water started collaboration with Tsinghua under the national 'industry-university-PRI' scheme. Meanwhile, the entrepreneur invested considerable funds on R&D team building (around 30% of their pure income according to the interviewee). The R&D team was composed of researchers graduated from both local and foreign universities; they successfully developed the first generation of domestic membrane in 2007. Origin Water and Tsinghua University cofounded an MBR research centre afterwards, which frequently undertakes national projects such as 863 programmes.

By 2009 Origin Water had obtained full IPRs for membrane formula, manufacturing, unit design and configuration technologies, addressing many gaps in China. The supplier's products such as polyvinylidene difluoride (PVDF) hollow membrane material and MBR unit have been selected as local and national innovation products, and were included in *Catalogue of Recommended Environment Protection Device (Products) 2010* (NDRC and the Ministry of Environment Protection, 2010). Origin Water switched its business focus from construction to providing tailored solutions. In response to customers' demand for long lasting units, Origin Water now is also investigating into MBR repair technologies to prevent fractures.

Similarly to many other suppliers, Origin Water encountered difficulties when it was introducing its MBR technology to the market. The main obstacle was that most customers did not believe in MBR as a radical substitute for settlement systems, plus the higher price compared with traditional solutions. The entrepreneur decided to install *demonstration systems* first; the customers only needed to pay if they were satisfied. The supplier won some public contracts; but by that time the concept of IOPP was not yet adopted. The firm won contracts because of 'value for money'. The supplier had not used its own membrane materials until 2008 when it became capable of large-scale manufacturing. It was since then the selling point of its products became *indigenous innovativeness*.

17.4 Contracts won by the supplier through contract-signing conferences

During the March 2009 Conference, Origin Water obtained procurement intent from the Beijing Drainage Group Co., Ltd. to construct the ‘second stage project for Beixiaohe recycling plant’. It was an MBR upgrade project for a traditional plant with a volume of 40,000 tons/day. The contract value was around 44 million Yuan and the supplier provided a whole package of MBR products (with IPRs fully owned by Origin Water), technology, construction and services.

The second conference was organized very soon in April 2009. Contracts of procurement for fourteen projects were signed with a total government investment of 3.42 billion Yuan, and 445 million Yuan was spent on indigenous innovation products. Beijing Drainage Group signed another ‘first procurement’ contract with Origin Water to conduct the ‘second stage project for Qinghe recycling plant’, which was also an MBR upgrade project for a traditional plant, with a volume of 150,000 tons/day. Meanwhile, Origin Water gained a contract from Yanqing county (part of Beijing) to construct the ‘2009 general treatment project for Jing-Jin Fengshayuan watershed in Yanqing’. The total value of the two contracts reached over 150 million Yuan.

In August 2010 during the third (the third one in 2010) contract-signing conference, Origin Water won three other ‘first procurement’ contracts, i.e. the ‘Gaobeidian project of water recycling plant and re-usage’ with volume of 1 million tons/day from the Beijing Drainage Group; the ‘Fengtai Hexi project of water recycling plant’ with volume of 50,000 tons/day from the Water Authority of Fengtai district; and the ‘Fangshan Chengguan project of water recycling plant’ with volume of 20,000 tons/day from the Water Authority of Fangshan district. The three contracts valued around 380 million Yuan.

Appendix 18: E-classroom Solutions case – other details

18.1 Details about Loongson processors

In 1998, the State Council initiated an experimental project called 'Knowledge Innovation Programme', with the aim of effectively developing strategically important technologies. The CAS was chosen as the main implementing body for information technology research. In 2000, the State Council announced a policy set, i.e. *Policies Encouraging the Development of Software and Integrated Circuit Industries*, which included a range of supporting measures for enterprises, e.g. financing, tax reduction, commercialization platforms, and human resources. The programme and the policy set have effectively stimulated the development of domestic processors.

The first generation of Loongson chip, Loongson No.1 XIA50 was developed in August 2002, followed by the second and third generations in 2004 and 2009 respectively. Loongson 2F (developed in 2006) was the first one with a basic frequency higher than 1GHz, and Loongson 3B (developed in 2011) was the first eight-core processor.

The Loongson research group encountered many difficulties when they firstly started the commercialization process. Internal factors mainly lay in that they did not have a complete structure of marketing, training and customer services to deliver business functions. External issues mainly lay in that the supply chain of CPUs is long, and they did not have many downstream business partners to produce end-products and software as it did not have fixed orders.

The initial effort to commercialize Loongson processors dates back to 2002, when Loongson No.1 was firstly developed. This achievement in domestic CPU drew much attention from firms, the government and the public. An alliance aiming to commercialize Loongson was formed between CAS and 6 companies including Haier Group, Great Wall Software, China National Software & Service Co. Ltd., Red Flag Software Co. Ltd., and Sugon Group. The initial plan was to promote the application of Loongson along the supply chain, covering the design and manufacturing of mother boards, servers, computers, and digital appliances. However, since the alliance was a voluntary, loosely organized community, and most of the members joined the alliance without an explicit strategy of adopting Loongson, they fell apart to pursue their own commercial benefits gradually (R5S_E).

18.2 Other information

Yuebao Qian, the lady who founded the Menglan Group, started her business of bed linens in 1972. R5S_E explained that the main motivation for her to decide to co-operate with CAS to commercialize Loongson was that the Menglan Group sought to transform their business from traditional textile manufacturing to a more diversified one integrating high technology.

In 2005, a commercialization base for Loongson was founded in Menglan Village, followed by the establishment of Lemote Technology Co. Ltd. in 2006, which is now the main body for commercializing Loongson, and also the supplier for school computers in this case study. Most of the top management members of Lemote came from the Loongson research group from CAS; their products now range from Fuloong desktops, Yeeloong laptops, and Lynloong all-in-ones, to CPUs, motherboards, and Loongson-based customized solutions. By now the company is still seeking market expansion rather than high profit, thus the price of Loongson-based products is competitive even compared with mature products.

Besides the education sector, the Changshu city made an effort to promote the use of Loongson computers in rural areas as well. In October 2009, the city issued a *Guideline on Informationizing Rural Area Using Loongson Computers*. For each of the 222 villages, 10 Fuloong computers and 1 Yeeloong laptop were allocated, with a total budget of around 6 million Yuan.

To fulfil the product warranty, Lemote has been running a user training scheme, namely ‘three-level training programme’, for the e-classroom solutions. The first level is to train officials from the education sector, telling them how to prepare the basic facilities for installing e-classrooms. The second level is to train teaching staff about the use of e-classrooms. The third level is to organize workshops for trouble-shooting. Although Lemote has signed contracts with business partners e.g. Founder to co-conduct the training programme, it is still very demanding considering the human resources, money and time required.

Appendix 19: Tunnel Engineering case – other details

STEC was founded in 1965 and now is part of the Shanghai Urban Construction Group. Its predecessor, Shanghai Bureau of Tunnels, built the first tunnel in Shanghai from 1958 using a domestically made ø10.22m grid shield machine[57]. Historically STEC's R&D strategy has been coherent with the national and local demand. It started to research on modern shield machines since the 1980s when the number of buildings in Shanghai increased and grid shield machines were unable to satisfy the requirement. In 1986 it developed a simple version of ø4.35m EPB[58] shield machine, but the prototype was not qualified for underground railways and was applied in sewers construction only. In the middle 1990s when Shanghai started to build underground lines, the shield machines in use were all imported from abroad; STEC collaborated with several foreign suppliers such as the Robbins Company, trying to learn manufacturing techniques.

At the beginning of the 10th five-year plan (the year 2001), the central government called for applications from the industry, PRIs and universities to jointly participate in 863 programmes targeting at strategic technology development. STEC submitted their proposal to develop EPB shield machines specialized for soft soil together with China Railway Tunnelling Group, Zhejiang University and Tongji University. In the early drafts of design proposal, STEC adopted 100% domestic components; as the project went on, they proposed to exchange part of the components into imported ones in order to achieve better performance. The government was supportive and encouraged STEC to conduct global procurement of components by lowering the custom tax. The final design reached a domesticalization rate of 67%, and the product quality was guaranteed with advanced bearing and hydraulic components selected.

In 2010, the Singapore government published an open call for 10 shield machines for metro construction. Several international manufacturers submitted bids, including Robbins, Lovat Inc., and Kawasaki. STEC won a contract of 6 machines and some construction contracts, with a total value of approximately £34 million.

---

[57] The soil in Shanghai is saturated soft soil. Soviet Union experts used to describe the difficulty of building underground lines in Shanghai that '*digging a tunnel in Shanghai is just like digging a hole in tofu*…'; they thought it was impossible to build underground railways in Shanghai and withdrew their collaboration plan with STEC (R2S_T).

[58] Earth-pressure-balanced (EPB) shield machines consist of a soil-cutting system, a soil-mixing system, a soil-discharging system and a control system; they mix the excavated soil into mud to help stabilize the cutting face via balanced mud pressure.

Appendix 20: Offshore Wind Turbines case – other details

20.1 About wind energy

The cost structures of onshore and offshore wind power generation vary significantly. Approximately for onshore projects in China (by 2010), turbine costs take up 68%, foundation construction takes up 9%, grid connection takes up 14%, maintenance takes up 0%, and the rest of costs take up 9%; while for offshore projects, turbine costs take up 33%, foundations 24%, grid connection 15%, maintenance 23%, and the rest 5% (Yang, 2010). High-quality turbines and construction work are needed to reduce maintenance costs for offshore systems.

Onshore wind farms in China's western inner provinces face serious challenges regarding electricity transmission due to the lack of a well-designed and robust grid-connection system.

> *'…I visited Inner Mongolia in last March. The wind was at the speed of 18 m/s, perfect for generation, but* ***more than half of the turbines were not working at all****… the grid operator required the farm to cut off devices as* ***the local network cannot fully consume the electricity generated****… especially at that time technologies like low voltage ride through (LVRT) and reactive power compensation were not widely promoted, once the turbines stored too much energy, big trouble could occur to the grid… the whole demand for power is uneven in our country;* ***developing offshore wind energy in coastal regions is a nice solution to avoid this difficulty****, and can be realized in a short time…' (WIND_P)*

20.2 China's wind energy policies

Encouraged by national and regional policies, the Chinese wind energy sector had been expanding at a growth rate of more than 100% per year; by the end of 2010, total installed capacity of wind energy in China surpassed that in the US, ranked as the top 1 in the world (Li et al., 2010). Benefiting from the growth of domestic market and expansion to market abroad, four Chinese wind turbine suppliers (Sinovel, Goldwind, Guodian United Power, and Mingyang) are among the largest in the world.

Since late 2009, the central government switched its policy focus from the previously '*encouraging'* to the currently '*regulating and controlling*'. The State Council issued *Advice on Restraining the Over-production in Certain Industries and Guiding Healthy Industrial Development* (State Council, 2009), pointing out that although wind energy industry has been an emerging sector that the state fully encourage to develop, the overheat, swarming and duplicate import/production/construction within the sector have to be dealt with. It stated that in principle no new whole-machine manufacturing plant should be approved to enter the market anymore; industry admission permit policy will be strengthened to cool down the sector. Tax reduction for importing wind-turbine-related components was cancelled as well (MOF et al., 2009).

In January 2010, in response to criticisms from US and EU, and also out of consideration to enhance the competitiveness of the Chinese wind energy industry, the National Energy Authority (supervised by NDRC) terminated a policy announced in 2005 (Russell, 2010), which used to require all wind energy devices in China to reach a domesticalization rate of 70%. Competition was emphasized after more than 20 years of infant industry protection.

Concession policy in China was initially designed as a cooperative mechanism for the business sector (public or private) to participate in the exploitation of state-owned mineral resources, or to participate in public infrastructure projects overseen by the government. The main purpose has been to guarantee the efficient operation of projects and share profits and risks between different parties. Since 2003 the NDRC started to employ concession policies to exploit wind resources, i.e. to select the developer and operator and to fix electricity price through open tendering. Several issues will be considered as selection criteria, including technological solutions, financing capability and electricity price. The three main parties involved are the government, potential operators and the transmission system operator. Through tendering initial electricity price for the first 30,000 operating hours will be fixed; the operator is obligated to purchase all the power generated. Apportioned fees from electricity users will cover the difference between the operating price and the market price. The concession tendering associated with this case was the first one for offshore projects.

20.3 About the project

During September – November 2006, the Shanghai DRC organized open tendering to fix the ownership and operatorship of the wind farm under the concession policy scheme. Eleven enterprises submitted bids. Eventually four SOEs won the ownership jointly, i.e. China Datang Corporation, Shanghai Green Energy Engineering Co. Ltd., China Guangdong Nuclear Power Group, and China Power International New Energy Holding Ltd. They formed a new operating company, i.e. Shanghai Donghai Wind

Power Generation Co. Ltd. with registered capital of 460 million Yuan. Datang Corporation holds 28% of the ownership and the other three holds 24% each. The operator of this case is East China Power Grid, which is part of the State Grid Corporation of China.

The total spending of the project was around 2360 million Yuan. WIND_P considered the price offered by Sinovel fairly reasonable compared with the high price asked by the international supplier in the first round of open tendering. By the end of 2010, the wind farm had generated 130 GWH, which all fed into East China grid. The electricity price was 0.978 Yuan/KWH, much higher than the price of onshore wind energy, which was around 0.5 Yuan/KWH.

> *'…We admit that, as the first company 'who eat the crab', the price is very high; but we are confident that it will become cheaper soon as the total amount is increasing, and the phase II project will dilute the overall cost for the whole project.' (WIND_P)*

In 2006, Sinovel was transformed from its predecessor which was an SOE; it then settled the headquarter in Zhongguancun, Beijing, and expanded to a number of provinces e.g. Inner Mongolia and Xinjiang. Compared with other big wind turbine companies in China, such as Goldwind (founded in 1986) and Shanghai Electric Group (dated back to early 20th century), Sinovel is definitely a latecomer in terms of both date-of-birth and technological accumulation. With the approval and support from NDRC, Sinovel was in charge of constructing the 'National Energy Offshore Wind Power Technology and Equipment R&D Centre', which was the only national-level research centre in China targeted at offshore wind energy. Sinovel has been active in collaborating with PRIs and universities. A recent achievement has been the fulfilment of '5MW Wind Turbine Domesticalization' Project (launched by Beijing S&T Commission in 2010) together with Tsinghua University and China Electric Power Research Institute.

Appendix 21: NEV case – other details

21.1 About the NEV Programme

Geographically most of the selected cities are located in the eastern and middle part of China, mainly municipalities, provincial capitals or medium-sized cities. Cities that have relatively small local markets but good industrial potential can form ‘city clusters’ to participate (Gong et al., 2013). For cities enjoying the private consumer subsidies from MOF, additional criteria needed to be fulfilled such as sufficient consumption capacity of citizens and traffic conditions in the locality. The amount of the subsidies was set according to the overall price difference between NEVs and traditional vehicles with similar performance characteristics (MOF and MOST, 2009). Both provincial and city-level governments are obligated to provide additional subsidies to procurers and to provide special funding for infrastructure construction and maintenance (ibid.).

Detailed criteria for products to be included in MIIT catalogues included that: the oil-saving rate of hybrid cars has to be above 5% compared to traditional vehicles with similar performance characteristics, while the oil-saving rate of hybrid buses has to be above 10%; the warranty of batteries and other key segments provided by manufacturers has to cover 3 years (or 150,000 kilometres) or longer; the manufacturing capacity of key components suppliers need to reach a certain threshold (MOF and MOST, 2009).

A wide range of policy instruments was used by localities. Besides typical measures such as consumer subsidies, tax reduction and public procurement, some cities issued favourable policies for NEV users to reduce their parking, toll and electricity fees; in the case of Beijing where people need to take part in a ‘lottery’ to get a license plate for their new cars, NEV buyers do not need to go through the lottery process. Some provinces followed the approach adopted by the central government and initiated their own demonstration programmes to encourage more cities to promote NEVs (Gong et al., 2013).

21.2 More information about Jinan

Jinan is the capital of Shandong province situated on the eastern coast of China. Historically it has been an important city in China in terms of economy, culture and transport. According to the materials Jinan submitted to the ministries, its local administrative setup for NEV demonstration is a group led by the mayor with heads of the local DRC, Bureau of S&T, Bureau of Finance, and Commission of Economy and Informationalization as group members. These agencies also set up a specialized office to monitor implementation progress. The main policies in the locality related to the NEV programme include Shandong Provincial Government (2009a, 2009b, 2009c, 2009d), and Jinan Government (2009a and 2009b), and the *Implementation Measures on NEV Demonstration and Promotion in Jinan* approved by the four supervisory ministries.

Some EV manufacturers in Jinan and other parts of Shandong have been focused on producing low-speed vehicles for rural areas, and their products are very popular among farmers. However, thus far the ministries have not announced any supportive measures for low-speed EVs as many experts do not consider low-speed EV technology based on lead-acid batteries as a promising technology, and it can be very harmful for the environment (R4O_NEV).

21.3 More information about Shenzhen

21.3.1 The city

Situated in the Pearl River Delta, Shenzhen is the second largest city (after the provincial capital, Guangzhou) in Guangdong and the first special economic zone in China nominated by the State Council in 1980. It has been developed from a small town into an internationalized city during the past three decades, and it is well-known for its impressive ‘Shenzhen Speed’ – a label that signifies the technologically advanced character of the people and the area. Shenzhen is ranked fourth in the 2011 GDP ranking (after Shanghai, Beijing and Guangzhou) of cities in mainland China, and it has been ranked as the most innovative Chinese city by Forbes China in 2011.

The governance of the city is similar to that of Jinan, i.e. an administrative group led by the vice mayor with heads of the local DRC, Bureau of STI, Bureau of Finance and Commission of Economy and Informationalization. Main policies in the locality related to the NEV programme include Guangdong Provincial Government (2009 and 2010), and Shenzhen Government (2009a, 2009b and 2011). According to Shenzhen’s plan in 2009, the city aimed to promote the use of 24000 NEVs (both public and private sectors) in the locality by the end of 2012, and build 50 charging stations for buses, 2500 charging piles for government vehicles, 200 charging stations and 30000 charging piles for the public.

21.3.2 The suppliers

BYD and Wuzhoulong are the two major NEV manufacturers in Shenzhen. Founded in 1995, BYD started its business in battery manufacturing; in 2003 it purchased Xi'an Qinchuan Automobile factory and entered the car manufacturing and sales business; in 2008 it purchased the Ningbo Zhongwei Semiconductor factory and integrated the upper-stream supply chain of motor manufacturing for electric cars. In July 2009 it purchased Changsha Meidisanxiang Coach Co. Ltd, through which it acquired the admission from MIIT for manufacturing coaches. Now it is a privately-owned high-tech enterprise covering IT and automobile businesses. The main advantage of BYD's NEV business compared to competitors lies in that almost all the upper-stream suppliers are from the BYD group, so that they can control product price and maintain a maximum profit (R3S_NEV). BYD has adopted a localization strategy in many regions. In 2011 it had nine R&D and manufacturing bases across the country including Guangdong, Beijing, Shaanxi and Shanghai. BYD's headquarters is now in Pingshan District in Shenzhen.

In contrast to BYD who focuses on EVs, Wuzhoulong Motors has adopted a clear strategy to develop energy-saving coaches since it was founded in 2000. Its core advantage lies in its vehicle material manufacturing technologies and its smart hybrid motor controller which integrates an energy control system, automatic clutch control system and information management system. Approved by the Shenzhen government in 2005, seven hybrid coaches manufactured by Wuzhoulong started to work as the first demonstration public transport line in the country. The average oil-saving rate of Wuzhoulong's products was 25-30%.

21.3.3 The pilot project

For the project, three public transport lines were designed with 10 hybrid buses running on each of them. 20 electric cars were then allocated by the local DRC to government departments, with charging facilities installed.

According to R3S_NEV_1, the procurement of hybrid buses was straightforward, while for electric cars the project group decided to adopt the mode of '*government renting'* instead of ‘government procuring’ as the government bodies at that time had failed to get permission for procurement from the local Bureau of Finance. The car model rented was an early version of F3DM, a plug-in hybrid compact sedan. The rental fee was fixed at 80,000 Yuan for two years, which according to R3S_NEV, was much lower than the actual cost as the supplier provided a whole pack of post rental services, insurance and tax. Still the supplier was very actively involved and grateful for this opportunity to promote their prototype.

BYD set up a specialized service group for the project which had two major functions – a routine visit to the user organizations to collect feedback and a trouble-shooting service when users encountered any problems. A ‘low-carbon’ version of F3DM was developed after this project, integrating a solar-energy board on top of the car.

An impact of this pilot project lies in growing interest and familiarity among citizens in Shenzhen with NEVs as government bodies volunteered to use them. The number of telephone enquiries about F3DM received by BYD increased significantly owing to the demonstration. Users in the bureaus were open enough to introduce their experience to the public. One of them indicated that he was impressed with two things in particular – one was that the acceleration speed was very high, so the driving experience was superior; the other was that by using the new car he paid 80% less for energy costs including electricity and petrol.

F3DM gradually gained ground in the private market afterwards. By May 2011, BYD had sold around 600 units of this model to private consumers, the majority of whom came from Shenzhen city. Considering that Shenzhen is meanwhile one of the demonstration cities for private user subsidies, the price of F3DM for local consumers was 80,000 Yuan (approximately 8000 pounds) after subsidy by central and local governments (the subsidizing amount was 50,000 Yuan and 30,000 Yuan respectively, covering 50% of the total price). Customers from other regions without subsidy policies had to pay a price of 169,800 Yuan.

21.3.4 More information about the procurement for Universiade

The top priorities of *Implementation Plan for NEV Demonstrating Operation for the 26th Summer Universiade* were defined as ‘safety, environment protection and a demonstration of the Shenzhen characteristics’. Four aims were outlined in the document, i.e. to achieve that NEVs take up more than half of the public transport, to cover the sport venues using a structured traffic network, to realize diversification of various NEV technologies, and to explore a commercialized way of operating NEVs. The government also specified technological configuration requirements with a clear manufacturing schedule, and organized an expert group to monitor the production and construction progress.

Sedan models provided by BYD included the plug-in hybrid car F3DM as mentioned, and a newly developed pure electric model E6, both of which have been listed in national and local innovation catalogues, and in the catalogue of recommended NEV models produced by MIIT. By May 2011, a batch of 50 E6 cars had been operating in Shenzhen as taxis for a whole year with a total mileage of 3 million kilometers. The electric coach model produced by BYD was K9, which is pure electric with fast charging function (50% of the capacity can be charged within 30 minutes) and solar energy board on top to provide additional electricity. Based on BYD's testing result, K9 (with air conditioners turned on) consumes less than 1/3 of the energy cost of a traditional coach.

Wuzhoulong proposed three models of NEVs. One was FDGFCL10, a 10-seating hydrogen fuel cell van with a maximum speed of 40 km/h, featuring a smart inductive electricity assisted steering system, stepless driving system and a permanent magnet synchronous motor. Another is FDG6120SDEG, a hybrid coach model equipped with lithium iron phosphate battery featuring an automatic series-parallel hybrid driving system, stepless series-parallel transmission function, automatic mechanic transmission technology and a diesel engine that qualifies Euro-III emission standard. The ratio of electric power can reach 43% and oil-saving rate is above 30%. The third model was FDG6700EV, a pure electric coach model equipped with a motor produced by Shanghai Dajun and a lithium iron phosphate battery.

Based on the three technological models described above, Wuzhoulong designed 6 different types of vehicles for Universiade use, including 1350 hybrid single-layer buses, 20 hybrid double-layered buses, 53 pure electric buses, 26 pure electric vans, 60 hydrogen fuel cell sport venue vans and 2 hydrogen fuel cell coaches. Among these vehicles, the double-layered hybrid coaches and pure electric vans with exchangeable batteries were new to the country.

21.4 Other NEV promotion examples

21.4.1 Beijing

As the capital, Beijing was the first city that procured NEVs for event use and demonstration in China. In 2008 before the Beijing Olympics took place, the Beijing government procured 595 NEVs of various models from various suppliers. These vehicles were used as official cars, venue vans, taxis and bus lines around the Olympics Village. It was a good chance for suppliers from across the country to demonstrate their indigenously developed products. Procured vehicles included 50 pure electric coaches by Jinghua Coach Company in collaboration with Beijing Institute of Technology, 20 fuel cell cars developed by Shanghai Fuel Cell Vehicle Powertrain Co. Ltd in collaboration with Tongji University and Shanghai Volkswagen, 25 hybrid cars by Changan Auto, 50 hybrid cars by Chery Automobile Co. Ltd, 5 pure electric coaches by Zhongtong Coach Co. Ltd, 15 hybrid vehicles by FAW Group, 15 hybrid coaches and 410 pure electric venue vans by Dongfeng Motor Corporation, and 3 hybrid fuel cell coaches by Beiqi Foton in collaboration with Tsinghua University. Most of these vehicles stayed in Beijing for public transport use after the event and some of them were sent to other regions for local transport use. According to an interviewee, the overall quality and performance of NEVs left by Beijing Olympics was not very satisfactory as domestic technologies by that time were far from being mature.

When the national NEV demonstration programme started in 2009, the Beijing government set up a collaboration network among city leaders and heads of regional bureaus, and Beijing Commission of S&T was chosen as the main venue of communication. They issued *Administrative Measures on Strengthening Indigenous Innovation to Promote the Development of NEV Industry in Beijing*, in which 20 policy measures were announced covering R&D support, industrialization, pilot demonstration, and infrastructure construction. Beijing has been trying to build a local supply chain featuring a focus on EVs and whole vehicle manufacturing (NO_NEV). Beijing's citizens enjoy subsidies from both central government and the locality (the amount of local subsidies is similar to that Shenzhen government provided for local citizens).

By May 2011, Beijing had procured more than 1100 NEVs for public transport and environment maintenance use. In terms of infrastructure, the location of charging stations and battery swapping stations are being constructed across the city. According to NO_2, the moves taken by Beijing have been effective in stimulating industrial development and public infrastructure improvement, but the impacts on private market are yet to be seen. Despite the friendly policies provided by the government, citizens in Beijing are still hesitating to buy NEVs, a major reason being concerns over the lack of enough charging infrastructure within reachable distance.

21.4.2 Shanghai

The Shanghai government issued *Regulations on Promoting the Development of NEV Industry in Shanghai* in December 2009 and detailed their implementation plan regarding the NEV demonstration programme. They announced a set of policy measures such as public procurement, R&D support, infrastructure construction and battery renting to promote the use of NEVs in the locality. In general the implementation design was a two-step plan – firstly to commence the NEV demonstration by taking the opportunity of Shanghai EXPO 2010, and then draw experience and move on to further and wider demonstrating operation. Their target was to promote the use of 4417 NEVs in Shanghai's public transport system by 2012.

The Shanghai government set up a goal together with MOST that they would realize 'zero emission within the Shanghai EXPO park and low emission surrounding the EXPO Park'. Shanghai procured 1147 NEVs for EXPO use, which included pure electric coaches, super capacitor buses, fuel cell coaches, pure electric venue vans, hybrid cars, hybrid coaches and fuel cell cars manufactured by various suppliers including Shanghai Automobile, Chery, FAW and Changan.

As Shanghai became one of the pilot cities enjoying private consumer subsidies in 2010, the government has set up detailed measures for implementation and explicit goals to achieve. The district of Jiading has been selected as a pilot area to be fully equipped with charging infrastructure and supportive measures (R2O_3). Shanghai's target for the private sector is to achieve the promotion of 20,000 NEVs for private consumers, and to build around 25,000 charging posts across the city.

21.4.3 Hangzhou

Hangzhou had promoted the use of 1374 NEVs by 2011, ranked the 3rd among the participant cities. Unlike the cities mentioned above, Hangzhou made the achievement by adopting a commercial mode of 'battery-swapping' and 'NEV renting'. As its peers were still hesitating about which type of charging infrastructures to build, Hangzhou has adopted the battery-swapping mode of power supply for NEVs. Different stakeholders i.e. electricity companies and NEV manufacturers, coordinated by the government, needed to reach an agreement for profit- and risk-sharing. The National Grid is in charge of providing battery-swapping services in the locality, and it has been trying to promote this service mode in other regions beyond Hangzhou. As long as the power supply mode is fixed, it is easier for the government and National Grid to invest money in building swapping stations. One advantage has been the lowering of NEV price for private consumers as only ‘naked’ cars without batteries were sold. It is also a way to save electricity as swapping stations charge batteries in off-peak time. Specialized services companies procure NEVs and then let them to consumers who need ‘temporary cars’, i.e. ‘NEV renting’, which is also a good way of demonstrating the functionalities of NEVs (NO_NEV).

Appendix 22: LED case – other details

22.1 More information about Weifang

Weifang, traditionally famous for its kite-flying and paper-cutting arts and strong agriculture base, is a medium-sized city in Shandong province. AODevices was founded in Weifang in 2004 by a group of 8 returnee PhDs from the US with an initial investment of RMB 370 million. Weifang is the hometown of the group leader and the government welcomed the group with friendly conditions and policies. AODevices focuses on LED lighting only and covers all the segments of the supply chain. Four models by AODevices were qualified as recommended products by the tendering organized by NDRC in 2010.

To implement the national LED lighting programme, the city government established a leading group for 'city-county-district integration' to enhance the vertical and horizontal collaboration. An 'LED night view' project was launched in the city at the same time, targeted at over 400 public infrastructures, buildings and tourist sites to promote scenery lighting. Investments from all levels of government reached around 100 million Yuan (the price of LED lights by that time was around 20 Yuan/Watt). The city was also actively promoting the construction of Solid-state Lighting testing centre together with the National Semiconductor Device Quality Supervision and Inspection Centre since 2010. The Weifang informant introduced that after establishing the testing centre, they would try to obtain more quality-testing work from ministries and promote the standardization of LED lighting products. Meanwhile the centre would provide certification services for commercial use.

The LED lighting supply chain in Weifang is composed of strong companies e.g. AODevices (covering all segments), Goer, Jinyuan Kingsun and Huaguang (focused on chips), and smaller companies such as Sanjing, Mingrui and Jiangdu. Six of them were accredited as high-tech enterprises in the city and enjoy higher tax reduction and R&D funding support. There have been around 100,000 LED streetlights installed in the city by May 2011, taking up around 80% of the total number of streetlights. The Weifang S&T informant was confident that the programme would radiate to surrounding counties and districts soon.

22.2 More information about Yangzhou

Yangzhou is a medium-sized historical city in Jiangsu province featuring rich traditional culture. In late 2007, Yangzhou was approved by MOST as the sixth solid-state lighting industrialization base. Right after the launch of the MOST LED programme, the Yangzhou city government organized a leading group composed of officials from relevant departments and lower levels of government. Implementation in Yangzhou has been taking two major steps: trial application demonstrating stage (2009-2010) and application promotion stage (2011-2015)[59].

According to R5O_YZ, the main objective of the first stage was to realize technological breakthrough and fully establish the supply chain, to explore commercialized modes of operation, and to build a common platform for communication, research and testing. The city government supported firms to control product quality through building a national-level key laboratory of LED lighting products testing, which also helped enhance the collaboration between firms and PRIs. This collaboration of 'firm-PRI-testing centre' has contributed to a number of technological breakthroughs in areas of optical design, heat relief and driver control (R5O_YZ).

The application promotion stage (2011-2015) takes two steps of implementation. The first is to promote the application of another 50000 LED lights during 2011-2012, i.e. to realize the application of at least 100,000 LED lights in total in public area. The second is to realize the usage of LED lights in 100% of residence area lighting, scenery lighting and secondary-roads lighting, and the usage of LED lights in 30% of main-roads lighting, business sector lighting and home indoors lighting by 2015. The main objective of this stage is to build a comprehensive system of 'testing-university-research' collaboration, which will work as a services platform for firms, offering product quality and safety testing services, and meanwhile integrating the new energy and new lighting industries in the locality. The system aims to offer world-level testing services for firms, and help them fully engage with international industrial players.

Founded in 1994, SFT Optoelectronic STI Co. Ltd. has been a large traditional light manufacturing firm specialized in grille lights. It started technological preparation for LED lighting very early, and in 2007 it founded the SFT Optoelectronics STI and

[59] Source for this part: *Yangzhou Plan on Building a Functional City through Semiconductor Lighting Demonstration Programme*, not available online.

Industrialization Park in one county in Yangzhou city. This effort of development transition received strong support from the city government. Similarly to AODevices, SFT is also one of the winners of the public tendering organized by NDRC. Ten of its product models were selected, covering three categories i.e. downlight, street/tunnel light and reflective self-ballasted light.

22.3 More information about the Shanghai LED case

A tunnel can be considered as a system integrating various technologies including ventilation, drainage, lighting, power supply, displays, broadcasting, video monitoring, wireless communication and fire prevention (R2S_LED). Shanghai Yangtze River Tunnel and Bridge is thus far the largest project combining a tunnel and a bridge, serving as a part of the G40 highway it connects the two banks of Yangtze River. The initiation of the project dates back to the middle 1980s when the State Council approved the construction plan; the actual construction work started in 1996 and finished in October 2009. The tunnel is 8.95 km long and has two layers – the upper layer is a highway for normal vehicles and the lower layer is kept for a future underground line. The tunnel is undulating due to the shape of the riverbed, which meanwhile makes the driving experience less tiring.

Baosight Software Co. Ltd used to be the ICT and automation department of Baosteel Group (an SOE). It was officially founded as a separate company in 1996 as its business size became larger and its products/services expanded beyond the mother company. Currently Baosight's business includes artificial intelligence solutions for various areas such as steel manufacturing, transport, outsourcing services, digging, equipment manufacturing and finance.

The developing of a single LED lighting control system was fairly easy, but integration with other segments in the tunnel was challenging (R2S_LED; R2O_4). The system delivered by Baosight incorporates a time-based control mode and a vision-based control mode. The former means that the system can adjust the switch time based on traffic monitoring results; during off-peak time the light strength is lowered to save electricity. The latter is promising in long distance tunnels, whereby three parts are differentiated, namely photopic vision part, scotopic vision part and mesopic part (referring to the visions of the eye under well-lit light conditions, middle light conditions and low light conditions). Lighting in the photopic vision part should be bright, the scotopic vision part should be dark, and the mesopic part should be gradually brighter again.

> *'...Drivers can adjust their visions along the tunnel, and feel less tired and bored, which will help avoid accidents… Our system is flexible and easy to be modified... energy-saving rate is very high, and there is still potential for higher rate and longer product life...' (R2S_LED)*

By May 2011, the tunnel had been working for two years. The lighting effect was very satisfactory according to R2O_4. Baosight gained more confidence owing to the FEBP support from SHEITC, and spent much more money on R&D afterwards.

In 2010 when NDRC organized the tendering for LED lighting demonstration projects, they selected Qianjiang Tunnel project as one of the 15 tunnel lighting participants. The constructor of Qianjiang Tunnel project, again, was STEC. Based on the previous experience, Baosight won a second contract from STEC to provide a tunnel lighting solution. Interviewee R2S_LED said that the Yangtze tunnel experience helped Baosight obtain more support from multiple channels, e.g. for the Qianjiang Tunnel project, funding for low-carbon transport pilot projects from Ministry of Transport.

R2S_LED as the champion in this case is an extremely active one; he once went to Beijing to communicate with ministerial officials

> *'...I suggested them (officials from one ministry) listen to ideas from various sources instead of totally replying on their 'think tanks' or 'experts' –* ***I frequently found governmental experts unqualified in the area of LED lighting****… I can guarantee I am relatively objective compared with other stakeholders, as I am not a light supplier, and strictly speaking I am not a buyer as well, and I am not the most important person…* ***a supplier might hide their weaknesses and try to sell more products; a buyer might choose low-quality products to save money; an important person might be biased by deficient information; I don't have these issues****… so I wanted the ministries to listen to me…' (R2S_LED)*

22.4 Other LED lighting promotion examples

22.4.1 Beijing

The first well-known, large-scale LED demonstration project was conducted in Beijing in preparation for the 2008 Olympic Games. The opening ceremony and sport venues adopted a large amount of LED lights and displays. In particular, the National Aquatics Centre (NAC) was equipped with 50,000 square meters of scenery lighting, which reached an energy-saving rate of 70%. The demonstration project was led by MOST;

through this opportunity the central government sent a signal to the market that LED lighting has big potential for various uses. According to NO_2, although MOST aimed to promote *domestic* LED lighting technology, it organized open tenders and selected several *international* suppliers to provide LED products for the games to guarantee the delivery on time.

Other than this famous example, NA_LED introduced a small-scale demonstration project in the Great Hall of the People.

> *'...Initially it was the idea of a representative from the People's Congress. He suggested to the NDRC that since the LED lighting technology is becoming popular in the country, we should let more government departments use it… we started an experimental project in 2010, to exchange the 160 lights on top of the rostrum…* ***We wasted a long time wrangling with the administration office of lights – the people there are not only conservative, but also very bureaucratic****… finally we chose two suppliers, one was from Shanghai, the other was from Zhejiang province. The suppliers wanted to provide the lights for free, but* ***we did not want them to provide free products since we needed to guarantee the quality****… we were very cautious to carry out this project as all the people below the lights are top-level leaders in our country… Anyway the outcome was beautiful – the light strength was raised by 40% while the energy consumption was reduced by 70%. Our next step is to exchange all the lights in the Hall into LED ones…' (NA_LED)*

22.4.2 Harbin

Harbin is a big city located in Northeast China. It is famous for its ice sculptures in the cold climate and the Russian legacy. It started the nurturing of local LED lighting industry since 2004; by far local suppliers have developed LED lighting products suitable for extremely cold weather. The major distinction of this participant city from others is the adoption of large-scale LED scenery lighting for ice sculptures, and more generally, for cold climate.

The *Implementation Measures for 'Ten Cities, Ten Thousand of LED lights' Programme in Harbin* announced that the city would promote the usage of around 100,000 LED lights through public procurement in three years. Main venues of adoption include ice scenes, natural landscapes along the Songhua River, architecture and culture attractions, streetlights and underground lighting. Meanwhile the city published a set of LED lighting standards under conditions of arctic weather, which was the first one in China. Harbin also organized an innovative design contest of LED lighting for ice sceneries; the contest attracted numerous LED suppliers to participate.