Signaling and accrediting new technology: Use of procurement for innovation in China

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Abstract

In China the use of public procurement as an innovation policy instrument has been closely associated with the drive to promote indigenous innovation. Implementation was largely through the use of catalogues intended to signal and to formally accredit the supply and demand of technologically-oriented products. This paper reviews these experiences by examining the wider context and three case studies. Accreditation is shown to carry a risk of protectionism. Signaling performs a function analogous to a technology roadmap and was assisted by giving listed technologies priority for public procurement. For both types of instrument the intended mechanism did not work as planned but the broader role they sought to fill was an important factor in bringing innovations to market. The appropriateness and effectiveness of such instruments are shown to be dependent upon the state of both the innovation and the procurement systems in which they are set.

Key words: public procurement; China; signaling; accreditation; indigenous innovation; innovation policy.

1. Introduction

The use of public procurement has long been recognized for its potential to drive innovation (Geroski 1990; Rothwell 1984; Dalpé 1994; Edquist et al. 2000). The basic principle is that a commitment to purchase goods and services with characteristics that require an innovative step incentivizes firms to invest in innovation through the provision of a guaranteed initial customer. The concept has been extended in several directions including: the favoring of existing innovative solutions and hence rewarding innovation and aiding its diffusion; using public procurement to catalyze the development of socially desirable goods for the private market (for example energy saving technologies); and the procurement of R&D to take technologies up to the prototype or demonstrator stage, with the US Small Business Innovation Research program as the archetype (Edler and Georghiou 2007; Uyarra and Flanagan 2010; Georghiou et al. 2014).

There has been a new wave of interest in these policies in Europe since the mid-2000s (Rolfstam 2013), a trend which has now been echoed in other parts of the world (OECD 2011; Li 2011; Edquist and Zabala Iturriagagorria 2012; Timmermans and Zabala Iturriagagorria 2013; Lember et al. 2014; Vecchiato and Roveda 2014; UNOPS 2014; Edquist et al. 2015). Policy measures to promote this agenda as well as to address the related regulatory framework conditions have included the following three categories (drawn from Georghiou et al. 2014): 1–6).

1. Addressing deficits in the organizational and individual capabilities to handle the additional complexities of procuring innovation (principally training and networking actions).
2. Seeking to provide improved methods of identifying, specifying and signaling needs (using pre-commercial procurement of R&D to develop and demonstrate solutions and use of foresight and platforms to bring suppliers and purchasers together).
3. Providing incentives to assist procurement of innovative goods and services (through subsidy, certification or guarantees to mitigate risk).

Policy measure types (2) and (3) will be a particular focus here, although, as we shall see, in the Chinese case policy instruments for public procurement of innovation (PPI) were also closely tied to the other categories. Both of the concerns of this paper, signaling and accrediting, seek to bring suppliers and purchasers together as set out in category (2), while accreditation, as interpreted in China, was clearly an instrument to provide incentives for the procurement of specific innovative goods and services and hence an example under category (3).

A wide range of challenges and issues associated with PPI have been investigated by the research community based in the OECD context (Edler et al. 2005; OECD 2011; Rolfstam 2013; Uyarra et al. 2014; Georghiou et al. 2014). Recently, there has been a developing body of literature on PPI issues in the context of developing countries (Mourão and Cantu 2014; Chen and Cheng 2014;
UNOPS 2014; Li et al. 2015; Ribeiro and Furtado 2015). While the existing literature addresses various issues related to the context of an emerging economy, from diagnosing institutional deficiencies to analyzing sector-specific practices, an in-depth understanding of the design and implementation of a particular PPI policy instrument is still lacking. The experience of China’s once dominant PPI policy offers an opportunity to gain such an understanding.

The emergence of a procurement-based innovation policy in China was externally recognized in a significant way by an OECD review of Chinese innovation policy in 2008 (Edler et al. 2008). The development of this policy had resulted, as we shall document, from a strong drive from 2006 to promote ‘indigenous innovation’ as the central theme of a reformed innovation system. During the same period the public procurement system in China was also evolving. While China is committed to aligning its procurement system with the World Trade Organization (WTO) Agreement on Government Procurement (GPA), it has not been able to fulfill the expectation of existing signatories of the GPA with sufficiently open public procurement market access and a well-developed legislative system.1 Being a non-signatory country, China is not regulated by the GPA. It has been using a government procurement system developed before joining the WTO in late 2001. As a result, China’s definitions and approach to public procurement remain different from those in the OECD countries. This incompatibility of the Chinese public procurement system with international practice, as we shall see, has impinged upon its use in the context of innovation.

In this paper we explore a distinctive feature of PPI in China, the signaling and accreditation of innovation through, among other instruments, the use of catalogues. In so doing we attempt to expand our knowledge regarding the utilization and suitability of a particular kind of PPI policy measure (i.e. instruments based on a rationale to formally bridge the supply and demand sides). Firstly, we examine key issues associated with PPI in developing countries through a short overview of the literature. We then set up a framework to investigate China’s experience. After reviewing the legislative and policy backgrounds, three case studies are used to illustrate the practical outcomes and limitations of PPI in this context.

2. Policies promoting PPI and the context of developing countries

The significance of a range of policy tools intended to promote the use of public procurement has been debated from a policy design perspective. As mentioned in Section 1, besides building friendly framework conditions, major categories of policy measures included: measures facilitating the communication between supply and demand, complementary incentives, and capability/capacity building measures (Georgiou et al. 2014). The rationales of those measures lie in the identification of a range of market and system failures associated with the procurement cycle as well as the innovation processes. Those failures (or what Borrás and Equist 2013 call ‘problems’) include but are not limited to: information asymmetry between various stakeholders, capability failures owing to lack of expertise of PPI practitioners, ‘soft institutional failures’ (Woolhuis et al. 2005) such as risk aversion, and ‘hard institutional failures’ (Woolhuis et al. 2005) such as flaws associated with regulatory settings (Edler et al. 2005; Georgiou et al. 2014).

Besides policy tools targeted at enhancing the role of PPI individually, there have been attempts to position public procurement as a ‘cornerstone’ of complementary policy tools so that different types of ‘policy mix’ can be effectively formulated (Edler and Georgiou 2007; Edquist and Zabala-Iturriagagoitia 2012). An exemplar of this type of systemic policy has been the building of ‘lead markets’. A lead market, as described by Beise (2004), has features that favor the introduction of certain innovations, which subsequently diffuse into other markets. A lead market would typically involve favorable regulatory and competition environments and users willing to pay a premium for particular characteristics of innovations (Beise 2004). PPI can effectively stimulate the creation of lead markets in that the scale of public demand could enable the government to perform as powerful ‘lead users’, while complementary policy measures can be launched to create friendly framework conditions in terms of standards and regulations (Edler and Georgiou 2007; Edler et al. 2012).

Concrete policy tools adopted by developed countries include platform/networking activities and training schemes in order to enhance both capacity and capabilities, as in the cases of Australia and EU (OECD 2011). Pre-commercial procurement practices targeted at small and medium-sized enterprises (SMEs) have also been increasingly adopted, with enhanced initiatives taken by the USA, the UK, the Netherlands and others (Lember et al. 2014). Another handy approach is to associate PPI with the development of specific sectors, especially in defense (Australia, USA) and energy (Brazil, Sweden) (Edquist et al. 2000; Weiss 2014; Thurbon 2014; UN Office for Project Services 2014). In terms of systemic instruments, the most substantial lead-market strategy has been the EU ‘Lead Market Initiative’, which aimed at stimulating innovation in six target markets using policy mixes based on PPI and complementary policies (European Commission 2007; OECD 2011). Among all countries, the USA has been the most experienced user of PPI. It has sophisticatedly integrated innovation objectives into a wide range of government schemes, involving technological areas in both the defense (Weiss 2014) and non-defense sectors (Vonortas 2015). An overall trajectory across the world, as noted by Lember et al. (2014: 306), has been that PPI policies have been increasingly used as a ‘generic tool in promoting innovation’ rather than simply an industrial policy instrument as originally used for the period up to the 1980s.

PPI in developing countries has some notable peculiarities and therefore might differ significantly from that of developed countries. We shall argue that differences lie in the nature of both innovation and public procurement, and in the institutional settings where the innovation and procurement systems are situated.

‘Innovation’ in the context of developed countries is frequently regarded as the creation of a good or service of socioeconomic significance that is ‘non-existing’ (Edquist and Zabala-Iturriagagoitia 2012). By contrast, in developing countries, ‘innovation’ is rarely ‘new to the world’ but rather is understood as being ‘new to the country’ or even ‘new to the region/company’. Thus, the process of innovation is associated with the intention to catch up and to realize import substitution, especially through the lens of development studies (Lall and Teubal 1998; Gao 2015). ‘Innovation’ in the developing world very often implies a process of ‘imitation’, involving technologies that might already be well-established in the developed world rather than world-level technological frontiers (Nelson 2004). This broader connotation of innovation, as demonstrated by Ribeiro and Furtado (2015) as well as Li et al. (2015), is very relevant to understanding the nature of PPI activities in developing countries. More explicitly, Yülek and Tiryakioglu (2014: 34) argued that innovation:

… lies at the heart of development-based public procurement policies in developing economies in a similar manner that procurement for innovation does in developed economies.
Furthermore, ‘public procurement’ in the context of developing countries also has differences from that practised in the developed world. The most prominent international framework for regulating public procurement activities derives from the WTO GPA, a plurilateral treaty serving to promote international free trade. In principle, because most of their procurement systems are still outside the regulatory scope of the GPA, developing countries have more room for utilizing public procurement to achieve various socioeconomic objectives. Developing countries often hesitate to join GPA, primarily because of the incompatibility of their existing domestic regulatory systems and their intention to utilize public procurement to drive domestic development (Ssennoga 2006; Agaba and Shipman 2007).

The implications of not being part of the GPA for PPI in developing countries are significant in at least two aspects. Firstly, it implies huge potential. The average spending on public procurement in developing countries is high because of their tremendous demands for investment in public infrastructures (OECD 2005). The potential effects of public procurement in leveraging socioeconomic development should not be underestimated. Not being part of the GPA means that in principle developing countries can be far more flexible than developed countries in utilizing PPI. Secondly, however, not being part of the GPA has eliminated the obligation for developing countries to implement procurement reforms, with a consequent exposure to severe corruption and very low levels of transparency, quality and accountability (Agaba and Shipman 2007). This may severely limit the institutional capacity for exercising procurement to drive innovation, which normally requires highly interactive supplier–procuree dialogues and fair competition between alternative designs (Uyarra et al. 2014).

A recent trend has been that public procurement systems in different countries have converged, pushed by parallel pressures of convergence in ‘normative’ (administrative, economic and innovation-policy paradigms), ‘regulatory’ (trade), as well as ‘economic’ (globalization) terms (Lember et al. 2014). Not only have practices related to regular procurement been converging, but also those aimed at wider socioeconomic and environmental effects (Geng and Doberstein 2008). International organizations such as the UN, the World Bank and OECD have been contributing to this trajectory by actively promoting the building of capabilities across the procurement community of the developing world (OECD 2003; UN Office for Project Services 2010).

Beyond the domains of innovation and public procurement, more broadly speaking, 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 (Ernst 2002; Chaminade et al. 2009). 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)). When it comes to PPI policies, it has been concluded that it is necessary to take the specific institutional settings and the socioeconomic contexts of the particular country/region into account, and to strike a balance between existing capacities and the PPI undertaking (Rolfstam 2013; Lember et al. 2014).

3. Framework and methodology

As pointed out by Edler et al. (2012), researching PPI is associated with challenges such as: the difficulty of establishing a relevant baseline, the inability of public statistics to capture the phenomenon, and the necessity of connecting multiple action levels. In particular for China, little secondary data (either quantitative or qualitative) regarding PPI is available. To gain insight into this policy area, we therefore track legislative and policy developments to contextualize PPI in China and then use three short case studies to illustrate the complexity of implementation in this environment. We adopt a multi-level approach to outlining the policy and governance context, since the social environment where PPI operates, as noted by Rolfstam (2009, 2012), is essentially shaped by institutions functioning at various directions and levels.

Our particular focus is upon efforts to signal needs for innovation to supplying firms and to accredit innovations which then receive preferential treatment during procurement processes. The starting point is the use of two types of official ‘catalogue’ developed at national and regional levels to fulfill these functions. As we shall describe below, it turned out that the two functions were effected via multiple channels but that the catalogue experience provided valuable insights into the underlying drivers, needs, and limitations of signaling and accreditation.

A case study approach was selected because of the nature of the research topic which requires an in-depth understanding of the dynamics and context of PPI. The processes involved are in an emergent stage for which prior typologies would not have been feasible and would not have been recognized by the research subjects. The case study work is at multiple levels to reflect the complexity embodied in the context. Hence, the development of policy and implementation strategies forms a contextual case in which the three specific case studies presented in Section 5 are embedded. These were selected to illustrate different approaches to signaling and accrediting new technologies at both the national and the regional levels. They are not intended to be representative. Rather they are illustrative of the often complex sequence of events involved in the interactions of supply- and demand-side innovation policies.

Following Yin (2009: 18) the aim was to build knowledge in a situation where:

… the boundaries between phenomenon and context are not clearly evident.

Data employed to build the context and the concrete case studies included both secondary data (mostly policy and business documentation) and primary data (i.e. stakeholder interviews). To improve the validity of this study we conducted two rounds of fieldwork in China, followed by additional telephone interviews after the suspension of the policy. The first round of fieldwork was for scoping purpose, to contextualize and identify concrete PPI cases. The second round was intensive data collection to further understand the policy implementation processes and to build case studies.

A ‘purposive sampling strategy’ (Miles and Huberman 1994) was adopted to select regions, cases and individual interviewee. Four major criteria were applied to select the regions: level of activity in terms of PPI, accessibility to interviewees, gross domestic product (GDP) ranking, and innovativeness ranking. The openness of policy processes in China (Martin 2010) and the USA–China disputes over ‘indigenous innovation’ (O’Brien 2010) added some political sensitivity to this topic. Hence accessibility to data was an essential sampling criterion. The criteria regarding GDP and innovativeness ranking are based on the assumption that wealthier and more innovative regions are more likely to generate PPI cases. After the regions were selected, PPI cases were chosen according to, firstly,
whether there was innovation created, improved, adapted or diffused because of the procurement, and secondly, interviewees’ recommendations and promised access to further interviewees.

In total 24 stakeholder interviews were conducted. Those included: two interviews with national-level government officials from the Ministry of Science and Technology (MOST); 14 interviews with regional-level government officials from innovation and procurement related departments in Beijing, Shanghai, Shandong, Guangdong, and Jiangsu; two interviews with Chinese academics working on procurement and/or innovation related issues; three interviews with representatives from the suppliers involved in the three case studies; and three interviews with public procurers/users of the solutions presented in the three case studies. In particular, five interviews were used for building the e-classroom solutions case, four interviews for the tunnel boring machine case, and three interviews for the water recycling technology case. Interviews with government officials were used to understand the policy design and implementation process, and contextualize particular PPI cases.

The first round of fieldwork, interviews with two national-level government officials and two Chinese researchers working on PPI were unstructured, to enable open discussions which further informed research design. The other 20 interviews were all semi-structured, to enable focused yet flexible discussions with various stakeholders. Core questions posed in semi-structured interviews were oriented to understanding the stakeholder’s experience related to the making and implementation of PPI policies in China, as well as their experience related to specific PPI cases.

Analysis followed the broad approach mapped out by Miles and Huberman (1994) in which raw data (transcriptions and their translations) were subject to overlapping phases of reduction, display through tabulation, and the drawing of conclusions.

4. China’s PPI policy approach: accrediting and signaling

4.1 PPI in the context of policies for indigenous innovation in China

The case studies are set in the context of ‘indigenous innovation’, which has been a ‘programmatic and overarching emphasis’ in China’s current stage of innovation system development (Benner et al. 2012). The concept was officially put forward as a national strategy by the President at the National Conference of Science and Technology in 2006, and articulated through the Guideline on National Medium- and Long-term Program for Science and Technology Development (2006–20) (State Council 2006b), hereafter called the MLP (2006–20). The State Council (2006b: 10) has defined indigenous innovation as:

… original innovation, integrated innovation, and re-innovation based on assimilation and absorption of imported technology.

In the Chinese context, indigenous innovation implies a connotation of ‘new to the country’ rather than ‘new to the world’. The motivation behind this strategy lies in the country’s strong intention to catch up in an increasingly knowledge-based global economy.

Featuring an explicit emphasis on enterprise innovation, the MLP (2006–20) defined key priorities for national science and technology (S&T) development and key policy instruments to promote them. The portfolio of policy instruments adopted included: tax reduction, financial support, standardization, venture capital and public procurement (State Council 2006b). Compared with the science, technology and innovation (STI) policies in place prior to 2006, the scope of instruments has been widened significantly, reaching beyond the conventional domains of S&T policy, to other domains such as public procurement. This change is consistent with the international trend of ‘systemic policies’ (Smits and Kuhlmann 2004; Liu et al. 2011; Wieczorek and Hekkert 2012).

Following this initiative, the supporting policies for the MLP (2006–20) (State Council 2006a), and the consequent implementation measures, elaborated practical approaches and designed an institutional setup for each of the policy instruments. Alongside the broadening of instruments employed for indigenous innovation, the range of actors engaged with innovation policy was also significantly broadened (Liu et al. 2011). Previously the implementation of STI policy in China (e.g. allocating R&D funding) was undertaken mainly by the MOST. With the launch of more diversified policies, the division of labor among government agencies and the resulting implementation structures became more complex and multi-dimensional. This was significant for the case of public procurement. Officials in charge of innovation policies needed to collaborate with procuring agencies, suppliers and sometimes users or other stakeholders. Coordination among actors is becoming more important than ever before. This is, again, consistent with what is happening internationally, whereby innovation policies feature increasingly ‘multi-level’ and ‘multi-actor’ characteristics (Flanagan et al. 2011).

4.2 Policies adopted for PPI: A brief overview

Public procurement in China is regulated by two primary laws: the Law on Tendering and Bidding (LTB) drafted by the National Development and Reform Commission (NDRC), and the Law on Government Procurement (LGP) drafted by the Ministry of Finance (MOF) (LTB 1999; LGP 2002). The LTB, which is focused on tendering regulations rather than on procurement activities as a whole, applies to both public and private sectors. Its scope is much broader than that of public procurement. On the other hand, the LGP adopts a narrow understanding of ‘government procurement’ by defining it as the purchasing activities carried out by governmental organizations for their own uses only (Article II, LGP). Other internationally recognized government procurement activities such as state-owned enterprises procurements are not covered by LGP. Hence the scope of LGP is much smaller than the size of the Chinese public procurement market. There has been competition and contradiction between the two laws, primarily as a result of fragmentation in terms of division of labor among the supervising and implementing authorities. Although the State Council recently launched Regulations on Implementation of the Law on Government Procurement (State Council 2015), it does not solve the fundamental problem of incompatibility between the two laws governed by two powerful authorities.

Underpinned by the two primary laws, the implementation of public procurement activities has been rather fragmented horizontally across different sectors, and vertically across levels of governance (Wang and Zhang 2010; EU Chamber of Commerce in China 2011). The concept of public procurement that we discuss in this paper is in line with the broader definition commonly adopted by OECD countries (see Office of Government Commerce (OGC) (2008: 3) for a definition of public procurement by the UK government), which is consistent not only with the theoretical perspectives in this area of research, but also, as we shall see in the case studies, with the implementation of PPI in China.
As shown in Table 1, at least three forms of policies were in force to support the use of PPI in China: routinized mechanism based on accrediting catalogues, signaling catalogues for particular technologies, and support programs for key areas trying to promote the establishment of lead markets. Against this broad landscape of policy implementation, in this paper we focus on the two types of catalogues: signaling catalogues and accrediting catalogues.

Table 1. Range of identified national policies for public procurement of innovation

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<tr>
<th>Forms</th>
<th>Implementation</th>
<th>Rationale</th>
<th>Forms</th>
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<tr>
<td>Routinized mechanism via accrediting catalogues</td>
<td>Ambiguous national measures, regional autonomy in developing local mechanisms, diversified across regions</td>
<td>Enhancing communication between suppliers and procurers</td>
<td>Signaling catalogues of equipment and other strategic technologies</td>
<td>Relatively smooth, government departments regularly launch catalogues to inform suppliers</td>
<td>Creating lead market, systemic mix of instruments</td>
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<td>Signaling catalogues</td>
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<td>Support programs for key, strategic and emerging areas ('lead-market initiative' type programs)</td>
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Table 2. Signaling and accrediting catalogues at national and regional levels

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<tr>
<th>Definitions</th>
<th>National examples</th>
<th>Regional examples</th>
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<tr>
<td>Accrediting catalogues</td>
<td>Catologues containing information on recently developed, officially accredited 'new to country/region' technologies/solutions which need further commercialization/diffusion</td>
<td>Regional catalogues of innovation products (regional 'innovation catalogues')</td>
</tr>
<tr>
<td>Signaling catalogues</td>
<td>* Catalogues of Indigenous Innovation Products ('innovation catalogues')</td>
<td>* Shanghai: Catalogue of Indigenous Innovation in Construction and Transport Sectors (regional 'innovation catalogues')</td>
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<td>* Catalogues of Recommended Vehicle Models for the Energy-saving and New Energy Vehicles Demonstration Program</td>
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<td>* Advising on Accelerating the Revitalization of Equipment Manufacturing Industry ('equipment catalogues')</td>
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<td>* Beijing: Technological Beijing Action Plan 2009–12</td>
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Explicit reference to the use of public procurement to stimulate innovation in MLP (2006–20) is made in Article VIII-3:

Formulate implementing regulations of the People’s Republic of China 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. Develop relevant technology standards through government procurement. (State Council 2006b: 54)

To respond to this initiative, in the following years MOF, MOST and NDRC issued a number of implementation measures. These constituted a regulatory system (later withdrawn) based on accrediting catalogues for PPI in China. From our fieldwork we found that the concrete implementation practices and the engagement of stakeholders went beyond the scope of explicit measures launched by the above-mentioned ministries. We derived Table 1 based on policy analysis and fieldwork, summarizing major categories of approaches encountered. Given the wide diversity of PPI practices and locations in China, Table 1 should be seen as exploratory rather than conclusive.

As shown in Table 1, at least three forms of policies were in force to support the use of PPI in China: routinized mechanism based on accrediting catalogues, signaling catalogues for particular technologies, and support programs for key areas trying to promote the establishment of lead markets. Against this broad landscape of policy implementation, in this paper we focus on the two types of catalogue and the interplay between them, although, as we shall see in the case studies, they might well interact with other policy measures in practice.

Table 2 summarizes our definitions and some examples of accrediting and signaling catalogues at both national and regional levels. In particular, the most explicit and controversial example of accrediting catalogues has been the production of Catalogues of Indigenous Innovation Products ('innovation catalogues' hereafter) aimed at accrediting innovative solutions nationwide, and then giving those solutions preferential treatment during subsequent procurement processes (US–China Business Council 2010; EU Chamber of Commerce in China 2011; Crookes 2012). The most significant example of signaling catalogues has been various equipment-related catalogues ('equipment catalogues' hereafter) including the Guiding Catalogues for Indigenous Innovation in Major Technological Equipment. These catalogues are relevant to PPI since there are regulations stipulating that once the technologies listed in signaling catalogues have been developed, they have priority for being procured in public projects.

In Sections 4.3 and 4.4 we will specifically look at the articulation of innovation catalogues (an example of accrediting catalogues) and equipment catalogues (an example of signaling catalogues) at national and regional levels.

4.3 Articulation of innovation and equipment catalogues at the national level

The use of innovation catalogues dated back to late 2006, when NDRC, MOF and MOST jointly stated that enterprises can apply
for national accreditation for their innovative solutions. Accredited products would form innovation catalogues which can be used as guidance for procurers who intend to buy innovative products (MOST et al. 2006).

MOST et al. (2006) stipulated that to qualify for inclusion in the innovation catalogue seven criteria for innovative products needed to be fulfilled, including:

- consistency with laws and STI policies
- enterprise/individual should have intellectual property ownership in China through their own innovation activities
- product should have a trademark registered in China and owned by applicant
- product should embody high innovativeness
- product should embody leading technologies in terms of international standards
- product should be of reliable quality
- product should have high potential in terms of economic value, commercialization or import substitution

In 2007, MOF announced five more administrative measures, to operationalize the innovation catalogue approach. Among those administrative measures, the Administrative Measures on First and Ordering Procurement (MOF 2007) played an important role in shaping the PPI processes as presented in the case studies of e-classroom solutions and water recycling technologies. ‘First procurement’ is procuring for the first time newly developed products demanded by socioeconomic needs, but which are not yet commercially competitive (MOF 2007). ‘Ordering procurement’, on the other hand, is ordering a good or service that does not exist to suit the needs of public users (MOF 2007). Further R&D is needed for suppliers to develop the product. The rationale of ‘ordering procurement’ in this context is similar to that of procurement of R&D, known inter-nationally as pre-commercial procurement (European Commission 2006; Rigby 2013). Nevertheless, it is worth noting that the nature of innovation required by MOF here is ‘new to the country’ rather than ‘new to the world’. A technology/solution that has existed in developed countries might still qualify for first procurement or ordering procurement in China.

The equipment catalogues were not designed specifically as instruments of PPI but are nonetheless performing a function in this domain. Rather than a bottom-up approach in which the government calls for applications from enterprises and then forms a ‘what we have’ list, an equipment catalogue states clearly what kinds of key technologies are in great need in China (a top-down ‘what we want’ list with specified technological requirements). An equipment catalogue that was later on linked explicitly with innovation catalogues is the Guiding Catalogues for Indigenous Innovation in Major Technological Equipment (see Ministry of Industry and Information Technology (MIIT) et al. 2009). MIIT et al. (2009). This stipulated that if enterprises intend and have the potential to develop the listed technologies, the government would provide them with various supporting measures including pre-commercial procurement. If a technology that was previously listed in the equipment catalogue was successfully developed, it had priority for accreditation onto the innovation catalogue.

Notionally at least, the two types of catalogues were linked. They can be considered as measures to formalize the supply and demand of technologically-oriented products. By working together in both directions, these two kinds of catalogues were intended to stimulate innovation through both ‘push’ and ‘pull’ forces. We characterize this policy design in Fig. 1.

In terms of institutional setup, MOST was mainly responsible for the technological aspect, calling for applications from firms and local governments and organizing expert groups to conduct accreditation work. MOF was responsible for the financial aspect, amending procurement measures to be more favorable to accredited products. MOST accredited 243 national indigenous innovation products during the pilot period 2007–9, but the national-level innovation catalogue was never officially released. International concerns about the potential protectionism caused by PPI had led to mounting pressure (US–China Business Council 2010; EU Chamber of Commerce in China 2011). The eventual ‘game changer’ was the US–China Strategic and Economic Dialogue (US Department of the Treasury 2011) in May 2011, following President Hu’s visit to the USA in January 2011 when he made a commitment to ‘delink’ government procurement from innovation. Key policies underpinning innovation catalogues were cancelled in July 2011 to fulfill this (US–China Business Council 2011a).

In contrast, the institutional setup and implementation trajectory of the equipment catalogue, led by the MIIT, differed from that for the innovation catalogues. In December 2009, the first version of a national-level equipment catalogue was jointly issued by MIIT, MOST, MOF and the State-owned Assets Supervision and Administration Commission of the State Council. The equipment
catalogue was then updated on a yearly basis in the period 2009–12. By comparing the contents of different versions of the equipment catalogues, we can observe that updated versions raised higher requirements than earlier versions.

Given the difficulties associated with the publication of innovation catalogues, and the subsequent termination of key policies, the implementation of the ‘linkage’ between the innovation catalogue and equipment catalogue at the national level arguably failed.

### 4.4 Regional actions related to innovation and equipment catalogues

According to the original policy design for PPI by the ministries, all regions were expected to implement the centralized, national innovation catalogue once it was published. During the transitional period when the national catalogue was not available, the MOF advised that regions could make and implement their own transitional policies until the publication of the national catalogue (MOF 2006).

Based on document analysis and interviews with regional officials, we observe that most regions, in terms of policy-making, followed the approach of the central government (i.e. through producing their own innovation catalogues). Division of labor in the regions was also similar. While no major actions were taken by the central government in 2008–10, many regional governments launched initiatives to conduct PPI activities. A review by the authors of regional government websites in early 2011 indicated that more than one-third of the provinces and municipalities in mainland China had developed their own innovation catalogues despite the lack of such catalogues at the national level.

Nevertheless, our fieldwork suggested that local implementation of the catalogue approach did not unfold as expected. At least three severe barriers were hindering it. Firstly, a tendency towards regional protectionism became increasingly obvious as innovation catalogues turned out to be a convenient instrument to screen out products from other regions. Most of the interviewed regional procurers considered this preference very understandable, while supplier interviewees complained that sometimes they had to ‘localize’ their firms to gain access to markets in other provinces. As a result of taxation and fiscal reforms since the 1990s, regions in China had gained a high degree of economic autonomy (Zhao and Zhang 1999). The implementation process of regional expenditure related policies in this de jure centralized country appears to be de facto federalist (Zheng 2007). While regional autonomy might not seem to be a barrier to the implementation of supply-side innovation policies, it unavoidably caused protectionism in the case of PPI.

A second barrier lay in inter-departmental coordination. Although the division of labor seemed to be clarified, collaboration between S&T and financial departments remained rather limited. An interviewee from a provincial S&T committee (supervised by MOST) complained that even though they could complete the accreditation work, they had no power to push the implementation process further, given that the procuring authority was under supervision of the financial department, who did not see innovation as a priority. This viewpoint was echoed by interviewees from the S&T departments of two other regions who, in general, had no knowledge about the downstream effects of the innovation catalogues. This barrier proved that PPI as a complex policy crossing the domains of innovation policy and public procurement requires the engagement of more actors than those in S&T departments.

A third barrier resulted from the fragmentation of the public procurement system. On the other side from the complaints raised by S&T departments about a lack of interest in innovation, financial officials and procuring agents also identified difficulties. A fundamental reason for them not to procure innovation products was that the accredited products were mostly ‘unprocurable’ (i.e. outside the scope of the LGP, hence outside the reach of financial departments’ authority). Financial departments do not have funding allocated for products that are not needed by government organizations as end users. A procurer interviewee from a provincial centre called for unification of the public procurement classification (which is now different from sector to sector) across the country, and ideally in conformity with the international classification. The capacity for public procurement to perform innovation tasks in China seemed to be severely compromised by this institutional fragmentation.

In contrast to the problems with innovation catalogues, interview evidence indicated relative support for the use of national equipment catalogues. In some regions, local commissions of economy and information technology (supervised by MIIT) initiated commercialization programs for the newly developed technologies required in the national equipment catalogue. In turn, these further stimulated pre-commercial procurements. Implementation was smoother since the compilation of catalogues and the following stages were all carried out by MIIT and its lower level agencies. Thus, those procurements that related to equipment catalogues were not within the scope of the LGP and were not supervised by financial departments. Coordination problems experienced elsewhere were bypassed here since MIIT and the local agents are in a strictly top-down system. This divergence in the trajectories for the implementation of the equipment and innovation catalogues re-confirmed the problem of inter-departmental coordination and the barriers posed by fragmentation of the procurement system.

The designed linkage between equipment and innovation catalogues did not work at the regional level either, as accredited technologies were not suitable for government procurement in the narrow sense. Although the innovation catalogues were not implemented as planned, there was evidence of procurement facilitating innovation. We now turn to three cases to arrive at a more detailed understanding of the operation of the processes.

### 5. Case studies

Three brief case studies are now presented to illustrate the reality of interaction between procurement and promotion of innovation in the Chinese context. While they are all examples of efforts to develop and source indigenous technology, they represent highly diverse technologies and diffusion paths and only share the involvement of regional government in terms of their institutional setting. As we shall explore, they involve both the supply side (through high-tech development programs) and demand side (through the involvement of public customers). Although each case is distinct from the others, to assist presentation we structure them in a similar logic. We start with an introduction to the technological, policy and business background, then give a description of the procurement processes (which feature highly dynamic interactions between stakeholders) and outcomes/impacts, and finally give a brief reflection on the role played by catalogues and agencies.

#### 5.1 E-classroom solutions

The case presented here concerns the role of PPI mechanisms in the commercialization of an application of a Chinese-produced processor in school computer projects. A Chinese government desire to
have an indigenous capability in processor design and production was a key policy driver for the emergence of China’s domestically made central processing units. The processors were initially developed by the Institute of Computing Technology in the Chinese Academy of Sciences in 2002, which formed the first generation of the Loongson ‘family’, or range, of domestically produced chips. In 2004 a company called Lemote Technology Co. Ltd. was co-founded by the Institute of Computing Technology and a private sector partner, the Menglan Group from the city of Changshu in Jiangsu province. The aim of the public–private partnership was to focus on the commercialization of Loongson chips while modernizing the industrial base of the city.

From the beginning, commercialization of these chips was a challenge and market share was low. The initial application was in Linux-based laptops and set-top boxes. Further generations of the processors are used for defense and super computers (Dawning 6000).

Two factors came together to provide an opportunity for further commercialization. The first was the regional implementation of PPI policies. Shortly after MOF had announced the national PPI measures in 2007, Jiangsu province followed up with local innovation catalogues which included Loongson-based laptops. The second favorable factor was that Jiangsu was promoting the informatization of its education system, with the aim of equipping primary, middle and high schools with modernized computer systems to facilitate e-teaching. These policy signals led Lemote to identify high potential for its products in the local education market.

Lemote then made an approach to the Changshu city government. The idea received attention from top officials, who set up a temporary coordination mechanism engaging chief officials from different departments to enhance efficiency. In early 2009, tailored e-classroom solutions with 10,000 computers were procured with a budget of CNY 25 million. The solutions were developed further post-procurement through user-supplier communication. These enabled multi-media interactions between teachers and students in class using connected computers.

Following this, the Changshu government helped Lemote to propose a province-wide procurement to the Jiangsu government. As this was the first PPI case for the province, senior provincial officials required the Government Procurement Centre to act quickly. The Government Procurement Centre developed a procurement plan after consulting the Department of Finance and the Department of Education. It organized a ‘first procurement’ negotiation process between an expert group and Lemote. This resulted in an agreement about the price, technological requirements, timing, training and services. In December 2009, 4,679 sets of e-classroom solutions with 150,000 computers were procured at a cost of CNY 410 million. A substantial proportion of the innovation involved was in the software rather than hardware and resulted from interaction with users and advice from specialized institutes. The company was able to develop further intellectual property during this stage around the hardware itself was largely ‘catching up’ with imported products.

Those public contracts brought about the employment of an additional 150 employees. Nevertheless, the supplier admitted that the profitability remained as low as less than 10% because Lemote had to invest greatly in capacity building and services/maintenance in order to deliver the contracts. This procurement greatly accelerated the building of Loongson-based supply chains.

There were clear lead-market effects in the successive stages. The success of city-level procurement provided a reference for the larger provincial exercise. The supplier obtained new design patents through the procurement and gained better knowledge of customer demand. It started to receive invitations to design tailored solutions for other public bodies including the local policing agencies and labor market agencies. Later on Lemote won a contract with value of CNY 6 million through open tendering to undertake the rural informatization project for Jiangsu, equipping more than 200 villages with its products.

The catalogues were utilized in different ways during the first and second stages of procurement. The first stage was an example of ‘special treatment’ and ‘local articulation’ with support from top officials. The function of the catalogue was mainly awareness-raising in that the publication of catalogues reminded the supplier of the possibility of gaining procurement support from government. The second, province-wide, stage was more formalized than the initial city order. The Government Procurement Centre followed the procedure elaborated in MOF (2007). Lemote products were qualified for ‘first procurement’ treatment since they were accredited as ‘national-level indigenous innovation products’, even though the full catalogue had not been published. The procured products were specially tailored to the contract, and hence did not correspond closely to the items listed in the innovation catalogues. The function of the catalogue did not follow the intended process for the measure designed by central government in which procurers look up the products they need and organize a tendering process that offers extra points for indigenous innovations. Nonetheless, it provided a legal reference, the first procurement procedure, for practitioners to follow.

### 5.2 Tunnel boring machine

This case concerns the development of China’s domestic earth pressure balanced (EPB) shield machines. Modern tunnel boring machine equipment is normally based on a complex and tailored combination of various technologies including control, electronics, measurement and hydraulics. Due to the high sophistication of the technology, the Chinese market, the largest for tunnel boring machines in the world, had been dominated by imported equipment. Concerned at the high price of such equipment, in the 1990s the government launched a State High-Tech Development Plan (known as an ‘863 program’) to develop a less costly domestically produced alternative. Working with collaborators, a beneficiary of this measure was the state-owned Shanghai Tunnel Engineering Co. Ltd (STEC), a firm engaged both in equipment manufacture and tunnel construction. They developed an Ø3.4 m EPB shield machine prototype ‘Forerunner No. 2’ in 2006, the first domestic model of this type based substantially on core Chinese intellectual property. Forerunner No. 2 was accredited into specialized innovation catalogues such as Shanghai Catalogues of Indigenous Innovative Technologies (Products) for Construction and Transport. According to Shanghai Trial Measures for Public Procurement of Indigenous Innovative Outcomes in Key Infrastructure Projects (Shanghai Urban Construction and Communications Commission 2006), items included in the above-mentioned catalogues have priority to be procured for local infrastructure projects. This measure is a PPI effort made by sectoral government departments, rather than by S&T and financial departments. However, as we shall see, this case was not stimulated by this specialized accrediting catalogue approach. Nonetheless, elements of both signaling and accrediting of the technology by government agencies were involved in its emergence.

Within China, Shanghai as the host city of EXPO 2010 was experiencing a particularly rapid growth of infrastructure with an...
ambitious program of underground railways and trans-river tunnel construction. STEC was keen to enter the local market but the underground transport operator was initially reluctant to risk meeting its deadlines for the EXPO by acting as a test-bed for untried technology. However, with the backing of a key official from the 863 program a risk-sharing pilot was agreed. The prototype achieved a daily advance of 38.4 meters, slightly better than its foreign counterparts and on this basis several of the state-owned construction companies working on the Shanghai underground projects placed orders for equipment which was 30% cheaper than the imported machinery.

In the meantime, after the central government launched systemic policy measures to support key equipment development, Shanghai followed up with explicit commercialization measures called ‘first (set of) key technology equipment achievement breakthrough programs’ (in this case short for First Equipment Program), defined as ‘the process during which the user for the first time uses domestically made key technology equipment within the 16 areas defined by Guofa[2006]8’ (Shanghai Economic and Information Technology Commission et al. 2007: 1). This tunnel case was recognized retrospectively as the first instance of Shanghai’s First Equipment Program. Initial users of Forerunner No.2 hence enjoyed a subsidy of CNY 2 million for each machine.

The 22 machines put into action finished one-third of the newly developed lines in 2007 in Shanghai. STEC also won contracts from other cities and countries, which greatly accelerated development of the supply chain. The overall price of tunnel boring machines in the Chinese market was lowered by 20%. Export contracts were subsequently won but domestically diffusion was inhibited by the reluctance of other regions to purchase items from outside their own geographical domain.

To summarize, this PPI case emerged as a result of interactions between the supplier, the S&T department, the transport company and the users. The demand for such equipment was clearly signaled by central government and supported by the technology investment program while accreditation was achieved through the risk-sharing pilot application. This case took place in the period 2005–7, before the equipment catalogue approach was established. The national policy Guofa 2006[8] (State Council 2006c) functioned as a signaling catalogue, which provided reference for Shanghai Economic and Information Technology Commission to include this case as a practice of First Equipment Program (Shanghai Economic and Information Technology Commission et al. 2007). The problems of inter-agency coordination referred to in the preceding sections were mitigated by the cross-cutting coordination role played by the Shanghai Economic and Information Technology Commission who provided the communication link between the technology development support agencies and the first usage.

5.3 Water recycling technology

This case concerns the role of PPI mechanisms in the commercialization of China’s domestic membrane bio-reactor (MBR) technologies. MBR technology is an advanced technology for wastewater recycling consisting of bio-reactor and membrane filtering units. In China, MBR was a rarely used approach and units were imported from abroad at a very high price compared with conventional technologies. To promote advanced water-processing technologies, the Chinese central government had highlighted the necessity of developing MBR solutions in a range of policies including State Council (2006a) and the Eleventh Five-Year Plan for S&T Development.

The supplier company in this case, Origin Water, was founded in 2001 by returnee students from abroad. It is located in the Zhongguancun National Indigenous Innovation Demonstration Zone in Beijing. As a high-tech firm in a strategic area, the firm benefited from various policies from Zhongguancun. By 2007, working with academic collaborators, they developed technology and secured intellectual property in several areas including the core membrane technology. In 2009 its MBR was accredited as a national indigenous innovation product.

Commercialization remained a major obstacle although the firm carried out some demonstration projects. The turning point was the emphasis placed on PPI by the Beijing administration since 2008. Beijing launched a regional demand-side policy mix built upon PPI. It clarified the scope and bodies for procurement activities, and defined practical forms of PPI including localized concepts of ‘first procurement’ and ‘ordering procurement’ (see Beijing Bureau of Finance 2009). The Beijing S&T Committee produced numerous batches of innovation and first procurement catalogues. The Beijing administration encouraged procurers to participate by offering incentives such as larger procurement budgets for the forthcoming year. Vertical and horizontal coordination was enhanced through inter-governmental and cross-departmental mechanisms. This policy change offered a promising public procurement market for innovative SMEs in Zhongguancun.

In order to implement PPI policies, Beijing’s governmental organizations jointly organized a promotion event for indigenous innovative products in January 2009, exhibiting innovation outcomes from Zhongguancun. Origin Water’s products were strongly recommended to potential procurers. Public procurement contract-signing events for Zhongguancun products were organized later. These events brought together potential buyers and suppliers along with other stakeholders around focused themes, in this case water processing. While the result is actually a statement of intent rather than a contract, and is preceded by exchanges of information, there is little doubt that public buyers come under pressure from regional authorities to conclude purchases. Origin Water obtained procurement contracts from the Beijing Drainage Group Co., Ltd. and other water authorities to build recycling plants. The contract value was around CNY 194 million in total. More contracts were obtained from the locality afterwards.

The supplier won contracts from other regions through open tendering as a result of demonstrating the effects of public procurement in the capital city. Better value for money and localized services are recognized as the supplier’s main advantage. Application of MBR technology has been accelerated countrywide. Confidence among SMEs in Zhongguancun to deal with the economic crisis was strengthened.

Beijing’s definition of PPI is broader and the policy mix adopted has been comprehensive. It has eliminated the barriers caused by the flawed government procurement system in China by building platforms. Beijing’s first procurement catalogues (for accrediting innovations seeking a first buyer) were utilized as well as the broader innovation catalogues. The implementation process is different from that designed by the central and local policies in that public procurers did not buy items directly from the first procurement catalogue. Instead, procurements were arranged through contract-signing events. Potential procurers were willing to promote indigenous innovation, either voluntarily or with strong encouragement from the administration (as indicated by two interviewees).
6. Analysis and conclusions

In the earlier parts of this paper we have noted the emergence of PPI as an established instrument of innovation policy with clear taxonomic characteristics for available policy instruments being documented in the literature (Georghiou et al. 2014). In broad terms we have shown that the approaches adopted in China were consistent with these taxonomies in that they addressed deficits in issues of identifying, specifying and signaling needs, and in providing incentives for PPI. However, it was also clear that the literature on innovation and procurement in a developing country context suggested strongly that PPI in this context, though potentially a potent instrument, could vary significantly from its counterpart in the developed world. Innovation was more broadly defined to include ‘catch-up’ products and processes (or in the Chinese case ‘indigenous innovation’). Deviance from international trade treaties and norms in terms of procurement reform allows greater scope for legislative intervention in the direction of innovation, but creates pressures for compliance and integration with international markets. In this concluding section we shall assess the effectiveness of the specific tools that emerged in China and what that experience may mean more broadly for other nations seeking to address the same barriers to innovation.

In this paper we have outlined the process of policy development in China that led to the convergence of the innovation and procurement agendas. A mixed picture has emerged in terms of the variety of procurement measures used to promote indigenous innovation. Looking at the empirical evidence on the Chinese experience, if we maintain the three-part taxonomy of PPI channels shown in Table 1 (accreditation, signaling and sectoral ‘lead-market’ development programs), we may see that the three cases showed elements of each. However, the emergence of successful products on the market followed a more complex path in which the use of the cataloguer instrument was sometimes more incidental than central. We summarize the key factors that led to the emergence of those three cases in Table 3.

Hence, for the case of the e-classroom the basic chip emerged in response to national signaling and Loongson-based products including Lemote’s laptops were accredited as regional and national innovation products. The company saw the opportunity presented by inclusion in the catalogue, but the most significant assistance for bringing the innovation to market came from the user–supplier interactions and the coordination of regional government that allowed the general endorsement to be translated into the development opportunity of an integrated educational solution. It also appears that the national accreditation legitimized preferential treatment in subsequent procurements as the technology diffused more widely. The lead-market effect resulted both from the opportunity to demonstrate the technology (and the capability to provide tailored solutions to a regional authority), and from the post-innovation improvements resulting from the first customer interactions.

In the case of the tunnel boring machine there was evidence of national signaling and regional accreditation. While pre-dating the equipment catalogue approach, enactment by the State Council (2006c) performed the national signaling function and legitimated the Shanghai government’s support for commercialization. The benefits of accreditation via an innovation catalogue were not evident in this case. Tunnel boring machines received regional accreditation by being included in Shanghai Catalogues of Indigenous Innovative Technologies (Products) for Construction and Transport, but this did not contribute to the case. A positive role for accreditation was achieved by means of the risk-sharing pilot. While forming a basis for exports, the case also illustrates a common barrier for lead-market effects in China, a reluctance of other regions to purchase products originating from outside their own area.

The water case illustrates the use of national signaling (in a general sense for water processing), and national as well as regional accreditation. Development plans for equipment sectors and S&T in general signaled the overall need in the country for water recycling technologies. While the supplier’s MBR products achieved accreditation at both levels, the real distinction of this case is that the catalogues were not a passive instrument of encouragement for procurers but rather were used to support a much more active process of securing first customers for innovations through the contract-signing events, backed by a series of financial and other incentives for the procurers. Beyond the point of first purchase the market appears to have taken over, with the firm concerned winning contracts elsewhere on the basis of the demonstration/lead-market effect in Beijing. The ability to force the process in this way is at least in part founded by the much more integrated administration in Beijing.

From a wider perspective the cases raise some concerns. The first is one of accreditation being used as an instrument of protectionism.

Table 3. Signaling, accrediting and other factors shaping cases

<table>
<thead>
<tr>
<th>Signaling</th>
<th>National signaling of demand for domestic processors; regional signaling of demand for education informatization</th>
<th>National and regional accreditation of Loongson-based products into innovation catalogues, which legitimized preferential treatment in subsequent procurements</th>
<th>Proactive supplier who took initiative; coordination of regional government engaging a range of departments involved in PPI; strong user–supplier interactions which accelerated development of solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-classroom solutions</td>
<td>National signaling of demand for education informatization</td>
<td>Regional accrediting catalogues did not contribute to case; instead a positive role for accreditation was achieved through risk-sharing pilot application</td>
<td>Tremendous local demand offering opportunity of a ‘lead market’; strong interactions between various stakeholders: supplier, local government, operator and procurers/users</td>
</tr>
<tr>
<td>Tunnel boring machines</td>
<td>National signaling of demand for technology which legitimated regional government’s support for commercialization</td>
<td>National and regional accreditation of supplier’s technologies into innovation catalogues</td>
<td>Exhibitions publicizing technologies; contract-signing conferences which brought potential suppliers and procurers/users together; integrated local administration employing PPI policies complemented with other instruments</td>
</tr>
<tr>
<td>Water recycling technologies</td>
<td>National signaling of demand for advanced water-processing technologies</td>
<td></td>
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</tbody>
</table>

The Chinese indigenous innovation strategy especially the PPI policies had become:

... one of the most contentious issues in the US–China relationship in recent years. (US–China Business Council 2012: 4)

The criteria adopted to accredit innovation products were particularly controversial owing to its discrimination against foreign suppliers and its explicit reference to the objective of ‘import substitution’ (US–China Business Council 2011b). This controversy eventually led to the official delinking of innovation from public procurement in China.

Meanwhile, the indications are that protectionism does not stop at China’s borders but is also a factor between regions. Catalogues are one means by which governments can favor industries within their region in China. While the innovations in each of our case studies did appear at the end of the process to provide genuinely competitive offerings, it is much less clear that they would have secured the contracts in an open competition at the start of the innovation cycle. The crucial issue here is whether the decision was correcting a market failure manifested as an aversion to innovation, or was simply aiming to create an opening for a local firm, when a competitor from outside the region would have made a superior offering. Regional protectionism may create a local market for innovative solutions in the short term, but can be harmful for the national market and industry in the long run, as it can easily lead to duplicate products and irrational investment.

This Chinese experience offers lessons for the general use of PPI policy instruments based on ‘accreditation’. In OECD countries there are PPI measures which seek to place a premium or guarantee on innovations from SMEs, but the focus is on the firm rather than the product. Trying to accredit newly developed products from domestic suppliers is problematic in at least three aspects. Firstly, there is a time lag between the accreditation and the procurement processes, which in some fast-changing sectors can be too slow a mechanism to offer advanced solutions to the market. Secondly, accrediting specifically configured products to form catalogues can overlook the potential of tailored solutions based on generic technologies. As seen in these cases, the public users often needed customized technological solutions to deliver their services, rather than ‘off-the-catalogue’ products. In this sense, a more responsive mechanism to signal the supply to the demand would be needed to address information asymmetry. Thirdly, and very importantly, promoting innovation with a domestic focus can easily violate, if not the formal rules imposed by international trade treaties, the strategic interests of trade partner countries. This, however, does not mean that a country should open its public procurement market unconditionally to its trade partners. In fact, to make better use of procurement as a policy instrument, a country should proactively negotiate its potential to do so (Dawar and Evenett 2011), the most well-known example being the USA with its Buy American Act (Linarelli 2011). Negotiating certainly requires a high level of institutional capacity and capabilities of practitioners which most developing countries lack. The most immediate lesson to be drawn from China’s experience is that, for a country that intends to employ PPI as a deliberate policy instrument, a first preparatory step should be a systematic assessment of the international institutional environment where its procurement system is situated.

Turning to signaling, there appears to be much less controversy. The equipment catalogues (or their equivalent in lists of target technologies embodied in other policy documents) meet the criteria of early signals from the demand side to the suppliers and hence reduce risks and entry/transaction costs for innovative firms. In a sense they are technology roadmaps, a tool which can be useful for purchasers to use to signal future needs. There remains a concern that making this a generic instrument rather than the sum of a myriad of bottom-up and specific indications of need is potentially cumbersome and redolent of the previous command economy. A key issue here is that of timing: can an officially endorsed and published requirement match the pace of technological change. The answer probably lies in the ‘clock-speed’ of the industry. Heavy machinery and system technologies such as the tunnel boring machines emerge relatively slowly while software-based innovations and some components are in constant flux.

Furthermore, the signaling instruments have yet to be tested at the frontier of technology. The test would be how many of the technological needs featured are truly generic, and of course, that they cannot be met by off-the-shelf purchases. It is relatively easy to design a roadmap based on milestones already achieved by leading countries but much harder to anticipate needs that have not yet been articulated. When featured items are already available from foreign suppliers the state is still entitled to support firms developing alternatives with R&D funding but future procurement decisions would still need to be fully competitive, not least to ensure that the highest quality components are used.

Implementation difficulties have also affected both types of instrument. These have ranged from the fundamental (definitions of innovation and equipment), through issues of coordination (horizontal and vertical) to as discussed, a tendency to conservatism, and a triggering of unforeseen consequences, such as enabling regional protectionism and creating fears of wider protectionism.

Underpinning these problems of implementation are the framework conditions. These appear to have been a particular problem in China, notably around the multiple and sometimes competing legislation and definitions surrounding public procurement. This makes it unclear where responsibility for innovation lies in this context (and will need to be resolved as China accedes to the WTO GPA). Divided responsibilities between those responsible for innovation policy and for public purchasing led to conflicts in the operation of the system. Coordination between S&T and finance and other specialized departments was problematic during the accrediting and procuring process. On the one hand, the catalogues approach required a centralized, well-regulated procurement system to be implemented, which was apparently not fulfilled. On the other hand, we identified potential for alternative approaches which did not receive much attention from policy practitioners (such as capacity building and distributing the responsibility for PPI across policy domains). Our case studies also suggest that the problems of coordination were mitigated at regional level. This paper found that, rather than the formal procurement procedures designed by national or regional governments, proactive stakeholders performing a ‘champion’ role largely contributed to the emergence of the cases. This finding corresponds to a key finding of Lember et al. (2014: 287), that:

... the very process of public procurement plays a far more modest role in the actual implementation of PPI policies than expected.

How can China move forward with PPI? Some of the issues raised will have to be confronted. Horizontal coordination across government ministries is needed, especially between those ministries responsible for innovation, those regulating procurement policy and...
those with sectoral missions and major purchasing budgets. There is also a need to open up markets for innovative goods and services across regions. PPI as practiced does not offer a shortcut to raising the technology level of Chinese firms. Cultural change and adjustment across the full range of institutions involved in supply and demand would offer higher rewards and a true stimulus for indigenous firms to aspire to the highest international standards. It should be recalled that procurement is primarily for the benefit of the buyers and hence access to innovative products and services will, in turn, allow those buying organizations to provide better and sometimes innovative public services. The rationale of the catalogue system requires a solid and unified public procurement regulatory system. If China is to utilize PPI in the current fragmented procurement system, related policies should be distributed (and sophisticated) rather than centralized. Indeed the policy-making is top-down, but case studies suggest that successful implementation was actually bottom-up.

There is a risk of over-reaction and a move away from PPI, but this would waste an opportunity. Instead the best elements of this policy should be taken forward along with further measures aimed at capacity building and cultural change in attitudes to innovation. The right set of policy measures will not be the same, or at least the same mix, as those in the OECD countries but an adaptive, evolutionary perspective can be used to rebuild the approach.

In terms of the study of procurement and innovation this work has identified additional types of instrument for the promotion of PPI but has not suggested that the broad taxonomy should be changed. What it does suggest is that the appropriateness and effectiveness of such instruments are closely dependent upon both the state of development of the innovation system and on the broader framework and community of practice for procurement in which they are set.

Notes
1. During the period 2007–14 China has made five rounds of offers in order to accede to the GPA. However, the GPA committee considers that:

   ...a number of significant gaps remain to be filled in the offer before China’s accession could be concluded. Emphasis was also placed on the need for China to advance work on reform of its procurement legislation.

2. See <https://www.wto.org/english/tratop_e/gp/gpca_e.htm> accessed 12 Apr 2015, for details of GPA.
3. One consequence of this fragmentation has been the impossibility of tracing procurement transactions and compiling accurate statistics. The actual size of China’s public procurement market seems mysterious. According to the data provided by MOF and its sub-departments, government procurement expenditure in China accounts for around 2% of the GDP, while according to the EU Chamber of Commerce in China (2011: 2), public procurement in China represents ‘well over 20% of China’s rapidly growing economy’. Although there are no statistics to evaluate exactly how large this market is, it is certain that the Chinese public procurement market is huge and expanding steadily, which indicates great potential to lever innovation performance.

4. Retrospectively speaking, the stagnation of national-level PPI policy implementation was primarily owing to political pressure as a result of disputes between China and major trade stakeholders such as the USA and EU.
6. Menglan’s chair made a proposal (Qian 2009) which received national endorsement at presidential level.
8. Differently from the designed national policy approach which aimed to incorporate ‘first procurement’ items into ‘innovation catalogues’, Beijing developed catalogues dedicated for ‘first procurement’ items in addition to its innovation catalogues.

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