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Assessing Public Procurement of Innovation as a Cross-domain Policy

– a framework and application to the Chinese context

Abstract

Despite the fact that public procurement of innovation (PPI) has become an increasingly popular policy tool, there has been a lack of holistic approaches to assessing policies promoting PPI. This paper attempts to address this gap by proposing a framework which links the multiple levels and aspects related to the design and implementation of PPI policies. By adopting a systemic understanding of ‘public procurement’ as well as ‘innovation policies’, this paper positions PPI as a cross-domain policy which is inherently a mix of procurement and innovation-related interventions. The paper develops an assessment framework using ‘vertical coherence’ and ‘horizontal coherence’ as criteria. It then illustrates the use of the framework by applying it to PPI policies in China. The framework can aid the conduct of *ex ante* as well as *ex post* assessment of PPI policies, which can further inform policy design, implementation and learning.

Keywords: public procurement, innovation policy, China, cross-domain, vertical/horizontal coherence

1. Introduction

Public procurement has long been recognized for its potential to drive innovation (see e.g. Rothwell 1984; Geroski 1990; Dalpe 1994; Edquist et al. 2000). More recently this policy instrument has been termed public procurement of innovation (abbreviated as PPI hereafter) (Georghiou et al. 2014). In the context of this paper PPI refers to ‘public

procurement activities that stimulate, or aim at stimulating the creation, improvement, adaption and diffusion of innovations'.

In the broader context of innovation policy instruments, which increasingly possess a 'systemic' feature enlightened by an innovation systems perspectives (Smits & Kuhlmann 2004), PPI is considered as a type of demand-side policy (Edler 2013). The functioning of PPI as a policy instrument is rather sophisticated, involving different rationales depending on factors such as demand structures, technological life cycles, market development stages and nature of procured items (Edler & Georghiou 2007; Edler et al. 2005; Edquist & Hommen 2000; Rothwell & Zegveld 1981; Uyarra & Flanagan 2010). Those factors imply the possibility of a variety of approaches to the design and implementation of PPI policies.

Nevertheless, PPI policy development, like the development of demand-side innovation policies in general, *'is characterized by policy imitation rather than evidence, reasoning, and informed learning'* (Edler et al. 2012, p.2). Analysis of PPI has mostly taken the form of case studies focused on concrete procurement processes at the micro level, as conducted in e.g. Edquist et al. (2000), Edler et al. (2005) and Lember et al. (2010). While those cases provided in-depth knowledge about the associated issues and pitfalls of PPI as an activity involving multiple stakeholders, it is time to propose a systematic framework to analyze PPI as a higher-level (e.g. national, regional, or sectoral) policy. In practice, the recent years have seen a new wave of interest in PPI by policymakers from OECD countries and beyond (Caloghirou et al. 2016; Edler & Georghiou 2007; Lember et al. 2013; Li & Georghiou 2016; OECD 2011; Uyarra et al. 2016; Vecchiato & Roveda 2014). Correspondingly, there is a strong need for analytical approaches to informing policy making and its implementation. This paper makes an initial attempt to address this need by proposing a conceptual framework to assist analysis and assessment.

The term ‘assessment’ involved in this paper refers more to the qualitative assessment of *design* and *implementation*, than that of *effectiveness* which is more widely associated with *policy outcomes*. This paper proposes that PPI policies are a type of ‘cross-domain’ policies that seeks to utilize an instrument which is not originally geared towards promoting innovation as an innovation policy, i.e. public procurement. In this regard, this paper can contribute to the analysis of cross-domain policies including but not limited to PPI policies, and to the wider debate on ‘policy coordination failures’ as a type of transformational system failure for innovation policy-making (Weber & Rohrer 2012). Cross-domain policies inevitably encounter coordination difficulties between the objectives of the original domain such as public procurement, and that of the ‘secondary’ domain such as innovation. Policymakers therefore would have to assess the costs and benefits of striking coherence between the various competing objectives of the same policy instrument, i.e. ‘horizontal coherence’. Meanwhile, coherence between the policy design and implementation processes, i.e. ‘vertical coherence’, is also an important factor in determining the effectiveness of policies. This paper proposes to use these two dimensions of coherence to assess the process of PPI policies.

This paper uses China, one of the few countries that had an explicit PPI policy portfolio, as an empirical case to illustrate the application of the proposed framework. In 2006 China ambitiously set out to implement systematic PPI policies through its *National Medium- and Long-Term Program for Science and Technology Development – an outline (2006-2020)* (see State Council (2006a); hereafter the MLP). The MLP and its supporting policies define a comprehensive guide for government agencies from multiple levels to design and implement concrete policy instruments to support PPI. The main instruments of this policy portfolio, however, were rather dramatically terminated in 2011 in response to concerns from international trade partners (Li & Georghiou 2016). China’s intense experience between 2006

and 2011 offers valuable evidence for us to gain a deeper understanding of PPI as a complicated policy instrument. As part of a larger doctoral research project, this study has access to a rich dataset developed from the fieldwork, which is another consideration why China is used as the empirical case here. The application of the proposed analytical framework to the Chinese case provides an assessment of the design and implementation of China's policies, and illustrates how domestic as well as international factors might shape the trajectory of the PPI policy cycle.

Findings from the Chinese context suggest that the three distinct PPI policy approaches, namely a 'centralized, routine mechanism', a 'major technological equipment (MTE) commercialization' program, and 'demonstration programs for emerging technologies', experienced different trajectories and achieved different degrees of coherence. While the centralized mechanism was the most high-profile instrument launched through the MLP, it was too systematic an instrument which the existing institutions in China were not able to support. Drawing upon Young (2002)'s notion of 'institutional fit', i.e. that institutional settings should suit the defining features of the problems they address, this study argues that the centralized PPI mechanism suffered from a poor fit between the institutional requirements of the policy design on the one hand, and the existing circumstances in the Chinese context on the other. Although the design of the centralized PPI mechanism appeared feasible in theory, in practice it failed to be an effective policy innovation which needs to align with the existing institutional settings and policy styles of the given jurisdiction (Auld et al. 2014).

In contrast, regional initiatives such as the MTE commercialization program, and sectoral initiatives such as the demonstration programs for emerging technologies proved to be more appropriate in the context of China. This paper argues that it is exactly the decentralized and experimental nature of those two approaches that enabled them to achieve a

higher degree of coherence with China's fragmented and underdeveloped institutions. This finding echoes what has been termed as 'experimentalist' or 'experimental' governance (Sabel & Zeitlin 2012; Fierlbeck 2014), which, unlike hierarchical command-and-control models, is based on overall rule-making, a recursive review of implementation experience in different local contexts, and iterative policy learning. Experimentalist governance appears particularly suitable for contexts featuring diverse conditions and practices across different localities such as in the context of EU, US and the arena of global/transnational governance (Sabel & Zeitlin 2008). Although the Chinese system is built on a high level of political centralization, the federalist feature in terms of socioeconomic development in fact justifies an experimentalist policy implementation process.

A key lesson derived from the analysis is that the design of cross-domain innovation policies will have to take coordination issues into account beforehand to ensure implementability, and this can be facilitated through iterative policy learning as well as informed policy-making approaches such as stakeholder consultations. While the ideal situation is to achieve full coherence between competing policy objectives, in reality trade-offs are often needed in order to achieve an optimal overall outcome.

This paper unfolds as follows. It firstly develops an understanding of public procurement by appreciating its systemic nature and multiple functions, including promoting innovation (Section 2). It then provides a review of the key issues with respect to PPI as a policy that crosses the domains of innovation and public procurement (Section 3). Section 4 then draws upon perspectives on policy coordination, and proposes a framework using 'vertical and horizontal coherence' as assessment criteria. In Section 5 the assessment framework is operationalized and applied to the case of China to assess the Chinese PPI

policies that were launched and implemented between 2006 and 2011. The paper concludes in Section 6 with a short discussion and implications for further practice and research.

2. Understanding public procurement - actors, institutions and interactions

Public procurement is commonly defined as the process whereby public bodies acquire various goods and services that they need for their activities from third parties (Arrowsmith et al. 2000). Typical examples of public procurement include purchasing computers and stationaries for a public prosecutor's office, outsourcing cleaning and catering services for public schools, and contracting the building of public railway infrastructures. Expenditure on public procurement takes up approximately 15-20% of an OECD country's GDP; this number is considered even higher in developing countries where governments are making tremendous investment in public infrastructure (Anderson et al. 2012).

The very large size of public procurement markets creates a need to regulate procurement activities in order to guarantee proper use of public money. For this purpose, considerations such as transparency, equality, integrity, accountability and anti-corruption are widely treated as primary principles in domestic procurement regulations in most organizations, sectors, and countries (Arrowsmith et al. 2000). On the other hand, the large scale implies a great potential in utilizing public procurement as a leveraging policy instrument to pursue other socioeconomic goals such as employment, SME development, sustainability, support for minorities, and promoting innovation (Kashap 2004; McCrudden 2004).

In addition to these domestic regulations and policies promoting various goals, public procurement activities are likely to be affected by another set of rules, i.e. regulatory regimes imposed by international organizations represented by the World Trade Organization (WTO).

The most influential one on public procurement is the plurilateral Agreement on Government Procurement (GPA) which puts 'non-discrimination' as the top priority (Anderson & Arrowsmith 2011). Signatory countries are required to negotiate on the degree of openness of their home public procurement market during the accession process. While this type of treaty greatly enhanced the mutual access to public markets, they posed a significant challenge for member countries who want to provide preferential support for domestic target groups (Kattel & Lember 2010). In other words, the potential of 'borrowing' public procurement as a policy instrument to address issues in other domains is heavily constrained.

All of the diverse principles and tasks have made public procurement a complicated, multifaceted public activity. Balancing the multiple goals and tasks has proved to be a tricky issue for both policymakers and procurement practitioners (Schapper et al. 2006). PPI as a national or regional innovation policy belongs in the category of 'secondary' policies, which implies that the design and implementation of PPI policies undoubtedly need to take into account, if not give way to, primary tasks and international obligations.

Owing to its multiple facets, a public procurement system involves a wide range of actors including but not limited to procuring agencies, suppliers, end-users, policy-makers, and policy beneficiaries. Although in general they are regulated by macro-level, formal institutions, those different stakeholders behave according to their respective institutional contexts and their personal logic of appropriateness (Edler et al. 2005). This heterogeneity of stakeholders implies a high degree of difficulty for goal alignment, stakeholder coordination, and policy implementation in practice (Telgen et al. 2007; Thai 2009). At the micro level, the design, planning and organization of procurement procedures have fundamental influence on the nature, process, and outcomes of public procurement (Arrowsmith et al. 2000). At higher levels e.g. regional and national levels, laws, regulations and government and administration

norms also shape the trajectories of procurement processes by enabling or constraining them (Thai 2009).

3. Public Procurement of Innovation (PPI) as a cross-domain policy

The innovation process is the core activity of an ‘innovation system’, which is defined by Lundvall (1992) as *‘the elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge’* (p. 2). Be it national, regional or sectoral, an innovation system can be characterized by components (e.g. actors, infrastructure and policies), institutions and interactions between them (Breschi & Malerba 1997; Cooke et al. 1997; Freeman 1987). Institutions including laws, regulations, standards and norms as the ‘rules of the game’ provide ‘stability’, set ‘preconditions’, and structure the interactions between various aspects of the system (Johnson 1992). Institutions are meanwhile influenced by actors and other elements, while radical changes are likely to be caused by the implementation of innovation policies. A classic example of innovation policy is R&D grants awarded from Science and Technology (S&T) governmental departments to companies to work on highly innovative projects. On the one hand, an innovation policy is a ‘source of change’ working on the innovation systems, trying to redirect the dynamics towards desired performance; on the other, the design and functioning of policies is based on and influenced by the existing framework of institutions (Edquist et al. 2000). In recent years, the variety of innovation policy instruments has moved far beyond research and development (R&D) support; in fact, Lundvall & Borrás (2005) compared ‘science’, ‘technology’, and ‘innovation’ policies, and concluded that innovation policies should cover all the issues related to innovation and target at *‘overall innovative performance of the economy’* (p.615). In this sense the scope of innovation policies is fairly broad, varying from context to context. Broader innovation policies employed nowadays include, for example, proactive

standardization strategies which aim to get first-mover advantages in emerging technology development, and cluster instruments which embed innovation as a priority into regional industrial strategies to exploit advantages of geographical proximity. Due to the broadening of scope and involvement of a wider range of stakeholders, innovation policies in reality nowadays are increasingly ‘messy and complex’, involving multiple levels and multiple actors (Flanagan et al. 2011). This increasing complexity of innovation policies has brought about higher demand for effective policy coordination (Magro et al., 2014).

In this context of complexity, PPI is one of the policies that crosses different policy domains and thus requires coordination from diverse stakeholders. An example of PPI is the purchase of buses for the local transportation system by the public transport authority. Instead of buying off-the-shelf buses using cost-effectiveness as the main procurement criterion, the authority buys innovative, environmental friendly electric buses which might not be on the market yet and thus need further development from innovative suppliers. Although the initial costs of buying innovative buses will be higher than buying off-the-shelf buses, the life-cycle costs of innovative buses are likely to be lower owing to better quality and environmental protection effects. Policy instruments to support the public transport authority’s PPI activities might include user subsidies/incentives, electric bus-related standards and supplier catalogues, and training/assistance for procurement staff to do technological assessment. In this case, the domain of innovation and the domain of public procurement, which used to be detached from each other, now have to interact in a coordinated way.

PPI processes possess characteristics of both innovation and procurement activities. On the one hand, given that innovation inevitably involves uncertainty and interactive learning, risk management and stakeholder coordination have been identified as the top issues to be dealt with in PPI practices (Edler et al. 2005; Tsipouri et al. 2010; Uyarra et al. 2014). On the

other hand, the multiple tasks and objectives associated with public procurement imply that PPI has to comply with primary principles such as transparency and equality, and various institutions such as international, domestic, as well as organizational rules (Kattel & Lember 2010). Special techniques and strategies are often required to implement PPI since appropriate timing and procedures are needed to conduct procurement on the one hand, and ‘capture’ innovation on the other (Wilkinson et al. 2005). Different circumstances in terms of technology and public procurement life cycles lead to different functioning rationales of PPI (Edler & Georghiou 2007; Hommen & Rolfstam 2009; Uyarra & Flanagan 2010).

As previously discussed, the settings of both public procurement and innovation can be considered as ‘systems’ constituted of their respective actors, institutions and interactions. As a policy instrument that crosses the procurement and innovation systems, PPI is unavoidably influenced by both systems; a PPI process inherently involves procurement activities on the one hand, and innovation activities on the other. PPI dynamics are shaped by actors, institutions and interactions from both systems. In particular, various stakeholders from both systems with diversified interests (e.g. suppliers, users, government officials, procurers, and intermediaries) impact on PPI processes. PPI is situated at the ‘intersection’ of both systems, and consists of, by nature, ‘interactions’ between the procurement and innovation systems. In particular, as both the innovation and the public procurement systems are open systems interacting with their contexts including various political and socioeconomic circumstances, PPI is further influenced by those factors as well.

A deliberate PPI policy is hence a source of change to impact on PPI dynamics, while PPI dynamics are (to a certain extent) a manifestation of PPI policy implementation outcomes. Policy implementation might or might not follow the logic of policy design, influenced by various factors throughout the process. On the one hand, policy design influence PPI

processes through implementation; on the other, diagnosing PPI processes can facilitate the assessment of PPI policies to inform further policy learning.

4. Proposing a framework to assess public procurement of innovation (PPI)

The characteristics of PPI as a cross-domain policy, as reviewed in Section 3, determine that a theoretical prerequisite for PPI to function effectively is to realize two types of coherence, i.e. ‘vertical’ coherence between the policy design and implementation of PPI on the one hand, and ‘horizontal’ coherence between the innovation elements and the procurement elements of PPI on the other. The necessity of vertical and horizontal alignment of different dimensions of innovation policies is not only confined to the case of PPI but also increasingly to other types of cross-domain policies.

Indeed, the issue of coherence and coordination has been an emerging theme of debate in the innovation policy literature, and various notions have been proposed to delineate this complexity (see e.g. Flanagan et al. 2011; Magro et al. 2014; Weber & Rohracher 2012). For instance, Weber & Rohracher (2012) introduce ‘policy coordination failures’ as a subcategory of ‘transformational failures’ to take on board the needs of goal-oriented transformative change and to capture the interaction of different levels and areas of policies. Policy coordination failures might occur between innovation policy and sectoral policies (e.g. transport and energy policies), and between innovation policy and cross-cutting policies (e.g. tax, procurement, and economic policies). This type of failure requires *horizontal coherence* between different policy domains. Magro et al. (2014) provide a comprehensive review of perspectives on policy coordination. Similarly, the authors argue that coordination problems are pervasive across government departments, and across governance levels, owing to inertia such as internalized routines and policy path-dependency (ibid.). The case of innovation policies is more complex than clear-cut policies, because the multidisciplinary nature of

innovation activities determines that the boundary of the field of ‘innovation’ is in fact blurred with that of many different fields. In addition, Magro et al. (2014) draw upon earlier literature and argue that coherence is also needed across various vertical layers, which in effect mirror the levels this study examines, i.e. the levels of policy design, articulation and implementation. The coherence of these three levels is therefore *vertical coherence*. Furthermore, as illustrated by Auld et al. (2014)’s systematic review of *ex post* evaluations of low-carbon technologies, the alignment of different dimensions has proved to be an important reason for policy innovations to be effective. In particular, there is a trade-off between built-in flexibility of policy design and complexity related to implementation, which is related to vertical coherence. Meanwhile, the alignment of new policies with existing policy goals and policy styles in the given context of institutions is also of high importance, which is related to horizontal coherence.

Despite the aforementioned advancement, and the wide consensus that modern innovation policy practices should take ‘coherence’ into account and seek alignment of diverse aspects, there has been no substantial development in integrating ‘coherence’ as a core consideration for policy assessment. In order to delineate and utilize the concept, we draw upon policy implementation and coordination perspectives and offer a set of definitions and approaches here, as shown in Table 1. The ‘Definition’ column gives the definitions of vertical and horizontal coherence as qualitative assessment criteria, and the ‘Approach’ column describes the concrete approaches employed by this study.

-----**Table 1 to be inserted here**-----

As summarized in Table 1, we define ‘vertical coherence’ as *‘the status that goals, rationales, instruments, designed implementation structures, actual implementation processes, and outcomes of the PPI policy are logically consistent with each other’*. In particular, to

differentiate the process of policy implementation from the process of policy design and articulation, we differentiate between ‘designed’ versus ‘actual’ vertical coherence. In ‘designed vertical coherence’, the rationale, logic and instrumentation of the policy should not contradict or mismatch. This type of coherence should underpin the process of very initial policy formation, so that the following stages of policy implementation are built upon a theoretically feasible policy design. For ‘actual vertical coherence’, the implementation of the policy in reality should be in line with the initial policy design, especially in the sense that the outcomes should be in line with the initial objectives of policies. Designed vertical coherence is the prerequisite of, but not a sufficient condition for, actual vertical coherence. Going through the process of vertical coherence, it is in fact a complete policy cycle, from design, to articulation/implementation, and further to improvement of the policy through policy evaluation and learning.

In the second row of Table 1, ‘horizontal coherence’ is defined as ‘*the status that PPI policy is coherent with horizontally-linked policy domains, i.e. the innovation system and the procurement system, and their wider contexts*’. Similarly to vertical coherence, we differentiate between ‘designed’ and ‘actual’ horizontal coherence. To achieve ‘designed horizontal coherence, the policy design process needs to be anticipatory, in order to foresee and plan the potential interactions and coordination between the designed policy and contextual factors linked to the policy. The ‘actual horizontal coherence’ will then need to be considered during the policy implementation process. The approach employed by this study to assess actual horizontal coherence is to identify ‘policy coordination failures’ as defined by Weber & Rohracher (2012). For cross-domain policies, if they simply proceed under their own logic, policy coordination failures are likely to be manifested in practice, which could substantially compromise the implementability of policies. In particular, policy coordination failures may result from the *existence of factors hindering policy process* (e.g. redundant

agencies whose responsibilities are not relevant anymore), as well as from the *absence of factors supporting policy process* (e.g. lack of communication mechanisms across different functional departments). Policy coordination failures could also emerge from the lack of coordination between public policies and private sector institutions, and lack of alignment between domestic and international institutions (Weber & Rohracher, 2012).

In order to make the definitions and approaches more directly usable for analysis/assessment, Table 2 articulates the criteria into concrete dimensions. In the table, vertical coherence crosses the rows while horizontal coherence crosses the columns. The vertical flow of the various dimensions is inherently the logic of policy design and implementation, and the horizontal flow concerns interactions between different policies in different domains.

-----**Table 2 to be inserted here**-----

As shown in Table 2, vertical coherence is more about policy implementation, while horizontal coherence is more about policy coordination. It is worth noting that we do not try to impose the ‘top-down’ policy implementation thinking here, since the process of policy implementation has been recognized as neither being purely top-down, nor being purely bottom-up (Matland 1995). Rather, it increasingly features a process of negotiations and interactions, as shown in the case of China. Therefore, Table 2 uses double arrows to connect the various elements of coherence.

Table 2 illustrates that a PPI policy is both a vertical mix of different aspects and stages of the policy process (namely, the *goals, theoretical rationales, instruments, designed implementation structures, actual implementation processes, and outcomes*), and a horizontal mix of procurement and innovation related interventions. For PPI policies to work effectively all the dimensions in theory should be coherent with, or align with the others. The vertical

dimension connects the overall policy mandate with lower-level dynamics, i.e. the macro-level policy design with meso-level policy articulation and with the micro-level PPI processes. The horizontal dimension connects PPI policies with the context, i.e. procurement and innovation systems and even broader political economic environment. For the procurement system there are primary policy goals to be fulfilled, and for the innovation system there are other policies with which PPI has to coordinate. PPI policies are situated at the intersection of the domains of innovation and procurement.

Traditionally, innovation agencies and public procurement agencies have been used to making their own policies independently, with the former primarily concerned with inducing domestic innovation activities and the latter concerned with many issues including cost efficiency and international trade. In this scenario, horizontal coherence is very challenging to achieve because there is no ready institution (e.g. clear leadership and coordination role to bridge the two domains) supporting the PPI process. The emphasis on horizontal coherence does not suggest that other objectives should give way to coherence around an innovation objective. In fact, achieving full horizontal coherence might be neither possible nor efficient in practice. Policies, institutions and resources in other domains are well justified to prioritize their primary objectives. To pursue secondary objectives such as innovation, a consideration that should be taken during policy design stage is to strike a balance between primary and secondary goals, and to achieve a certain (although not full) degree of horizontal coherence. This is increasingly important in the current context whereby policymakers increasingly design policies by considering the wider 'policy mix' (Flanagan et al. 2011).

5. Applying the framework to the case of China

We now move on to illustrating the use of this conceptualization for PPI policy assessment through the case of China.

5.1 Developing a methodology for the case of China

Operationalization of the framework and research design primarily take into consideration the policymaking and implementation process of the particular country/region. The Chinese political system has been recognized as a sophisticatedly bureaucratic and seemingly centralized one (Blanchard & Shleifer 2000; Lieberthal & Oksenberg 1988; Martin 2010). The three conceptual levels of policy process defined by this paper, i.e. the macro level of policy design, the intermediary/meso level of policy articulation, and the micro level of policy implementation, in general mirror the *national, regional and micro levels* in practice. The *national* level concerns the design and articulation of PPI policies by the central government including the State Council and ministerial agencies. 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. The micro level mostly involves dynamics of stakeholder interactions centered on concrete innovation and procurement cycles, which are the ultimate activities that PPI policies target to influence. Guided by the vertical/horizontal coherence framework, an assessment methodology has been developed for the case of China.

The methodology looks into the three levels of policy process, as well as vertical and horizontal coherence issues. It translates conceptual issues into practice for which empirical data is needed. Assessing China's PPI policy thus requires knowledge about China's innovation and public procurement systems, knowledge about PPI policies and practices at the national, regional and micro levels, and knowledge about the wider context where the innovation, procurement and PPI processes are situated. In this way, this assessment methodology addresses issues 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).

Data to build the above mentioned different aspects of knowledge were collected through an extensive documentation search across national and regional PPI related policies, as well as over 50 interviews in the field with stakeholders including policymakers, policy practitioners, procurers, suppliers and users at national, regional and micro levels. A purposive sampling strategy (Miles & Huberman 1994) was adopted to select regions, cases and interviewees. Main criteria of selection included the level of activity in terms of PPI, maturity of regional policies, data accessibility and degree of innovativeness. Eventually five regions were selected, including two municipalities (Beijing and Shanghai) and three provinces (Shandong, Jiangsu and Guangdong). Interviewees were then approached based on information collected through documentation analysis and snowballing. Core questions covered in semi-structured interviews depended on the type of interviewees. For instance, government officials from financial departments were asked about their experience of making and implementing PPI policies, and their perspectives on policy effectiveness; while suppliers were asked about their experience in participating in the policies and their experience of user-supplier interactive learning. Each interview took on average 1.5 hours to finish. Interview data were then coded around policy themes and regional characteristics. Data analysis was directly guided by the assessment framework proposed in Section 4, involving the analysis of the macro-level environment (notably innovation and procurement systems) for PPI policies to function, the characterization of each dimension of each policy approach, and evaluative analysis to assess the vertical and horizontal coherence of the three policy approaches.

5.2 The context of PPI in China – procurement and innovation systems

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 by adopting tendering procedures in large-scale procurements (Wang & Zhang 2010). Although its recent development has been well influenced by international regulations (Chou 2006; Wang & Zhang 2010), the procurement system appears rather detached from international practices in terms of institutional settings.

Formal institutions of the current system are fundamentally underpinned by two primary laws, i.e. the Law on Government Procurement (LGP 2002), and the Law on Tendering and Bidding (LTB 1999), which are supervised by two ministerial-level authorities, i.e. the Ministry of Finance (MOF), and the National Development and Reform Commission (NDRC). The LGP regulates procurement activities of fiscally-funded organizations only, accounting for approximately 2% of China's GDP, while the LTB regulates all formal tendering procedures operated by both public and private organizations. Therefore, the scope of the LGP is much narrower than that of public procurement regulations adopted by the signatories of the World Trade Organization (WTO) Agreement on Government Procurement (GPA)¹; while the scope of the LTB is in effect much larger than that of the LGP, it remains ambiguously defined.

Public procurement activities beyond the scope of LGP but within the scope of LTB are hence regulated in a rather decentralized way, fragmented across sectors and across levels of government. NDRC plays an even more powerful role than MOF as it supervises procurement activities of state-owned enterprises. Region- and sector-specific agencies form

¹ See http://www.wto.org/english/tratop_e/gproc_e/gp_gpa_e.htm for more details (accessed April 10th 2014).

the main actors undertaking public procurement, serving their need for purchasing goods/services for their own use and delivering public services. Due to the lack of unified national-level regulations, provinces and their lower-level governments have published numerous regulatory measures to carry out procurement. Implementation regulations published by ministries and levels of governments formed the ‘backbone’ of the Chinese public procurement regulatory system (Wang & Zhang 2010). These regulations often compete rather than coordinate with each other due to their contradictory institutional roots (ibid.).

Interactions between actors, especially those between procurers and suppliers, are rather limited, taking the form of public tendering regulated by formal institutions and policies concerning anti-corruption and budget-saving. Nevertheless, fieldwork suggests that informal institutions and informal interactions between actors play a strong and multifold role in shaping procurement processes, mitigating the flaws and fragmentation of formal institutions on the one hand while competing with top-down policy implementation on the other.

Similarly to the procurement system, China’s innovation system has experienced rounds of reforms, driven by major policy changes since the 1970s (see Xue 1997; OECD 2008; Liu 2009). Despite these reforms, China’s national innovation system (NIS) governance approach has maintained some characteristics of a centrally planned one (OECD 2008). Main target groups of government interventions have been actors from the public sector (universities and public research institutes) rather than firms from the private sector. The most recent policy milestone has been the MLP, which aims to build a firm-centered NIS undertaking ‘indigenous innovation’. The MLP was accompanied by the launch of a portfolio of diversified STI policy instruments (see State Council 2006a). The overall policy move

featured a strong ‘catching-up’ intention, underpinned by ‘a more systemic understanding of innovation’ (Liu et al. 2011, p.930).

The range of government agencies involved in innovation policy making and implementation has widened. The State Council has the top-level authority in policymaking and governance. Key ministries governing China’s NIS include the Ministry of Science and Technology (MOST) as the main body for innovation policymaking, the MOF overseeing financial and taxation systems, the Ministry of Industry and Information Technology (MIIT) in charge of the development and implementation of industrial policies, and the NDRC in charge of China’s macroeconomic issues, socioeconomic development agenda, national investment and crucial sectors such as energy and raw materials (see Liu et al. 2011 for a detailed account).

Below the central government are regional governments and agencies. The institutional settings of different levels of government are similar; the lower level in principle conforms to the higher level (Martin 2010). In contrast to the *political centralization*, regions have a high degree of *financial autonomy* owing to waves of reforms towards financial decentralization (Zheng 2007). The role played by regional governments and their agencies in shaping China’s innovation policy processes should not be underestimated. ‘Significant disparities’ across different regions in terms of innovation performance have been observed (Arbolino 2011; Li 2009). This 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.).

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). The diversification of innovation policies requires coordination between more types of government agencies than the traditional S&T system led by MOST. The increasing complexity of Chinese innovation policy dynamics corresponds with what has been observed in the broader, international context (Flanagan et al. 2011).

5.3 Characterizing the Chinese PPI policies – three major approaches

China started the use of PPI policy in 2006 when the MLP was launched. 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. Develop relevant technology standards through government procurement...’

(State Council 2006b, p.54)

Following the MLP a range of supporting policies and implementation measures were announced by joint agencies to build PPI policy approaches. Integrating findings from policy documentation and fieldwork, this study identified three main approaches of PPI policy process, namely a centralized PPI mechanism based on innovation and procurement

catalogues (approach 1), policies promoting the commercialization of MTE (approach 2), and PPI elements in demonstration programs targeted at emerging technologies (approach 3). The design and implementation of the three policy approaches are classified² and characterized in Table 3 based on the dimensions defined in Table 2. Due to the limitation of space, Table 3 only illustrates the elements concerning vertical coherence here instead of all the elements concerning both vertical and horizontal coherence. Issues of horizontal coherence are discussed later on.

-----Table 3 to be inserted here-----

Backed by a set of policy measures issued by MOST, NDRC and MOF (see e.g. MOST et al. 2006; MOST et al. 2009; MOF 2007), policy approach 1 was the most explicit and controversial one. Its primary goal was to promote PPI based on the existing institutional settings of the government procurement system, which, as reviewed in Section 5.2, is fundamentally fragmented. The rationale of this policy approach was to enhance demand-supply communication and inter-departmental coordination by bringing the innovation and procurement systems together through catalogues of accredited innovation products, i.e. a routinized mechanism. Innovation catalogues and the corresponding PPI catalogues were supposed to be used as a reference for government procurers to buy new products (Li & Georghiou 2016). This approach is by nature what Edler and Georghiou (2007) term as ‘general procurement’ whereby ‘*innovation becomes an essential criterion in the call for tender and assessment of tender documents*’ (p.953). The central government appeared determined to implement this approach and more than half of the regions responded actively by articulating national policies. A range of instruments were employed to ensure the

² The classification should be considered as an exploratory rather than conclusive one, since the PPI policy dynamics in China proved to be very complicated and constantly changing, with diverse implementation structures across regions and sectors.

implementation of this approach, such as a pilot accreditation process coordinated by NDRC, MOF and MOST, public awareness raising, as well as concrete measures regarding procurement management such as contracting procedures. The designed implementation structures involve inter-departmental coordination mechanisms engaging various levels and domains. Science and Technology (S&T) agencies supervised by the MOST were designated to take care of technology accreditation, while finance departments supervised by MOF bore the responsibility of tendering and contracting issues.

The actual implementation process of policy approach 1, however, deviated from the original design significantly. 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. Some individual cases of PPI emerged, but the outcomes were far from being fruitful considering the ambitious policy design backed by the cross-departmental coordination arrangement. The overall effectiveness had not been formally evaluated when the approach was abolished in July 2011 in response to international concerns of China's tendency towards protectionism (USCBC, 2011). Following a series of Sino-US high-level dialogues, the national implementation of policy approach 1 eventually came to a standstill. At the regional level, owing to their autonomy, some local governments (e.g. Beijing) developed local mechanisms to carry on this policy approach based on catalogues. The actual implementation processes in localities featured flexible stakeholder interactions shaped by informal institutions (for details see Li, 2013).

Policy approach 2 aimed to accelerate the commercialization of MTE. The procurement of indigenous innovation equipment by state-owned enterprises was heavily encouraged by the central government (State Council 2006c). The rationale of this approach was on the one hand, to signal the national demand to potential suppliers through equipment catalogues, and

on the other, to conduct experimental or demonstration projects to use newly developed equipment. In contrast to policy approach 1, policy approach 2 aimed to support organizational procurers' procurement of newly developed domestic equipment, which by nature falls into the category of 'strategic procurement' defined by Edler and Georghiou (2007). 'Strategic procurement' refers to the case whereby *'the demand for certain technologies, products or services is encouraged in order to stimulate the market'* (ibid., p.953). One benefit of strategic procurement, as shown by China's PPI policy approach 2, is that it is often sector-specific and therefore required minimal degree of horizontal coherence. Concrete instruments employed through this policy approach included, in addition to catalogues and demonstration projects, user subsidies, prizes and awards, as well as risk control measures to compensate the uncertainty embedded in the early adoption of new technologies. The designed implementation structure involved the participation of state-owned enterprises or other public organizations to apply for the opportunity to launch 'experiment' or 'demonstration' projects to enjoy policy support from the government.

Due to limited resources, this study did not investigate the national status of the actual implementation process of policy approach 2; rather this study focused on the experience of a few regions. It was found that regions featuring strong equipment industry bases, such as the Shanghai municipality, followed this initiative closely 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. Very often, proactive stakeholders and informal institutions played important roles in shaping the actual implementation. For instance, the procurement of tunnel boring machines in Shanghai implied that proactive suppliers and intermediaries were key drivers to success rather than policy incentives (see Li & Georghiou, 2016 for a detailed account). Moderate behavioral additionality and increased awareness were

achieved among state-owned enterprise (SOE) users. For a few years, a national event, the China Industry Forum, served the function of reporting good practices nationwide and providing *ex post* recognition of early adopters of MTE. This approach drew international concerns as well, notably owing to the equipment catalogue's explicit pursuit of import substitution when initially launched in 2009. Later versions modified the wording and thus far it remains valid and seems promising in accelerating China's catching-up pace (see MIIT et al. 2009; MIIT et al. 2012 for details of the catalogue).

Policy approach 3 primarily aims to promote the uptake and diffusion of newly emerging technological solutions. It can be considered as systemic policies with various demand-side innovation policy instruments adopted, e.g. technological standards, consumer subsidies, capacity building and public procurement. The rationale of this policy approach lies in its potential to nurture lead markets which are favorable for innovation diffusion. Similarly to policy approach 2, policy approach 3 is also sector-oriented, and the PPI involved is often strategic procurement as well. More specifically, PPI embedded in policy approach 3 is typically connected to private consumption, and thus requires coordination between public and private institutions. As summarized in Table 3, although different programs might share the same goals and rationales, their concrete policy instruments, implementation processes and outcomes are diverse. This study takes two Chinese programs as examples – the 'New Energy Vehicle' (NEV) Program (also called 'Ten cities, Thousands of NEVs', see Zheng et al. 2012; Sun 2012; Li et al. 2015), and the LED Lighting Program (also called 'Ten cities, Ten thousand of LED lights', see ISA 2012). PPI elements associated with the two programs were introduced by core ministries in charge of innovation (MOST, MIIT and NDRC). In the NEV program, substantial amounts of subsidies were provided to incentivize public procurement and private consumption in a number of selected 'demonstration cities'. Regulations and standards, especially regarding charging facilities,

were designed to be in place to complement PPI and private consumption incentives. In the LED lighting program, main instruments were *ex-post* subsidies from MOST to encourage public and private users, as well as large-scale public tendering by joint agencies for infrastructure projects. Both programs feature flexible implementation structures designed by city governments to suit local circumstances. The core difference between the two programs was that the NEV program achieved relatively higher level of centralization because city plans were subject to approval from joint agencies in the central government, while the LED lighting program had no unified national implementation structure until 2013.

Both programs in policy approach 3 to an extent accelerated the diffusion of NEV and LED lighting technologies and nurtured some local industries; both shared some common implementation patterns such as high autonomy and diversity of policy settings across regions, and were meanwhile faced with a tendency towards regional protectionism and duplicate investment. In particular, the development trajectory of the LED lighting program appeared to be a rather chaotic picture owing to the lack of centralized regulations or standards to shape the industry. Local governments, driven by the potential economic payback, frequently and proactively played the roles of policy entrepreneurs to mobilize resources and promote PPI. This proactiveness of local government, although facilitating policy implementation to an extent, triggered a strong atmosphere of competition between regions to develop new technologies with hype. Duplicate investment was observed in both programs, leading to overheat of NEV and LED technologies nationwide and pervasive regional protectionism.

5.4 Evaluative analysis

The criteria defined in Section 4, i.e. vertical and horizontal coherence, are employed here to appraise the appropriateness and implementation of China's PPI policies. As

characterized in Table 3, the first four rows of the table are primarily concerned with policy design and articulation, while the bottom three rows are more about the ‘reality’ of policy implementation. The ‘designed’ vertical coherence can be assessed through analyzing the coherence between upper rows, while to assess the ‘actual’ vertical coherence all the rows need to be synthesized. The designed horizontal coherence can be assessed by contrasting the design of policy approaches against the context of PPI in China as outlined in Section 5.2. As for the actual horizontal coherence, Table 1 has defined ‘policy coordination failures’ as a qualitative indicator in detail. As a policy phenomenon situated at the ‘intersection’ of innovation and procurement systems, PPI practices ideally need to realize horizontal coherence with the circumstances of contextual domains. This means the design and implementation of the three PPI policy approaches should be coherent with the settings of the domestic innovation and procurement systems, as well as with the contexts of the two systems, i.e. the broader domestic and international circumstances. On the basis of the characterization outlined in Table 3, the coherence of each dimension is checked with that of the overall innovation and procurement policies/regulations; the dynamics of actors, institutions and interactions during the course of PPI cycles are also reflected on, to identify major tensions resulted from policy coordination failures.

Up to 2010, China’s PPI policy approach 1, which was based on innovation catalogues moderately realized its designed vertical 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. Time-consuming accreditation procedures and fragmented responsibilities for promoting innovation and conducting procurement across a wide range of agencies made the *actual* vertical coherence unlikely to be achieved. The actual implementation process of approach 1 turned into one that featured low ambiguity yet high conflicts. Although some regions carried on

implementing approach 1 and to some extent achieved outcomes coherent with the original design, the implementation processes were rather ad hoc and experimental, and the outcomes were individual examples of PPI rather than systematic PPI activities. For instance, Beijing as the capital city proactively implemented policy approach 1 during 2006 – 2012. The city adopted a broader definition of procurement, and plugged in new coordination mechanisms to smooth the implementation process, which triggered the emergence of a few well-known PPI examples such as the procurement of advanced water recycling solutions (Li & Georghiou 2016).

In terms of designed horizontal coherence, the ‘one-size-fits-all’ design counting on centrally-controlled coordination across multiple levels of government, and across innovation and procurement systems, was incompatible with the institutional fragmentation and regional autonomy of both systems. As reviewed in Section 5.2, China’s procurement system is fundamentally fragmented across sectors and levels of government, and China’s innovation system is built on very different stakeholders and mechanisms compared to its procurement system. The incompatibility between innovation and procurement missions was reflected during the implementation stage. While innovation agencies are keen to promote increasingly systematic policy approaches, the procurement system does not have the institutional capacity to support PPI. Although increasingly diverse stakeholders are involved in innovation policy, procurement practices in China are structured in a completely different and arguably problematic manner. Besides the detachment of procurement practices from innovation practices, the disparity between regions in terms of scientific and socioeconomic development is severe, which further poses barriers to a one-size-fits-all policy design. PPI policy approach 1 had no actual horizontal coherence at all as a result of its lack of designed horizontal coherence. Besides the horizontal coordination failures in the domestic environment, coordination failures with the international context (notably incompatibility of

procurement regulations and goal conflicts with developed countries) were the fundamental cause leading to the termination of policies.

PPI policy approach 2, which was designed with the objective of promoting MTE commercialization, realized a higher degree of vertical coherence. Empirical data collected from the context of Shanghai suggested that the implementation became ‘administrative’, whereby both ambiguity and conflict were low, while the provision of resources, capacities and techniques might need to be enhanced. For instance, in a procurement of tunnel boring machines by the state-owned underground construction companies in Shanghai, the amount of user subsidies were rather moderate and insufficient to compensate the potential risks involved. More sufficient provision of resources could have better incentivized the users to adopt domestic innovations. Vertical coherence of this approach was more or less realized in terms of both design and implementation given that the policy characteristics fit very well with the local circumstances of institutions and existing policies.

A higher degree of designed horizontal coherence was realized since policy approach 2 only targeted the equipment sector in which the procurement functions and innovation functions are relatively well-aligned. Within the MTE sector, the key innovation agencies primarily belong to a single ministry, which is MIIT, and the key procurers are mostly SOEs. In this institutional setting, there are few potential conflicts in terms of regulations and departmental division of labor. In the domestic context, the chance of horizontal coordination failures is low, thereby determining a high degree of actual horizontal coherence. In the international context, coordination failures emerged at one point, when the equipment catalogues imposed explicit requirements for ‘indigenouslyness’ and import substitution. When those requirements were subsequently removed from the policy, coordination failures with the international context were diminished.

The design of both programs situated in policy approach 3 appeared to be more ambiguous compared with that of the other two approaches. The implementation structure, i.e. selected cities implementing the program according to their local plans, determined that regional autonomy played a key role in shaping the dynamics. This built-in flexibility gives more room for designed vertical coherence, which enables regions to select the concrete policy instruments and implementation structures to suit their local circumstances. Different cities can flexibly choose the technological route they would like to follow. For example, in terms of battery technologies, the city of Shenzhen experimented with systematic charging poles across the urban area, while the city of Hangzhou adopted a ‘battery swapping’ approach whereby users could rent NEVs and batteries, and benefit from rapid battery swapping services provided by the National Grid. This autonomy allowed experimentation of alternative approaches to upgrading the transport system. The NEV program realized a higher degree of actual vertical coherence than the LED program due to its greater national control over regions through a unified ministerial-level governance structure, larger amounts of subsidies and industrial regulations. The implementation of both programs was also an ‘experimental’ one, producing diversified outcomes as well as lessons for further policymaking.

Unlike policy approaches 1 and 2, policy approach 3 has become an increasingly popular instrument promoting emerging technologies internationally, which implies that the appropriateness judged according to international ‘rules of the game’ is less controversial. In this sense, the designed horizontal coherence of policy approach 3 in the international context is fulfilled. Domestically this policy approach was well supported by the procurement system owing to its sector- and region-specific characteristics which were in line with the institutional fragmentation. The actual horizontal coherence with the domestic procurement system was high. Nevertheless, the actual horizontal coherence with the other domestic

institutions depended very much on the implementation of the specific program. For example, in the first three years of implementing the LED program, MOST and other ministries worked separately instead of in collaboration. This proved to be problematic given that traditionally public lighting is regulated by departments such as municipal construction authorities, who do not see promoting innovation as part of their mission. The overall progress was severely compromised because of this coordination failure.

6. Discussion and conclusion

The potential of public procurement for stimulating innovation and leveraging socioeconomic performance has been well recognized and documented by the literature. Observing that there has been a lack of holistic approaches to analyzing PPI policies, this paper has made an initial attempt to propose a conceptualization, i.e. a ‘vertical/horizontal coherence’ framework, which links the multiple levels and aspects of the PPI policy process.

PPI dynamics feature the characteristics of both innovation and public procurement. Concrete PPI processes are viewed as dynamics situated at the intersection of innovation and public procurement systems, and shaped by the contexts, institutions, actors and interactions of the two systems. PPI policies are, on the one hand, horizontal mixes of innovation and public procurement related interventions, and on the other, vertical mixes of goals, rationales, instruments, designed implementation structures, actual implementation processes, and outcomes. PPI policies impact on concrete PPI processes through implementation, whilst PPI processes, shaped by various factors in the context, are manifestations of PPI policy implementation. One precondition for PPI policies to be appropriate is that, elements within the ‘horizontal mixes’ and the ‘vertical mixes’ should be coherent with each other. Therefore, ‘vertical’ and ‘horizontal coherence’ can be employed as qualitative criteria to assess the design and implementation of PPI policies.

The framework and an operationalized assessment methodology have then been applied to the case of China to analyze the design and implementation of China's PPI policies up to 2011. The three PPI policy approaches in China followed diverse trajectories and realized different degrees of coherence owing to their respective characteristics and institutional contexts. The current institutional setup of China's innovation system appears to be too fragmented to deal with 'systemic' innovation policies, while China's government procurement system has too limited a scope to cover all types of public procurement. An advantage of the equipment commercialization approach and the demonstration programs over the routinized approach has been attributed to their relative coherence with China's institutional fragmentation, as they were both 'fragmented' policies, targeting specific sectors and levels of governance. Their actual horizontal coherence with international institutions was also better realized than that of the routinized approach, in the sense that the tendency of national protectionism was less explicit and fewer controversies were drawn. Policy coordination failures 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. A common problem identified, perhaps more for the routinized approach and the demonstration programs approach, and less for the equipment commercialization approach, was local protectionism, which hindered the actual vertical coherence of policy implementation for the country as a whole.

The Chinese experience offers implications regarding the potential to reconcile procurement and innovation systems towards shared policy goals. Although there are spaces where the innovation agenda can influence and even alter the procurement systems and processes, domestic and international regulatory regimes mean that the laws guiding public procurement often serve to constrain PPI. Therefore, a government's desire to advance PPI policies is limited by, and potentially secondary to, regulations governing public procurement.

As evidenced by the trajectory of PPI policy approach 1, objections from international trade partners imposed pressure on the Chinese government, which eventually led to the termination of the policy. In short, there is a hierarchy between procurement and innovation systems in the case of PPI, which could lead to potential imbalance that is not reconcilable to pursue a common agenda. The question is therefore to what degree coherence can be achieved and with what kind of emphasis on innovation versus procurement imperatives. The answer to this question, again as evidenced by the Chinese experience, would depend very much on the context and design of policies. Whether or not a policy can reconcile two systems towards shared goals to a great extent lies in how well the policy fits the goals and styles of existing policies and institutions, i.e. the ‘institutional fit’ (Young 2002).

The three different policy approaches represent both centralized and decentralized approaches to cross-domain policy. In the context of China, the decentralized approaches governed by regional and sectoral stakeholders seemed more efficient than a centralized approach. The reason for decentralized approaches to work in this context is that there was fundamental incompatibility between the procurement and innovation systems and thus a centralized approach was arguably not implementable. In contrast, in a context where there is no fundamental incompatibility between procurement and innovation systems, a centralized approach might be more efficient in the longer run owing to more stable political support and policy continuity. Contextualization is important when utilizing the proposed analytical framework, since the actual vertical and horizontal coherence of a cross-domain policy relies no less on the practical circumstances than on a well justified policy design. An implication from the analysis is that, in developing countries who are typically not part of the WTO-GPA and who typically do not have well-established procurement or innovation systems, decentralization (e.g. pioneering by the most advanced regions) and policy experimentation seem to be the way to go.

The distinction between designed and actual coherence offers further implications for policy experimentation and learning. Developing countries, especially large ones, often feature unevenness across regions in terms of socioeconomic development stages and institutional settings. In the specific case of China, the country features both strong political centralization (i.e. the appointment, assessment and dismissal of government officials are strictly top-down) and socioeconomic decentralization (Zheng, 2007). Given the high level of diversity across regions, it is difficult to plan in advance the implementation procedures in the policy design stage, i.e. the degree of actual coherence is hard to predict *ex ante* even if the designed coherence seems well justified. In this context, policy experimentation based on ‘experimentalist governance’ (Sabel & Zeitlin 2008, 2012) could be a way forward to align the designed and actual coherence of a new policy. The concept of experimentalist governance has emerged from the context of EU and more broadly, transnational governance (ibid.). Key features of experimentalist governance, such as flexible ways of coordination and participation of diverse stakeholders, could be particularly relevant to support the exploration of locally workable policy approaches. An advantage for China to exercise experimentalist governance lies in the strong political integration which can enable the wider adoption of effective policies once the experimentation proves effective, implying great potential to enhance the efficiency of policy learning from ‘difference’ and ‘diversity’ (Sabel & Zeitlin 2012). Nevertheless, a weakness of the Chinese system which might undermine an experimentalist approach is the often opaque process of decision making (Martin 2010).

Experimentalist governance can facilitate the trial and error process of policy learning, thus improving the likelihood of achieving actual coherence in addition to achieving designed coherence. It is worth noting that horizontal coherence requires particular attention, since thus far this issue has not been taken into account explicitly by most policymakers. When deciding whether to launch a cross-domain policy or not, *ex ante* assessment of potential policy

coordination failures with closely linked policy domains becomes increasingly necessary. Early-stage consultations with stakeholders prior to launch of policy can effectively facilitate this learning process. The process of policy improvement is likely to be an incremental one with a few cycles of learning to attain a higher degree of coherence. This further requires a higher level of willingness and capabilities of policy practitioners, as well as continued political support.

There are opportunities to apply the analytical framework proposed in this paper to other contexts, beyond PPI policies and beyond the context of China. Through policy learning based on experimentalist governance, the use of this framework could contribute to the achievement of eventual coherence of a cross-domain policy. For example, during the priority setting and policy design stage, the notion of ‘designed coherence’ can facilitate the critical reflection on the policy intervention logic by explicitly linking the goals, rationales, instruments, intended implementation structures and anticipated external contradictions. Early detection of contradictions of a policy can be realized by identifying any mismatches between the various dimensions of designed coherence, and by correcting contradictions a higher degree of institutional fit can be achieved. During policy implementation stage, clear communication of the designed policy logic and the ongoing policy implementation statuses across governance levels can underpin real-time policy learning. A key feature of experimentalist governance, i.e. learning from difference, can be enhanced by using the proposed framework, since it could help extract the essential elements of the experimented policy approach and inform policy transfer to wider context.

Meanwhile, there are challenges associated with the application of the framework to contexts beyond China. There are unique qualities of the Chinese case embedded in the analysis of this paper, while implies that the generality of the analysis should not be taken for

granted. For example, the overall policy style of China, underpinned by its top-down political system, has clearly defined power hierarchy and stages of design and implementation. In reality, the institutional environments of different countries can be distinct, and the stages of policy design and implementation might not be easily distinguishable. Before applying the framework to other contexts, analysts might want to critically assess the feasibility of delineating the different elements of a policy in the way proposed by this paper. In short, for the application of this framework to other contexts there is also an issue of ‘institutional fit’ to consider.

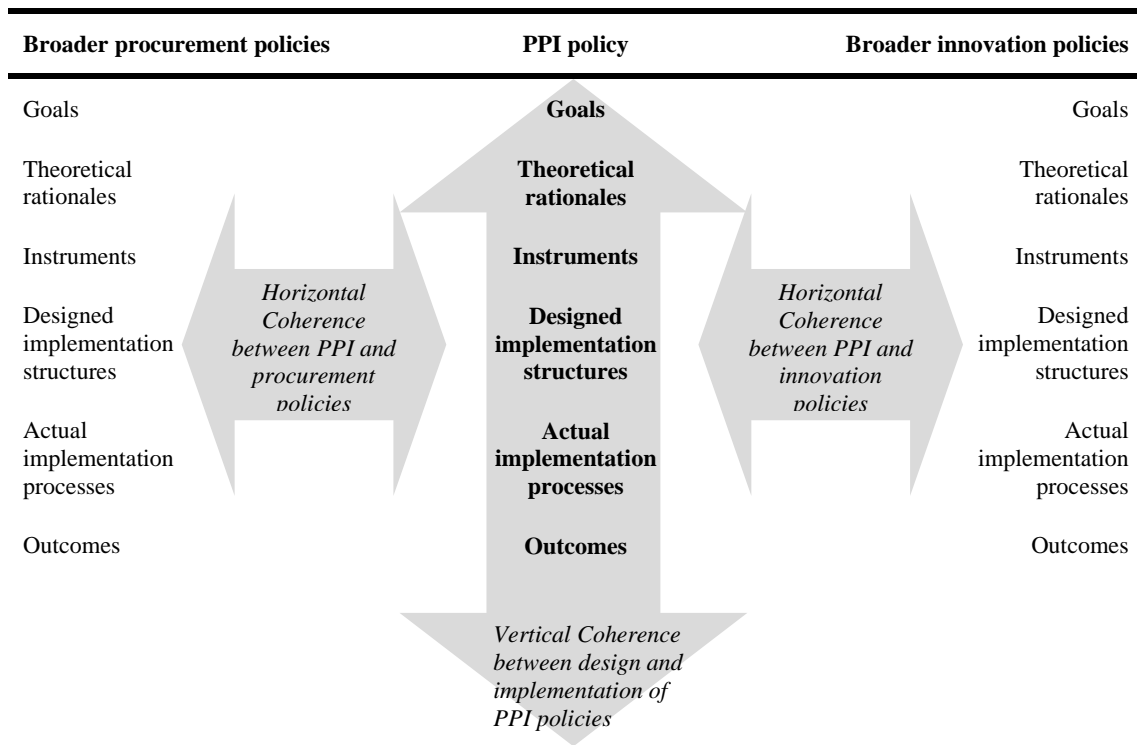
As an initial attempt to conceptualize PPI, this framework is subject to ambiguity. Some important concepts and perspectives this study draws from the literature, including the notion of ‘coherence’, are still conceptually underdeveloped and/or ambiguous. The study has attempted to contribute to the field in addressing such gaps by proposing initial definitions and approaches, and offered an illustrative case study using the evidence from China. Nevertheless, this is only an early effort, which should be considered open-ended rather than conclusive. Further refinement and empirical testing is needed to better guide policy analysis, assessment, and learning.

Table 1 Vertical and horizontal coherence as criteria for assessment

	Definition	Approach
Vertical coherence	<p>The status that goals, rationales, instruments, designed implementation structures, actual implementation processes, and outcomes of the PPI policy are logically consistent with each other. <i>Designed</i> vertical coherence is likely to increase the chance of <i>actual</i> vertical coherence.</p>	<ul style="list-style-type: none"> • Designed vertical coherence: Justifying the rationale and logic of the policy design; from goals to implementation structures, are all the elements coherent? Any mismatches? • Actual vertical coherence: Judging the <i>actual implementation</i> of the policy; from design to implementation, and from outcomes back to goals, are the elements coherent? Any mismatches?
Horizontal coherence	<p>The status that PPI policy is coherent with horizontally-linked policy domains, i.e. the innovation system and the procurement system, and their wider contexts. <i>Designed</i> horizontal coherence is likely to increase the chance of <i>actual</i> horizontal coherence.</p>	<ul style="list-style-type: none"> • Designed horizontal coherence: Anticipating the potential interactions and coordination between the designed policy and contextual factors linked to the policy. • Actual horizontal coherence: Detecting policy coordination failures; policy coordination failures would be manifested in the policy domains proceeding under their own logic without regard for other domains, and potentially therefore creating <i>contradictions</i> and <i>inconsistencies</i>.

Source: Author

Table 2 Concrete dimensions of vertical and horizontal coherence



Source: Author

Table 3 Design and implementation of PPI policy approaches identified in the Chinese context

Approach	1: Centralized, routine mechanism for PPI	2: Major technological equipment (MTE) commercialization	3: Demonstration programs for emerging technologies (taking the new energy vehicles (NEV) and LED lighting programs as examples)
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 emerging technologies
Rationales	Enhancing demand-supply communication; establishing a routine mechanism treating 'innovation' as an essential criterion ('general procurement')	Government signaling national demand; supporting organizational procurers' procurement of newly developed domestic equipment ('strategic procurement')	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 PPI 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: <i>ex-post</i> 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	Projects conducted by all organizations can apply for the status of 'experiment or demonstration projects' to enjoy policy support from joint authorities	NEV: implement city-level program 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; regional autonomy in developing local mechanisms; 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 program), divergent pathways followed; local governments proactively played the roles of 'policy entrepreneurs'; pervasive regional protectionism
Outcomes	Individual cases emerged; awareness raised but government procurers' behavior did not change much	Successful examples emerged in regions; moderate behavioral additionality 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 program

Source: Author

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