

1. Introduction

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INTRODUCTION

This book addresses public procurement for innovation, which is a demand-side innovation policy instrument in the form of an order, placed by a public organization, for a new or improved product to fulfill its particular needs. With this book we aim to contribute to the understanding of public procurement for innovation, including its operationalization and implementation. It is oriented to a wider readership of scholars interested in the study of innovation policies, practitioners involved in the public procurement of goods and services, and students of public policy.

Traditionally, innovation policy initiatives have mostly come from the supply side. Countries and regions have actively implemented and used innovation policy instruments such as fiscal measures, support for training and mobility, public financing of research and development (R&D), information and brokerage support and networking measures.

The role of demand as an enabler and source of innovation has been a topic in innovation studies and innovation policy for quite some time (Izsak and Edler, 2011). Discussions on the positive impacts of demand-side innovation policies took place as far back as the 1970s (Dalpé, 1994; Geroski, 1990; Mowery and Rosenberg, 1979; Rothwell and Zegveld, 1981). Recent years have seen a resurgence of the interest in demand-side approaches to innovation policy (Edquist and Hommen, 1999; OECD, 2011). For example, in 2004, three governments issued a position paper to the European Council calling for the use of public procurement across Europe to spur innovation (Edler and Georghiou, 2007; French, German, UK Governments, 2004). This development continued and was manifested in various reports, including the Aho Group Report (Aho et al., 2006), which

identified several application areas, or grand challenges, where demand-side policies could be used to a larger extent: e-health, pharmaceuticals, energy, environment, transport and logistics, security and digital content (Edler and Georghiou, 2007, p. 951).

Demand-side intervention is intended to increase the demand for innovations, to improve the conditions for the uptake of innovations and to improve the articulation of demand (Edler, 2007). Cluster policies, regulation (for example, standards), public procurement (that is, R&D procurement and innovation procurement), and support of private demand are examples of demand-side innovation policy instruments (Edler and Georghiou, 2007, p. 953). We largely limit the scope in this book to the analysis of public procurement as an innovation policy tool, that is, what we refer to as public procurement for innovation (PPI).

Until fairly recently this phenomenon was called 'public technology procurement'. Edquist et al. (2000) compiled an extensive set of cases illustrating the potential for innovation involved in this policy instrument. Since then, the terminology of the 1990s and earlier has changed into 'public procurement for innovation'. This reflects a widening of the content of the notion, since 'innovation' includes more than 'technology'.

The next section briefly addresses the development of innovation research and innovation policy of relevance for our topic. It includes a discussion of innovation systems, determinants of innovation processes and demand-side innovation policies. The third section is devoted to presenting a taxonomy of different kinds of innovation procurement. Then we look, in some detail, at the challenges involved in the implementation of innovation procurement, such as identification of challenges to be mitigated by public procurement for innovation, translation of these into functional requirements, and the tendering process (including the assessment of the tenders and the delivery process). The final section concludes the Introduction with a short summary of the chapters in this book.

DETERMINANTS OF INNOVATION AND DEMAND-SIDE POLICY INSTRUMENTS

This section briefly considers the determinants of innovation processes and demand-side innovation policy instruments. However, first let us define what we understand by innovation.

Innovations are new creations of economic or societal significance mainly carried out by firms. Innovations are the result of interactive processes among the multiple actors contained within innovation systems (Edquist, 1997). In fact, according to the innovation systems approach, interaction and interactive learning between organizations are pillars upon which innovations are based. These innovations may be new or improved products or processes. While new or improved products may be material goods or intangible services, new or improved processes may be technological or organizational advancements.

To qualify as an innovation, the product or process needs to be implemented (Oslo Manual, 2005, p. 47), which means that the new products must be introduced on a market or that the new processes are used in production. Innovations must therefore be commercialized, that is, launched on the market, or in other ways widely diffused to users on a large scale in the economy or society. This includes innovations in public activities. A prototype is a model that functions under certain conditions. It is not produced in a large series, not commercialized and its commercial viability is not proven. Hence, a tested prototype is not an innovation.

In the early days of innovation research and innovation policy, the so-called 'linear model', based on the assumption that innovations are applied scientific knowledge, dominated the view of how innovation processes developed. It was called 'linear' because the process was seen as a number of well-defined and consecutive stages that innovations were assumed to go through, for example basic research, applied research, development work resulting in new products and processes that ultimately influence growth and employment. It was a supply-push view.

In the realm of innovation research, the linear view has been replaced almost completely by the systems of innovation approach in the latest couple of decades. In its different versions, it is defined in terms of determinants of innovation processes, although different determinants are emphasized in different versions. A general definition of systems of innovation is that they include 'all important economic, social, political, organizational, institutional and other factors that influence the development, diffusion and use of innovations' (Edquist, 1997, p. 14).¹

One way to introduce the variety of innovation policy instruments is to talk about the activities that configure an

innovation system, which are the same as the determinants of innovation processes. Table 1A.1 in the Appendix contains a list of important activities in innovation systems. The activities are not ranked according to importance, but are clustered as:

- provision of knowledge inputs to the innovation process (for example, research);
- demand-side activities (for example, public procurement for innovation);
- provision of constituents in innovation systems (for example, entrepreneurship);
- support services for innovating firms (for example, public seed funding of innovations).

The list of activities presented in Table 1A.1 (also sometimes called functions²) is preliminary, hypothetical and one among several (Johnson, 2001; Edquist, 2005; Hekkert et al., 2007). It will certainly be revised as our knowledge about the determinants of innovation processes increases. It is important to point out though that public innovation policy is not included as one of these ten activities. The reason is simply that public policy is a part of all ten activities. Part of each activity is performed by public organizations, which is policy (see the definition of innovation policy below). What is important is the division of labour between private and public organizations with regard to the performance of each of the activities.

Non-firm public organizations do not normally take part directly in innovation processes, although they certainly are important in terms of participating, for example, in research and other activities that influence innovation (see Table 1A.1). They affect the context in which the innovating firms operate. Innovation policy may thus be understood as actions by public organizations that influence innovation processes, that is, the development and diffusion of innovations (Edquist, 2011, p. 1728)

What then is this context? A general answer to this question is that the context is all those things that influence innovation processes; that is, all the determinants of innovation processes. The literature on systems of innovation has discussed the determinants of innovation processes extensively (Galli and Teubal, 1997; McKelvey, 1997; Edquist, 1997; Johnson, 2001; Edquist, 2005; Hekkert et al., 2007; Bergek et al., 2008). Innovation policy

can thus be understood as the actions by public organizations that influence innovation processes.³ Such actions relate to all key activities in systems of innovation, see Appendix Table 1A.1 (Edquist, 2011).

In the realm of innovation policy, the linear view is still much more dominant than it is in innovation research (Godin, 2006). In recent years there has been an increasing interest in 'broad-based innovation policies', systemic innovation policies, 'a demand-pull view', and 'demand-oriented policy instruments', such as public procurement for innovation (PPI) or pre-commercial procurement (PCP) (Edquist and Zabala-Iturriagagoitia, 2012, forthcoming). This may constitute the very beginning of a transformation towards a 'holistic innovation policy'. This is defined as 'a policy that integrates all public actions that influence or may influence innovation processes', for example by addressing all the ten activities in Table 1A.1 in a coordinated manner. It must include demand-side innovation policy instruments (Edquist, 2014b).

Edquist (2014c) shows that most European Union (EU) member countries are trying to develop a holistic innovation policy, but that very few have come close to achieving this. A questionnaire was sent to 23 EU member states in 2014; 19 responded. That the linear model is still dominant in innovation policy was strongly confirmed by the responses. Sixteen of the 19 countries (84 per cent) indicate that they are striving in the direction of developing innovation policy into a more holistic one. However, the responses also indicate that they are not actually pursuing much innovation policy that can be considered demand-side-oriented. Also, a majority of the countries indicate that 'provision of R&D results' is the most important activity in terms of resources spent for innovation policy purposes. Together, these responses clearly indicate that many of the countries striving in the direction of pursuing a holistic innovation policy have a long way to go on the path from linear to holistic. There may also be countries that are paying lip service to holism, but have actually not achieved much at all (Edquist, 2014c).⁴

Demand-side innovation policies can be defined as 'a set of public measures to increase the demand for innovations, to improve the conditions for the uptake of innovations or to improve the articulation of demand in order to spur innovations and the diffusion of innovations' (Edler and Georghiou, 2007, p. 952).

Table 1A.2 in the Appendix provides a list of instruments that can aid the development of demand-based innovation interventions. These are grouped into three major blocks. The first one addresses the purchasing power of the public sector, an area where public procurement plays a major role. The second block deals with instruments that support demand, but on the private side. Three other types of instruments are included in this block: direct support, indirect support and regulations. Finally, the third block entails all the possible combinations of both supply- and demand-side instruments.

We do not intend to address the whole battery of all demand-side innovation policy instruments in this book. Instead, we limit ourselves to innovation procurement, mainly PPI.

In the real world, however, the instruments of innovation policy are rarely used standing 'alone'. Normally innovation policy instruments are combined in specific mixes, using groups of different instruments in a complementary manner. Instrument mixes are created because the solution of specific problems requires complementary approaches to the multi-dimensional aspects of innovation-related problems (Borrás and Edquist, 2013; Flanagan et al., 2011; Guy et al., 2009; Nauwelaers, 2009).

PUBLIC PROCUREMENT FOR INNOVATION: A TAXONOMY⁵

There are different types of public procurement (for innovation). The different types are used as policy instruments in different ways and according to different rules and procedures. They are also often mixed up with each other.

Public procurement refers to the purchase of goods and services by a public agency. In the case of regular procurement, public agencies buy ready-made products 'off the shelf', and normally no innovations are the result of the public intervention. Public procurement is roughly estimated to account for 15–20 per cent of gross domestic product (GDP) in developed countries. In 2009 it was 19.4 per cent of European GDP, equal to €2.3 trillion.

Public procurement for innovation (PPI) occurs when a public organization places an order for the fulfillment of certain functions (that are not met at the moment of the order or call) within a reasonable period of time through a new or improved

product.⁶ Hence, the objective of PPI is not primarily to enhance the development of new products, but to target functions that satisfy human needs, solve societal problems or support agency missions or needs. Still, some form of innovation (new product or process) is necessary before delivery can take place.

Because of the large numbers involved, and to the extent that something new is purchased, there is also the notion that public procurement may provide a 'lead customer' or a lead market for an innovative product or process (European Commission, 2007a).

We must point out here that the diffusion of the product from the procuring organizations is not always among the major objectives of this type of programme. However, there are cases in which diffusion of the new product is aimed at from the very start of the procurement process. This difference reflects the distinction between PPI carried out mainly for the missions or needs of the procuring agency, and PPI to support economy-wide innovation. That way, a public agency may demand the purchase of certain products or systems that are novel to the agency, but not to the market. Be that as it may, innovation is needed in all PPI before delivery can take place.

PPI is a part of the second set of key activities in innovation systems in Table 1A.1, namely demand-side activities. It provides a demand-pull that complements the supply-push for innovation, which has traditionally tended to attract attention in innovation policy studies, and is an important demand-side innovation policy instrument (Dalpé, 1994; Edler and Georghiou, 2007; Edquist et al., 2000; Geroski, 1990; Rothwell and Zegveld, 1981).

A taxonomy that covers different types of PPI is presented below. We include the notion of pre-commercial procurement (PCP) although it is not PPI.⁷ First, however, we present the notion of innovation-friendly public procurement, although it is not PPI either.

Innovation-friendly public procurement is regular procurement which is carried out in such a way that new and innovative solutions are not excluded or treated unfairly. The background is a concern that many public procurements are carried out in a routine-like manner, meaning that the procuring organization demands the same solution as in the previous procurement. This might actually constitute an obstacle to innovation. The most powerful means to overcome this obstacle is to require calls for

public procurement to be formulated in functional terms, and not as descriptions of products.⁸ Hence, there is reason to distinguish between innovation-friendly procurement and public procurement for innovation. Innovation-friendly procurement does not require innovation as PPI, but encourages and facilitates innovation (see the section below on 'Operationalizing public procurement for innovation', and Edquist, 2014a).

The classification of PPI below is made according to three dimensions. The first dimension that allows us to identify different forms of PPI relates to whom the user of the result (good, service, system, and so on) might be. This dimension may be used to identify two categories of PPI: direct and catalytic (Edquist et al., 2000; Hommen and Rolfstam, 2009; Edquist and Zabala-Iturriagoitia, 2012).

Direct PPI is when the procuring organization is also the end-user of the product resulting from the procurement, which is the 'classic' case. The buying agency simply uses its own demand or need to influence or induce innovation. This type of PPI includes the procurement undertaken to meet the ('mission') needs of the public agencies themselves. It exerts direct 'demand-pull' on suppliers, often through long-term contracting arrangements. Nonetheless, the resulting product is often also diffused to other users once the initial procurement process is finished, and the agency has benefited from the results obtained for a certain period. Hence, innovations resulting from PPI can be useful for the procuring agencies, as well as for society as a whole.

Catalytic PPI is when public sector organizations act as buyers even if they are not the intended end-users of the results of the procurement process. In other words, the procuring agency serves as a catalyst, coordinator and technical resource for the benefit of end-users. The needs are located 'outside' the public agency acting as the 'buyer'. Thus, the public agency aims to procure new products on behalf of other organizations, and public demand articulates, sponsors, and helps to shape private demand. It acts to catalyze the development of innovations for broader public use and not for directly supporting the mission of the agency.

The second dimension in the classification relates to the character of the innovation embedded in the resulting product. This dimension leads to two types of procurement: incremental and radical (Edquist et al., 2000).

Incremental PPI is when the product or system procured is

adaptive and new only to the user of the results of the procurement process (public agency, private firm, country, region, city, and so on). Hence, innovation is required in order to adapt the product to specific national or local conditions. It may also be labelled 'diffusion-oriented' or 'absorption-oriented' PPI.

Radical PPI implies that completely new-to-the-world products and/or systems are created as a result of the procurement process. It may be regarded as 'creation-oriented' PPI and involves the development of brand new innovations.

It is also important to address a third dimension in the classification, namely the fact that PPI can be characterized by different degrees of collaboration and interactive learning (among procurers, suppliers and – sometimes – other organizations). This collaboration is a matter of degrees, not a dichotomous variable. It is important, since we know that interactive learning is a central determinant of the development and diffusion of innovations. All four previous categories can be carried out with different degrees of collaboration. It may be expected, though, that collaboration is more important in catalytic than in direct PPI, simply because the catalytic type involves more than two actors.

In January 2014, the European Parliament decided on new directives on public procurement. In addition to considering the lowest price in the procurement, other dimensions are now important in the selection of contractors: quality, sustainability, social conditions and innovation. The decision also includes a new 'procedure' called innovation partnerships. Such partnerships make possible collaboration between the procuring organization and suppliers in order to achieve the objectives of the procurer. The new directive has to be implemented in all member states within 24 months.

Pre-commercial procurement (PCP) refers to the procurement of (expected) research results and is a matter of direct public R&D investments, but not actual product development. Moreover, it does not involve the purchase of a large number of units of a (non-existing) product, and no buyer of such a product is therefore involved in the procurement (as in PPI). It is not PPI since a product must be commercialized to constitute an innovation.⁹ This type of procurement may also be labelled 'contract' research, and may include the development of a product prototype.¹⁰ This type of public R&D funding is very problem-oriented and targeted, as opposed to general public R&D funding or tax deductions that firms can make for their

R&D expenditures. Of course, the procured research results may be developed into a product innovation when the PCP process (or phase) has been completed. In addition, a PCP may be the same as the R&D phase in a PPI.

OPERATIONALIZING PUBLIC PROCUREMENT FOR INNOVATION

There are many challenges involved in the implementation of PPI, and we address a number of these in this section. The typical PPI process may be divided into the following stages (Edler et al., 2005; Edquist and Zabala-Iturriagoitia, 2012; Expert Group Report, 2005):

1. Identification of a public agency mission need or of a grand challenge and its formulation in terms of a lack of satisfaction of a human need or an unsolved societal problem.
2. Translation of the identified challenge into functional specifications.
3. Tendering process:
 - a. opening of the bidding process through a tender;
 - b. translation of the functional specification into technical specifications by potential suppliers;
 - c. submission of formal bids by potential suppliers.
4. Assessment of tenders and awarding of contracts.
5. Delivery process:
 - a. product development;
 - b. production of the product;
 - c. final delivery to the purchasing agency.

This general structure does not imply by any means that the PPI process is of a linear nature. As we will see in the cases illustrated in this book, these general steps are very much inter-related and intertwined. But let us see what is involved in each stage.

Identification of (Social or Agency) Challenges or Needs

There are several issues involved in (societal) needs anticipation. Who is actually responsible for performing that function? And how? Is it done through some formal, open, participatory

process – through technology foresight, road mapping, public consultation, and so forth – or through more closed processes? How far into the future should one look? More concretely, is the public agency looking within a single technology life cycle (incremental PPI) or across two different life cycles (that is, creating a new one: radical PPI)? That is to say, the term ‘reasonable’ should be interpreted as relative to the degree of newness or radicality of the pursued solution, as is done in our understanding of PPI. It is fairly uncontroversial that public sector involvement may be warranted in the case of needs relating to ‘big issues’ (for example, grand challenges) where the costs are large and the risks considerable. There are several reasons for this, including:

- ‘big issues’ impact upon large numbers of constituents or even the whole society;
- the public sector has means of raising large amounts of funds, unavailable to the private sector, to target long-term issues;
- the public sector has means of sharing the risk among much larger numbers of bodies than private sector organizations, indeed among the whole society (all taxpayers);
- the public sector can deal much better than the private sector with the adverse effects of widespread positive externalities on the incentives to innovate and the consequent free-riding phenomena;¹¹
- the private sector tends to be much better and faster at reading market signals for ‘smaller’ (near-term) innovations which entail limited and measurable risk, in marked contrast to ‘bigger’ (long-term) innovations which entail unmeasurable uncertainties.¹²

The ideal outcome of the exercise to identify (social) challenges and needs is the creation of a public ‘vision’, which has as an important by-product the transformation of genuine uncertainty confronting the private sector into manageable risk. Governments, politicians, administrations, policy-makers and public agencies may specify long-term, or at least mid-term, objectives in sectors including energy, transport, health, communication and defence (all suffering from large externalities and uncertainties). In this way future public demand may be influenced and widely communicated.¹³ While it is extremely hard to predict demand in the longer term, this may help to transform

uncertainty to limited risk in relation to public demand. The state may also adapt its own R&D funding to accommodate these objectives.¹⁴ This could induce private suppliers to respond by investing in R&D and product development in the direction indicated by the probable future demand.

A case in point here is the need for interactive learning between organizations as an extremely important factor for innovations to emerge, an issue emphasized in the innovation systems literature (see the section on 'Determinants of innovation and demand-side policy instruments'). One way to achieve such interaction is to organize focus groups or networks of stakeholders to help articulate the social need and formulate the 'vision' within certain need or problem procurement areas. They should involve potential users, politicians, policy-makers (high-level bureaucrats), researchers, firm representatives, and so on. The researchers should come not only from the relevant fields of natural science and technology, but also from the social sciences such as economics, psychology and political science. The firm representatives should come from different divisions of firms including R&D, marketing, management, and so on. Diversity is key in order to achieve the 'new combinations' that underlie innovation in Schumpeter's terminology.¹⁵

Translation of the Identified Challenges into Functional Requirements

The successful 'translation' of needs or problems into functional requirements presupposes highly developed competences on the part of the procuring organization (Georghiou et al., 2013). The functional specifications must constitute solutions to the challenges while also being achievable given the state of the art at the time. Some relevant questions in this context are (Edquist, 2009):

1. For which sectors of production are the identified needs or problems relevant?
2. For which kinds of firms (large, small, old, new) are they relevant?
3. What 'visionary' products, produced by the firms in these sectors, can contribute to satisfying the needs and solving the problems?

The issue at hand is not only a matter of articulating demand and transforming it into functional requirements. This articulation must also be matched with supply possibilities. The satisfaction of the demand and the solving of the current and expected future problems must be within reach, within the specific time and budget limitations. Utilizing the system to do this smartly is often a very difficult task requiring the systematic training of PPI administrators.¹⁶ There are ways in which this matching can take place but the process remains more of an art than a science. The focus groups or networks of stakeholders mentioned in the previous subsection may also be quite useful in this translation of needs and problems into functional specifications.

Long experience has shown that the procuring agency should limit itself to clearly articulating the need it is trying to fulfill while letting the bidders propose the best ways to fulfill this need. In other words, the procurer should abstain from providing technical specifications.¹⁷ PPI should be pursued as 'functional procurement'. Accordingly, the procuring organization should formulate its requirements in functional terms and not in product terms. In other words, the function to be achieved should be defined, instead of defining the product to achieve it. This is a way to develop the creativity and innovativeness of the potential supplier (Edquist, 2014a).

But how is that done in practice and by whom? Ample experience in both the private and public sectors points to the usefulness of engaging prospective bidders early on, and consulting with them on a regular basis regarding what is feasible within a set time limit and budget, and what is not.¹⁸ Expert advisory bodies can also provide great assistance here, perhaps working in parallel with public consultation.

Important threats here originate in 'special interests'. On the one hand, these may be the interests of politically influential organizations or individuals who are heavily involved in particular existing technological solutions (trajectories) and, as a result, might try to steer the process conservatively in their favour. On the other hand, there may be special interests of other societal groups that feel constrained by the current technological trajectories and are looking for new and creative solutions. Public authorities must balance such interests across the various stakeholders. But this is easier said than done. The danger of corruption is severe.

Tendering Process

Here we reach certain areas where most public agencies face significant bottlenecks. As indicated earlier, this tendering process is subdivided into three related phases.

The first phase is opening of the bidding process through a tender. This activity requires skills and is checked by demands for equality and fairness of treatment. Missteps entail serious dangers of legal challenge (lawsuits) which can be costly and consume valuable time.

The tendering process and the different phases included in it are very much dependent on the regulations that may exist in the different countries in relation to public procurement processes. In the European case, the current rules that apply to public procurement are included in Directive 2004/17 on procurement in water, energy, transport and postal services sectors, and Directive 2004/18 on procurement contracts for public works, public supply and public service. However, a set of new legislative rules was adopted by the European Parliament in January 2014. This new directive aims at replacing the current public procurement directives just mentioned.

Some of the proposed changes include increasing the flexibility and simplification of the procedures, the possibility of using life-cycle costing as an assessment criterion, the clarification of when cooperation between public bodies is subject to public procurement rules, and the possibility of conducting market consultations prior to the launch of the formal procurement procedure (COM/2011/896; European Commission, 2011). These new rules, for example, 'innovation partnerships', are also briefly mentioned in the section on 'Public procurement for innovation: a taxonomy'.¹⁹

In the case of the US, the Federal Acquisition Regulations of the General Service Administration are studied in detail in Chapter 6, devoted to the analysis of PPI in the United States. Chapter 7 discusses the most relevant rules that apply to public procurement intervention in China.

The second phase is translation of the functional specification into technical specifications. There are three (related) issues here: the extent of the translation to be carried out by the public sector employees; the problem of PPI risks and employee incentives pointing in different directions; and the tolerance of failure by the policy decision-making system.

As stressed above, if the objective of public procurement is to foster innovation as a means to target social and/or agency needs, the public buyer must avoid the translation of desired functionalities into technical specifications. This translation must be done by the potential supplier. Regardless, such practice is antithetical to the incentives of public purchasing managers who are inclined to minimize risk exposure. Risk reduction can be achieved either by procuring off-the-shelf products or by determining technical specifications in detail.

By definition, in PPI schemes the procurement of existing products should be partly replaced by the procurement of results in terms of societal problem-solving and the satisfaction of needs. In the short run this might be incompatible with the objectives of various agencies and budget constraints, but in the longer run it might lead to large cost savings. There is a clear tension here, and as some of the case studies in this book show, more recent trends in public procurement practice may be moving against PPI. In order to incentivize public employees (bureaucrats, policy-makers) to take on more risk, they must be protected by publicly elected officials (politicians). It is the latter individuals who should assume the risks since taxpayers' money is involved and they express the public interest.

Coming to the tolerance of failure by the policy decision-making system, we have a very interesting phenomenon. On the one hand, the emergence of new analytical methodologies nowadays allows the construction of complex project portfolios which spread risk and can thus allow the pursuit of a few highly risky projects among them (which presumably could correspond to PPI targets). On the other hand, in pluralist political systems, public media will typically pick on single failures and hammer elected officials on that basis rather than on the existence of the balanced portfolio of projects. It requires excessive political skill by an elected official to redirect attention to the whole portfolio.

The third phase, the submission of formal bids by potential suppliers, may be the area of least danger for public authorities. This stage is usually regulated by strict procedures which ensure proper handling of the submitted proposals.

The new EU procurement directives stress that supporting the development of innovation and guaranteeing the participation of small and medium-sized enterprises should be explicitly targeted by procurement initiatives. Still, there are no separate rules for regular procurement and PPI and the proposal for a new

EU directive on public procurement does not solve this problem either (Edquist and Zabala-Iturriagoitia, 2012; Edquist, 2014a).

Assessment of Tenders and Awarding of Contracts

This is another challenging area for public authorities. The first challenge is to construct the appropriate committees with members knowledgeable enough to make intelligent decisions on the proposals. At least two kinds of competencies are required for this assessment task: technical judgement and economic judgement. However, these do not usually go hand in hand with each other, as they typically do not reside within the same expert.

The second challenge is the appropriate contracting instrument(s) for PPI. Experience shows that the special features of technology and innovation – especially relating to appropriability and uncertainty – require special treatment in terms of contracting instruments that create the appropriate incentives for private organizations to engage without manipulating the system. Here the experience of the military procurement by developed countries may prove quite useful as defence acquisitions have traditionally concerned technologically advanced, systemic products.

The third challenge has to do with the question of multiple sources versus one contractor as per the stipulations of the EU rules. Multiple sourcing in the earlier stages of longer-term innovative efforts has proven to be an effective strategy in the private sector in the presence of uncertainty.²⁰ In fact, in December 2007, the European Commission issued a new communication in order to introduce a new policy instrument, labelled 'Pre-commercial procurement' (European Commission, 2007b). The goal of pre-commercial procurement is to procure R&D services. Its formulation may be regarded as an exemption to current procurement regulations in Europe, as the previously discussed public procurement directives do not apply to pre-commercial procurement (see Art. 16f of 2004/18/EC, Art. 24e of 2004/17/EC). This particular form of procurement increases the scope for multiple sourcing of R&D results, and therefore partially limits this third challenge. However, pre-commercial procurement will not be addressed in detail in this book.

The last challenge is related to contract follow-up, monitoring and evaluation (Edler et al., 2012). Monitoring experts for PPI contracts require a deep understanding of the process of R&D

and technology solution development in specific technical fields. 'Discrete' monitoring should check progress regularly without becoming intrusive in the research process and experimentation. Again, there may be lessons to be learned from successful military procurement.

Delivery Process

This final stage encompasses product development, production and final delivery to the purchasing agency. The big problems here are, of course, cost overruns and time overruns. These problems affect public procurement in general but they become much more acute in the case of PPI due to the uncertainties of the targeted programmes. In some sense, there is a very strong positive relationship between the complexity of the procured product and the risk of cost and time overruns.

One huge concern here is the interference of the political system which may dictate changes in the original design to accommodate 'fluid' political needs.²¹ While reacting on impulse would lead one to prescribe no such interference, the reality is that such interference is almost unavoidable in most big public projects, and what is more difficult is that it is even necessary to some extent, given the evolving needs of society.

A second concern here is technological uncertainty. If we are looking for radical, game-changing technologies or products, we run a significant risk that our early understandings were simply wrong, leading to cost and time overruns, and occasionally to outright failures. Lines of defence exist – good management systems, independent expert committees, citizen voting, and so on – but they are not invulnerable against strong external interests.

Finally, another more subtle issue of political economy ought to be pointed out with regards to the practical implications of the systematic introduction of demand-based innovation policies. Incorporating PPI on a large scale may well intensify governance difficulties and the risks that policies may push in different directions and become contradictory rather than coordinated (IDEA, 2013). Innovation policies have traditionally been (and are still²²) quite linear and supply-side oriented. Confronted with the relative novelty (from an institutional and organizational viewpoint) of demand-side policies, bureaucracies, which are accustomed to dealing with supply-side-oriented innovation policies, may have

learning difficulties. This may lead to governance difficulties, at least in a start-up phase.

Our discussion in this section has until now focused on the challenges and constraints associated with PPI practice and the behavioural and incentive structures in the public sector that accommodate them. However, a major barrier to PPI implementation could also prove to be the much higher dispersion of stakeholders and organizations. While supply-side R&D and innovation policy development and implementation are usually concentrated in only a few public agencies, this is not the case with a demand-side policy instrument such as PPI. The actual procurement projects must be handled by a large number of public agencies. Consequently, substantial learning efforts are required within the public sector at large to cope with PPI as such, and the increased coordination challenges (Navarro and Magro, 2013).

Turning to the risks of policy misalignment, the integration in the policy instrument mix of a set of new measures or instruments geared towards new objectives will require the redesign of the policy system (Borrás and Edquist, 2013). In addition to supply-side policy instruments, demand-side measures must be compatible with instruments and objectives pertaining to competition policy, social policy, fiscal policy, trade policy, sectoral policies, and so forth. The integration of an important and diverse new element into the system will change the system itself, modify interrelations within the system, cause problems of incompatibility, and intensify the risks of trade-offs. This again requires lengthy adjustments and policy learning from the side of the public sector (IDEA, 2013).

SUMMARIES OF BOOK CHAPTERS

The chapters in this book reflect on the issues discussed in this Introduction, and illustrate different types of procurement interventions. The book thus intends to provide both case studies and conceptual contributions that help to extend the frontier of our understanding in areas where there are still significant gaps. In this sense, Part I of the book (Chapters 2–5) has a more conceptual or theoretical orientation, whereas Part II (Chapters 6–10) reflects on specific cases related to PPI practice.

Chapter 2, by Jakob Edler, Luke Georghiou, Elvira Uyarra

and Jillian Yeow, discusses the meaning and limitations of PPI from the point of view of UK suppliers. On the basis of data from 800 responding suppliers in the UK, they show that the public sector is indeed a driver and a source of innovation for suppliers, especially with regard to service innovation. The study shows the range of barriers to innovation, such as the lack of application of those procurement practices that are most conducive to innovation, the general attitudes towards risk and innovation, and procurers' lack of market and technological knowledge. It also highlights some important differences between types of suppliers, sectors and government areas, and concludes with a range of recommendations to lower the barriers and unleash the potential of public procurement for innovation.

Chapter 3, by Ville Valovirta, investigates PPI primarily from an organizational perspective. The author describes how public agencies are faced with the need to develop capabilities in order to manage new organizational processes. The chapter is based on a thorough review of the relevant literature on PPI, studies on public procurement and research on innovation systems. As a result, the chapter identifies a set of management functions required to implement PPI effectively, and derives a list of key capabilities needed for its implementation.

Chapter 4, by Jakob Edler, Max Rolfstam, Lena Tsipouri and Elvira Uyarra, conceptualizes risk and risk management in PPI, and discusses the value of such a conceptualization for PPI practice and policy-making. The chapter first introduces the general concepts of risk, uncertainty and risk management and develops a typology of PPI risks. It also indicates some governance and managerial challenges that the various types of risks pose for PPI. Using the previous typology, the authors illustrate how specific characteristics of the procurement itself, the procurement process and its environment are more likely to be linked to some of the risks identified and not others, and how different situations necessitate different risk management strategies.

Chapter 5, by Hendrik van Meerveld, Joram Nauta and Gaynor Whytes, looks at forward commitment procurement and its effect on perceived risks in PPI projects. Both public sector customers and private sector suppliers perceive risks in procuring innovative solutions. This chapter investigates the effect of applying forward commitment procurement to these risks in order to: (1) assess its capacity for risk management; and (2) support public sector organizations in the improved

application of forward commitment procurement. The research uses agency theory and transaction cost economics, explaining the effect of forward commitment procurement on risk in terms of uncertainty and transaction bounded investments. Three case studies are used to show that applying the forward commitment procurement method can indeed contribute to the management of perceived risks.

The chapters included in Part II of the book (Chapters 6–10) reflect upon the lessons from a variety of cases in the United States, China, Greece, the UK and Brazil, respectively. Chapter 6, by Nicholas S. Vonortas, categorizes the main features of PPI in the United States. It details the main stipulations and objectives of the Federal Acquisition Regulation, which is the main set of rules applied by the federal government (and applied, in some slightly adapted form, in many states) in regulating public procurement. As such, this set of rules is instrumental in shaping the incentives and behaviour of public employees regarding procurement. Despite PPI having received much attention in Europe, it is hard to find literature on US PPI practices in cases where public procurement may have promoted innovation outside the national defence and security areas. It is reported that most of the strategic procurement in United States is geared towards achieving social purposes like environmental protection, energy conservation, assisting disadvantaged groups, and so on. However, these are seldom connected to the search of innovative outcomes. The chapter also summarizes several cases of PPI at the federal level.

Chapter 7, by Yanchao Li, Luke Georghiou and John Rigby, examines the application of PPI in the Chinese new energy vehicles programme by using procurement activities carried out by the cities of Jinan and Shenzhen as case studies. It is argued that the programme has stimulated the technological advancement and quantitative growth of new energy vehicles in China despite problems such as regional protectionism and duplicate production. At the city level, motivations for conducting procurement have gone beyond promoting technology diffusion, extending in particular to a desire to stimulate local industrial development. The study concludes that the range of policy instruments employed in this programme (public procurement and subsidies) remains limited. A wider range of favorable framework conditions, such as a fully competitive procurement system, must be in place to achieve the wider objective of nurturing lead markets.

Chapter 8, by Yannis Caloghirou, Aimilia Protogerou and Panagiotis Panaghiotopoulos, explores the application of PPI for e-government services in Greek local authorities. In particular, the study focuses on the Local Government Application Framework pilot project, which was launched by the Central Union of the Greek Municipalities. This project attempts to address the general challenge of providing value-added e-government services, at the same time creating more efficient internal management structures and achieving significant scale economies. In the Greek context, this new procurement approach may be considered as an effort to substitute the usual inefficient and ineffective practices whereby local authorities buy an almost identical information and communication technology package but pay differing licence fees. It is worth noting that these packages are usually turnkey solutions, that is, they are not products typically tailored to the specific requirements of each municipality. In particular, the platform's architectural features support its interconnection and interoperability with other information systems of the public sector in Greece and other EU countries so that cross-sectoral and cross-border services can be provided in the future.

Chapter 9, by Jillian Yeow, Elvira Uyarra and Sally Gee, focuses on the application of PPI to achieve sustainable goals. This chapter uses a single case study to illustrate the procurement of recycled paper by a UK government department. It charts the transformation in procurement from a product to an integrated service, and highlights the procurement of a sustainable innovation to achieve multiple objectives. The study indicates the importance of certain factors for enabling the procurement of a more innovative and sustainable solution. In particular, it illustrates the role of project champions in successful innovative change; a few typical examples of such champions are senior management support, a good working relationship between buyer and supplier, and the creation of a space in which trust and ideas generation can be enabled. Data is drawn from secondary sources, observations and in-depth interviews with public and private stakeholders participating in the process.

Chapter 10, by Cássio Garcia Ribeiro and André Tosi Furtado, reflects upon the application of PPI in an emerging economy. Petrobras, a Brazilian state-owned enterprise, serves as a case study. It is a global leader in the field of deepwater oil

production technology and so offers an interesting opportunity to investigate whether public procurement in such a country is used to promote the capability of domestic firms to develop innovations. The authors present the findings of a field survey on P-51, a platform that was ordered by the Brazilian state-owned enterprise and began producing in 2009.

Chapter 11, by Jakob Edler, Charles Edquist, Nicholas S. Vonortas and Jon Mikel Zabala-Iturriagoitia, concludes the book by summarizing its main lessons and limitations. In this sense, the authors make a clear distinction between PPI as an innovation policy tool, and the practice of PPI to achieve organizational and policy improvements. The chapter closes with a way forward for both academia and policy-makers.

NOTES

1. If a definition of a system of innovation does not include all the determinants of innovation processes, then which of the potential determinants to exclude, and why, have to be justified. Therefore a broad definition seems useful.
2. See, for example, Bergek et al. (2008).
3. This implies that innovation policy also includes public-organization actions that unintentionally affect innovation.
4. In Edquist (2014c), it is also discussed why there is such a large difference between innovation research and innovation policy in this respect.
5. This section is partially based on Edquist and Zabala-Iturriagoitia (2012, forthcoming) and Edquist (2014a).
6. The public organization may also financially contribute directly to the R&D leading to the development of the product. However, such contributions are not intrinsic parts of the PPI as such. Public R&D funding is a different – complementary – policy instrument in the instrument mix, one which is not in focus here. The purchase of a non-existing product is the central element of PPI. However, the development costs of the new product are, of course, indirectly supported by the procurer by (initially) paying a high price for the product. This is part of the very idea of PPI, but since the procurers' commitment is only to buy a number of units of the product at a certain price, this support of the development cost is brought about through the product price mechanism and cannot be regarded as direct public R&D funding.
7. For a discussion, see Edquist and Zabala-Iturriagoitia (forthcoming).
8. This is further discussed below, and in Edquist (2014a).
9. See definition of innovation above.
10. For a more thorough analysis of the particularities of pre-commercial procurement, see Edquist and Zabala-Iturriagoitia (forthcoming).
11. Extensive positive externalities raise the expectation that the innovator

will quickly 'lose' the innovation to competitors (without proper compensation) and thus the ability to benefit privately from it. This expectation, in turn, creates unwillingness to pursue the innovation in the first place, rather to wait for someone else to make the move. Being concerned with social returns, the public sector has exactly the opposite incentives: pursue innovations with high positive externalities.

12. Frank Knight's (1921) differentiation between risk and uncertainty is invoked here. Risk signifies the ability to formulate probability distributions of potential events. This is typically the case with short-term, less radical innovations. Uncertainty signifies the absence of such distributions and is more applicable in the case of longer-term, more radical innovations.
13. There is also a form of procurement called 'forward commitment procurement' (see Chapter 5 in this book). It is actually statements about future procurements. It is not legally binding, but a way to inform potential suppliers about future needs that procuring organizations have.
14. The EU technology platforms or forward commitment procurements may serve as a means of communicating probable future demand.
15. The technology foresight literature has, in fact, produced very valuable justifications and guidance on how to organize such public consultation processes. See, for example, UNIDO (2005).
16. For PPI on the civilian side, it might also be very good experience to learn from the ample experience that has been built up in the procurement of defence equipment. Moreover, there may be retired people with significant experience that public agencies can tap.
17. The acquirer typically does not understand what is possible at a specific point in time. And even if they do understand this to some extent, they do not normally have competence in the field of detailed technical design. The Swedish X2000 high-speed train and the Norwegian public safety network are two examples illustrating how overspecification often leads to the failure of the procurement initiative (Edquist and Zabala-Iturriagoitia, 2012).
18. The 'industry days' by procuring public agencies in the United States are exactly such an attempt (Edquist and Zabala-Iturriagoitia, forthcoming).
19. For a review of existing regulations on public procurement in the European context, see the website that the European Commission has created for this purpose, http://ec.europa.eu/internal_market/publicprocurement/index_en.htm (accessed December 2013).
20. Multiple sourcing in the presence of innovative products is the typical approach of industry, for example, in 'private procurement for innovation'. Companies regularly pursue parallel research projects at earlier stages of the pre-innovation process in trying to minimize uncertainties at that relatively inexpensive stage. As new products move into development, prototyping and early production, costs increase exponentially and experimentation tends to be taken out of the system. No technical uncertainties are allowed at the point of scale-up (Fusfeld, 1986).
21. The concept of 'fluid' political needs refers to the short time periods politicians are elected for and the fact that their constituencies evolve. The politicians may therefore try to introduce some of the evolving issues into the project.

22. That innovation policies are, in practice, still dominantly linear and supply-side oriented rather than holistic, systemic and demand-side oriented is shown in Edquist (2014b, 2014c), and as discussed above.

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APPENDIX

Table 1A.1 Key activities in systems of innovation

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- I. Provision of knowledge inputs to the innovation process
 1. Provision of R&D results, and thus creation of new knowledge, primarily in engineering, medicine and natural sciences.
 2. Competence building, for example, through individual learning (educating and training the labour force for innovation and R&D activities) and organizational learning. This includes formal learning as well as informal learning.
 - II. Demand-side activities
 3. Formation of new product markets (for example, public procurement for innovation).
 4. Articulation of new product quality requirements emanating from the demand side.
 - III. Provision of constituents
 5. Creating and changing organizations needed for developing new fields of innovation. Examples include enhancing entrepreneurship to create new firms and intrapreneurship to diversify existing firms, and creating new research organizations, policy organizations, and so on.
 6. Networking through markets and other mechanisms, including interactive learning among different organizations (potentially) involved in the innovation processes. This implies integrating new knowledge elements developed in different spheres of the SI and coming from outside with elements already available in the innovating firms.
 7. Creating and changing institutions – for example, patent laws, tax laws, environment and safety regulations, R&D investment routines, cultural norms, and so on⁹⁶ – that influence innovating organizations and innovation processes by providing incentives for and removing obstacles to innovation.
 - IV. Support services for innovating firms
 8. Incubation activities such as providing access to facilities and administrative support for innovating efforts.
 9. Financing of innovation processes and other activities that may facilitate commercialization of knowledge and its adoption.
 10. Provision of consultancy services relevant for innovation processes, for example, technology transfer, commercial information, and legal advice.
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Source: Adapted from Edquist (2011).

Table 1A.2 Demand-side policy instruments

Instrument	Method of functioning
<p>1. Public demand: state buys for own use and/or to catalyze private market General procurement</p>	<p>State actors consider innovation in general procurement as main criterion (for example, definition of needs, not products, in tenders)</p>
Strategic procurement	<p>State actors specifically demand an already existing innovation in order to accelerate the market introduction and particularly the diffusion</p>
Cooperative and catalytic procurement	<p>State actors deliberately stimulate the development and market introduction of innovations by formulating new, demanding needs (including forward commitment procurement)</p>
<p>2. Support for private demand <i>Direct support for private demand</i> Demand subsidies</p>	<p>Special form: catalytic procurement: the state does not utilize the innovation itself, but organizes only the private procurement</p>
Tax incentives	<p>The purchase of innovative technologies by consumers or industrial demanders is directly subsidized, lowering the entry cost of an innovation</p>
<p><i>Indirect support for private demand: information and enabling</i> Awareness-building measures</p>	<p>Amortization possibilities for certain innovative technologies, in different forms (tax credit, rebate, waiver, and so on)</p>
Labels or information campaigns	<p><i>State mobilizes, informs, connects</i> State actors start information campaigns, advertise new solutions, conduct demonstration projects (or support them) and try to create confidence in certain innovations (in the general public, opinion leaders, certain target groups) The state supports a coordinated private marketing activity which signals performance and safety features</p>

Table 1A.2 (continued)

Instrument	Method of functioning
Training and further education	Consumers are made aware of innovative possibilities and simultaneously placed in a position to use them
Articulation and foresight	Societal groups and potential consumers are given voice in the market place, signals as to future preferences (and fears) are articulated and signaled to the marketplace. Variations (including constructive technology assessment)
User–producer interaction	State supports firms to include user needs in innovation activity or organizes fora of targeted discourse (innovation platforms, and so on)
<i>Regulation of demand or of the interface demander–producer</i>	The state sets requirements for the production and introduction of innovations (for example, market approval, recycling requirements). Thus demanders know reliably how certain products perform and how they are manufactured
Regulation of product information	Smart regulation to ensure freedom to choose technologies, but changing the incentive structures for those choices (for example, quota systems)
Process and ‘usage’ norms	The state creates legal security by setting up clear rules on the use of innovations (for example, electronic signatures)

Support of innovation-friendly private regulation activities	The state stimulates self-regulation (norms, standards) of firms, supports/moderates this process and plays a role as catalyst by using standards
Regulations to create a market	State action creates markets for the consequences of the use of technologies (most strongly through the institutional set up of emission trading), or sets market conditions which intensify the demand for innovations
3. Systemic approaches	Strategically coordinated measures which combine various demand-side instruments
Integrated demand measures	Combination of supply-side instruments and demand-side impulses for selected technologies or services (including clusters integrating users and supply chains)
Integration of demand- and supply-side logic and measures	Conditional supporting of user-producer interaction (R&D grants if user involved)
	Pre-commercial procurement

Source: Edler (2013).

