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PUBLIC PROCUREMENT OF INNOVATION:

A REVIEW OF RATIONALES, INSTRUMENTS AND DESIGN

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Public procurement of innovation:

A review of rationales, instruments and design

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Abstract

Public Procurement of Innovation (PPI) has received recent renewed impetus and interest in most OECD countries although the academic literature pays little attention to its economic rationales. Since public procurement is being seen increasingly as an instrument of innovation policy, it is important to understand which situations favour its implementation. Based on a review of the literature on innovation policy, the present paper develops a failure-based framework that allows the resolution by PPI of three types of failures: demand-side, supply-side and user-supplier interaction traps. We propose a four-category typology of PPI based on the type of demand-side failures addressed, and whether or not it also targets supply-side failures. Each category is refined based on the degree of user-supplier interactions required. This typology based on the economic foundation of PPI allows the linking of failure, innovation and public procurement characteristics alongside the types of instruments derived from the academic literature on PPI. One of the strengths of this PPI typology is that it links to the various classifications proposed in the PPI literature and contributes to the smart design of PPI policy. It also considers PPI as a hybrid innovation instrument, that is, a demand-side policy tool, which, if appropriately designed, can be applied to resolve supply-side failures.

Keywords: Public procurement; Innovation policy instruments; Policy rationales; Policy design.

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1. Introduction

The primary objective of public procurement is to provide public administrations with the goods and services required for the performance and delivery of public services. Several public authorities have been exploiting their purchasing power to achieve additional socio-economic goals (McCrudden, 2004). The specific inclusion of public procurement in national and regional innovation policy mixes (Edler and Georghiou, 2007) is attracting renewed interest. One of the objectives of the OECD's (2010, p. 118) innovation strategy is "to leverage public procurement to foster innovation". The European Commission has identified PPI as an instrument that can be used to leverage R&D expenditures to achieve the Barcelona target (European Commission, 2003). In 2011, policies and/or strategies to support the procurement of innovative goods and services had been implemented in more than half of the OECD countries (OECD, 2013).

The academic literature on innovation policy is focusing increasingly on the heterogeneity of PPI and its innovation impacts. Several typologies have been proposed, defining PPI categories based on criteria such as degree of maturity and nature of the market, type of social need, design issues, user-supplier interaction, geographical aspects and contracting modes (e.g. Edler & Georghiou, 2007; Fraunhofer Institute Systems and Innovation Research, 2005; Hommen & Rolfstam, 2009; Uyarra & Flanagan, 2010). However, none of this work provides a unified framework that helps to explain and justify the variety of PPI. Moreover, consideration of the obstacles to innovation that public procurement might resolve is marginal, although their identification is key to determining the appropriateness of public procurement as a policy to foster innovation, and how it should be implemented. In the context of smart policy design, policy-makers need to carefully consider "the nature of the problem to be solved as well as its causes" (Borrás and Edquist, 2013, p. 1518), and choose and design innovation policies accordingly.

Since the primary objective of public procurement is rarely to encourage innovation, a range of "policy instruments" (Howlett, 1991) is needed to orient public purchase towards novelty. Georghiou *et al.* (2014) define policy instruments based on their functions along the different stages of the procurement cycle, and the resulting deficiencies they seek to remedy.

In line with this smart policy approach, we suggest that these various approaches should be complemented by a focus on general failures that impair innovation and which might be resolved by public procurement. The paper aims to investigate the range of these failures, on the one hand to build an analytical framework to allow identification of the categories of PPI

and, on the other hand to connect with previously elaborated typologies through the linking of rationales, instruments and designs of PPIs.

Our literature survey is in two parts to enable the elaboration of an analytical framework and to build a unifying typology. First, we review the literature on innovation policy to identify the failures that impede innovation which may be solved by public procurement. The rationales for any policy consist of “more or less formalised models implicitly or explicitly drawing upon academic theories or concepts that could inform policy design, implementation and evaluation” (Laranja et al., 2008, p. 823). This definition underlines the existence of a link between justification of public interventions and academic theories, although this link is far from straightforward. Policy formulation is a complex process that is shaped by a number of factors and contingencies, which are not restricted to recommendations derived from the theory. In addition, policy-makers “cherry-pick” various theoretical elements in order to justify their interventions, ignoring possible inconsistencies. Due to these features of policy-making, it is important that policy analysis neither overestimates nor disregards the role of academic theories which can contribute to assessing the appropriateness of specific policies with regard to their objectives and the economic context (Guellec, 2001). Policy analysis needs to be comprehensive, that is, to consider different sets of failures which may derive from various economic theories. Without such consideration, the analysis will not reflect the actual policy-making process and could be misleading. In addition, differences in the focus of economic theories should be perceived as potential complementarities rather than radical oppositions (Bach and Matt, 2005). This article seeks to identify rationales for PPI among market failures, evolutionary gaps, systemic traps and failures related to the transformation of systems.

An analytical framework is built based on a literature review of innovation policy rationales. It is assumed that PPI can address three broad categories of failures: demand-side and supply-side failures, and user-supplier interaction traps. Public procurement is essentially a demand-side innovation policy, that is, a policy aimed at fostering innovation by encouraging its uptake (Edler, 2009). Public procurement consists of the purchase by a public authority of a novelty to address a need. This article adopts a broad understanding of what is new by encompassing the users’ perspective (definition of new uses). Therefore, the scope of demand-side failures includes issues related to diffusion. Moreover, in line with evolutionary and systemic approaches, PPI is considered an example of user-supplier interactions. Finally, in some instances, PPI may target supply side failures, that is, innovation producers’ deficiencies. In taking account of this last category of failures, this article questions the possibility of public

procurement being a hybrid innovation policy instrument able simultaneously to address demand-side and supply-side failures.

Second, we review the literature on PPI through the lens of our analytical framework. It is possible to link each type of failure to elements of the policy design (innovation characteristics, implementation mode), but also to instruments able to overcome it. In this second analytical step, we identify a unifying PPI typology in which each category is characterized by a set of rationales, instruments and design elements. This two-stage literature review allows us to link the present work with previously elaborated PPI typologies.

This paper is organized as follows. Section 2 explores the different failures impairing innovation performance which public procurement might remedy. Section 3 describes the methodology used to build the proposed typology and Section 4 discusses the PPI categories identified based on their associated failures. Section 5 discusses our typology of PPI and concludes the paper.

2. Public procurement and failures impairing innovation performance: Towards an analytical framework

In this section, we present three broad categories of failures that PPI might overcome: demand-side (Section 2.1) and supply-side (Section 2.2) failures, and user-supplier traps (Section 2.3). These failures are linked to the overall policy objectives.

2.1. Demand-side failures

Two groups of PPI can be distinguished (Cave and Frinking, 2003). The first is related to situations where innovation is a by-product which is required to improve the performance or delivery of public services. The second is focused explicitly on fostering innovation mainly in terms of new uses. It relies on the positive effect public procurement can exert on the uptake of goods and services. These two groups of PPI are linked to two types of demand-side failure (see Table 1) involving different actors. In the first group, the demand-side actors are public organizations interested in improving public services; in the second group, demand-side actors are targeted as potential new users. If the objective of the procurement is both to improve the performance and delivery of public services through the introduction of an innovation, and to support its diffusion, these two groups of actors might overlap. In this case, the purchasing

public organization acts as the first user, which role can be crucial for accelerating the adoption of a product or service by other agents.

2.1.1. Improvements to public services

According to Edquist and Zabala-Iturriagagoitia (2012, p. 1758), the primary objective of PPI is to “target functions that satisfy human needs or solve societal problems”. The authors assume that public procurement is oriented to innovative products or services mostly to improve the quality of the public services offered. The role of PPI in public service improvements consists essentially of translating public sector needs into demand thereby creating a market. In other words, public procurement leads to a demand-pull effect (Cave and Frinking, 2003; Mowery and Rosenberg, 1979): public procuring organizations that issue calls for tenders **create the market for a product or service** by expressing a demand which previously did not exist.

This basic function of public procurement is less straightforward than it might seem. Public procuring organizations need to be careful about identifying a need, a task made more difficult if the public procurer and final user are different or when official public procurers are acting on behalf of a group of users to which they belong.

2.1.2. Diffusion of innovation

Public procurement is also designed to foster the adoption of an innovation by a new population of users, that is, to increase its **diffusion** (Geroski, 2000). In their evolutionary approach to market formation, Bleda and del Río (2013, p. 1045) conceptualize the diffusion of new products and or services as a “process of coordination among the agents that are adopting this new knowledge (or new rule complex)”. They identify “**surface coordination failures**” resulting from agents’ inertia and lack of adaptive skills.

The public sector traditionally is a major user of new products and services (Ergas, 1987) and their adoption by larger groups of users is made easier by their introduction in the public domain (Geroski, 2000). The public sector often acts as a **lead user** (von Hippel, 1986) in agreeing to bear the risks related to a novelty. However, a diffusion-oriented policy requires a representative first user. Public procuring organizations must have sufficient similarities to other users and be part of the same social networks in order to influence their adoption decisions (Mangematin and Callon, 1995).

Public procurement can ease the diffusion of innovation by **reducing switching costs** and **increasing the returns to adoption** (Mangematin and Callon, 1995). Switching costs

consist of **transaction and learning costs** and the **costs related to the adoption of complementary equipment**. Excessively high costs can lock agents into existing products. In this case, public procurement can create network externalities through initial mass purchase. Enlarging the installed base of an innovation makes it more attractive compared to other products (Geroski, 2000). This effect can be key to the diffusion of products “whose value rises with the units sold in the market” (Edler and Georghiou, 2007, p. 956). In acting as an early user, the public sector can create an “information cascade” (Geroski, 2000): it experiments an innovation which allows it to provide other agents with information that will **reduce their learning gap** and hasten their adoption decision (Steinmueller, 2010).

Table 1. Objectives of PPI linked to demand-side innovation failures

Overall objectives of public procurement	Improvement to public services	Diffusion of innovation	
		Public administrations as lead users	Diffusion of innovation to external users
Related failures	Absence of market (unfulfilled needs - demand)	Absence of market (unfulfilled needs - demand)	Surface coordination failure
		Surface coordination failure	Transition failure
		Transition failure transaction costs, consumers' learning and preferences	transaction costs, consumers' learning and preferences
		Demand articulation failure	Demand articulation failure

The public sector can also act **on consumers' preferences** by orienting them towards new products, thereby easing the emergence of a demand for innovation (Saviotti and Pyka, 2013). Public procurement can contribute to the elaboration of standards for specific products (Uyarra, 2012), resulting in greater demand for those products. Based on Schumpeter's “creative destruction” process, Rolfstam (2013) suggests that the role of public procurement is to end the life cycle of one product and to replace it by another. Public procurement essentially consists of choosing among different options to satisfy a need and, thus, create demand.

Consumers' preferences can be manipulated by the creating of a space where external users can experiment and adapt to innovations in the public domain. For instance, in Italy, public procurement of school meals has been used to promote healthy eating habits and the consumption of locally produced food (Morgan and Sonnino, 2007). In this case, consumers' preferences are oriented through education rather than standards. These efforts by policy-makers are aimed at enabling **demand articulation** (Weber and Rohrer, 2012).

2.2. Supply-side failures

Although public procurement is commonly described as a demand-side innovation policy instrument, it can also overcome supply-side failures such as the lack of incentives for firms to innovate, and lack of innovation capabilities (see Table 2).

2.2.1 Lack of incentives to innovate

The literature on the demand-pull effect assumes that demand size and sophistication are key factors in the firm's decision to introduce a new product or service (Guerzoni, 2010). Demand for specific innovations **reduces uncertainties related to the outcome** of research and development (R&D) activities, which can make firms reluctant to invest in them (Arrow, 1962). Due to the volumes involved, public procurement can have a significant effect and can act as an insurance, guaranteeing a minimum level of sales in a given time period (Cave and Frinking, 2003; OECD, 2014a). Public administrations can influence demand and achieve critical mass by aggregating demand (Edler and Georghiou, 2007; Fraunhofer Institute Systems and Innovation Research, 2005; Uyarra, 2012).

Montmartin and Massard (2014) consider public procurement an appropriate policy instrument to solve **surplus appropriability problems**, or the inability of firms to appropriate the full benefits of commercialization of their innovation (Smith, 1996). Innovative firms are assumed to adopt monopolistic behaviour by setting a higher selling price for their innovation than would prevail in a competitive market. In these circumstances, innovators can make profits, but may fail to appropriate the consumer surplus and the “static inefficiency”, which is the reduction in demand and consequently in production resulting from prices that are superior to the marginal production cost. In a dynamic perspective, firm profit is a measure of the profitability of the innovation. However, the increase in social welfare also includes consumer surplus and static inefficiency. This results in private welfare being inferior to social welfare, which leads to underinvestment in corporate R&D. In this case, public procurement can increase the demand for differentiated and innovative goods. The static inefficiency is corrected, and the profitability of innovation increases thereby increasing the incentive in the business sector for investment in R&D.

Finally, an **inappropriate market (and competition) structure** can reduce the incentive for firms to innovate. Public procuring organizations need to be supplied with the best solution. In most cases, they encourage competition by attracting bids from the maximum number of firms (Uyarra and Flanagan, 2010).

2.2.2 Capabilities failures and inappropriate market structure

Another objective of public procurement can be “to strengthen key suppliers” (Laranja et al., 2008). An evolutionary approach to innovation emphasizes learning; an insufficient level of R&D to accumulate competencies, an inadequate level of human capital, and limited knowledge diffusion throughout the business sector (Malerba, 1996) are major failures that impair innovation performance. Because selected suppliers are asked to engage in R&D and innovation activities which allow them to create knowledge and capabilities, public procurement can be an appropriate solution to **firms’ learning deficiencies** (Malerba, 2009, 1996). Such learning failures are similar to systemic capabilities failures in Klein Woolthuis *et al.*’s (2005) policy framework. In addition, public procurement can **break path dependencies** by favouring alternatives to the dominant technologies deemed inefficient to address targeted needs (Chaminade and Edquist, 2005; Malerba, 1996).

Table 2. Objectives of public procurers linked to supply-side failures

Overall objectives	Improve firms’ incentives to innovate	Improve innovation producers’ capabilities
Supply-side failures	Market uncertainties related to novelty Appropriability surplus failure Inappropriate competition	Learning failure / Capabilities failure Lock-in situation

2.3. User-supplier interactions traps

The most basic effect of public procurement is to create an interface between demand and supply. The respective actors interact with each other throughout the procurement process. For these reasons, public procurement should be considered “a special case of users-producers interaction” (Rolfstam, 2009, p. 349), which is deemed essential for any innovation process. This article distinguishes two groups of public procurement according to the degree of user-supplier interactions required for the supply of an appropriate innovation (see Table 3).

2.3.1 Need to signal the state of demand

In some circumstances, calls for tenders are sufficient to create a demand-pull effect. They provide firms with information and reduce some of the uncertainties related to investment in

corporate R&D. Therefore, PPI can address market failures (Arrow, 1962; Nelson, 1959) related to the firm's lack of knowledge of demand (reducing **information asymmetries**).

The assumption that a call for tender can be sufficient to drive innovation implies that public procurers know which innovative products are required to satisfy targeted needs and that these innovative products already exist. In this case, innovation consists of the introduction of already existing products onto new markets (definition of new uses).

2.3.2 Public procurement as an interactive learning space

Evolutionary and systemic approaches to innovation highlight the key role of iterative user-supplier interactions allowing the user to contribute to the innovation process in the form of requests and feedback. Public procurement initiatives allow such interactions and can be conceptualized as **interactive learning spaces**. They may be a solution to a **lack of “dynamic complementarities”** between suppliers and users (Malerba, 2009, 1996) or “**weak network failures**” (Klein Woolthuis et al., 2005), which prevent mutual learning.

User-supplier interactive learning contributes to the first phase of market formation from an evolutionary perspective (Bleda and del Río, 2013). It enables links among all categories of knowledge in order to transform inventions into innovations. In response to **deficient deep coordination**, public procurement can help to build new knowledge complexes by facilitating the exchange of information between producers and users, that is, by improving the match between supply and demand.

Table 3. Objectives of public procurers linked to user-supplier interactions traps

Overall objectives	Signal to the business sector the state and nature of demand	Match demand and supply through an interactive learning space
User-supplier interactions traps	Reducing information asymmetry and uncertainty	Dynamic complementarities failure Weak network failure Deep coordination failure

3. Methodology: A failure-based approach

The review of the literature on innovation policy informs our analytical framework, which is based on three groups of failures that can be remedied by appropriately designed public procurement. A smart policy design implies the choice and implementation of instruments and modalities that are relevant to the existing problems (Borrás and Edquist, 2013). This article defines PPI categories within a framework that could contribute to the design of smart policy by linking failures, implementation modalities and relevant policy instruments. This is achieved through an analysis of the PPI literature through the lens of our failure-based analytical framework.

The literature on public procurement of innovation proposes several typologies. The so-called “Hommen matrix” (Rolfstam, 2013) defines PPI groups according to the type of social need addressed and the role of public procurement in the market development process (Lember et al., 2011; Rolfstam et al., 2005). Uyarra and Flanagan (2010) suggest categories of PPI based on the size of the market for the procured products and the degree of specialization of their production processes. Each category is associated with innovation types, modalities of implementation, instruments, risks and geographic considerations. Wang and Bunn’s (2004) typology highlights user-supplier interactions, which are characterized based on level of information exchange and shared belief that this co-operation is essential for success. Some elements of these typologies (market size, targeted social needs, nature of the production process, and coordination of actors) can be easily linked to the three aforementioned types of failures.

On the other hand, Georghiou *et al.* (2014) adopt a functional approach to public procurement and “plot the various policy instruments designed for public procurement of innovation against the various functions they seek to support and the deficiencies they seek to remedy” (Georghiou et al., 2014, p. 2). They define four phases of policy intervention characterized by specific deficiencies: framework conditions (procurement rules are not conducive to innovation); public sector organization and capabilities (lack of awareness of innovation potential and skills to adopt innovation-friendly practices); identification, specification and signalling of needs (lack of interaction between procurers and the business sector for an appropriate definition of demand); and incentives to seek innovative solutions (aversion of public procurers to ask for and adopt innovations). Sets of instruments are explicitly linked to each of the four phases and their deficiencies. The second, third and fourth

phases of intervention and their related deficiencies can be interpreted in terms of our three types of innovation failure.

In the succeeding sections of this paper, we show that it is possible to associate the failures identified (see Section 2) with some of the dimensions of the aforementioned typologies, such as the degree of product complexity, the size and level of development of the market, the nature of user-supplier interactions, and the types of relevant instruments. We assume that the nature of the policy-makers' objectives is related directly to some characteristics of the innovation and implementation modalities of public procurement, which call for specific instruments to ensure that public purchase will be oriented towards necessary innovations.

We build a failure-based typology of four categories of PPI based on demand-side and supply-side failures. Policy arguments are rarely based on user-supplier interaction traps. Nevertheless, most innovations require some degree of stakeholder interaction, which can be conceptualized as a continuum of varying intensity. The two categories of user-supplier interactions developed previously (one-sided information asymmetry, and need for an interactive learning space) are at the opposite ends of this continuum. Each of our four PPI categories are refined and associated with instruments adapted to the degree of user-supplier interactions required.

4. A typology of public procurement of innovation: failures, design and instruments

In this section, we associate each of the three groups of failures previously identified with innovation characteristics and appropriate PPI instrument types derived from the literatures (Section 4.1). We define four types of PPI and their respective failures, implementation modalities and instruments (Section 4.2).

4.1. Characteristics derived from the nature of the failures addressed

The nature of the innovation-related failures addressed by public procurement is assumed to relate directly to their implementation modalities and innovation characteristics, and to call for specific instruments.

4.1.1. Consequences of demand-side failures

The nature and the location of demand-side failures are associated with types of social needs and market sizes (see Table 4). If the sole objective of public procurement is improvement to

public services, then the procuring public organization is the end-user. Public procurement is “direct”, that is, it addresses needs intrinsic to public purchasers (Edler and Georghiou, 2007; Edquist and Zabala-Iturriagagoitia, 2012; Fraunhofer Institute Systems and Innovation Research, 2005; Hommen and Rolfstam, 2009; Rolfstam, 2013; Uyarra, 2012). Related initiatives correspond to the procurement of products for dedicated or niche markets (Uyarra and Flanagan, 2010).

Table 4. Characteristics of public procurement of innovation derived from demand-side failures

	Improvement to public services	Diffusion of innovation	
		Public sector is first-user	Diffusion only to external users
Market size	Dedicated market	Generic market	
Type of procurement according to targeted social needs	Direct procurement	Co-operative procurement	Catalytic procurement
Type of instruments	Innovation strategies encompassing PPI Training, guidelines, exchange of good practice Financial support for procurers Interacting governance system		
			Information and communication on innovation Educational programmes

Public procurement aimed at accelerating the diffusion of innovation can be catalytic if the end-users of the procured products do not include procuring public organizations (Edler and Georghiou, 2007; Edquist and Zabala-Iturriagagoitia, 2012; Fraunhofer Institute Systems and Innovation Research, 2005; Hommen and Rolfstam, 2009; OECD, 2014a; Rolfstam, 2013; Uyarra, 2012) or co-operative (Edler and Georghiou, 2007; Fraunhofer Institute Systems and Innovation Research, 2005; Hommen and Rolfstam, 2009; Rolfstam, 2013). In the first case, targeted social needs are exclusively extrinsic to the public sector; in the second case, they are

common to both groups of actors. Beyond this distinction, common to diffusion-oriented procurement initiatives is that they essentially target generic markets.

Within the procurement process, demand-side failures are related mostly to deficiencies in the capabilities of procurers to properly define their needs. Public procurers may fail to express a need because of lack of awareness of innovation potentials and lack of skills related to innovation-friendly procurement procedures. In response to this type of deficiency, Georghiou *et al.* (2014) recommend the implementation of the following instruments: **strategies** explicitly identifying public procurement as a tool of innovation policy; **training, guidelines and exchange of good practice** related to innovation-friendly procurement practices; and, **financial support** to procurers to cover the additional costs that PPI might imply. In some circumstances, public procurement can be conducted by a specific department on behalf of the final users, or by a team that includes representatives of the final users. Such governance systems require **interactions** between these different actors, for example, through groups of purchasers, to ensure that the needs expressed through calls for tenders relate to the actual needs of the final users. The diffusion of an innovation calls for specific instruments to ease and boost the decisions of third-party users to adopt the innovation; these instruments include **information and communication tools**, and **education programmes** (Morgan and Sonnino, 2007).

4.1.2. Consequences of supply-side failures

Supply-side failures are usually seen as related to complex products requiring specialized inputs and associated with high uncertainty (Uyarra and Flanagan, 2010). This uncertainty can be reduced by greater information exchange between procurement parties (Uyarra and Flanagan, 2010; Wang and Bunn, 2004). Therefore, appropriate PPI instruments should ensure that users and suppliers exchange information about their needs and capabilities in order to solve supply-side failures. This requirement is lower for public procurement initiatives that are not aimed explicitly at supporting suppliers' innovation activities (see Table 5).

The ability of public procurement to overcome supply-side failures is affected by risk-averse procurers. Solutions identified by Georghiou *et al.* (2014) consist of **insurance guarantees** and “**financial cushions**” for public procurers demanding innovations. **Standards and certificates** can reduce the uncertainty related to new products. Finally, the chances of procuring an innovation will be maximized by a **clear requirement** in the call for tenders of an innovative solution and indications to potential suppliers of a **guaranteed price and/or**

purchase volume. In relation to competition, **access of SMEs to public procurement** can be eased through the setting of specific rules and techniques such as allotment. Finally, specific funding instruments can be implemented to overcome firms' capabilities failures. We assume that these will include **pre-commercial procurement (PCP)**, which could be assimilated in targeted R&D funding because it essentially targets products that require further R&D activities and, consequently, more finance (Edquist and Zabala-Iturriagoitia, 2015).

Table 5. Characteristics of public procurement derived from supply-side failures

	Existing supply-side failures	No supply-side failure
Nature of production processes	Specialization	Standardized
Level of information exchange	High	Low
Type of instruments	Structures for user-supplier interactions Insurance guarantees Financial cushion Standards and certificates Requirements for innovation in tendering Population targeted to ease procedures and techniques Pre-commercial procurement	None

4.1.3. Consequences of user-supplier interactions traps

Public procurement aimed at solving poor signalling of demand to potential suppliers requires public procurers to clearly identify beforehand their needs and solutions. This has consequences for the modalities of user-supplier interactions (see Table 6). First, since signalling the nature and state of demand is considered sufficient to “pull” innovation means that none of the parties believes that their co-operation is required. This type of public procurement is characterized by low “collaborative norms” (Wang and Bunn, 2004). Public procurement understood as mission-oriented policy (Ergas, 1987) because it consists essentially of selecting suppliers to develop

solutions to specific problems, should be organized through a model of vertical coordination between public procurers and suppliers if one of the objectives is to improve the signalling of demand to the latter (Foray and Llerena, 1996). In these circumstances, policy-makers should have thorough knowledge of a need and which solutions to implement, based on accumulated experience and know-how. Such knowledge and experience contributes to highly prescriptive calls for tenders which leave very few margins for suppliers in the design and development of solutions.

In the context of interactive learning spaces the configurations of user-supplier interactions are almost reversed. Both parties must recognize the importance of co-operation for identifying and developing optimal solutions. Public procurers need to interact with potential suppliers and experts to draft appropriate calls for tenders and to help in the development of the best solutions. These dynamic complementarities represent high cooperative norms (Wang and Bunn, 2004) between users and suppliers, which coordinate horizontally. This horizontal mode of coordination is slightly different from that explored by Foray and Llerena (1996), which describes a decentralized policy-making organization in which policy decisions rely mostly on participating firms and organizations. In our cases, “horizontal coordination” consists of situations in which public procurers and (potential) suppliers collaborate intensively (it is possible for firms to influence the policy decision).

Wang and Bunn (2004) identify four types of user-supplier interactions in the implementation of procurement contracts based on the already mentioned two dimensions: degree of information exchange, and level of cooperative norms. Our article tentatively extends the scope of their model and its application to earlier procurement phases. During a “collaborative relationship”, both procurement parties share information “frequently, intensively and openly” (Wang and Bunn, 2004, p. 95) and an awareness that their collaboration is *sine qua non* to the success of PPI. These cooperative norms are lower in “supervisory relationships” where procurers dominate the procurement process, but provide suppliers with all the necessary information. In “recurrent relationships”, the level of information exchange is low, but both parties need to meet/interact frequently in order to achieve the objective of the PPI. Finally, “arms-length relationships” are similar to any standard market and transactional interactions: the flow of information exchange is low and the parties do not need to cooperate.

Table 6 . Characteristics of public procurement derived from user-supplier interactions traps

	One-sided information asymmetry	Need for interactive learning spaces
Cooperative norms	Low	High
Coordination between procurers and suppliers	Vertical	“Horizontal”
Type of instruments	Communication tools (commercial fairs, websites)	
	Prescriptive calls for tenders	Competitive dialogue and the like Foresight and innovation platforms Functional calls for tenders Pre-commercial procurement

The tools facilitating these different user-supplier relationships are several. Based on their functional approach, Georghiou *et al.* (2014) state that the objective of such policy instruments should be to address deficiencies related to “identification, specification and signalling of needs”. Policy-makers must ensure that the various stakeholders communicate sufficiently frequently with each other, that procurers and users are aware of suppliers’ innovation potential, and that suppliers are aware of the needs of procurers and users (Edler and Georghiou, 2007). These interactions are guaranteed in the formal procurement process by techniques such as the **competitive dialogue** introduced by the Directive 2004/14 of the European Union “[allowing] the contracting authority to have discussions with the candidates during the procedure so to better define its needs and the appropriate means to achieve its objectives” (Telles, 2010, p. 1). Procurement rules can include similar techniques (e.g. negotiated procedures) to favour user-supplier interactions for the identification and signalling of needs. In addition, public procurers can publish **functional calls for tender** stating only a need and leaving it to suppliers to develop their own solutions. Another related solution is **pre-commercial procurement (PCP)** since it consists essentially of financing R&D projects to address identified needs and define potential solutions. The business sector might also be involved in **foresight exercises** in order to be aware of future public sector demands, and to contribute to the identification of priority needs (Vecchiato and Roveda, 2013). Efficient

communication between stakeholders can also be facilitated through **Internet websites** (dedicated to specific PPI initiatives or projects) and the participation of public procurers into **commercial fairs, exhibitions, etc.**

4.2. A two-fold typology of public procurement of innovation

Four categories of public procurement of innovation are identified according to the type of demand-side failures considered (barriers to improvement in public services or innovation diffusion) and whether or not supply-side failures exist (see Table 7).

Edquist and Zabala-Iturriagagoitia (2012) assume that most public procurement of innovation are aimed at improving public services provision. The purchasing public organizations may ask for a new solution to be developed (*developmental procurement*) or decide on adaptations to an already existing product (*adaptive procurement*). Public authorities and government can also use public procurement as an explicit innovation policy instrument with the objective of encouraging the development of new products and their diffusion. In other words, procuring organizations can try to change production and consumption habits by orienting them towards goods or services deemed essential to achieve grand challenges. Such public procurement initiatives are described as *transformational*. In less ambitious diffusion-oriented public procurement initiatives, the objective may be to accelerate the uptake of existing products, described as *diffusive procurement*. Each of these categories can be refined based on the degree of user-supplier interaction required.

Table 7. Typology of public procurement of innovation

	Improvement to public services	Diffusion of innovation
Existing supply-side failures	Developmental procurement	Transformational procurement
No supply-side failure	Adaptive procurement	Diffusive procurement

4.2.1. Development PPI

Developmental PPI consists of public procurement initiatives aimed at stimulating the development of innovative solutions to improve the **performance of public services**. They

target **specialized or complex products** developed for a **niche market**, namely a public administration. This category is similar to Uyarra and Flanagan's (2010) "**experimental procurement**", which is expected to lead to a **revolutionary innovation**, i.e. an "innovation that disrupts and renders established technical and production competence obsolete, yet is applied to existing markets and customers" (Abernathy and Clark, 1985, p. 12).

Two sub-categories of developmental procurement are identified according to the degree of user-supplier interactions required. If a call for tender unilaterally drafted by the public procurer is sufficient to encourage firms to undertake R&D and innovation activities, the developmental procurement is said to be *experimental*. Purchasing public organizations ask for the development of a precisely identified product that will improve a public service. The user-supplier interaction trap consists of one-side information asymmetry (affecting suppliers). Therefore, supply-side failures that are addressed by public procurements with such low user-supplier interaction requirement are assumed to correspond coherently to a lack of firm incentives to innovate. In *creative* developmental procurement initiatives, procurers and suppliers collaborate to develop the most appropriate solution to the problems impairing public services.

Public procurement of food in Klippan, Sweden, (Knutsson and Thomasson, 2014) can be considered an example of creative developmental procurement. Its objective was to increase the quality of the municipal food service. The process started with an inventory of food purchases, based on 17 quality categories. Then a marketing study was conducted which involved asking incumbent suppliers to provide samples for testing. The largest food firms exploited their oligopolistic position to try to force Klippan's authorities to abandon their quality criteria. Ultimately, the procurement manager issued calls for tenders based on the 17 categories of food identified, which allowed smaller firms to be part of the tendering process. All the features of creative PPI are present in this case: the objective to improve a deficient public service; the definition of demand specifications subsequent to exchanges with potential suppliers; and the previous lack of capability and incentives for incumbent firms meet these specifications.

4.2.2. Transformational PPI

Transformational public procurement addresses **supply-side failures** and is aimed at **diffusing procured innovative solutions**. The public sector tries to transform systems by exploiting its purchasing power. Because transformational procurement targets specialized products for

generic markets, it could be considered equivalent to “technological procurement” in the product-based typology proposed by Uyarra and Flanagan (2010). Related innovations are considered “architectural” (Abernathy and Clark, 1985) because they depart from the established systems and, in turn, attempt to build new industries and markets.

Within the transformational procurement category, *industrial* procurement is characterized by simple user-supplier interactions and favours industry. The public sector identifies the characteristics of the products to be developed and diffused, and policy-makers drive the transformation of systems in a clearly identified direction. As already described, it can be assumed that public procurements with low user-supplier interactions address supply-side failures that consist of lack of incentives to innovate. On the other hand, *systemic* transformational PPI are aimed at transforming systems by acting simultaneously on the innovation capacities of producers and the absorption capabilities of the demand side, through the establishment of an interactive learning space. In this configuration, public procuring organizations have identified needs whose effective translation into demand requires dialogue with potential other users and suppliers.

Procurement initiatives implemented in 1988 by the Swedish government to encourage the production and market penetration of eco-efficient products (Edquist and Zabala-Iturriagagoitia, 2012) are examples of systemic transformation procurement. Expert panels consisting of representatives of the public administration, manufacturers and specialists were established to define quantitative goals which were then translated into functional specifications in the calls for tenders. Agreements were signed with large purchaser groups to guarantee minimum purchase volumes of the procured products. The overall objective was to accelerate diffusion of specific products whose production was encouraged through guaranteed sales.

4.2.3. Adaptive PPI

The main objective of adaptive PPI initiatives is to **improve public services** through the purchase of goods and services, whose **production and supply encounter no obstacles**. In other words, these public procurements are aimed at adaption to already existing products and services, for the public sector. It is aimed at adapting standardized products for a niche market, namely a public administration. The resulting innovation opens up new market opportunities for existing goods and services, i.e. “niche creation” (Abernathy and Clark, 1985).

Adaptations to existing products starts with a signal to the business sector of a particular need in the public sector. In some cases, tenders are deemed sufficient to enable the supply of

an appropriate solution to improve public services. Because of this vertical coordination between procurers and suppliers, this category of public procurement is assimilated in *top-down public orders*. In other cases, improvements to public services might require a product whose technical specifications cannot be identified by the public procuring organization on its own. Suppliers and procurers will need to interact to identify a suitable solution. This coordination between procurers and suppliers includes *negotiation*.

An example of a negotiated public order is the procurement in 2007 of a new system for maritime radio telecommunication by the then Swedish state-owned company Telenor A/S (Rolfstam, 2013, 2009). The overall objective was to improve the maritime radio telecommunication service, which was based on obsolete technologies and whose ageing workforce was threatening its efficiency. Telenor A/S identified distributed technologies as an adequate solution. Tenders were published for its provision; the specifications remained functional allowing bidders to propose different but related solutions. An interactive learning space between Telenor A/S and its potential suppliers was established and remained in place even after formal selection of Frequentis GmbH. The procured product required two years of software development although, essentially, it consisted of adaptations to a distributed technology already implemented in other contexts. Therefore, it is assumed that the public procurer was not aiming (at least explicitly) to solve a supply-side failure.

4.2.4. Diffusive PPI

The objective of the last category of PPI is to **accelerate the diffusion of already available goods and services**. These products are standardized, and public procurers aim to diffuse them within a generic market where they are considered not sufficiently exploited. Uyarra and Flanagan (2010) define this category as “efficient procurement”. Resulting innovation is “regular”: it is almost invisible because it “involves change that builds on established technical and production competence and that is applied to existing markets and customers” (Abernathy and Clark, 1985, p. 12).

Diffusive procurement, in which user-supplier interactions are restricted to calls for tenders, relies on a process of *epidemic diffusion*, which implies that “information diffusion drives technology diffusion” (Geroski, 2000). To provide potential users with the information needed to adopt an innovation, public procuring organizations purchase a product and put it into the public domain. This provides a group of first users with the opportunity to familiarize themselves with the innovation, and to subsequently diffuse information. Policy instruments

orienting consumer preferences can accelerate this epidemic diffusion model. In contrast, other diffusive procurements need to ensure *coordination of first users* for successful diffusion of the targeted innovation. These cases are somewhat related to situations where diffusion is impaired because of a demand-supply mismatch. Therefore, public procurers need to establish an interactive learning space for users and suppliers, in order to promote the development of products that respond to users' expectations and, therefore, will become widely diffused. The role of first users is to collaborate to identify and signal their needs clearly, and then to contribute to the related adapted solutions.

Abernathy and Clark (1985) suggest that instances of diffusive procurement are difficult to identify because the resulting innovation is almost invisible. However, we would consider the procurement in Italy of organic and local food for school meals (Morgan and Sonnino, 2007) diffusive procurement. The overall objective was to diffuse healthy eating habits among school pupils and then throughout the population. The nature of user-supplier interactions is difficult to identify because of lack of related information. However, the compulsory establishment of canteen commissions of parents in every school, responsible for monitoring and evaluating food quality and reporting any problems, is evidence of interactions between users and suppliers. The involvement of parents was aimed at accelerating the diffusion of healthy food habits beyond the schools' pupils. Thus, the procurement of organic and local food for Italian schools would seem to be a case of epidemic diffusion.

Table 8 presents a synthesis of our four broad categories of PPI. For simplicity, we present only the information contained in Section 4.2. Since each category of PPI corresponds to a combination of failures, it is possible to associate the relevant policy instruments and other elements of design detailed in section 4.1.

Table 8. Extended typology of PPI categories

PPI category	Transformational		Diffusive		Developmental		Adaptive	
PPI subcategory	Industrial	Systemic	Epidemic diffusion	Coordination of first users	Experimental	Creative	Top-down public orders	Negotiated public orders
Supply-side failure	Only lack of incentives	Lack of incentives and/or capabilities failure	No	No	Only lack of incentives	Lack of incentives and/or capabilities failure	No	No
Users-producers interactions traps	One-side information asymmetry	Interactive learning space	One-side information asymmetry	Interactive learning space	One-side information asymmetry	Interactive learning space	One-side information asymmetry	Interactive learning space
Demand-side failure	Diffusion	Diffusion	Diffusion	Diffusion	Improvement of public services	Improvement of public services	Improvement of public services	Improvement of public services
User-producer interaction	Supervisory	Collaborative	Arm's length	Recurrent	Supervisory	Collaborative	Arm's length	Recurrent
Product-based PPI category	Technological		Efficient		Experimental		Adapted	
Innovation type	Architectural		Regular		Radical		Market niche	

5. Discussion and conclusion

Public procurement has gained renewed impetus as an instrument to stimulate innovation, with supply-side innovation policies shown to be insufficient. Also, the ability of public procurement to achieve several objectives simultaneously is a major benefit in the current context of fiscal constraints (OECD, 2014b). Although public administrations can use their purchasing power for various purposes, their primary objective is to ensure the performance and delivery of high quality public services. Therefore, smart design of PPI is needed, exploiting specific instruments and modalities of implementation that convince the public procurer to adopt innovation-friendly practices and to address possible barriers to innovation. The main contribution of this paper is identifying failures that public procurement could resolve, and defining categories of PPI associated with sets of instruments and other elements of policy design. Each procurement category is defined according to the type of demand-side failures addressed and according to whether or not it also targets supply-side failures. Four categories were identified: developmental, transformational, adaptive and diffusive. These four categories were refined according to the degree of user-supplier interactions required. We developed a failure-based analytical framework which complements existing work on PPI and links the various typologies developed therein.

Each category of public procurement should be associated with a specific set of instruments and design elements in order to resolve underlying failures. For this reason, the proposed typology could serve as a guiding framework for policy makers. It might also be useful for evaluation exercises based on the strategic intelligence model (Edler et al., 2012), by focusing on the link between objectives and implementation tools. Our typology could be used

to analyse cases of failed (or less successful than expected) PPI initiatives. For instances, Morgan and Sonnino (2007) compare changes to the procurement of school meals in Italy and the UK to promote and diffuse healthy eating habits. The UK experience is shown to be less effective because of stricter compliance with European directives and insufficient instruments to empower customers. Such instruments are key to diffusive PPI initiatives, especially if they rely on epidemic diffusion models. Italian schools implemented the right set of instruments, namely education programmes, and the involvement of parents in monitoring quality.

Rolfstam (2013, 2009) explores cases of failed PPI to better understand the impact and role of institutions. In 2004, the UK Department of Health set up a Rapid Review Panel to assess solutions submitted by the business sector to reduce catheter-associated urinary tract infections and thereby improve their public health service. The Bardex IC silver alloy coated catheter was identified as the best solution and its use was fast-tracked in the UK National Health Service (NHS) supply chain with the objective of its wide diffusion among NHS Trusts and hospitals. However, the availability of a product on an electronic supply system does not guarantee its diffusion, which was less than expected. Rolfstam (2009, p. 358) identified the following barriers: “budgeting silos; a perceived lack of sufficient clinical tests; organised scepticism; lack of technology champions; and a decentralised organisation”. Our analysis suggests that some of these issues could have been addressed by appropriate instruments, especially in relation to scepticism and lack of information. The NHS seemingly conducted an adaptive procurement (to improve the public health system by introducing a technology already widely diffused in other markets), whereas a diffusive procurement would have been more appropriate (to encourage adoption by NHS trusts and hospitals of this already existing technology).

The case of procurement of silver-coated catheters also highlights the difficulty involved in identifying clearly the overall objective of policy-makers in complex procurement configurations. The procurement authority fast-tracked this product into the NHS supply chain catalogue, but the final purchase decision remained in the hands of the competent authorities in NHS hospitals and hospital trusts. In this case, we might ask who were the actual procurers: The NHS procurement department? Individual NHS hospitals and trusts? The answers to these questions would influence how the procurement initiative should be analysed using our typology. We can define the procurement of silver-coated catheters as diffusive only if we consider the NHS to be the procurer, otherwise it would be adaptive. The overall objective of this initiative was to reduce catheter-associated urinary tract infections in order to improve the

public health system. However, this required a strategy of technology diffusion among NHS Trusts and hospitals, whose purchasing activities were autonomous. Therefore, it seems consistent to consider this procurement initiative to be diffusion oriented.

Our typology of PPI will inform policy-making and policy-analysis only if procurement initiatives are considered broadly. The approach should not be restricted to the procurement process, but should encompass the background in order to identify public procurers' objectives and failures.

We illustrated some categories of our typology based on existing case studies. Therefore, we can assume that they are not just theoretical constructs, and that supply- and demand-side failures can be addressed simultaneously by public procurement. Another original contribution of this paper is that it highlights that public procurement can be considered a hybrid innovation policy instrument: it is a demand-side policy that can solve supply-side failures in specific situations.

Our typology associates failures with a number of relevant instruments. Because our PPI categories are identified based on failures, each of these categories can be associated with a set of instruments. These instrument sets consist of the policy instruments identified to address each of the three groups of failure. For instance, creative developmental procurement requires tools to address supply-side failures and improvements to public services, and promote user-supplier dynamic complementarities. In order to make a more accurate contribution to PPI policy-making, the potentially large list of instruments associated with each PPI category should be refined. The present lists are mainly the result of a theoretical construct which might help to guide policy decisions. However, they should not be considered recipes that policy-makers can systematically implement. We assume also that policy-makers cannot cherry-pick instruments from these lists. Indeed, the selection of instruments should be careful to respond to the specific PPI context. Specific attention should be paid to the possible incompatibility of instruments and the possibility that they might cancel one another out. This requires further investigation, based on an empirical approach, in order to complement our typology of PPI and link rationales, instruments and design.

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Bibliography

- Abernathy, W.J., Clark, K.B., 1985. Innovation: Mapping the winds of creative destruction. *Research Policy* 14, 3–22. doi:10.1016/0048-7333(85)90021-6
- Arrow, K. (1962). Economic Welfare and the Allocation of Resources for Invention. In Universities- National Bureau Committee for Economic Research. (Ed.), *The Rate and Direction of Inventive Activity: Economic and Social Factors* (p. 609–626). Princeton: Princeton University Press.
- Bach, L., & Matt, M. (2005). From Economic Foundations to S&T Policy Tools: a Comparative Analysis of the Dominant Paradigms. In P. Llerena & M. Matt (Ed.), *Innovation Policy in a Knowledge-Based Economy: Theory and Practice*. Berlin: Springer.
- Bleda, M., del Río, P., 2013. The market failure and the systemic failure rationales in technological innovation systems. *Research Policy* 42, 1039–1052. doi:10.1016/j.respol.2013.02.008
- Borrás, S., Edquist, C., 2013. The choice of innovation policy instruments. *Technological Forecasting and Social Change* 80, 1513–1522. doi:10.1016/j.techfore.2013.03.002
- Cave, J., Frinking, E., 2003. Public Procurement for R&D: Short Analysis of the Potential and Practices, in: Public Procurement and R&D: A JRC/IPTS-ESTO Fast Track Working Paper. European Commission Joint Research Centre-Institute for Prospective Technological Studies, European Science and Technology Observatory, Brussels, pp. 11–44.
- Chaminade, C., & Edquist, C. (2005). From theory to practice: the use of the systems of innovation approach in innovation policy. *CIRCLE Electronic Working Paper Series, No. 2005/02*. Lund: CIRCLE.
- Edler, J. (2009). Demand policies for innovation. *Manchester Business School working paper, No. 579*. Manchester: Manchester Business School.
- Edler, J., Georghiou, L., 2007. Public procurement and innovation - Resurrecting the demand side. *Research Policy* 36, 949–963. doi:10.1016/j.respol.2007.03.003
- Edler, J., Georghiou, L., Blind, K., Uyarra, E., 2012. Evaluating the demand side: New challenges for evaluation. *Research Evaluation* 21, 33–47. doi:10.1093/reseval/rvr002
- Edquist, C., Zabala-Iturriagoitia, J.M., 2012. Public Procurement for Innovation as mission-oriented innovation policy. *Research Policy* 41, 1757–1769. doi:10.1016/j.respol.2012.04.022
- Edquist, C., Zabala-Iturriagoitia, J.M., 2015. Pre-commercial procurement: a demand or supply policy instrument in relation to innovation? *R&D Management* 45, 147–160. doi:10.1111/radm.12057

- Ergas, H. (1987). Does technology policy matter? In B. R. Guile & H. Brooks (Ed.), *Technology and global industry: Companies and nations in the world economy* (p. 191–245). Washington, D.C.: National Academies Press.
- European Commission. (2003). *Investing in research: an action plan for Europe*. Luxembourg: Office for Official Publications of the European Communities.
- Foray, D., Llerena, P., 1996. Information structure and coordination in technology policy. *Journal of Evolutionary Economics* 6, 157–173. doi:10.1007/BF01202592
- Fraunhofer Institute Systems and Innovation Research. (2005). *Innovation and Public Procurement. Review of Issues at Stake*. (J. Edler, L. Tsipouri, L. Hommen, & J. Rigby, Ed.). Karlsruhe: Fraunhofer Institute Systems and Innovation Research.
- Georghiou, L., Edler, J., Uyarra, E., Yeow, J., 2014. Policy instruments for public procurement of innovation: Choice, design and assessment. *Technological Forecasting and Social Change* 86, 1–12. doi:10.1016/j.techfore.2013.09.018
- Geroski, P.A., 2000. Models of technology diffusion. *Research policy* 29, 603–625. doi:10.1016/S0048-7333(99)00092-X
- Guellec, D., 2001. Les politiques de soutien à l'innovation technologique à l'aune de la théorie économique. *Economie & prévision* 150, 95–105.
- Guerzoni, M., 2010. The impact of market size and users' sophistication on innovation: the patterns of demand. *Economics of Innovation and New Technology* 19, 113–126. doi:10.1080/10438590903016526
- Hommen, L., Rolfstam, M., 2009. Public Procurement and Innovation: Towards a Taxonomy. *Journal of Public Procurement* 9, 17–56.
- Howlett, M., 1991. Policy instruments, policy styles, and policy implementation. *Policy Studies Journal* 19, 1–21. doi:10.1111/j.1541-0072.1991.tb01878.x
- Klein Woolthuis, R., Lankhuizen, M., Gilsing, V., 2005. A system failure framework for innovation policy design. *Technovation* 25, 609–619. doi:10.1016/j.technovation.2003.11.002
- Knutsson, H., Thomasson, A., 2014. Innovation in the public procurement process: A study of the creation of innovation-friendly public procurement. *Public Management Review* 16, 242–255. doi:10.1080/14719037.2013.806574
- Laranja, M., Uyarra, E., Flanagan, K., 2008. Policies for science, technology and innovation: Translating rationales into regional policies in a multi-level setting. *Research Policy* 37, 823–835. doi:10.1016/j.respol.2008.03.006
- Lember, V., Kalvet, T., Kattel, R., 2011. Urban Competitiveness and Public Procurement for Innovation. *Urban Studies* 48, 1373–1395. doi:10.1177/0042098010374512
- Malerba, F. (1996). Public Policy and Industrial Dynamics: an Evolutionary Perspective. In C. Edquist (Ed.), *The Innovation Systems and European Integration (ISE) Final Report*. Linköping.
- Malerba, F., 2009. Increase Learning, Break Knowledge Lock-ins and Foster Dynamic Complementarities: Evolutionary and System Perspectives on Technology Policy in Industrial Dynamics, in: Foray, D. (Ed.), *The New Economics of Technology Policy*. Edward Elgar, Cheltenham, pp. 33–45.

- Mangematin, V., Callon, M., 1995. Technological competition, strategies of the firms and the choice of the first users: the case of road guidance technologies. *Research Policy* 24, 441–458. doi:10.1016/0048-7333(93)00776-P
- McCrudden, C., 2004. Using public procurement to achieve social outcomes. *Natural Resources Forum* 28, 257–267. doi:10.1111/j.1477-8947.2004.00099.x
- Montmartin, B., & Massard, N. (2014). Is financial support for private R&D always justified? A discussion based on the literature on growth. *Journal of Economic Surveys*, *Forthcoming*.
- Morgan, K., Sonnino, R., 2007. Empowering consumers: the creative procurement of school meals in Italy and the UK. *International Journal of Consumer Studies* 31, 19–25. doi:10.1111/j.1470-6431.2006.00552.x
- Mowery, D., Rosenberg, N., 1979. The influence of market demand upon innovation: a critical review of some recent empirical studies. *Research policy* 8, 102–153. doi:10.1016/0048-7333(79)90019-2
- Nelson, R.R., 1959. The Simple Economics of Basic Scientific Research. *Journal of Political Economy* 67, 297–306. doi:10.2307/1827448
- OECD (2010). *The OECD Innovation Strategy: Getting a Head Start on Tomorrow*. Paris: OECD Publishing.
- OECD (2013). *Government at a Glance 2013*. Paris: OECD Publishing.
- OECD (2014a). Intelligent Demand: Policy Rationale, Design and Potential Benefits. *OECD Science, Technology and Industry Policy Papers*, No. 13. Paris: OECD Publishing.
- OECD (2014b). *OECD Science, Technology and Industry Outlook 2014*. Paris: OECD Publishing.
- Rolfstam, M., 2009. Public procurement as an innovation policy tool: the role of institutions. *Science and Public Policy* 36, 349–360.
- Rolfstam, M. (2013). *Public Procurement and Innovation: The Role of Institutions*. Northampton: Edward Elgar.
- Rolfstam, M., Hommen, L., Edler, J., Tsipouri, L., Rigby, J., 2005. Literature Review: Innovation and Public Procurement: Review of Issues, in: Fraunhofer Institute Systems and Innovation Research (Ed.), *Innovation and Public Procurement. Review of Issues at Stake*. Fraunhofer Institute Systems and Innovation Research, Karlsruhe, Germany, pp. 3–29.
- Saviotti, P.P., Pyka, A., 2013. From necessities to imaginary worlds: Structural change, product quality and economic development. *Technological Forecasting and Social Change* 80, 1499–1512. doi:10.1016/j.techfore.2013.05.002
- Smith, K., 1996. Systems Approach to Innovation: Some Policy Issues, in: *The Innovation Systems and European Integration (ISE) Final Report*. Linköping.
- Steinmueller, W. E. (2010). Economics of Technology Policy. In B. H. Hall & N. Rosenberg (Ed.), *Handbook of the Economics of Innovation* (Vol. 2, p. 1181–1218). Amsterdam: North-Holland.
- Telles, P., 2010. Competitive dialogue in Portugal. *Public Procurement Law Review* 1–32.

- Uyarra, E., 2012. Review of Measures in Support of Public Procurement of Innovation, Compendium of Evidence on the Effectiveness of Innovation Policy Intervention. Manchester Institute of Innovation Research, Manchester.
- Uyarra, E., Flanagan, K., 2010. Understanding the Innovation Impacts of Public Procurement. *European Planning Studies* 18, 123–143. doi:10.1080/09654310903343567
- Vecchiato, R., Roveda, C., 2013. Foresight for public procurement and regional innovation policy: The case of Lombardy. *Research Policy* 43, 438–450. doi:10.1016/j.respol.2013.11.003
- Von Hippel, E., 1986. Lead Users: A Source of Novel Product Concepts. *Management Science* 32, 791–805. doi:10.1287/mnsc.32.7.791
- Wang, S., Bunn, M.D., 2004. Government/Business Relationships: Insights into Contract Implementation. *Journal of Public Procurement* 4, 84–115.
- Weber, K.M., Rohracher, H., 2012. Legitimizing research, technology and innovation policies for transformative change: Combining insights from innovation systems and multi-level perspective in a comprehensive “failures” framework. *Research Policy* 41, 1037–1047. doi:10.1016/j.respol.2011.10.015