Version final – 16th November 2012

Why Pre-Commercial Procurement is not Innovation Procurement

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Abstract

In 2006 the European Commission introduced the concept of "Pre-Commercial Procurement" as an instrument to promote innovation and to mitigate grand challenges. One of the main motivations for the support of Pre-Commercial Procurement schemes was to use public needs as a driver for innovation. This concept was also introduced as a response to the need to reinforce the innovation capabilities of the EU, while improving the quality and efficiency of public services. However, there is still a certain degree of confusion as to what is meant by Pre-Commercial Procurement and what rationales are behind it.

This paper addresses the differences between two public policy instruments, Pre-Commercial Procurement (PCP) and Public Procurement for Innovation (PPI), and clarifies what is meant by each of them. The analysis is based on three cases, one from the Netherlands, one from the UK and one from Australia. While PPI is a demand-side policy instrument, these cases provide evidence of the supply-side nature of Pre-Commercial Procurement in relation to innovation. The paper claims that PCP is a matter of R&D funding of a specific kind, geared towards very specific goals and in a focused way. Thus, we would like to raise a flag for going back to the origins of the PCP program, and calling it a pre-competitive R&D program rather than talking about procurement.

Keywords: Pre-Commercial procurement; Public Procurement for Innovation; R&D; Innovation; Innovation policy.

1. Introduction

A new European-level interest has recently emerged with regard to demand-side approaches to innovation policy and, more specifically, in the use of public demand as an engine for the development and diffusion of innovations (Edquist and Hommen, 1999). Edler and Georghiou (2007, p. 953) consider regulation, standardization and public procurement to be the main demand-side instruments. In 2004 the French, German and British governments issued a position paper to the European Council calling for the use of public procurement across Europe to spur innovation (French/German/UK Governments, 2004). This move continued and was manifested in various reports, including the Aho Group Report (Aho et al., 2006) which identified several application areas where demand-side policies could be used to a larger extent: e-Health, pharmaceuticals, energy, environment, transport and logistics, security and digital content.

Clearly, these application areas are very much related to the grand challenges specified in the Lund Declaration (2009). We believe that public innovation procurement policies can play a prominent role in the mitigation of grand challenges (e.g. global warming, tightening supplies of energy, water and food, ageing societies, public health, pandemics or security) (Edquist and Zabala-Iturriagagoitia, 2012). Needless to say, grand challenges may also be mitigated through other means and instruments, alone or in combination with procurement policies (Flanagan et al., 2011).

"Public technology procurement" had been practiced and discussed for a long time, as indicated in Edquist et al. (2000). Later, the language changed and the term "technology" was replaced by the concept of "innovation", reflecting a widening in the content of the notion. Edquist and Zabala-Iturriagagoitia (2012) use the term Public Procurement for Innovation (PPI) to denote public demand when it is used to trigger innovation. They consider that PPI occurs when a public organization places an order for the fulfillment of certain functions within a reasonable period of time (through a new good, service or system). The objective of PPI is to target functions that satisfy human needs or solve societal problems (Edquist and Zabala-Iturriagagoitia, 2012).

A recent communication from the European Commission (2006a, 2006b) addresses the phenomenon called "Pre-Commercial Procurement" (PCP), which is an EU-specific method for procuring Research and Development (R&D) services. The EU public procurement directives do not apply to PCP schemes (European Commission, 2008). PCP relies on using the R&D exemption in the EU procurement directives so as to adhere to the principles in the EU treaty as well as to EU state aid rules.[1] Accordingly, PCP schemes do not conflict with current

[1] Article 16f, included in the directive for public authorities (2004/18/EC), and Article 24e of the public procurement directive for utilities (2004/17/EC) state that these directives do not apply to "research and development services other than those where the benefits accrue exclusively to the contracting authority/entity for its use in the conduct of its own affairs, on condition that the service provided is wholly remunerated by the contracting authority/entity." In December 2011, the European Commission launched a proposal for a new directive to the European Parliament on public procurement (European Commission, 2011). This is the outcome of discussions on the regulations for public procurement in the EU (Martin et al., 1997; Bovis, 1998; Morand, 2003; Gelderman et al., 2006).

regulations, provided the processes are based on the guiding principles of public procurement, that is, open and free competition, transparency and equal treatment of operators and tenders. PCP concerns the R&D phase before commercialization (European Commission, 2008, p. 2), and as an approach to procuring R&D services, involves risk-benefit sharing but excludes State aid (European Commission, 2006b; European Commission, 2008, p. 6).[2] This implies that the private supplier will share the risk of the R&D, and that the public authority will not be required to purchase the good, service or system that may (or may not) result from the R&D (Sloth, 2011).

In PCP, the public purchaser does not reserve the R&D results exclusively for its own use (European Commission, 2008). In contrast, it is the supplier that solely owns the Intellectual Property Rights (IPR) or shares them (after negotiation) with the corresponding public agency.[3] Public authorities and industry thus share the risks and benefits of the R&D needed to develop new R&D-based knowledge, which may later lead to innovative solutions that will outperform those already available in the market (European Commission, 2008, p. 3). In this way, both parties have an incentive to pursue wide commercialization and take up innovative solutions.

The very term Pre-Commercial Procurement leads our thoughts in the direction of procurement of actual goods and services. PCP has sometimes been presented as a demand-side innovation policy instrument (Berman and Squire, 2011; DG Connect; 2012). Due to this demand-side assumption, PCP is often mixed up with another policy instrument, namely PPI. For example, Vinnova (the Swedish Governmental Agency for Innovation Systems), in a recent communication (where they build upon EU documents), refers to PCP as "procurement of innovations" (Vinnova, 2007, p. 45). Edler and Georghiou (2007, p. 954) also mix the two terms when stating that "the basic idea behind public pre-commercial procurement is that it targets innovative products and services for which further R&D needs to be done". Similarly, in June 2011 the European Commission organized a conference on innovation procurement in Torino (Italy),[4] with several hundred participants – mainly policy-makers, which reflects the increasing attention this topic is receiving in Europe. It was explicitly labeled a conference on "Public Procurement of Innovation" but mainly addressed issues related to PCP. One rationale for writing this article is based on the existing confusion between the two policy instruments, namely PCP and PPI.

[2] The following activities fall within the definition of R&D: basic research, industrial research, experimental development, and the production of a limited 0-series (see EC - 2006/C 323/01 and COM/2007/799). R&D does not include commercial development activities such as production, supply to establish commercial viability or to recover R&D costs, integration, customization, incremental adaptations and improvements to existing products or processes (European Commission, 2008, p. 2-3).

[3] The public agency can also share the R&D results with other public authorities and industry through publication and standardization, as well as through their commercialization (European Commission, 2008, p. 7). The public purchaser can also demand a free license to use the R&D results for internal use (ibid).

[4] http://www.comune.torino.it/relint/PPI/ (last access October 2012).

This paper intends to be a contribution to the so far non-existent scientific literature on PCP. We will try to advance the theoretical understanding of an area that has remained under-conceptualised up to now. This includes answering the question whether PCP can be regarded a demand-oriented innovation policy instrument. Further, we aim to identify similarities and differences between PCP and PPI. We will also analyse the relations between them and reflect on if and how they can complement each other as policy instruments, i.e. in an innovation policy instrument mix.

We base this article on empirical experiences by presenting three examples of PCP, one in the Netherlands, one in the UK and one in Australia. This is done in Section 3, where the three case descriptions are discussed in some detail. Before that, we define basic concepts in Section 2. Based on the evidence from these cases, Section 4 addresses the question of what is meant by PCP. Discussions on the characteristics of PCP as a demand or supply-side policy instrument in relation to innovation, and the differences and complementarities between PCP and PPI conclude the paper (Section 5).

2. Definitions and classifications[5]

Innovations are defined here as new creations of economic and societal significance, primarily carried out by firms (but not in isolation). They include product innovations as well as process innovations. *Product innovations* are new – or improved – material goods as well as new intangible services; it is a matter of what is produced. *Process innovations* are new ways of producing goods and services. They may be technological or organizational; it is a matter of how things are produced. To qualify as an innovation, the product or process needs to be commercialized, i.e. launched on the market.

Public procurement is related to the role of demand (Dalpé et al., 1992) and occurs when a public organization buys a product (a good, a service or a system). In *regular public procurement* processes, public agencies buy ready-made products "off-the-shelf", where no innovation is involved (e.g. pens, paper, etc.). Only the price and quality of the existing products are taken into consideration when the supplier is selected. Total public procurement accounted for 19.4 % of European GDP in 2009, i.e. the enormous sum of 2.3 trillion Euros (Kahlenborn et al., 2010).

In turn, *Public procurement for innovation* (PPI) occurs when a public organization places an order for a product (a good or a service or a combination of the two, which might be called a system) that does not exist at the time, but could (probably) be developed within a reasonable period of time. That is, innovation is needed in all PPI processes before delivery can take place. Below we introduce a taxonomy of different phenomena that are considered either PPI or

[5] This section is based on Edquist and Zabala-Iturriagagoitia (2012).

innovation procurement.[6] This classification is made according to two dimensions, the user(s) and the character of the procurement process. The first dimension refers to the user of the resulting product (good, service, system, etc.), which can be used to identify two different categories of PPI: direct and catalytic:

- *Direct PPI* occurs when the procuring organization is also the end-user of the product resulting from the procurement. This is the "classic" case when the buying agency itself uses the resulting product. The buying agency uses its own demand or need to influence or induce innovation. This type of PPI refers to the procurement undertaken to meet the (mission) needs of the public agency. In spite of this, the resulting product is often diffused to other users. Hence, innovations resulting from PPI can be useful for the procuring agencies, as well as for society as a whole.
- *Catalytic PPI* is when the procuring agency serves as a catalyst, coordinator and technical resource for the benefit of the end-users. In this PPI form, the needs are located 'outside' the public agency acting as the 'buyer'. Hence, the procuring public agency is not the end-user of the resulting product, but aims to 'buy' new products on behalf of other actors (public or private). It acts to catalyse the development of innovations for broader public use and not for directly supporting the mission(s) of the agency.

The second dimension refers to the character of the procurement process and the degree of innovation of the resulting product. This dimension consists of three types of procurement:

- *Pre-commercial procurement (PCP)* refers to the procurement of (expected) research results, i.e. it involves direct public R&D investments. However, it does not involve the purchase of a (non-existing) product, so no buyer is involved. This type of procurement may also be labeled 'contract' research.
- *Adaptive PPI* occurs when the procured product or system is only new to the country (or region) of procurement. Innovation is thus required in order to adapt the product to specific (national, local) conditions. It may also be labeled 'diffusion oriented' or 'absorption oriented' PPI. It implies incremental innovation.
- *Developmental PPI* implies the creation of new-to-the-world products and/or systems as a result of the procurement process. It may be regarded as 'creation oriented' PPI and involves radical innovation.

It is worth noting that all these types of procurement are open only to the participation of firms as suppliers, i.e. other agents in the innovation system are excluded. This paper focuses on one of these types of procurement, PCP. In the next section we will provide descriptions of three PCP initiatives, two of them from Europe (the Netherlands and the UK) and one from Australia.

[6] Our typologies are based on the contributions by Edquist et al. (2000), Hommen and Rolfstam (2009), Edler (2009) and Uyarra and Flanagan (2010).

3. Case studies

3.1. Introduction to the case studies

This section introduces three case descriptions that aim first to clarify whether PCP can be regarded a demand-side innovation policy instrument. As we will see, the three cases provide reasons for us to qualify PCP as a supply-side policy instrument in relation to innovation.[7] Second, we want to provide evidence that PCP is a different (but still related) instrument to PPI.

The reason for focusing on these three cases is the experience that the three countries have gained in the application of PCP schemes (OECD, 2011). Despite the differences in their institutional (i.e. regulatory) environments, the reader will appreciate the uniformity of the PCP process in all three locations. The methodological approach followed is exploratory. Information on each case has been compiled by accessing relevant documents such as calls for tenders, scientific literature, policy documents and evaluations and other written materials and reports.

The first case refers to the development of a real-time dike observation and inspection system, an initiative launched by the Directorate-General of Public Works and Water Management as part of the Dutch Small Business Innovation Research (SBIR) program. The program was divided into a three-phase competition: feasibility, research phase and commercialization. The first two stages were totally funded by the contracting authority, but the respective company was in charge of financing the commercialization. Hence commercialization was not actually included in the program. Two proposals were tested in this *DigiDijk* process. Although the program did not aim at producing new products on a large scale, these two prototypes were afterwards transformed into commercial applications, financed by the firms.

The second case exemplifies one of the multiple cases funded under the Small Business Research Initiative (SBRI) scheme in the UK, one of the most active countries in the use of public procurement as an instrument to boost innovation. The '*Making Waves'* initiative, supported by the Department for Business Innovation and Skills and the Technology Strategy Board, aimed to develop technologies capable of converting gestures or sign language into digital data, so that people with communication difficulties could function effectively and independently.

The third case illustrates the procedure followed by the Smart SMEs Market Validation Programme (*MVP*), one of the programs defined by the Victorian Government (Australia). It aims to identify the technology needs of Victorian public sector entities and match them to small medium-sized enterprises´ (SMEs) innovative capabilities. It is qualified as a PCP program,

[7] The reader may wonder why only examples of PCP practices are illustrated if one of the goals of the paper is to address the differences between the two types of policy instruments (read, PCP and PPI). For a compilation of cases on PPI and their implications, see Edquist and Zabala-Iturriagagoitia (2012).

whereby SMEs undertake R&D activities to provide solutions that meet the needs of public agencies.

Table 1 summarizes these cases in more detail, according to a set of dimensions related to three distinctive aspects of procurement initiatives: the characteristics of the process, the procurer and the supplier.

1. PCP process
    a. Challenge/need: illustrates the point of departure of the policy. What was the challenge/problem/unsatisfied need?
    b. Result of the procurement process: describes whether a product (material good or intangible service) or system was the intended result; i.e., to mitigate the challenge. Or were R&D results the intended output?
    c. Degree of cooperation and type of call: was there an open call where potential suppliers could "bid" in competition or was the call restricted to selected suppliers? This dimension shows whether the procurer cooperated with the supplier(s) during the PCP process, if there was communication (i.e. consultation/dialogue/ partnership) among them, etc. Did this differ in the various stages of the process?
    d. Intended consequences: other intended consequences that the results had on the identified challenge/need/problem.
    e. Unintended consequences: other unintended consequences of the policy (e.g. regarding profits, exports, etc.).
    f. Type of subsidy: shows how the PCP process was funded, by R&D subsidies, by promising (the purchase of) a future order, by offering economic rewards, etc.
    g. Instrument mix: illustrates whether other policy instruments were also used as a complement to the PCP process.
2. Procurer
    a. Who was the procurer: identifies the organization acting as a procurer of the intended result.
    b. Functional/Technical specifications: illustrates whether the procurer developed functional or technical specifications, or both, prior to launching the PCP process. How did the procurer develop the specifications?
    c. End-user: identifies who was the end-user of the (intended) result of the PCP.
3. Supplier
    a. Who was the supplier: identifies the organization/firm acting as the supplier of the intended result.
    b. Award criteria: defines the criteria by which the supplier was awarded the contract.

Following these dimensions, sections 3.2, 3.3 and 3.4 contain more thorough descriptions of each case.

Table 1: Detailed summary of case descriptions

	1. PCP process						
	A. Challenge/ Need	B. Results	C. Cooperation and type of call-Consultation / dialogue / partnerships	D. Intended consequences	E. Unintended consequences	F. Type of subsidy	G. Instrument mix
1. DigiDijk	Keep the low-lying regions of the Netherlands from flooding	Develop R&D-based knowledge for permanent, real-time dike monitoring	Open call Consultation and dialogue with district water boards and regional dike boards, in early and late stages	Match technological solutions to societal problems Develop R&D-based solutions	Growth of spin-off companies Spillovers to other sectors	R&D grant	R&D funding
2. Making waves	Develop technologies enabling learners with communication difficulties to function effectively and independently	Develop communication systems that enable people with disability or communication difficulties to interact with others	Open call	Develop new software to help users communicate with other people without the need for an intermediary support worker Evolve their communication skills by building up a vocabulary of translatable gestures	-	R&D grant	R&D funding
3. MVP	Assist SMEs to undertake R&D and match the needs of public agencies	Prioritize technology requirements of public agencies Stimulate and support local SMEs	Open call (only within Australia) Information sessions Consultation of agencies´ needs Collaboration - among SMEs, universities and research institutes - to develop new technologies	Technological development Match R&D-based solutions to public needs	Still running Cooperation (between SMEs and with universities and R&D centers)	R&D grants	Industrial policy SME policy R&D policy Competition policy

	2. Procurer			3. Supplier	
	A. Who was the procurer	B. Functional/Technical specifications	C. End-user(s)	A. Who was the supplier	B. Award criteria
1. DigiDijk	Dutch Directorate-General of Public Works and Water Management (Ministry of Transport)	Functional (expressed as a desired outcome)	District Water Boards	Alert Solutions Hansje Brinker	Impact on ecological and societal aspects Entrepreneurship Innovation Budgeted costs Added value for society Technical, economic and organizational feasibility
2. Making waves	Technology Strategy Board Department for Business, Innovation and Skills	Functional	People with communication difficulties (i.e. deaf or motor disabilities)	Technabling Gamelab	Free and open source software model Accessibility and cost effectiveness Technical feasibility Skill set and experience of the company Technical, commercial and environmental risks Project management
3. MVP	Victoria Department of Innovation, Industry and	Public agency needs	None (yet)	Victorian SMEs	Scope of the R&D project Location of R&D

	Regional Development (DIIRD)				Resources required Milestones Costs and financing Risk management Commercialization plan

Source: own elaboration

3.2. Digital Dike (DigiDijk) - Real time dike observation and inspection

In 2004, the Dutch government implemented its Small Business Innovation Research (SBIR) program with the aim of finding innovative solutions to societal issues within a short time span (NL agency, 2011). Although the name of the program may suggest that SMEs constitute its target group, any company, regardless of its size, stands a chance in SBIR tendering procedures (NL agency, 2011, p. 2).

The US Small Business Innovation Research (SBIR) program was the role model for the Dutch SBIR. The US program was created in 1982 through the Small Business Innovation Development Act. The aims (Small Business Innovation Development Act, 1982, p. 97) were:

a) to stimulate technological innovation;
b) to use small business to meet Federal research and development needs;
c) to foster and encourage participation by minority and disadvantaged persons in technological innovation; and
d) to increase private sector commercialization innovations derived from Federal R&D.

The US SBIR program may be regarded as an example of PCP as it aims to generate multiple R&D-based knowledge outputs.[8] These R&D outputs may later reach the market through a mix of post-SBIR funding from a variety of sources such as venture capital, non-SBIR federal funds or foreign investment.

Initiated in 2004, the Dutch SBIR program significantly increased its budget from 0.2 million euro in 2004 to 26.3 million euro in 2010 (NL agency, 2011, p. 2; Sloth, 2011, p. 13). The procedure in the Dutch SBIR starts with a public authority identifying a specific challenge or a societal issue for which new solutions are needed, and making a budget available for it (NL agency, 2011, p. 4).[9] Then the public authority launches an open competition within a specific tender period. All competitions are expressed as a desired outcome or challenge/need to be solved rather than a detailed set of specifications. An independent evaluation committee reviews the proposals according to the following criteria: impact on the societal issue, economic prospects, ecological and societal aspects, contribution to the solution of public demand and entrepreneurship, (technological) quality and degree of innovation, budgeted costs and added value for society (NL agency, 2011, p. 4; Sloth, 2011, p. 15).

As in the US SBIR, contracts are awarded in a three-phase competition: feasibility, research phase and commercialization. The Dutch contracting authority fully funds the first two phases

[8] These varieties of knowledge outputs are embodied in "data, scientific and engineering publications, patents and licenses of patents, presentations, analytical models, algorithms, new research equipment, reference samples, prototypes products and processes, spin-off companies, and new human capital" among others (Wessner, 2008, p. 3).

[9] This is a point of contrast with the US program, which essentially mandates that 2% of federal agency R&D budgets must be directed to small firms, which are supposed to carry out R&D projects and activities to support agency missions (Vonortas et al., 2011).

through a fixed-cost R&D contract, while the company must finance the commercialization. In other words, the commercialization is actually not part of the PCP program. The possible resulting IPR remain with the company.

During the feasibility stage (phase 1), companies must demonstrate the practicability of their proposal; that is, establish the scientific and commercial potential of their idea in order to solve the identified need or challenge (maximum of 6 months, maximum of 50,000€ per project). At this stage the technical, economic and organizational viability of the project idea is defined. The contracting authority decides which projects will be commissioned as phase 2 contracts. In the research phase (phase 2), R&D activities are carried out until a first, non-commercial prototype is obtained (maximum of 2 years, maximum of 450,000€ per project). Finally, in phase 3, the companies start preparing their prototypes/solutions for market launch. However, as pointed out above, this phase is not financed by the Dutch SBIR.

Here we will focus on one of the cases funded by the SBIR in the Netherlands (Roos, 2011), a typical Dutch one: Real time dike observation and inspection. As is well-known, dikes are crucial elements to keep the low-lying regions of the Netherlands from flooding. Some dikes have been broken: Wilnis in August 2003 and Stein in January 2004. The Directorate-General of Public Works and Water Management (Ministry of Transport) decided that there was a need to find new solutions for monitoring dikes, and saw an opportunity to achieve it through the SBIR. The "DigiDijk", a real time dike observation and inspection project, was started in 2007. The invitation for bids to the private sector was simple and reflected a broad challenge: Is it possible to apply new technologies for conducting permanent, real-time dike monitoring and early detection of weak spots?

21 proposals were received for phase 1. Five of them were allocated funding for a feasibility study. Of these five, two were selected for further development in April 2008 to create a prototype in collaboration with several district water boards. The two proposals – both start-ups, were 'GeoBeads' (from Alert Solutions) and 'Monitoring of Dikes from Space' (from Hansje Brinker).[10] GeoBeads revolved around measurement instruments (sensors) installed within the structure of the dike itself, which sent data to a central station (NL agency, 2011). The Monitoring from Space proposal provided dike inspectors with software enabling them to detect any type of movement and alteration in size by satellite footage. While GeoBeads was particularly interesting for use on a smaller scale, Monitoring from Space offered added value when used on a larger scale. The two systems complemented each other, even if that was not the original intent.

[10] Alert Solutions was founded in 2007 and had 2 employees during the involvement in the DigiDijk project. The company had established cooperation with well-known companies like GeoDelft and 2M Engineering Ltd. Hansje Brinker was a spin-off of TU Delft, also founded in 2007 and with 2 employees at the time of the DigiDijk project (Roos, 2009).

The involvement of water boards from the start of the PCP project did not guarantee that the solutions would be purchased. In fact, it took a lot of commercialization efforts for the companies to find their first customers. In this sense, the two companies benefitted from the networks of the contracting authority with water control boards, and built on the IPR they got from the DigiDijk project. Alert Solutions sold the Geobeads system to five district water boards. Hansje Brinker also sold its system to Hondsbossche en Pettemer Zeewering, the highest dike in the Netherlands. Nowadays both companies have their products in the market, and can expand to other application areas on the basis of their unique product basis. Something that holds true for both innovations is that they can also be used for purposes other than those originally intended, including opportunities in the building sector, for example monitoring risks in and near excavation sites (NL agency, 2011, p. 5).

3.3. Making Waves: Gesture-based communication system

One of the countries that has adopted a more hands-on approach towards the promotion of procurement policies is the UK. In 2011, the UK introduced the Small Business Research Initiative (SBRI) which earmarked a share of the government's procurement budget for SMEs through competitive R&D contracts (OECD, 2011, p. 41). The SBRI aims to use government procurement to drive innovation by providing business opportunities for innovative companies to solve the specific challenges facing government departments and public sector organisations. The goal is to create research and development intensive SMEs as well as raising their awareness of the future commercial benefits that the research base can offer.[11]

The SBRI is one of the tools that the Technology Strategy Board uses to enhance innovation in the UK. The Technology Strategy Board, which is sponsored by the Department for Business, Innovation and Skills, is a business-led executive non-departmental public body, established by the government. In order to increase economic growth and improve the quality of life, its role is to promote and support research into, and development and exploitation of, technology and innovation for the benefit of UK business.

Within the UK SBRI, we will focus on the 'Making Waves: Gesture-based communication system' initiative. This SBRI competition, launched on 10th January 2011, sought the development of location and gesture-based communication systems which could enable learners with disability or communication difficulties to interact with mobile technologies, resulting in the production of text and/or audio input or execution of commands (Innovate UK, 2012).[12]

The competition was structured in two phases. Phase 1 (proof of concept) was intended to show the technical feasibility of the proposed concept. The SBRI funding covered 100% of all eligible costs for a maximum of 6 months, with a total amount of £250,000 for this phase 1. Phase 2

[11] http://www.bis.gov.uk/policies/innovation/procurement/sbri (last access October 2012).
[12] http://www.innovateuk.org/content/competition/making-waves-gesture-based-communications-system.ashx (last access October 2012).

(development of prototype) was intended to develop and evaluate prototypes or demonstration units from the most promising proposals in phase 1. A set of eleven evaluation criteria were defined, going from the possibility of developing a free and open source software model, to assessing the accessibility, technical feasibility and cost effectiveness of the solutions or the skill sets of the candidate companies (Technology Strategy Board, 2011).[13]

The deadline for the submission of proposals was set (15th March 2011) two months after the call was announced, so applicant companies were expected to respond rapidly. The contracts with the successful candidates were expected to be issued on 21st April 2011, and the feasibility of the solutions was expected to be assessed by 28th October 2011 (Technology Strategy Board, 2011).

Three candidates were funded for phase 1, and after a period of rigorous review and assessment the two successful companies that progressed to phase 2 were Gamelab (London) and Technabling Ltd. (funded at the University of Aberdeen). Gamelab developed an interactive gesture recognition programme (uKinect) based on Microsoft Kinect technology. The 'Portable Sign Language Translator' from Technabling enabled non-signers to communicate with signers by translating their signs into text. This was a portable, flexible and customizable solution, so it could accommodate a range of different sign languages and work with a wide variety of handheld camera-enabled devices (e.g. laptops, smartphones, tablet devices). These two projects on gesture recognition allowed the user (i.e. people with communication difficulties, either deaf or motor disabilities) to 'talk' to the device in sign language. The gestures were then captured, stored up and software processed to recognise sequences of user gestures through a locally stored library of core concepts or words. These were then assembled into sentences, which are outputted as text in real time (Innovate UK, 2012).

Many in the British sign language community are showing interest in how uKinect and the Portable Sign Language Translator may be used in both educational and social settings, so this could be an important potential market.[14] However, both companies are still working to advance their technologies in order to capture the whole set of British sign language and transform their prototype into a full-fledged product affordable for the average person.[15]

This case illustrates how this type of public support for the satisfaction of a social need does not imply any real purchase, but only funding of R&D activities. In fact, the call from the Technology Strategy Board explicitly states that if the "technology development is successful, every effort will be made to source and purchase the innovative product from the organisation.

[13] The proposals also needed to meet the following functional specifications: accessible and usable, discreet, robust and transferable, responsive, based on location based technologies, adaptable to/sustainable with technological developments, simplified use, online and offline usage, built in help and guidance for usability issues (Technology Strategy Board, 2011).

[14] http://www.scoop.it/t/sensory-impairment-solutions/p/2449781917/inclusion-in-elearning-blog (last access October 2012).

[15] http://www.enterprise-europe-scotland.com/sct/news/index.asp?newsid=3369 (last access October 2012).

However there is no commitment to do so or to purchase any specific quantity in this phase of the competition" (Technolosy Strategy Board, 2011, p. 4).

3.4. Smart SMEs Market Validation Programme (MVP)

The Smart SMEs Market Validation Programme (MVP) (AU$ 28 million) is one of the programs included in the Victorian Government Innovation Statement (Australia), managed by the Department of Innovation, Industry and Regional Development (DIIRD).[16] On the one hand, the aim of the MVP is to identify the needs of Victorian public sector entities and match them to SMEs with the specific potential capability to meet those needs. On the other hand, and according to Berman and Squire (2011, p. 98), it also aims to assist these SMEs to create and commercialize new intellectual property and develop globally competitive technology, products and services.

We acknowledge that PCP is an EU-specific program. However, it might be a good idea to remember that, despite the EU-supported origin of PCP, there are also differences in Europe about what is meant by PCP. Different support mechanisms have been implemented across the EU in order to embody PCP as a policy instrument; e.g. the Dutch SBIR programme, the British SBRI programme, the Flemish Action Plan on Procurement of Innovation, the Swedish Forska & Väx and the Hungarian Észak-Alföld programme (Sloth, 2011). By including a case from a non-EU country that has nevertheless used the same PCP scheme, we want to put this particular policy instrument into perspective.

Berman and Squire (2011, p. 98) qualify it as a "demand-driven programme… [which] differs from a traditional supply-side grant programme in that the MVP invites public-sector entities to identify their priority technology requirements (thereby becoming the client of the programme) and SMEs are given the opportunity to undertake R&D in an environment in which they are able to prove their new technology in a real-world customer context". However, these authors also consider the programme to be one that revolves around a technology-pull mechanism, as "an [public] entity's demand for particular types of R&D for innovation pulls the need for these technologies onto the market" (p. 99). Let us come back to this in order to provide some clarification later (section 4).

As in the previous cases, the MVP also takes the US SBIR programme as a starting point, sharing some of its rationales. Nonetheless, it differs from the latter in many ways. First, the MVP encourages voluntary participation by public-sector entities. Second, the MVP is open to about 300 public agencies and organizations in the state of Victoria. Last, the MVP is open to SMEs with fewer than 200 employees. The MVP involves two rounds of grants over a four-year

[16] http://tafecentre.vic.edu.au/wp-content/uploads/2009/03/innovationvictoriasfuture_000.pdf (last access September 2011).

period, and is divided into three stages: (i) Technology Requirement Specifications (TRS), (ii) feasibility study and (iii) proof of concept.[17]

The process begins with Victorian public agencies identifying a specific need associated with their mission and for which there is no commercial solution on the market. Approved TRS are then included in a call for proposals inviting SMEs to propose an R&D-based solution to the need. During the second stage, SMEs develop their own concepts, showing that they propose a new solution which potentially can be a basis for intellectual property. Successful firms receive a grant of up to AUD 100,000 (from the DIIRD) to develop a feasibility study. The MVP offers the possibility of funding more than one SME for the same TRS, which increases competition among bidders. This feasibility study (3 months) is assessed by the host entity (i.e. agency defining the need) together with industry experts and the DIIRD. The assessment criteria include the scope of the R&D project, the main location for the development of the R&D, the resources required, key milestones, staff, costs and financing, risk management strategy and commercialization plan.

If the proposed project is approved, the SME is given the opportunity to prove its concept. In this last stage, the SME is supported with up to AU$ 1.5 million over 2 years. The firm retains all the IPR, while the funding entity formulating the problem retains a license to use them. The successful completion of the proof of concept finally leads to a demonstration of the solution. Once the host entity accepts the developed solution, the R&D obligations of the program are finished - with no guarantee from the public agency that procurement will follow (Berman and Squire, 2011, p. 100).

In August 2008, when the MVP was announced, several information sessions were conducted in order to disseminate the content of the program. As the assessment criteria above reflect, collaboration (among SMEs or between SMEs and universities or research institutes) was not included as one of the key principles for the selection process. However, eighty five SMEs (69% of all submissions) indicated an intention to collaborate with another enterprise, a university or publicly funded research facility in the development of their solution. Hence, collaboration was an important determinant in the formation of the proposals (Edquist and Zabala-Iturriagagoitia, 2012).

The first round of the program opened in 2009. For stage 1, 74 TRS were submitted by 27 public-sector entities. 19 TRS from 11 agencies were shortlisted for stage 2, which attracted 124 submissions from Victorian SMEs during the feasibility study.[18] These were sent to the

[17] http://www.egov.vic.gov.au/victorian-government-resources/case-studies-victoria/vps-innovation-case-studies/smart-smes-market-validation-program-vps-innovation-case-study.html (last access September 2011).

[18] For some of these TRS and the companies that submitted feasibility studies see: http://www.government-grant.com.au/2010/10/market-validation-program-round-2/ (last access September 2011).

respective host agencies for their selection. After evaluation of the feasibility studies, nine projects progressed toward the proof of concept phase.[19]

The first round of the MVP finished not long ago, so a comprehensive assessment of its effects cannot yet be done. However, some interesting trends can be observed. One of them is the high levels of intended collaboration of the received proposals (69%) and the high representation of SMEs with fewer than seven employees (Berman and Squire, 2011, p. 101). In addition, a relatively high number of proposals (70) were received from SMEs with no prior R&D performance history. This is significant, as it indicates that the program has supported the entry of new actors in the innovation system.

4. What is Pre-Commercial Procurement (PCP)?

PCP is receiving increasing attention in Europe. However, to date, we cannot refer to any academic studies in this area - which explains why most references come from official reports, white papers and national policy initiatives.[20] As noted in the introduction to this article, PCP is sometimes called "innovation procurement" or even "Public Procurement of Innovation". In our view this is inaccurate, since PCP is not a matter of procurement of innovations (which PPI is). The aim of this section is to provide clarification of what is meant by PCP.

PCP is defined as "a process by which public authorities in Europe can steer the development of new technologically innovative solutions that can address their specific needs" (European Commission, 2006b, p. 2). One of the rationales for the support of PCP policies is to provide the missing link in the development of completely new 'yet-to-be-designed' technology research in Europe (European Commission, 2006a, p. 18).

PCP is regarded by the European Commission (2006b) as an interactive learning multi-stage, multi-competitor process/method for procurers, suppliers and users, since the capabilities of new technological developments on the supply-side are intended to match the needs on the demand side (OECD, 2011). In general, PCP practices are managed in three steps:

1. Solution exploration phase (~ 6 months): where a number of offers from competing suppliers are selected.
2. Prototyping phase (~ 2 years): where the chosen suppliers develop their own models or solutions in parallel.

[19] For the nine proof of concepts and the companies that were chosen to solve them see: http://www.business.vic.gov.au/BUSVIC/STANDARD/PC_64101.html (last access September 2011).

[20] One of the reasons for the lack of scholarly discussion on PCP may be that in academic environments PCP is regarded as a new branding or buzzword referring to the traditional procurement of R&D results, a field where several contributions can be found (Rothwell, 1986; McGarrah, 1987; Smith, 1990; Mowery and Simcoe, 2002; Miles, 2007; Fuchs, 2010; Vonortas et al., 2011).

3. Testing phase (~ 2 years): where at least two suppliers remain to ensure future competition in the market. The solutions are validated through field tests.

The PCP process (as outlined by the European Commission, 2008) starts with a pre-commercial tendering initiated by a public agency, which intends to provide a solution to a societal or agency need/challenge by means of curiosity driven research. Once the feasibility studies have been received from candidate companies for this solution exploration (phase 1), they are subject to an intermediate evaluation according to a predefined set of criteria. Some of the candidate companies are shortlisted for a second phase, in which they conduct the required R&D activities until a first, non-commercial prototype is obtained. Once the assessment of these prototypes is finished, some of them are invited to test a limited number of these prototypes under field conditions (phase 3).

After these field tests a commercial tendering may take place, either by the same agencies funding the PCP scheme or by others (public or private[21]) interested in the results of the PCP process. The firm that developed the solutions may also try to commercialize its solutions on its own. However, this commercial tendering or commercialization, which may lead to a (real) procurement, is not part of the PCP scheme.

From our point of view, the language used in the third phase of the PCP process is confusing. The European Commission calls this phase (2008, p. 8), "original development of a limited volume of first products/services in the form of a test series". However, testing a prototype (or a series of prototypes) under field conditions is not the same as developing a product innovation. As indicated earlier (see definition of innovation in section 2), innovations necessarily require commercialization through launching on the market. This is not completed by prototype testing. A prototype is interpreted as an effective model or archetype that needs to work under certain conditions, but without including its further market exploitation/use. A prototype (or a limited number of copies of it) only intends to demonstrate its effectiveness in mitigating the challenge/need and suitability for production according to the required quality standards (European Commission, 2006a, p. 21). It does not include its production on a large scale, and therefore does not have to prove any commercial viability.

A scheme with similar characteristics to the PCP is the "pre-competitive R&D programs" created by the EU in the 1980s (European Commission, 2006a). The main goal of these pre-competitive R&D initiatives was to conduct R&D activities which were "distanced from the market, being focused on 'generic' or 'enabling' technologies rather than the development of final-use products targeted on specific markets" (Quintas and Guy, 1995, p. 326). As Quintas and Guy discuss, despite the fact that these programs "covered a spectrum of work from applied research through to near-market development… [they were] not expected to produce commercially usable process

[21] If a public agency is involved, this would constitute an example of regular public procurement – see definition in section 2.

technologies or products, but rather to reach the stage of demonstrating feasibility or providing research prototypes" (ibid).

The Dutch and British cases illustrate that a PCP project may (but not necessarily will) have an impact on the development of innovative products, despite the fact that this is not part of the PCP scheme. The intention is to induce companies to create R&D-based solutions to existing societal challenges (i.e. avoiding risks from flooding and allowing people with communication difficulties to be able to communicate effectively and independently), not to achieve commercialization. It is more a matter of public funding of applied R&D ('D' rather than 'R') that is socially relevant - in the sense that it takes its point of departure from a specific challenge. The PCP form of R&D funding is very 'purpose-oriented' or 'focused' and certainly not a matter of general R&D funding without a specific target. Hence, we would like to raise a flag for going back to the origins of the PCP program, and calling it a pre-competitive R&D program rather than a procurement instrument.

Presumably, both winning the competition and progressing through the subsidized proof of concept development convey some marketing advantage to the winning firm and the associated technical solution. Hence, it could be argued that PCP may aid companies, particularly SMEs, to take a leadership position in technological development, which may set the basis for future exploitation in new markets. It might also be that no product or system can be developed on the basis of the R&D results emanating from the PCP. And, of course, the PCP may fail in the sense that no R&D results at all emerge. Therefore, PCP cannot be considered a particular type of PPI in our sense of this term (see section 2). PPI and PCP may complement each other as parts of a policy instrument mix, but they should not be mixed up.

5. Policy implications and discussion

This paper has aimed to answer the question of whether PCP can be regarded as a demand-side innovation policy instrument. We have defined Pre-Commercial Procurement (PCP), argued why it should not be considered as a particular type of Public Procurement for Innovation (PPI), shown the main stages in which it is realized, and presented three examples of PCP initiatives from three countries. This section contains the conclusions and policy implications arising from the above analysis. We aim to make a contribution to both the theory and practice of an area that has so far remained under-conceptualised. We will first discuss whether PCP is a demand or supply-side policy instrument in relation to innovation (section 5.1), then analyse the differences and relations between PCP and PPI and discuss how both instruments can complement each other in an innovation policy instrument mix (section 5.2). The section will close by illustrating how some of the weaknesses of the PCP model may be overcome (section 5.3).

5.1. Is PCP a supply or demand-side instrument in relation to innovation?

PCP refers to the acquisition of expected research results and entails direct public R&D investments. PCP is not expected to produce commercial product innovations, but rather to reach the stage of demonstrating feasibility or providing prototypes addressing social or agency needs/challenges.

Edler and Georghiou (2007, p. 954) indicate that in PCP schemes "the procurement in fact is an R&D service contract, given to a future supplier in a multi-stage process, from exploration and feasibility to R&D up to prototyping, field tests with first batches and then, finally, commercialization". However, no real purchase of a resulting product is made by procuring public agencies, and the IPR belong to the SMEs, not to the public agency acting as a 'procurer' (Sloth, 2011). Just like the pre-competitive R&D programs, PCP does not imply any intention or guarantee from the public agency funding the PCP initiative to buy the resulting R&D services/solutions (Quintas and Guy, 1995; OECD, 2011). This was evidenced by the three cases in section 3, in which the calls for solution exploration proposals were formulated as public agency or societal challenges/needs. Hence commercialization is not a part of the PCP process.

Since PCP aims at providing (R&D-based) solutions to existing challenges, no buyer could be identified. The Dutch Directorate-General of Public Works and Water Management, the Technology Strategy Board, the Department for Business, Innovation and Skills and the Victorian Department of Innovation, Industry and Regional Development acted as the funding agencies, but they did not act as the buyers of the solutions. Commercialization activities, i.e. the sales of the product on a large scale, do not lie within the boundaries of the PCP process, contrary to what Edler and Georghiou seem to suggest.

As we have indicated in the MVP case (section 3.4) Berman and Squire (2011, p. 98) qualify PCP as a "demand-driven programme… [which] differs from a traditional supply-side grant programme in that… [it] invites public-sector entities to identify their priority technology requirements… and SMEs are given the opportunity to undertake R&D in an environment in which they are able to prove their new technology in a real-world customer context". However, and based on the arguments above, it is our contention that their classification of PCP as a demand-side instrument as suggested by, for example, Berman and Squire (2011) and DG Connect (2012) should be questioned.

Demand-side innovation policies are 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). Based on the evidence from the three cases it can be said that PCP schemes foster the development and diffusion of R&D-based solutions, but they do not intend to increase their demand. We consider PCP to be a supply-side instrument in relation to innovation, rather than a demand-based one.

Following our definition of PPI, the DigiDijk, the Making Waves initiative and the market validation programme are not examples of PPI. In the case of the DigiDijk, we have seen how, after the completion of the PCP program, Alert Solutions and Hansje Brinker (the two companies awarded contracts) managed to sell their systems to different water boards in the Netherlands through regular procurement. Something very similar also occurred in the Making Waves case with Technabling and Gamelab. Commercialization cannot be regarded as part of the PCP process in either case, as none of the procurers funded the commercialization of the selected solutions, nor was there any commitment from the funding public agencies to buy the resulting product. The procurements (selling and buying) that followed these PCP processes may be regarded as examples of the acquisition of off-the-shelf products, i.e. it was a matter of regular procurement. The PCP resulted in the development of prototypes that were commercialized outside the PCP process. Without the PCP interventions, however, these prototypes may not have existed or perhaps existed much later.

Summing up, PCP involves public financing of R&D and thus has to be considered a supply-side innovation policy instrument in relation to innovation (as opposed to PPI, which is a demand-side instrument), since the responsibility for a possible commercialization lies with the company. Accordingly, PCP may be defined as a technology-push rather than a market pull instrument in relation to innovation. However, PCP may be considered a demand-side policy instrument in relation to R&D.

5.2. Different but complementary: integrating the PCP in a policy instrument mix

The goal of this sub-section is to discuss the differences between PCP and PPI, i.e. unpack their rationales, analyse their processes, and justify if and how they can complement each other.

As we have shown, the commercial tendering (or other mode of commercialization) that leads to the procurement of product innovations is located outside the PCP process. Accordingly, a distinction should be made between the procurement of R&D results and innovation procurements. Many of the SMEs participating in PCP initiatives may later develop their prototypes and manage to commercialize their products. Since the PCP scheme only funds the R&D stages, aiming at developing new solutions up to a certain level of readiness, evidence shows that commercialization successes still require substantial subsequent funding – e.g. private funding, other non PCP-related public agency funding, or even PPI (Ramboll Management, 2007; Wessner, 2008; OECD, 2011).

It is not uncommon for innovation policy instruments to be called differently but share the same rationales, or be nominally the same but aim at different things. Arguably, two instruments may also share the same name and yet have entirely different rationales. From our point of view, the complementarities between PPI and PCP are considerable.

PCP is defined as "a process by which public authorities in Europe can steer the development of new technologically innovative solutions that can address their specific needs" (European

Commission, 2006b, p. 2). This definition stresses the problem-solving character of the intervention, not the commitment to buy the results derived from it. PPI occurs when a public organization places an order for a product that does not exist at the time, but could (probably) be developed within a reasonable period of time (Edquist et al., 2000). That is, innovation (and hence market commercialization) is needed in all PPI before delivery can take place, as the unit subject to purchase is a product/system.

PCP involves the 'procurement' of R&D results and potentially the development of a prototype. PCP, just like other public grant support programs for R&D, is intended to foster R&D as a high-value business activity which generates positive spillovers. In contrast, PPI aims to trigger the creation of products (goods, services or systems) which do not yet exist. There is a difference as to whether the public organization procures the R&D output or the finished product. It could also be argued that the rationale is not the same for PPI and for PCP initiatives. PPI is intended to create the incentive to develop specific innovations that help fulfill public sector objectives, which may be linked to a social need or to the operations/missions of a public sector agency.

Despite the recent origin of the PCP approach in Europe, the procurement of R&D to address public needs, for which no solution exists, has traditionally been used as an important mechanism to stimulate innovation both in the US and in Japan (European Commission, 2007, p. 5). When the US Department of Defense (DoD) uses ex-ante financing of company R&D to support the development of a certain technology (e.g. a fighter aircraft), this is not PPI but R&D funding, similar to PCP. Still, such initiatives are not labeled procurement in the US, but public R&D funding, and they may also lead to the development of prototypes.

It could be mentioned that these kinds of initiatives have certain similarities with catalytic PPI (see section 2). For example, the public agency does not procure the resulting product. The catalytic procurement of new kinds of ballasts intended for fluorescent tubes and highly energy-efficient refrigerators was organized by two Swedish public agencies around 1990. In contrast to the kind of US DoD R&D funding mentioned above, these two procurement projects included the guaranteed acquisition of 26,000 units of the new ballasts and of at least 500 units of the energy-efficient refrigerators. However, these purchases were not guaranteed by the procuring agencies, but by two private purchaser groups. The first purchase of the refrigerators was subsidized by the public agency that organized the catalytic procurement (Edquist and Zabala-Iturriagagoitia, 2012). Hence, there are also differences between catalytic PPI and PCP.

The typical PPI process can be divided into the following stages (Edler et al., 2005; Expert Group Report, 2005):

1. Identifying requirements and ensuring user readiness: Identification of a grand challenge or a public agency need, and its formulation in terms of a lack of satisfaction of a human need or an unsolved societal problem.

2. Gathering market intelligence: 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. Management of contract delivery:

a) Product development

b) Production of the product

c) Final delivery to the purchasing agency

PPI is related to the role of demand in innovation, and the role of users in it is the cornerstone of the process (Dalpé et al., 1992). As indicated by Edquist and Zabala-Iturriagagoitia (2012), one of the key stages in PPI practices revolves around the definition of the specifications. They also point out that, in PPI processes, the procuring organization should not specify the technical characteristics of the innovation, but only specify the functional requirements that the product innovation should fulfill. Similarly, PCP processes only point to a challenge/need to be solved rather than provide a detailed set of specifications of the solutions. In these types of schemes, how the potential suppliers solve the challenge is irrelevant for the public agency funding the PCP initiative. The goal is to support the development of solutions that can satisfy the human needs or solve the societal problems constituting the grand challenge at hand, and not to specify the solutions to be used for the purpose. Over-specification may inhibit the creativity of those providing solutions.

The degree of interactive learning achieved by the two parties (i.e. procurer and supplier) is larger in PPI than in PCP processes. In the former (PPI), the procurer is expected to work hand in hand with the supplier from the start, since the procuring organization will act as the main user of the purchased product (unless the PPI is of a catalytic character). Should this cooperative behavior not take place, then the public agency funding the initiative may encounter problems when using the supplied innovation, or may realize that the functional specifications provided in the call have led to the development of a product that does not satisfy their needs. In the latter (PCP), the role of the public bodies is more ‘passive’. The public agency identifies a societal challenge/problem/need, but will not (necessarily) act as the buyer of the proposed solution, so there is not such a strong need for engaging in an effective communication with the potential

suppliers. Thus, the agency will act more as an evaluator of the proposals (in the three stages of the PCP process) than as an active agent that contributes to the mitigation of the challenge.

PCP differs from and complements other innovation instruments such as grants, tax incentives, access to finance, joint technology initiatives, venture capital investments, demand-based foresight, development/modification of regulations and norms, standard setting, innovation vouchers and of course PPI (European Commission, 2006b; Edler, 2009; Flanagan et al., 2011; OECD, 2011). Such instruments may be combined in a mix in order to solve or mitigate problems that should be subject to innovation policy intervention (Smits and Kuhlmann, 2004; Smits et al., 2010; Wieczorek and Hekkert, 2012).[22]

PCP can be integrated in a broader policy instrument mix, and shorten time to market as well as encourage market acceptance of new solutions when seen as part of a coordinated policy framework (European Commission, 2008). In this way PCP (or other R&D grant funding mechanisms) may be used to support the development of the new R&D-base of the potential product that the agency is looking for. The results emanating from these R&D-oriented types of supply-side instruments may fail altogether if no R&D results at all appear, but they may also constitute a basis for the subsequent development and commercialization of a product. Funds may be provided 'up front' by the procurer in a PCP process, prior to the development of the product. If the same or another agency is interested in buying the resulting product, then it may use regular procurement as a complementary instrument.

5.3. Overcoming the weaknesses of PCP

We have concluded that PCP should be considered a supply-side instrument in relation to innovation. However, can the PCP scheme be improved? Could it be organized in a different way?

One of the potential risks of PCP is the degree of uncertainty associated with it. The European Commission has recently identified that the more innovative the product to be purchased, the more uncertain the reaction of the market, which may constitute a barrier to suppliers´ willingness to accept a risk-sharing scheme (Ramboll Management, 2007). Nonetheless, this reaction may be mitigated if the procuring agency funds 100% of the R&D costs. There is also a need to link PCP programs with instruments that may guarantee the acquisition, exploitation and use of the R&D results developed within the PCP schemes. In this respect, the European Commission considers that PPI initiatives are "a very important complement to PCP… [in order] to ensure a wide take-up of newly developed pre-commercial R&D pre-products" (European Commission, 2006a, p. 17). As we have seen in the previous section, regular procurement is one of the many instruments that can be combined with PCP. If the result of a PCP process needs further development before it can constitute a product, PPI could also be a complement to PCP.

[22] For a detailed analysis of mixes of innovation policy instruments, see Borrás and Edquist (2012).

A second pitfall of PCP policies may also emerge when/if the company participating in the PCP is not willing or able to exploit the developed solution in the marketplace. In these cases, a possible solution might be to make the IPR belong to the public agency financing the PCP. Then this agency could invite tenders for the use of the solution in potential applications. In this scenario the agency would own the IPR resulting from the PCP initiative and the new bidders would get a license to exploit it. In this case, the firm that develops the solution should not get a return, since the development of the solution is financed by a public organization.

PCP empowers public agencies to proceed with several suppliers in parallel, which is an advantage from a competition point of view. However, the national public agencies that launch PCP initiatives mainly rely on suppliers of R&D based solutions based in their home countries. We believe that PCP programs are particularly useful in providing R&D-based solutions for the grand challenges and other types of societal problems that are global in their character - and hence not country-specific. To pursue several or many national PCP programs in Europe with regard to the same challenges may be a waste of resources (European Commission, 2006b). Accordingly, some PCP programs should be pursued at the EU level. It may actually be noted that PCP is better suited to be carried out at the EU level than PPI. One reason for this is that the European Commission is not - unlike national governments - a large procurer of goods, services and systems. PCP programs at the EU level would also help to exploit economies of scale and scope.

Finally, and from a competition point of view, PCP may also run the risk of having only one single supplier of the solution (Ramboll Management, 2007). Our contention is that this may be (partially) solved by allowing a broader spectrum of agents to actively participate in PCP processes, such as research organizations and universities. They are, to date, excluded from participating in these schemes as only private companies are targeted. In fact, many of the projects (including those funded by the EU Framework Programs) have to deliver prototypes, although they involve consortia, not only of companies but also research centres, universities, hospitals, public authorities responsible for setting standards, etc. Why cannot this also be the case in PCP schemes?

Acknowledgments

A preliminary version of this draft was presented at the Annual Eu-SPRI conference 2012 in Karlsruhe (Germany) in June 2012. The authors are grateful to the European Commission for providing the funding to develop the AEGIS project (Advancing Knowledge-Intensive Entrepreneurship and Innovation for Economic Growth and Social Well-being in Europe), grant agreement number 225134. We are grateful to André Roos, from the Dutch Ministry of Economic Affairs, Agriculture and Innovation for facilitating information on the Dutch case. We

are indebted to Fergus Harradence and to Nina Widmark for their invaluable comments on an earlier version of the article.

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