

Paper no. 2012/11

Pre-Commercial Procurement: a demand or supply policy instrument in relation to innovation?

Charles Edquist (charles.edquist@circle.lu.se)

Circle, Lund University

And

Jon Mikel Zabala (jon_mikel.zabala@circle.lu.se)

Circle, Lund University

This is a preprint version of a paper submitted to a journal for publication

This version: October 2013

Centre for Innovation, Research and Competence in the Learning Economy (CIRCLE)
Lund University

P.O. Box 117, Sölvegatan 16, S-221 00 Lund, SWEDEN

<http://www.circle.lu.se/publications>

ISSN 1654-3149

WP 2012/11

Pre-Commercial Procurement: a demand or supply policy instrument in relation to innovation?

Charles Edquist and Jon Mikel Zabala

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 motives 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.

But what is meant by Pre-Commercial Procurement? Is it a demand or a supply side instrument in relation to innovation? This is the research question addressed in this paper, the goal being motivated by the lack of academic discussion in this direction.

The paper is based on three cases, one from the Netherlands, one from the UK and one from Australia. These cases provide evidence that PCP is a matter of R&D funding of a targeted kind, geared towards very specific goals and in a focused way. This leads the authors to conclude that PCP is a supply-side policy instrument in relation to innovation. In this sense, they 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 labeling it as an innovation procurement instrument.

Key words: Pre-Commercial procurement; R&D; Demand; Supply; Innovation policy.

JEL: H57, L38, O25, O32

Disclaimer: All the opinions expressed in this paper are the responsibility of the individual author or authors and do not necessarily represent the views of other CIRCLE researchers.

Pre-Commercial Procurement: a demand or supply policy instrument in relation to innovation?

Charles Edquist, Professor

CIRCLE (Centre for Innovation, Research and Competence in the Learning Economy)

Lund University, Sweden

<http://charlesedquist.com>

Charles.Edquist@circle.lu.se

Jon Mikel Zabala-Iturriagagoitia, Assistant Professor

CIRCLE (Centre for Innovation, Research and Competence in the Learning Economy)

Lund University, Sweden

www.circle.lu.se

Jon_Mikel.Zabala@circle.lu.se

Centre for Innovation, Research and Competence in the Learning Economy (CIRCLE)

Lund University

P.O. Box 117, Sölvegatan 16, S-221 00 Lund, SWEDEN

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 motives 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.

But what is meant by Pre-Commercial Procurement? Is it a demand or a supply side instrument in relation to innovation? This is the research question addressed in this paper, the goal being motivated by the lack of academic discussion in this direction.

The paper is based on three cases, one from the Netherlands, one from the UK and one from Australia. These cases provide evidence that PCP is a matter of R&D funding of a targeted kind, geared towards very specific goals and in a focused way. This leads the authors to conclude that PCP is a supply-side policy instrument in relation to innovation. In this sense, they 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 labeling it as an innovation procurement instrument.

Note: This is an update from the November 2012 version, entitled: “Why Pre-Commercial Procurement is not Innovation Procurement”

JEL: H57, L38, O25, O32

Keywords: Pre-Commercial procurement; R&D; Demand; Supply; Innovation policy.

1. Introduction

A new European-level interest has recently emerged regarding demand-side approaches to innovation policy and, more specifically, 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 systemic policies (e.g. cluster policies, supply chain policies), regulation (e.g. standards, technology platforms), public procurement (i.e. R&D procurement and innovation procurement), and support of private demand as the main demand-side innovation policy 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.

“Public technology procurement” had long been practiced and discussed, 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). A 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.¹ The PCP scheme is based on the experiences within the United States, amongst others on the Small Business Innovation Research (SBIR) programme (Small Business Innovation Development Act, 1982), but structured within the context of the European legislative package (Bodewes et al., 2009, p. 53).

The US SBIR program may be regarded as an example of an instrument similar to PCP practiced outside the EU, as it aims to generate multiple R&D-based knowledge outputs (Wessner, 2008). 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. The EU public procurement directives do not apply to PCP schemes (European Commission, 2008). Instead, 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.² Accordingly, PCP schemes do not conflict with current EU procurement regulations.

¹ 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).

² 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

The very term Pre-Commercial Procurement leads our thoughts in the direction of procurement of actual goods and services. As a result, PCP has often been presented as a demand-side innovation policy instrument (Berman and Squire, 2011; DG Connect; 2012; ECORYS, 2011; Lember et al., 2014). Due to this demand-side assumption, PCP is often mixed up with another policy instrument, namely Public Procurement for Innovation (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, Lember et al. (2014) consider PCP as a demand-side policy instrument that can support the development of innovation. In a case study conducted on the pre-commercial procurement in the field of security, ECORYS (2011, p. 7), it is concluded that “PCP is a demand based innovation scheme”. Finally, in June 2011 the European Commission organized a conference on innovation procurement in Torino (Italy),³ 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. In addition to this, a considerable number of people, who have not reflected on this in detail, intuitively believe that PCP is a demand-side policy instrument in relation to innovation.

This paper intends to be a contribution to the so far non-existent scientific literature on PCP. Indeed, there is no correspondence between the large number of policy reports written on the PCP scheme and the lack of academic discussion of it. Our goal is to respond to the research question formulated in the title of this manuscript: is PCP a demand or a supply-side policy instrument in relation to innovation? With it, we will try to advance the theoretical understanding of an area that has remained under-conceptualized up to now, in order to provide an academic understanding of a well-spread phenomenon in the policy realm.

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. We ought to mention that we are fully aware of similar examples that have for long existed in the SBIR programme in the US. In fact, as acknowledged above, it may be said that the European experience might be influenced to a great extent by the American one. However, the goal of this paper lies in the qualitative analysis of the PCP. Accordingly, we have excluded SBIR cases, as these have already been extensively studied in the literature (Audretsch et al., 2002; Link and Scott, 2010; Wallsten, 2000; Wessner, 2008). However, we believe that the conclusions drawn in our study might also be of relevance to

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).

³ <http://www.comune.torino.it/relint/PPI/> (last access October 2012).

similar schemes in place in the US and other countries with similar institutional settings, and which have received longer attention in the scholarly literature.

Section 2 introduces the methodology. Based on the evidence from the cases (section 3), section 4 addresses the question of what is meant by PCP. The reason for including the conceptual discussion of PCP in section 4 is related to the goal of the paper. Since we are interested in qualifying the character of PCP, it is not meaningful to introduce a conceptual discussion up front in the paper, where we still do not have evidence that suggests its demand or supply orientation. Finally, a discussion on the characteristics of PCP, as a demand or supply-side policy instrument in relation to innovation, concludes the paper (Section 5).

2. Methodology and introduction to the cases

The methodological approach is exploratory. Information on each case has been compiled by accessing relevant secondary sources such as calls for tenders, scientific literature, policy documents and evaluations and other written materials and reports.

The reason for focusing on these three cases lies in the experience that the three countries have gained from the application of PCP schemes (OECD, 2011). In addition, the number of PCP cases that may be considered is quite restricted, as many of them are still running or under definition, and hence available evidence is still limited.⁴ In fact, only a few countries have already started to fund pilot PCP initiatives in Europe.⁵

Our approach should thus be regarded as qualitative and exploratory. Provided that our goal in this paper is to clarify the nature of PCP, the use of a qualitative approach seems sensible as qualitative studies provide the grounding for more rigorously structured research (Knafl and Howard, 1984). Given the still limited number of completed PCP experiences, there is not yet a comprehensive dataset to rely upon in order to conduct a quantitative assessment of this policy instrument.⁶ Thus, we have had to limit our information to the secondary sources of those cases where this information is available. In addition, the pay-off of qualitative research is higher in fields that are not yet conceptually mature, which seems to be the case, at least in so far as an academic discussion is concerned.

The following section introduces, by means of a short description, the three cases considered in this paper. Despite the partial differences in their institutional (i.e. regulatory) environments, the reader will appreciate the uniformity of the PCP process in all three locations.

⁴ For other PCP cases, see: http://cordis.europa.eu/fp7/ict/pcp/projects_en.html (last access October 2013).

⁵ See: http://cordis.europa.eu/fp7/ict/pcp/msinitatives_en.html (last access October 2013).

⁶ As a matter of fact, the Frascati manual does not include this type of targeted R&D support among the indicators that are collected in order to assess R&D capabilities and related activities.

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 cases funded under the Small Business Research Initiative (SBRI) scheme in the UK. 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 the innovative capabilities of small and medium-sized enterprises (SMEs). It is a program 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. 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 for 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 3.1, 3.2 and 3.3 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. Case studies

The following three sub-sections provide a broader description of the stages and evolution of each policy initiative.

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

The Dutch government implemented its Small Business Innovation Research (SBIR) in 2004, a 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 SBIR program, which was the role model for the Dutch SBIR, was created in 1982 through the Small Business Innovation Development Act and aimed to (Small Business Innovation Development Act, 1982, p. 97):

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

Initiated in 2004, the Dutch SBIR program significantly increased its budget from € 0.2 million in 2004 to € 26.3 million 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).⁷ 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 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 Intellectual Property Rights (IPR) remain with the company.

⁷ 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).

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?

Of the 21 proposals received for phase 1, 5 were allocated funding for a feasibility study. Of these, 2 were selected for further development in April 2008 to create a prototype in collaboration with several district water boards. The 2 proposals – both start-ups, were ‘GeoBeads’ (from Alert Solutions) and ‘Monitoring of Dikes from Space’ (from Hansje Brinker).⁸ 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, by satellite footage, any type of movement and alteration in size. 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.

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.

⁸ 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).

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).

3.2. Making Waves: Gesture-based communication system

A country that has adopted a more hands-on approach towards the promotion of procurement policies is the UK. It introduced the Small Business Research Initiative (SBRI) in 2011, earmarking 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 organizations. The goal is to create research and development in intensive SMEs and raise their awareness of the future commercial benefits that the research base can offer.⁹

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 and development and exploitation of technology and innovation for the benefit of UK business.

We focus on the 'Making Waves: Gesture-based communication system' initiative of the UK SBRI. 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).¹⁰

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 (development of prototype) was intended to develop and evaluate prototypes or demonstration units from the most promising proposals in phase 1. Eleven evaluation criteria were defined, going from the possibility of developing a free and open source software model, to assessing the

⁹ <http://www.bis.gov.uk/policies/innovation/procurement/sbri> (last access October 2012).

¹⁰ <http://www.innovateuk.org/content/competition/making-waves-gesture-based-communications-system.ashx> (last access October 2013).

accessibility, technical feasibility and cost effectiveness of the solutions or the skill sets of the candidate companies (Technology Strategy Board, 2011).¹¹

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 (with communication difficulties, either deaf or motor disabilities) to ‘talk’ to the device in sign language. The gestures were then captured, stored 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, and 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.¹² 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 fully fledged product affordable for the average person.¹³

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

¹¹ 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).

¹² <http://www.scoop.it/t/sensory-impairment-solutions/p/2449781917/inclusion-in-elearning-blog> (last access October 2013).

¹³ <http://www.enterprise-europe-scotland.com/set/news/index.asp?newsid=3369> (last access October 2012).

3.3. 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).¹⁴ 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 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 & V  x and the Hungarian   szak-Alf  ld 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 later in order to provide some clarification (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, it is open to about 300 public agencies and organizations in the state of Victoria. Last, it is open to SMEs with fewer than 200 employees. The MVP involves two rounds of grants over a four-year period, and is divided into three stages: (i) Technology Requirement Specifications (TRS), (ii) feasibility study and (iii) proof of concept.¹⁵

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

¹⁴ http://tafecentre.vic.edu.au/wp-content/uploads/2009/03/innovationvictoriasfuture_000.pdf (last access September 2011).

¹⁵ <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 October 2013).

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 can be a potential basis for intellectual property. Successful firms receive a grant of up to AU\$ 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).

When the MVP was announced in August 2008, 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.¹⁶ These were sent to the respective host agencies for their selection. After evaluation of the feasibility studies, nine projects progressed toward the proof of concept phase.¹⁷ As to the second round, this was opened in July 2010 and the selected six proof of concept projects are expected by the end of 2014.¹⁸

¹⁶ 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).

¹⁷ For the nine proof of concepts see: <http://www.business.vic.gov.au/industries/science-technology-and-innovation/programs/smart-smes-market-validation-program/proof-of-concept> (last access October 2013).

¹⁸ For details of the granted proof of concepts in this second round see: <http://www.business.vic.gov.au/industries/science-technology-and-innovation/programs/smart-smes-market-validation-program/round-2-proof-of-concept-projects> (last access October 2013).

The first round of the MVP is not yet finished, as proof-of-concept projects are still running and expected to be finished by the end of 2013; hence, a comprehensive assessment of the effects cannot yet be made. However, some interesting trends can be observed, for example the high level 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 into 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 included in this paper come from official reports, white papers and national policy initiatives.¹⁹ This section provides an answer to the question we posed at the beginning of this paper, regarding the demand or supply-side character of 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). As the three cases presented in section 3 illustrate, PCP practices, in general, 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.
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

¹⁹ One of the reasons for the lack of scholarly discussion of 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).

received from candidate companies for this solution exploration (phase 1), they are subjected 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 the companies are invited to test a limited number of these prototypes under field conditions (phase 3). This is where the PCP process ends.

After the field tests that conclude the PCP process, a separate commercial tendering may take place. It may be pursued either by the same public agencies funding the PCP scheme or by other organizations (public or private) interested in the results of the PCP process. The firm that developed the solutions may also try to commercialize its solutions on its own. 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 IPR or shares them (after negotiation) with the corresponding public agency.²⁰ However, this commercial tendering or commercialization is not part of the PCP scheme. We will come back to this point in the concluding section.

From our point of view, the language used in the third phase of the PCP process is puzzling. 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. *Innovations* are defined 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. Hence, to qualify as an innovation, the product or process needs to be commercialized, i.e. launched on the market, a feature which is not completed by prototype testing. A prototype is an effective model or archetype that needs to work under certain conditions. A prototype (or a limited number of copies of it) is only intended to demonstrate its effectiveness in mitigating a certain challenge/need and its suitability for production according to the required quality standards (European Commission, 2006a, p. 21). It is not produced on a large scale; i.e. it is not commercialized and neither is its commercial viability proven.

A scheme that shared many of the 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.

²⁰ The public agency can 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).

326). As Quintas and Guy point out, these programs “covered a spectrum of work from applied research through to near-market development... [they were] not expected to produce commercially usable process 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 product innovations, 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 societal challenges (e.g. avoiding flooding and allowing people with communication difficulties to be able to communicate effectively and independently), not to achieve commercialization of new products. It is a matter of public funding of applied R&D (i.e. ‘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’, ‘targeted’ or ‘focused’ and certainly not a matter of general R&D funding without a specific purpose. It can thus be concluded that PCP is a supply-side policy instrument in relation to innovation. However, at the same time, it is a demand-side instrument in relation to R&D, as it only intends to influence the production of R&D outputs. In this sense, 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. PCP may still influence innovation processes, but only in an indirect and mediated way by being publicly funded R&D, which in the context of this paper we label as ‘targeted R&D’. And public R&D funding as such (including PCP) is certainly a supply-side innovation policy instrument, when it influences innovation processes.

The conclusions above were discussed with scholars and policy-makers in the field, such as Charles Wessner (National Academy of Sciences, US), Fergus Harradence (Department of Business, Innovation and Skills, UK), and Kirsten Bound (Nesta, UK) during 2013. They agree that PCP processes and SBIR projects are not demand-side innovation policy instruments, since they do not fund commercialization of products.

5. Conclusions and discussion

This paper aims to answer whether PCP can be regarded as a demand or supply-side innovation policy instrument. The paper follows an exploratory methodological approach based on secondary sources through which information on PCP experiences is available. In particular, we base our conclusions on the analysis of three PCP case studies, one in the Netherlands, one in the UK and one in Australia. PCP is a topic on which many policy reports have been written, but there is still no solid empirical base, at least in so far as the EU is concerned. In addition, there are still no profound academic and theoretical contributions regarding PCP. Therefore, this paper intends to advance the theoretical understanding of an area that has remained under-conceptualized. Accordingly, we try to provide a scientific understanding of a phenomenon that is well-spread in the policy realm.

PCP concerns the R&D phase before commercialization (European Commission, 2008, p. 2). It is an approach to procuring R&D services, one which involves risk-benefit sharing but excludes State aid (European Commission, 2006b; European Commission, 2008, p. 6). This implies that the private supplier shares the risk of the R&D, and that the public authority is not required to purchase the good, service or system that may (or may not) result from the R&D (Sloth, 2011). Public authorities and industry thus share the risks and benefits of the R&D needed to develop new R&D-based knowledge. These R&D results may (or may not) later lead to product innovations that may outperform those already available in the market (European Commission, 2008, p. 3).

PCP is an approach that aims to support R&D and the prototyping/demonstration of new products (goods and services) by providing funding to a company, usually an SME. PCP refers to the acquisition of expected research results and entails direct public R&D investments. However, it does not support further commercialization in terms of providing funding for a company to invest in manufacturing capability, increase the scale of its production facilities, or market and promote its product. The company has to find other funding for this. Just like the pre-competitive R&D programs implemented in Europe in the 1980s, PCP does not imply any intention or guarantee from the public agency funding the PCP initiative to buy R&D services/solutions that may result (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 addressing public agency or societal challenges/needs.

Nevertheless, participation in PCP programs has helped some companies to attract such investment from the private sector (Bodewes et al., 2009). Therefore, whilst PCP does not directly provide support for these activities, it can help companies to leverage additional funding, because the process of product development and testing has been de-risked. This removes, at least in part, a key potential problem in terms of information provision in the innovation process, i.e. the technological uncertainty associated with new product development and whether this will be successful.

As shown in the introduction to this paper, PCP is often considered to be a demand-side innovation policy instrument. Based on the evidence gathered in this paper, though, it can be concluded that the classification of PCP as a demand-side policy instrument 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). As the three cases have illustrated, PCP aims at providing (R&D-based) solutions to existing challenges, but without identifying a buyer that may indeed contribute to the further uptake, articulation and diffusion of innovations, as indicated by the previous definition. Commercialization cannot be regarded as part of the PCP process, 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 may follow PCP processes may be regarded as examples of the acquisition of off-the-shelf products (the prototypes for which have been developed in the PCP process), i.e. it becomes a matter of *regular* procurement.²¹ Without the PCP interventions, however, these prototypes may not have existed or perhaps existed much later.

PCP involves public financing of R&D and thus has to be considered a supply-side policy instrument in relation to innovation. Supply-side policy instruments address those determinants that intend to increase the operative efficiency of markets and industries. In this sense, fiscal measures, support for training and mobility, grants for industrial R&D, information and brokerage support and networking measures entail some examples of supply-side policy instruments (Edler and Georghiou, 2007). 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. This conclusion may be also extensible to other similar programs such as the SBIR in the US.

PCP can be integrated into a broader policy instrument mix, shortening time to market and encouraging market acceptance of new solutions when seen as part of a coordinated policy framework (European Commission, 2008). In this sense, PCP can complement other innovation instruments such as grants, tax incentives, access to finance, joint technology initiatives, venture capital investments, demand-based foresight, regular procurement, development/modification of regulations and norms, standard setting, innovation vouchers, etc. (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 would otherwise be subject to innovation policy intervention (Edquist, 2011; Smits and Kuhlmann, 2004; Smits et al., 2010; Wieczorek and Hekkert, 2012).²²

Let us add a few comments about different kinds of procurement that may be parts of such innovation policy instrument mixes. We have already seen that PCP and regular procurement may supplement each other. The introduction mentioned that PCP is often mixed up with Public Procurement for Innovation (PPI).²³ Obviously PCP is not the same as PPI, since no placement of orders for products is involved in the former. However, the combination of PCP and regular procurement may be a substitute for PPI, since the two alternatives may cover the same “parts” in an innovation process as a whole. If the result (prototype) of the PCP process needs further development before it can constitute a finished product, PPI can also be a supplement to PCP.

That PCP is not a demand-side innovation policy instrument certainly does not diminish its importance. It may be crucial as a demand-side R&D policy instrument in efforts to mitigate

²¹ In *regular public procurement*, a public organization buys ready-made products “off the shelf” (Edquist and Zabala-Iturriagoitia 2012).

²² For a detailed analysis of mixes of innovation policy instruments, see Borrás and Edquist (2013).

²³ PPI occurs when a public organization places an order for a product that does not exist at the time (Edquist and Zabala-Iturriagoitia 2012).

global challenges and societal problems at the same time as satisfying human needs. It may do so as a targeted, demand-side R&D policy instrument. It is therefore excellent that PCP is currently receiving increasing attention and is being developed as a part of comprehensive policy instrument mixes.

Acknowledgments

Preliminary versions of this paper were presented at the Annual Eu-SPRI conferences in Karlsruhe (Germany) - June 2012 - and Madrid (Spain) - April 2013- at DG Enterprise and DG Research and Innovation in Brussels (Belgium) - November 2012 -, and at a key-note speech at the OECD Expert Workshop on the Measurement of Public Procurement for Innovation in Paris (France) - February 2013 -. 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. Jon Mikel Zabala-Iturriagagoitia acknowledges financial support from the Basque Government Department of Education, Language Policy and Culture; Charles Edquist acknowledges support from the Rausing Foundation. 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 (Department of Business, Innovation and Skills, UK), Katarina Krell (Managing Director of Greenovate! Europe), Charles Wessner (National Academy of Sciences, US), Lieve Bos (Directorate General Communication Networks, Content and Technology), Kirsten Bound (Nesta, UK) and two anonymous referees for their comments on earlier versions of the article. The content of the article reflects the opinions and views of the authors alone.

References

- Aho, E., Cornu, J., Georghiou, L. and Subira, A. (2006) Creating an Innovative Europe. Report of the Independent Expert Group on R&D and Innovation appointed following the Hampton Court Summit and chaired by Mr. Esko Aho. European Communities, Brussels, January 2006.
- Audretsch, D.B., Link, A.N. and Scott, J.T. (2002) Public/private technology partnerships: evaluating SBIR-supported research. *Research Policy*, **31**(1), 145-158.
- Berman, T. and Squire, M. (2011) Demand-side innovation policies in Australia, in: OECD (2011), *Demand-side Innovation Policies*. OECD Publishing, pp. 95-113.
- Bodewes, H., Hargeskog, S.E., Müller, L., Ottolander, M., Thevissen, P., Veys, C. and Widmark, N. (2009) Exploring Public Procurement as a Strategic Innovation Policy Mix Instrument. EU

project OMC-PTP. Available: http://www.technopolis-group.com/resources/downloads/reports/public_procurement.pdf (last access October 2013).

Borrás, S. and Edquist, C. (2013) The choice of Innovation Policy Instruments. *Technological Forecasting and Social Change*, **80**(8), 1513-1522.

Bovis, C. (1998) The Regulation of Public Procurement as a Key Element of European Economic Law. *European Law Journal*, **4**, 2, 220-242.

DG Connect (2012) FP7 ICT WP2013. Objective 8.2 Technology-enhanced learning. Unit G4 "Skills, Youth and Inclusion", European Commission (Luxembourg). Available: http://ec.europa.eu/information_society/events/ (last access October 2012).

ECORYS (2011) Study on pre-commercial procurement in the field of Security. Within the Framework Contract of Security Studies – ENTR/09/050. Final Report. Rotterdam, November 2011.

Edler, J. (2009) Demand Policies for Innovation in EU CEE Countries. Manchester Business School Working Paper No 579, The University of Manchester.

Edler, J. and Georghiou, L. (2007) Public procurement and innovation – Resurrecting the demand side. *Research Policy*, **36**, 949-963.

Edquist, C. (2011) Design of innovation policy through diagnostic analysis: identification of systemic problems (or failures). *Industrial and Corporate Change*, **20**(6), 1725-1753.

Edquist, C. and Hommen, L. (1999) Systems of Innovation: theory and policy from the demand side. *Technology in Society*, **21**, 63–79.

Edquist, C. and Zabala-Iturriagagoitia, J.M. (2012) Public Procurement for Innovation as mission-oriented innovation policy. *Research Policy*, **41**(10), 1757-1769.

Edquist, C., Hommen, L., Tsipouri, L. (eds) (2000) *Public Technology Procurement and Innovation*. Boston/Dordrecht/London: Kluwer Academic Publishers.

European Commission (2006a) Pre-commercial Procurement. A missing link in the European innovation cycle. European Commission, March 2006

European Commission (2006b) Pre-commercial Procurement. Public sector needs as a driver of innovation. European Commission, September 2006.

European Commission (2008) Pre-commercial Procurement: Driving innovation to ensure sustainable high quality public services in Europe. SEC(2007) 1668. Brussels, December 2007.

European Commission (2011) Proposal for a directive of the European Parliament and of the Council on public procurement. Brussels, 20.12.2011, COM(2011) 896 final.

Flanagan, K., Uyarra, E. and Laranja, M. (2011) Reconceptualising the ‘policy mix’ for innovation. *Research Policy*, **40**, 5, 702-713.

French, German and UK Governments (2004) Towards and innovative Europe. A Paper by the French, German and UK Governments. 20th February 2004.

Fuchs, E.R.H. (2010) Rethinking the role of the state in technology development: DARPA and the case for embedded network governance. *Research Policy*, **39**, 9, 1133-1147.

Gelderman, C.J., Ghijsen, P.W.T. and Brugman, M.J. (2006) Public procurement and EU tendering directives – explaining non-compliance. *International Journal of Public Sector Management*, **19**, 7, 702-714.

Innovate UK (2012) Empowering people through technology. Innovation ideas, Spotlight on a current project #30, T12/026 March 2012.

Knafl, K.A. and Howard, M.J. (1984) Interpreting and reporting qualitative research. *Research in Nursing and Health*, **7**, 17-24.

Lember, V., Kattel, R., Kalvet, T. (eds) (2014) *Public Procurement, Innovation and Policy. International Perspectives*. Heidelberg: Springer.

Link, A.N. and Scott, J.T. (2010) Government as entrepreneur: Evaluating the commercialization success of SBIR projects. *Research Policy*, **39**(5), 589-601.

Martin, S., Hartley, K. and Cox, A. (1997) Public purchasing in the European Union: some evidence from contract awards. *International Journal of Public Sector Management*, **10**, 4, 279-293.

McGarrah, R.E. (1987) The decline of U.S. manufacturers: Causes and remedies. *Business Horizons*, **30**, 6, 59-67.

Miles, I. (2007) Research and development (R&D) beyond manufacturing: the strange case of services R&D. *R&D Management*, **37**, 3, 25-36.

Morand, P-H. (2003) SMEs and public procurement policy. *Review of Economic Design*, **8**, 301-318.

Mowery, D.C. and Simcoe, T. (2002) Is the Internet a US invention?—an economic and technological history of computer networking. *Research Policy*, **31**, 1369-1387.

NL Agency (2011) SBIR. The power of public procurement: innovative solutions to societal challenges. NL agency, The Hague. Publication-nr. 3SBIR1002.

OECD (2011) *Demand-side Innovation Policies*. OECD Publishing.

Quintas, P. and Guy, K. (1995) Collaborative, pre-competitive R&D and the firm. *Research Policy*, **24**, 325-348.

Roos, A. (2009) SBIR in The Netherlands: a new perspective for Europe? Available: http://ec.europa.eu/enterprise/policies/innovation/policy/lead-market-initiative/files/nl_sbir_en.pdf (last access July 2011).

Roos, A. (2011) Pre-Commercial Procurement in The Netherlands: SBIR. Available: http://www.eszakalfold.hu/uploads/Kulkapcsolatok/PCP2011/eloadasok/2_1_ROOS.pdf (last access July 2011).

Rothwell, R. (1986) Public Innovation Policy: To Have or to Have Not? *R&D Management*, **16**, 25-36.

Sloth, M. (2011) WP 2 - Analysis of public Pre-Commercial Procurement models and mechanisms. P3ITS – Pre-Commercial Public Procurement for Intelligent Transport Systems and Services innovation and deployment. Project financially supported by the 7th FP. Project number 248659.

Small Business Innovation Development Act (1982) Public Law 97-219-July 22, 1982.

Smith, R.P. (1990) Defence procurement and industrial structure in the UK. *International Journal of Industrial Organization*, **8**, 185-205.

Smits, R. and Kuhlmann, S. (2004) The rise of systemic instruments in innovation policy. *The International Journal of Foresight and Innovation Policy*, **1**, 4-32.

Smits, R., Kuhlmann, S. and Shapira, P. (2010) *The Theory and Practice of Innovation Policy. An International Research Handbook*. Cheltenham: Edward Elgar.

Technology Strategy Board (2011) SBRI Assistive Technology Competitions - Invitation to Tender. Available: <http://www.innovateuk.org/content/competition/making-waves-gesture-based-communications-system.ashx> (last access October 2012).

Vinnova (2007) Public procurement as a driver for innovation and change. Report on government commission to Nutek and VINNOVA. VP 2007:03.

Vonortas, N.S., Bhatia, P. and Mayer, D.P. (2011) Public Procurement and Innovation in the United States. Elliot School of International Affairs, George Washington University, Washington DC.

Wallsten, S.J. (2000) The effects of government-industry R&D programs on private R&D: the case of the Small Business Innovation Research program. *Rand Journal of Economics*, **31**(1), 82-100.

Wessner, C.W. (2008) An Assessment of the SBIR Program. National Research Council. Committee on Capitalizing on Science, Technology, and Innovation. The National Academies Press, Washington D.C.

Wieczorek, A.J. and Hekkert, M. (2012) Systemic instruments for systemic innovation problems: A framework for policy makers and innovation scholars. *Science and Public Policy*, **39**, 74-87.