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Please cite this paper as:

OECD (2014-02-14), "Intelligent Demand: Policy Rationale, Design and Potential Benefits", *OECD Science, Technology and Industry Policy Papers*, No. 13, OECD Publishing, Paris.
http://dx.doi.org/10.1787/5jz8p4rk3944-en



OECD Science, Technology and Industry Policy Papers No. 13

Intelligent Demand: Policy Rationale, Design and Potential Benefits

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FOREWORD

Policy instruments to accelerate innovation have been described as either technology (supply) push or demand (market) pull. The concept of fostering innovation through demand-side policy – particularly public procurement - is not new. Indeed, some countries have pursued active technology procurement policies for decades, most notably in defence, energy and transport. For a variety of reasons, however, policy interest in demand-side initiatives has grown in recent years. This may reflect an expectation that demand-side policy could be particularly effective in steering innovation to meet societal needs, in such areas as ageing and the environment. In addition, owing to constrained public finances in most OECD countries, there is attraction in the possibility that demand-side policies might be less expensive than direct support measures. The renewed interest may also reflect some degree of disappointment with the outcomes of traditional supply-side measures.

This paper reviews demand-side innovation policies, their rationales (which vary across each of the different demand-side instruments), the importance they are accorded across countries, different approaches to their design, the challenges entailed in their implementation and evaluation, and identified good practices. Three main forms of demand-side policy are considered: innovation-oriented public procurement, innovation-oriented regulations, and standards. Emphasis is placed on innovation-oriented public procurement.

The work began in early 2012, in response to a request from, and with the financial support of, the Danish Enterprise and Construction Agency (now part of the Danish Business Authority). The OECD's Committee for Industry, Innovation and Entrepreneurship (CIIE) reviewed this report and agreed to its declassification in October 2012.

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Introduction and executive summary

This paper provides the final report on a project that the OECD has undertaken on demand-side innovation policies. The project involved two phases: in the first phase, a short paper was developed on policy rationale, different approaches to intelligent demand as well as some broader considerations. The second phase involved work on policy and programme design, implementation and evaluation, and is more focused on good practices (where and how).

In the innovation literature instruments to accelerate innovation have been categorised as either technology (supply) push or demand (market) pull. Technology-push instruments focus on the supply-side of innovation, and specifically on knowledge production through boosting the supply of funds, laboratories, researchers or patents. Examples of supply-side innovation policies include direct and indirect government funding of public and business R&D, equity support by the government (e.g. through support to venture capital), provision of research infrastructure, and investment in education and training. By contrast, demand-based innovation policies have been defined as a "set of public measures to increase the demand for innovation, 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, 2007).

Policy interest in demand-side initiatives has grown in recent years. In part this appears to reflect an expectation that such policies might be particularly effective in stimulating innovation in areas where societal needs are pressing, such as aging, health and the environment. In addition, given the pressing financial circumstances facing most OECD governments, there is an attraction in the possibility that well-designed demand-side policies might be less expensive for governments than direct support measures. A turning to demand-side initiatives may also reflect some degree of disappointment with the efficacy of traditional supply-side measures. Another appealing feature of demand-side policies is that they are not necessarily directed at specific firms, but may instead be designed to reward innovation and efficiency wherever they arise.

Three main forms of demand-side policy are considered in this report: innovation-oriented public procurement, innovation-oriented regulations and standards. Policies to shape consumer behaviour also fall within the ambit of demand-side initiatives.[1] However, consumer-oriented policies are not examined in this report. The main focus of the report is on innovation-oriented public procurement.

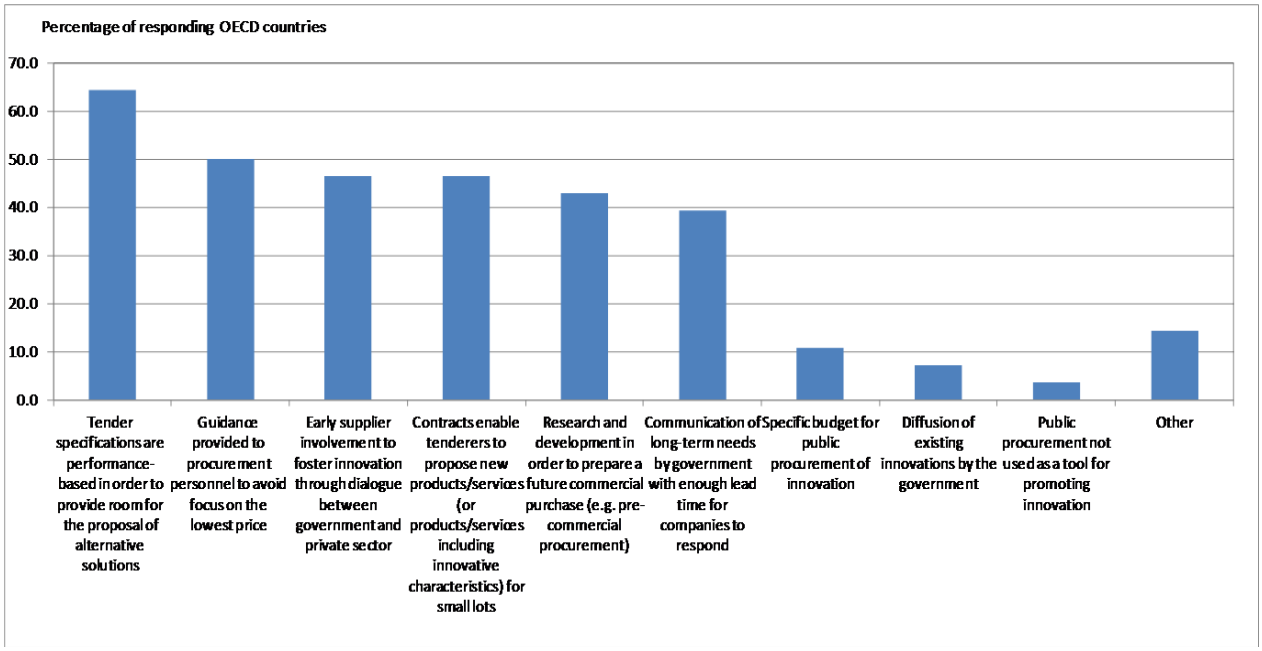
The concept of fostering innovation through procurement is not new and some countries have pursued active technology procurement policies for decades, particularly in defence, energy and transport. A number of OECD governments have recently given renewed impetus to using procurement to foster innovation. For instance, the United Kingdom has actively sought to integrate procurement for innovation across government since 2003. Germany has created a new Agreement on Public Procurement of Innovation by which six federal ministries (interior, economics, defence, transport, environment and research) will publish long-run demand forecasts, engage in continuous market analysis to identify potential new solutions, offer professional training on legal options to promote innovation, and foster a strategic dialogue and exchange of experiences between procuring agencies, end-users and industry. The Netherlands, Finland and Spain all operate programmes for innovation procurement, and it is reported that Austria might spend up to EUR 2 billion a year on such procurement. Legislation to support innovation procurement is in place in France. And in 2007 the United States was estimated to spend approximately USD 50 billion a year on the procurement of R&D services (European Commission, 2007).

The potential for use of innovation procurement has also been highlighted in a number of European Union reports, including Public Procurement for Research and Innovation (2005), Creating an Innovative Europe (2006) and the Innovation Union Communication (European Commission, 2010a). Indeed, the latter communication calls on European Union Member States to set aside dedicated budgets for

pre-commercial procurement and public procurement of innovative products and services. The proposed EU Framework Programme for Research and Innovation ("Horizon 2020") aims at providing support throughout the entire innovation system, also through public procurement and market uptake of innovation to tackle societal challenges (European Commission, 2011a). In addition, the Industrial Policy Flagship proposes targeted actions in standardisation, regulation and public procurement to boost the innovation performance of specific sectors, such as construction, security industry, space, key enabling technologies, and bio-based products (European Commission, 2010b). And finally, among the twelve instruments in the 2011 Single Market Act, the European Commission proposed to modernise the legislative framework on public procurement to make rules more simple and flexible and, among other objectives, foster demand for innovative goods and services (European Commission, 2011b).

A recent review by the OECD (2012) suggests that while most OECD countries are seeking to use procurement for innovation in some way or the other, few had set aside a separate budget for this purpose (Figure 1).[2] However, many countries had at some point used performance-based tender specifications to encourage innovation, provided guidance to procurement officers, or involved suppliers at an early stage in the tender process to help foster innovation.

Figure 1. Use of procurement to promote innovation



Source: 2011 OECD Survey on Reporting Back on Procurement Recommendation, see OECD (2012).

This paper is structured as follows: Section 1 begins by reviewing the rationales for policy support to encourage innovation. The research literature on the role of demand in the innovation process is briefly sketched. The specific rationales for demand-side policy are considered in some detail, noting that these vary across each of the different demand-side instruments.

Section 2 addresses challenges faced in developing and implementing demand-side policies. Again, these challenges vary according to the instrument in question. It is noted that, to be successful, innovation-oriented procurement requires significant capacity development in the public sector – and a considerable break with traditional and risk-averse procurement practices. Capacity constraints and problems of limited scale economies are often especially marked in subnational governments. Interaction

may also be needed across different parts of government, while risks – both technological and of user uptake - will need to be mitigated. The design of procurement procedures must also ensure that competition is preserved and that SME participation is facilitated.

Innovation-oriented regulation involves a number of complexities: the effects on innovation can be ambiguous *a priori*; regulated parties may circumvent the regulation, or may behave in otherwise unexpected ways; time lags between regulation and intended outcomes might be considerable; and a regulation that achieves its immediate objectives could be cost-ineffective compared to other policies once its general equilibrium effects (across all markets) are calculated. Significant industry-specific expertise is also likely to be needed to design good innovation-oriented regulation.

The development of technical standards also faces challenges. Key among these is that a standard should not be captured by any one firm and that the standard development process be inclusive. A further challenge – which offers no easy solution – stems from the possibility that inappropriate timing in the introduction of a standard could lock businesses into an inferior standard and hinder further innovation.

Section 3 addresses the design and implementation of demand-side policies. Separate consideration is given to each of the three instruments in question, i.e. public procurement, regulation and technology standards. With respect to innovation-oriented procurement this section distinguishes the main features of the different types of procurement: general, catalytic and pre-commercial (which can have both demand and supply components). Programmes that commercialise R&D (also involving an element of public procurement) are also described. This section observes that the use of procurement should be preceded by consideration of the likely market response. Depending on the sector, and the scale of the initiative, the level of effective demand mobilised through procurement could be too small to bring about innovation. For instance, in some industries firms may primarily be responsive to the global market. A discussion is included of: governance arrangements, and the need to create capacities and expertise in public authorities, especially in subnational governments; standardisation in procurement practices across subnational governments; possible mechanisms for managing the particular risks of innovation procurement; drawing on know-how from across government; engaging the right stakeholders; ensuring the principle of competitive tender is preserved; and making use of electronic media. Finally, this section reviews the role of policies to foster intelligent demand within the broader policy mix for innovation, including the interaction with R&D and entrepreneurship policies.

Section 4 explores the scope for, and record of, evaluation of demand-side policies. By drawing on experiences in OECD countries the paper provides some guidance to policy makers on how to develop methods of evaluation suited to demand-side policies. Generally, demand-side policies have been under-evaluated compared to other categories of innovation support. This reflects the technical challenges of such evaluation, the relative novelty of demand-side policy, the fact that some demand side policies are not entirely comparable to ‘programmes’ that have a schedule of deliverables and a budget (Edler et al., 2012a) and data constraints. In particular, there have been almost no systematic assessments of innovation-oriented public procurement. As this section makes evident, more should be done to improve the evaluation record. Doing so is necessary to come to a properly informed view of the efficiency and operational pitfalls of demand-side policy.

Whatever the chosen mix between policy types, good framework conditions are necessary to allow an efficient supply response to expressed demand. Annex 1 briefly reviews framework policies in the areas of tax, the labour market, competition, education and training and intellectual property rights.

1. The policy rationale behind intelligent public demand

1.1 The rationale for policy intervention in support of innovation: Market and system failures

Prior to considering the specific rationales for demand-side policies it is relevant to briefly review commonly perceived failures related to markets for innovation and relevant system failures.

1.1.1. Market failures

A set of relevant market failures stem from technological (or innovation) externalities specific to markets for innovation.[3] The idea that market failure leads to under-investment in research and innovation has for half a century provided a principal rationale for public funding of R&D. Arrow (1962) highlighted three fundamental causes of this failure: indivisibilities, uncertainty and externalities: *i)* R&D activity often incurs high fixed costs and economies of scale, while learning-by-doing gives rise to dynamic economies of scale; *ii)* investment in R&D is inherently risky and information asymmetries abound in markets for knowledge and technology, where they exist; and *iii)* because knowledge has properties of a public good as performers of R&D can only imperfectly appropriate the results of their effort and the use of knowledge does not preclude its simultaneous use by others. The lack of appropriability is reflected in positive externalities (as shown in a range of empirical studies), with social returns exceeding private returns. Under these circumstances, under-investment in the production of new knowledge will occur. Traditional responses to market failure due to non-appropriability of the results of R&D include policies aimed at strengthening intellectual property rights (notably the patent system); R&D subsidies to private producers of knowledge, and policies that can help capture externalities through (horizontal) R&D co-operation (Geroski, 1995). Demand-side policies are increasingly also considered to be part of the policy response to these market failures.

Market failures or gaps may also negatively affect the operation of a range of markets on which innovating firms critically depend. In this connection, one particularly important issue concerns risk capital. There is much empirical evidence to support the proposition that the supply of small volumes of equity can be particularly problematic for start-ups and new-technology-based firms. This is largely because venture capitalists face costs in assessing, monitoring and managing investments that vary little with the size of the investments they make. Whether the investment is worth EUR 1 million, or EUR 50 million, the basic costs entailed in the transaction are similar. Accordingly, smaller investments become relatively unattractive for the venture capitalist. As is discussed later in this paper, demand-side conditions have been shown to be a strong predictor of risk finance activity, as they can provide greater certainty about the potential returns to an investment. For example, a recent OECD study on the clean-tech sector finds that countries with high levels of venture capital investment in the clean-tech sector tend to be characterised by a combination of strong supply conditions (e.g. investment in public R&D, patenting in cleantech) and demand-side policies, such as regulations (Criscuolo and Menon, 2012).

Markets might also undersupply certain forms of technology-related information and advice. Small firms in particular can incur high costs in information search and screening processes (at least relative to their turnover). And small and micro-enterprises might not know their real information needs, especially in a context of rapidly changing technologies.[4] On the supply side, the elevated costs of marketing services to large numbers of small enterprises - relative to expected revenues - is held to be a barrier to institutional (and particularly private sector) outreach.[5] Whether the market works well in providing advisory and information services to new and small firms is a contested subject (the Internet is augmenting information supply to small firms, and many providers of technical information have a strong interest in demonstrating products, equipment and services to potential small-firm clients).

Some failures may be more prevalent in specific sectors. For example, investment in the energy sector may be characterised by a high level of uncertainty about the prospects for success, as the high capital cost of investment and the long timescale for deployment and returns tend to make investors risk averse with respect to new technologies. In addition, consumers may experience difficulties in differentiating between products, making it difficult for new entrants to obtain appropriate returns to their investment in innovation. For example, customers do not possess sufficient information with which to discriminate between electricity generated from a wind or a gas turbine, and thus are not in the position to value them differently according to their characteristics (OECD, 2011a).

The role of consumers and better understanding consumer behaviour also plays a role of growing importance for innovation, notably on the demand-side. Consumers collectively account for more than 60% of final consumption in the OECD area. The purchasing decisions that they make therefore have major impacts on the extent to which markets can work to promote innovation. Their ability and willingness to do so depend in large measure on:

- The economics of making choices for more innovative products, and the supporting infrastructure that can be put in place to support such choices.
- The quality and reliability of the information available on the attributes of products; good information is essential to informed decision making.
- The knowledge consumers have of the impacts of their consumption and lifestyle decisions; and of the practical actions that they can take to support broader policy goals.
- The level of commitment to supporting such objectives.
- The impact that behavioural biases have on the decisions and actions taken by consumers and households.

Industry, governments and civil society, acting individually and/or in partnership, can play an important role in creating an enabling environment, in which consumers are provided with the information and tools needed to make more innovative purchasing choices and adopt different lifestyles.

Problems of collective action may also arise. In particular, the development of standards is likely to experience some degree of market failure. By itself, the market may provide too few standards. Creating standards entails fixed costs, while the gains may not be appropriable by the individual firm.

1.1.2 System failures

Barriers to innovation may also emerge from inertia in economic systems that hinders the flow of knowledge and technology, and reduces the overall efficiency of the innovation effort. A broad literature exists on innovation system failures, which includes failures relating to network effects, difficulties in making the transition to new technologies, as well as slow-changing norms and values.[6]

Network effects (or positive network externalities) can occur when the value of a network to users is positively correlated with the size of the network (i.e., the mass of users). In this case, once a network is established, it may be hard to change. Because of the network effect, the network's technology might become locked-in. And in some cases this technology may be less-than-optimal (the QWERTY keyboard is an often-quoted example of a locked-in technology: while there are better keyboard layouts, QWERTY remains the dominant design because of its prevalent use). So the existence of network effects highlights the risk that public procurement could lead to the lock-in of sub-optimal technologies. Network failures also relate to problems with interactions among actors in the innovation system (Arnold, 2004).

The generic term "network" also covers multiple forms of informal and formal collaboration. Of relatively recent policy attention are formal mechanisms of co-operation among groups of firms, and sometimes among firms and research institutions or centres of technical excellence. Governments might justify a facilitatory role in network development owing to the fact that in some places and industries there may have been no, or limited, prior familiarity with the opportunities that networks afford. In some industries the network principle may be hard to establish, with fears existing of possible unfair appropriation of the benefits from collaborative undertakings. Co-ordination problems among geographically dispersed firms may also create inertia in the establishment of business or technology-oriented networks.

Transition failures arise when innovation systems fail to take on board new technological opportunities (Arnold, 2004; Smith, 2000). Firms (especially small ones) concentrate on the technologies they know best and are likely to experience difficulties in responding to major technological changes.

Closely related to transition failures, path dependence[7] may lead to **lock-in failures**. For example, dominant designs in energy and transportation can create entry barriers for new technologies, due to high fixed costs of developing new infrastructures (The UK Committee on Climate Change, 2010). High entry costs may exist for new technologies, and therefore lead to high costs of switching to these new technologies for users. Emerging technologies may fall into a vicious circle: they are not adopted because they are too expensive, but at the same time they are too expensive because they have not yet been adopted. Compatibility requirements with existing technologies may prevent the emergence of more radical and systemic innovations (del Río et al., 2010).

Slow-changing norms and values can also add to inertia, as discussed above for consumers. For example, people's values, lifestyles and consumption choices can act as a significant barrier to innovation.

Systemic failures may also exist in the **provision of and investment in infrastructure**. Because of large scale, indivisibilities and long-time horizons of operations, both physical infrastructures and science and technology infrastructures are unlikely to be sufficiently provided by private investors. For example, in the case of the energy sector, governments may need to support research and large-scale demonstration activities. They may also need to assess infrastructure needs for promising but not yet mature technologies, as it is unlikely that the private sector alone will fully address these activities.

The discussion above shows that a range of potential market failures and other sometimes systemic barriers affect innovation. Demand-side policies are part of the toolbox that policy makers have at their disposal to overcome these barriers and strengthen innovation performance.

1.2 Demand and innovation

The identification of the role of demand in stimulating innovation can be traced back to Schumpeter and the conceptual trilogy of invention, innovation and imitation/diffusion. In his view, the demand-side of the market is characterised by routine behaviour and limited foresight. Hence, he saw little potential for market demand alone to stimulate innovation, unless users' preferences are influenced in that direction, e.g. through government intervention or by providers of innovation who persuade buyers to change their preferences (Andersen, 2003).

But Schmookler (1966) and Griliches and Schmookler (1963), through their analysis of patent statistics, showed that inventive activity is responsive to demand-pull factors. This insight ran counter to the then prevailing view that the direction and magnitude of innovation were mainly driven by supply factors, i.e. changes in scientific and technological knowledge (Scherer, 1982). In the view of Schmookler and Griliches, the larger an actual or potential market is, the more demand in this market will stimulate

innovation, partly because the profitability of an invention rises with market size (other things being equal) and partly because when productive activity is directed to meeting demand in the market, it is more likely that an invention matches a need.

In a nutshell, innovation depends on relative profitability, which in turn depends on demand. Such "demand-pull" drives innovative activity. In fact, research shows that the number of inventions is a lagged outcome of changes in demand (Andersen, 2003). In this sense, OECD (2009) stresses the importance of demand for innovation, and also that the potential to recoup investments will increase with growing market size. Hence, successful innovations are more likely in fast-growing economies, particularly in sectors where demand is particularly strong.

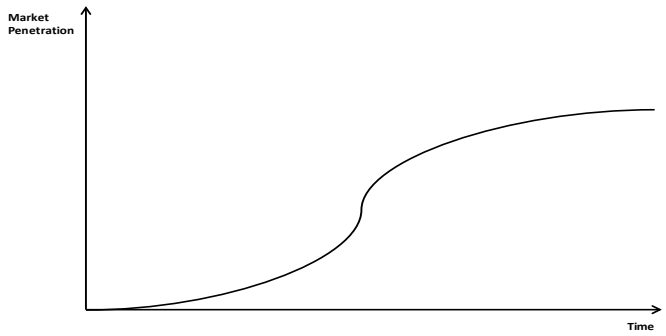
The different perspectives of Schumpeter (focusing on technology-push) and Schmookler (emphasising demand-pull) do not necessarily contradict each other; they may instead point to the different patterns of causation involved in radical and incremental innovation (Andersen, 2003). In reality, demand is important in both cases. Indeed, growing interest in demand-side policies has emerged in part because of greater awareness of the importance of feed-back linkages in the innovation process between supply and demand. Demand-oriented innovation policies are thus part of an evolution from a linear model of policy, usually focused on R&D, to a more broad-based approach that considers the full innovation cycle.

Recognition of the essential interaction between demand and supply conditions is also reflected in a broader academic literature. For example, Mowery and Rosenberg (1979) conclude that neither supply nor demand factors are necessary and sufficient for innovation. Both must exist simultaneously. And Freeman (1974) surveyed a set of 40 innovations, showing that successful innovations were able to link technical with market opportunities. Neither supply-side nor demand-side policies are likely to be optimally effective in isolation. Efforts to foster innovation will likely have greatest effect when they address the entire innovation chain.

In the Schmooklerian view an innovative product or technology is successful because it possesses one or several characteristics superior to available alternatives, while in the Schumpeterian framework, innovations are so radical that users do not expect them, and demand for such innovative technologies needs to be induced externally (by government or by providers of innovations themselves, for instance through marketing). This is also where the role of early users and sophisticated consumers emerge: they take up innovations in niche markets and thus influence the preferences of ordinary buyers.[8]

By accelerating the acceptance of new products and technologies by potential users, and hence the willingness to adopt them, demand conditions can also play an important role in facilitating the diffusion of innovation. A vast body of literature has consistently shown that the diffusion of new technologies is a slow and gradual process that follows an "S-shaped" path over time (see Figure 2). In a first phase technologies spread slowly, then their uptake rises steeply, until diffusion slows down and finally reaches a plateau when technologies become mature and most potential consumers have adopted them.

Figure 2. S-shaped innovation diffusion curve



1.3 Rationales for demand-side policies

Edler (2007) defines demand-based innovation policies as a "set of public measures to increase the demand for innovation, 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". Policy may act where the demand for innovations is insufficient, or non-existent, but where a technology or product has a high potential benefit; or where the articulation of demand may be insufficient, as human or social needs are not automatically translated into clear market demands.

More generally, demand-side policy may be useful when governments need to create a market for certain types of innovations in order to meet a policy challenge that is time-bound. The search for commercial-scale low carbon emission technologies is a case in point. Indeed, a central part of the rationale for demand-side policies is to stimulate innovation in areas where societal needs are pressing, such as aging, health and the environment.

Where the scale of public sector demand is significant, profitability might also be increased on account of economies of scale. This in turn prompts innovation, demonstration, experience and learning, which lower costs, ultimately making technologies more attractive for adoption by users (Romani et al. 2011).

In addition, while better evaluative evidence is needed to establish this argument, well-designed demand-side policies could potentially be less expensive for governments than direct support measures. For example, most OECD countries thus far appear to integrate innovation objectives within existing public procurement policies, without providing additional budget (Figure 1). And such policies have the further merit that they can be designed not to be directed at specific firms, but instead to reward innovation and efficiency wherever they arise.[9]

Three main forms of demand-side policy are considered in this report: innovation-oriented public procurement; performance-based regulations and standards; and technology-based regulations and standards. Other policies to shape consumer behaviour, such as labelling schemes, are touched on only briefly. The specific rationales for these three forms of policy are examined here.

There are various rationales for using **public procurement** as a policy tool for fostering innovation:[10]

- Because of their purchasing power, governments can shape innovation directly (and indirectly). Firms benefit because procurement can help them recuperate the sunk costs of large and sometimes risky investments over a pre-determined period of time. Indeed, a number of major technological innovations have their origin in public procurement, including microprocessors, Internet Protocol technology and the Global Positioning System. And public

procurement has been a determinant of the emergence of a number of high-tech sectors in the United States, Japan and France (where public procurement has been used, for instance, to develop high-speed rail technology and to ensure a competitive advantage in nuclear energy technologies). Some studies have compared R&D subsidies and non-R&D public procurement and concluded that, over time, public procurement triggered greater and more diverse innovation than R&D subsidies (see for instance Geroski, 1990 and Rothwell, 1984).[11] Public procurement has also been found to have a particularly marked effect on smaller firms in regions under economic stress (Aschhoff and Sofka, 2009). Such benefits can be amplified when public demand is co-ordinated, in particular by bundling together the demand emanating from various government agencies and bodies. The concentration of public demand that is brought about by such co-ordination creates clear incentives for suppliers and reduces their commercial risk (Fraunhofer Institute for Systems and Innovation Research, 2005). Where the scale of public sector demand is significant, profitability might also be increased on account of economies of scale. This in turn prompts innovation, demonstration, experience and learning, which brings down the cost of technologies and processes, thus making them even more attractive for adoption by users, in a virtuous circle (Romani et al., 2011).

- Furthermore, by creating a signalling or demonstration effect as a lead user, governments can also influence the diffusion of innovation and catalyse private demand (and, in parallel, businesses that win procurement contracts can achieve an enhanced reputation within their sector [Binks, 2006]). This effect on private demand might be bigger and more beneficial for the economy than the initial public purchase.
- If targeted innovation is achieved, the delivery of essential public services can become more cost-effective. New products and services may enable governments to innovate to improve process efficiency and enhance the quality and availability of public service delivery, for example in the areas of health, e-government and education (OECD, 2011b). More efficient procurement might also liberate public resources that can be deployed to satisfy private needs through other channels.
- The possibility of inducing innovation via procurement outlays that would have occurred anyway is particularly attractive in the context of fiscal constraint.

Innovation-oriented **regulation and standards** can also play an important role in spurring innovation.[12] In particular, governments can use performance-based standards and regulations and/or technology-based standards and regulations.

Performance-based approaches have the advantage that they can be designed to be technology neutral, compared to support targeting specific technologies and solutions. They can be mandatory (regulations) or voluntary (standards). They provide flexibility for producers to innovate and adopt new technology. They may also induce competition among manufacturers in terms of performance. By affecting the performance (quality, compatibility) or consequences (health, safety, the environment) of products or services (e.g. labelling and certification, recycling regulations, emission standards, etc.), they can have a direct impact on demand for innovative goods and services.

However, when a technology is already locked in, performance-based regulations and standards may not be sufficient to bring about more radical innovations. In some cases, this has led regulators to turn performance-based approaches into de *facto* technology mandates. For example, the "Zero Emission Vehicle" (ZEV) regulation of California is quite unique, as it combines a performance standard – zero emissions – with a sales mandate to carmakers (Bedsworth and Taylor, 2007). It represents an example of a performance standard that is nominally technology neutral, but is in fact technology forcing. Although the California Air Resource Board (CARB) formally allowed carmakers to choose whatever technology they

saw appropriate to meet the ZEV targets, electric vehicles were the only feasible option when the mandate was conceived in 1990.

This is a risky approach: if regulators underestimate the pace of technological development, they may set a performance level that is not stringent enough to reap the potential benefits of innovations brought to the market. But if regulators overestimate the speed of technological change, the stringency of the standard could place too heavy a burden on manufacturers, relative to the resulting benefits.

Technology-based regulations and standards set out the specific characteristics of a product, process or production method, such as its size, shape and design. They affect innovation by setting technical specifications for ensuring interoperability, securing minimum safety and quality, achieving variety reduction and providing common information and measurement. The standardisation of technical specifications for converging technologies is a key to accelerating their successful deployment.

Swann (2000) provides a comprehensive review of the literature on the economics of standards, which includes evidence that successful standardisation can achieve some or all of the following:

- Standardisation drives innovation because innovation requires competition and competition requires interoperability. Successful standards facilitate that interoperability.[13]
- Standardisation can increase trade.
- Standardisation codifies and diffuses information on technology and best practice. By setting ground rules, common terminology, development methods and measurement techniques, standards enable the diffusion of innovation. Publicly available standards in particular have a potentially powerful effect on the dissemination of information about technology, from both domestic and international sources. In some markets - such as automotive parts supplies, flat screen TVs and mobile telephony - quality certification and consumer safety rules are important in shaping demand and in the diffusion of innovations.
- Standardisation reduces risks for producers and consumers. For instance, standardisation of measurement helps producers of innovations demonstrate innovative traits to consumers. And standards lower the risk of investing in a redundant technology. Directly related to this point is the observation that standardisation can also facilitate public procurement. For instance, in the United Kingdom, one goal of recent public support for biometrics standardisation has been to open public procurement contracts to competitive tender through reference to standards (in turn facilitating access for smaller companies). An independent 2009 review found that funding in the area of biometrics had in fact facilitated the diffusion of technology in the marketplace, made procurement more cost-effective and eased access for SMEs to the procurement market. Standardisation had saved large sums by enabling competition on identity card contracts, and the use of standards had accelerated progress on biometrics programmes, such as that run by the Identity and Passport Service, and had future-proofed the technology.
- Standardisation reduces transaction costs between producers and between producers and consumers.
- Standardisation may protect against situations in which high-quality producers are driven out of the market by low-quality producers because information is not fully available to consumers on the quality content of their output (Gresham's law).
- Standardisation may efficiently reduce unnecessary variety among products (in construction, for instance, there might be no need for production of a continuous variety of steel girder widths).

Standardisation is particularly helpful in the formative stages of a given market. Standards can focus demand for innovations that might otherwise be spread over multiple technical solutions. Standards are especially important in network industries, such as ICTs, in that they can facilitate a critical mass of users. The GSM is a good example in this context. In this connection, standards ease the emergence of technological platforms - independently supplied yet inter-operable components with shared technical standards. Many successful platforms, such as the Internet and the cellular telephone, are based on open standards.

There is often also complementarity between regulations and standards. Regulations set the essential levels of safety, environmental or health protection and are frequently complemented by harmonised consensus-based standards-setting on technical specifications.

Other policies that affect **user behaviour** can also affect the direction of innovation, in particular:

- *End users/consumers*: Purchasing decisions made by consumers have major impacts on the extent to which markets are innovative. OECD (2011b) stresses that the real challenge for an innovation is take-up by mainstream consumers, as the majority of users usually join in when innovations become more incremental and embody a smaller degree of inventiveness. On the other hand, early users have an important role because they bear the risk of testing an innovation.
- *Businesses:* Businesses do not only play an important role as innovators, they are also users of innovations, including through their interactions with other firms in the supply chain.

2. Challenges of demand-side policies

Policies to foster demand as an explicit tool for innovation are not without risks and challenges. These vary according to the form of policy (or instrument) in question, and are discussed further below.

2.1 Challenges affecting innovation-oriented public procurement

The design of pre-commercial procurement, as with traditional procurement, must avoid the risk of capture by vendors and/or other anti-competitive effects. For example, in some countries procurement procedures may end up giving preferential treatment to state-owned enterprises, which hinders competitive neutrality. At the same time, when special measures for SMEs or disadvantaged communities are considered, these must fall within the framework of national competition policies as well as international standards and obligations. The challenge of avoiding anti-competitive effects will likely be more acute for pre-commercial procurement, as some interaction with suppliers of not-yet-existing products may be needed in formulating tenders that are technically feasible.

Moreover, as public procurement is increasingly used to support innovation objectives, this has increased the **risk of inefficient policies** (e.g. in the form of hidden trade barriers). Evidence from an OECD survey on public procurement suggests that most countries do not explicitly consider the opportunity costs and potential risks when using procurement to support socio-economic objectives (OECD, 2012). The expense of achieving these goals should be considered, and the trade-offs, if they exist, need to be made explicit – e.g. finding out whether procurement is a more cost-effective way to achieve innovation objectives than other innovation policies. There is also a risk of procurement itself becoming inefficient where this is used as a lever to support socio-economic criteria without sound initial cost-benefit analysis. In the United Kingdom, a new Government Buying Standard (GBS) for transport was published in November 2010, and became mandatory for central Government departments in February 2011. An *ex ante* impact assessment of the revised standards found that the benefits following the introduction of the preferred option (i.e. update and align GBS with the EU Green Public Procurement Transport

Requirements, plus additional proposed considerations to further the sustainability benefits) would outweigh the costs.[14]

An overarching challenge concerns **the lack of capacity in the public sector** for developing and implementing innovation-oriented procurement. Procurement officials are increasingly requested to integrate innovation (and other) considerations in their purchasing decisions. When award criteria include considerations other than economic value, this introduces a level of subjectivity in the decisions of procurement officials. For instance, if the innovative character of the goods is to be considered in the award decision, procurement officials will need to be able to assess the extent to which each tender is innovative, which may involve trying to evaluate bids for innovative solutions against qualitative award criteria. Expertise in the procurement body will also be helpful in deciding whether an alternative and innovative solution to a current procurement practice is likely to be available at all, and therefore whether innovation procurement should be pursued. Recent work in the United Kingdom found that only 14% of surveyed firms strongly agreed with the statement that "public procurers are knowledgeable about the market in which our product and/or service operates." Just 18% of firms strongly agreed with the statement "public procurers are knowledgeable about the technical aspects of our product and/or service' (Edler et al., 2012b).

While many governments have made efforts to create guidance for procurement officials, most countries do not yet have a formal policy explicitly aimed at using procurement to foster innovation. These problems are even more acute at the sub-national level, as municipalities and regions often lack procurement-specific knowledge and personnel (a relevant experience here is the Gateway Review undertaken by the United Kingdom's Office of Government Commerce. For acquisition programmes and procurement projects in central government, the Gateway Review allows experienced independent practitioners to examine projects at critical stages in the lifecycle). Procurement officials today are expected to comply with increasingly complex rules and pursue value-for-money goals, while taking account of economic, social and environmental considerations. They variously face challenges related to:

- Understanding the increasingly complex public procurement rules that generally provide incentives for procurement officials to pursue value-for-money criteria.
- Managing conflicting objectives when using procurement to support broader policy goals such socio-economic and environmental objectives.
- A lack of guidance on how to take innovation, social or environmental criteria into account in public procurement.
- Keeping up with the development of e-procurement systems and ensuring their effective implementation.

An additional challenge is that general public procurement is often highly fragmented across local, regional and national government agencies. Sub-national governments account on average for 64% of public investment in OECD countries. This not only entails challenges, as already noted, in having requisite expertise across many procurement bodies. A decentralised procurement system may also lack scale-efficiency and risk-mitigation possibilities open to more centralised systems. Indeed, pro innovation and/or green public procurement has been found to be more challenging in OECD countries with de-centralised procurement systems (OECD, 2012).

Furthermore, many agencies with responsibilities for public procurement operate separately from government agencies tasked with fostering innovation. Specialised procurement agencies are mainly responsible for the efficiency of purchasing, and expertise in the respective fields of innovation may be lacking. In 2007, an OECD survey indicated that the most frequent obstacle to environmentally-friendly procurement was a lack of knowledge among procurement officials (OECD, 2012). A number of studies

suggest that innovation is often low on the list of priorities among procurement agencies (Technopolis, 2011). In addition to the need for legal expertise on procurement regulations at the various levels of decision-making, procurers will also need expertise on technologies and markets.

Procurement of innovation also entails risks beyond those that arise in traditional procurement. These risks – mitigation strategies for which are discussed later in this report – include:

- Technological risk – that is, non-completion risk stemming from technical features of the procured good or service.
- Risks related to the uptake by users of the good or service. These might stem from such issues as inadequate absorptive capacities in procuring institutions or incompatibilities with existing technologies or routines.
- Market risks – these risks exist on the side of both supply and demand. On the demand side, risks are greatest for wholly novel items. Public bodies might mitigate such risk by implementing additional demand-side measures, such as user training schemes, or using demand aggregation, in particular by bundling public demand. On the supply side, the main risk is that suppliers do not respond to the tender.

Aspects of legislation may also unnecessarily hinder innovation-oriented procurement. In Belgium, Denmark and the Netherlands it is reported that innovators – i.e. the suppliers of the original prototypes – are prohibited from bidding for the later procurement, as this might provide them with an unfair competitive advantage over their rivals (Technopolis, 2011). While no doubt aimed at ensuring competition, such a restriction could conceivably act as a disincentive to investment in innovation.

Finally, evidence **of the impact of procurement for innovation** is often lacking. Few countries currently analyse public procurement to support improvement, even if most countries collect basic data on a regular basis on the number of bids, contract awards and the use of open vs. non-competitive procedures. The use of e-procurement systems strengthens data collection, although the reliability of the data may not always be consistent across government agencies.

2.2. Challenges affecting performance-based regulations

There are also a number of risks and challenges associated with the use of performance-based approaches to foster innovation. To start with, the effects of economic regulation on innovation are far from straightforward, and can be ambiguous *a priori*. For instance, Mahdi et al (2002) review the impact of health, safety and environmental regulation on the chemical industry in Europe. This study was spurred by concerns that the more stringent regulatory conditions in Europe would retard innovation relative to competitors in the United States. But their findings indicate that rates of new chemicals notification between Europe and the United States had experienced convergence over the previous decade. Their review of the literature suggests that in most cases regulation both inhibits and stimulates innovation. They conclude that "Despite a long tradition of research on the question of how regulation influences innovation in different industries and in different countries, it is far from clear where the balance between these two effects falls".

The relationship between innovation and regulation has also been examined extensively in the area of environment innovation, particularly related to the so-called Porter Hypothesis (Porter and Van de Linde, 1995), which suggests that strict environmental regulations can encourage innovation and improve competitiveness. For example, Ambec et al. (2011) surveyed the literature and report that empirical evidence that stricter regulation leads to more innovation is fairly well established (while evidence on the notion that stricter regulation enhances business performance is mixed, with some recent studies providing more supportive results). Lanoie et al. (2011) test the significance of different variants of the Porter

Hypothesis using a rich dataset (i.e. observations from approximately 4 200 facilities in seven OECD countries). They find: strong support for the "weak version" of the hypothesis (i.e. environmental regulation will stimulate environmental innovations); qualified support for the "narrow version" (i.e. flexible environmental policy regimes give firms greater incentives to innovate than prescriptive regulations, such as technology-based standards); no support for the "strong variant" (i.e. properly designed regulation may induce cost-saving innovation that more than compensate for the cost of compliance).

Regulation is often used when markets do not provide price signals to individuals or organisations that reflect the costs of behaviour. Overall, regulatory instruments have drawbacks relative to pricing instruments because they fail to provide an intrinsic mechanism for ensuring that targets be attained at the least economic cost. Indeed, by concentrating action on the supply-side, non-market instruments need to over-compensate for the absence of shifts in demand. Studies confirm that shifting from regulatory to price-based instruments can yield significant efficiency gains. In the United States, for example, a shift from standards-based regulation to permit trading for sulphur dioxide in the late 1990s was estimated to yield compliance cost savings of between USD 153 million to USD 358 million per year due to the flexibility it gave firms to respond to requirements to reduce emissions (Anthoff and Hahn, 2010).

That said, well-designed regulation can deliver strong net benefits and may be preferred by firms and other stakeholders in the policy process, even where prices are a technically superior alternative. Regulatory approaches may simply be more feasible in jurisdictions where constituencies are strongly against tax increases. This is important to the extent that large scale changes to production in sectors like energy may require significant price increases which are politically unsustainable. In this regard, it is essential that policy options are subject to careful consultation with the private sector and civil society.

The impacts of regulation on innovation are also likely to be highly technology– and industry-specific. This implies that considerable industry-specific expertise will be required in public bodies as a pre-requisite to the design and implementation of such regulation-based policy.

To assess the appropriateness of regulatory policy targeted at a specific sector, analysts also need to be able to assess whether the market would introduce the right level technology in the absence of the regulation. For instance, with respect to regulation on fuel efficient vehicles, if the market were efficient in terms of fuel economy technologies the regulation could be redundant. Whether the market is efficient or not will likely have industry-specific considerations, again requiring significant expertise in the public bodies concerned.[15]

The precise form that the regulation takes will also affect its impact on innovation. For example, in the United States, the Corporate Average Fuel Economy (CAFE) regulation introduced in 1978 was framed in such a way that increases in average vehicle fuel efficiencies could be achieved through manufacturers changing relative car prices so as to sell fewer large cars and more small cars.[16] Regulations in the United States enacted in the 1970s and governing energy efficiency in refrigerators served to increase efficiency over time, but only up to levels already existing in equivalent appliances in Europe. No technological innovation was observed initially. The key factor in this respect was the low stringency of the regulation. The fuel economy standard remained unchanged since 1990 until quite recently, and this lack of stringency was reflected in a comparatively slower rate of improvement in vehicle fuel efficiency. In the European Union, there was a continuous improvement in vehicle fuel efficiency in the same period, driven by more stringent targets than those in the United States. And this occurred in spite of the fact that the CAFE regulation was mandatory, while the EU standards were voluntary (although they became mandatory in 2009). Again, these examples indicate the complexities involved in regulation-based policies.

A further critical consideration is that even in cases where regulation spurs innovation, regulation-based policy might be cost-ineffective overall (from a general rather than partial equilibrium perspective).

Kleit (2004) provides a detailed economic cost benefit analysis of the aforementioned CAFE vehicle efficiency regulations in the United States. The analysis shows that a small increase in the gasoline tax would deliver equivalent savings in fuel consumption but at a much lower cost to society (in part because the regulation lowers the marginal cost of driving and thus induces more driving, with concomitant increases in pollutant emissions, accidents and congestion).

It can also be relatively difficult to isolate the specific effects of regulation from other influences. This reflects the inherent complexity of the pathways by which regulation can shape innovation, the possibility of long lead times between a regulatory stimulus and an industry response, the simultaneous impacts of an array of supply-side factors, as well as inherent uncertainties in the dynamics of innovation (including a possible exhaustion of the research frontier).

2.3. Challenges affecting technology-based standards

Unlike regulation, the setting of standards is mainly the responsibility of industry bodies – with government acting as facilitator or co-ordinator (the public sector's role largely involves measures to include under-represented groups in the process of developing standards, and subsidisation of teams drafting international standards). This has practical implications: procedures in standards bodies can be slow and bureaucratic and can be held up by large players, which raises the important issue of timing. If standardisation is brought into effect too early, it could preclude and shut out better technologies. But if standardisation occurs too late then the costs of transition to the new standard could be high enough to slow or prevent diffusion. If product life-cycles are shortening, the issue of timing is likely to increase in importance.

Another potential problem with standards is that they might be captured by a single firm. Innovation and, in particular, the networked character of the information economy, require active standards-setting (for instance for complementary system components and interconnected networks). And standards, as noted above, can be pro-competitive. But, as Shapiro (2002) observes, anti-trust concerns exist here on two main issues. The first concerns a defining of the limits to co-operation in standard setting: most standard-setting bodies limit the scope of issues that can be discussed, excluding product pricing. The second main concern relates to behaviour that might allow a single firm to control a standard. To counter this danger, all standard-setting bodies require the collaborating parties to make available any intellectual property needed for compliance with a standard (either royalty-free or on the basis of so-called 'friendly royalties').

While governments have many good reasons for fostering standards development, including innovation, it may be difficult to foresee the precise nature of the innovations arising through the greater competition (and therefore pressure to innovate) coming from enhanced interoperability brought about by standards. By comparison, procurement policies or smart regulations can be focused more towards a specific outcome than standards development.

Lastly, there is a trend towards standardisation work being conducted at the international level because, in a globalised economy, compatibility and interface across borders are important. Competitive disadvantages could arise if a country were to free ride on the standards setting work of others. Countries and firms that play primary roles in setting international standards can enjoy advantages from doing so, to the extent that the new standards align with their own national standards and/or features of their productive base.

3. The design and implementation of intelligent public demand

This section considers the design of demand-side innovation policies. The design issues affecting procurement, regulations and technological standards differ considerably and so are treated separately in the text.

3.1 Designing innovation-oriented procurement

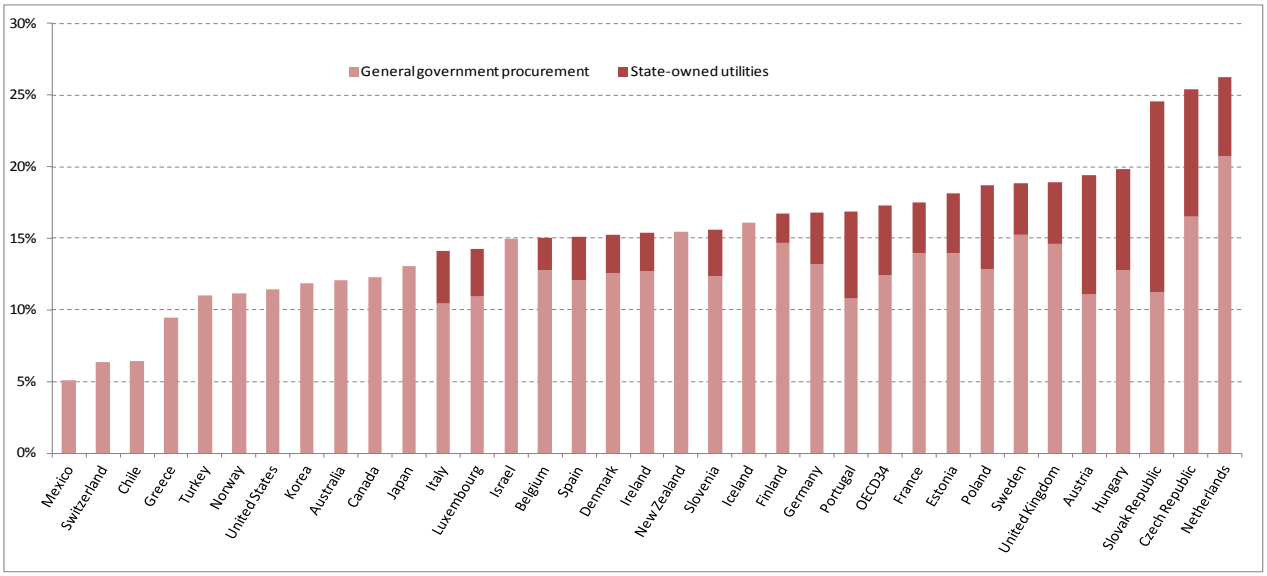
This section examines the design of innovation-oriented procurement. The issues addressed include: assessment of the likely market response, and therefore the appropriateness of procurement as the tool of choice; governance arrangements, and the need to create capacities and expertise in public authorities; possible mechanisms for managing the risks that innovation procurement can entail; drawing on know-how from across government; engaging the right stakeholders, and doing so early in the process; ensuring competition; and making use of electronic media.

3.1.1 Gauging the weight of public demand

The scope for impact from public procurement will depend on the weight of public procurement in specific markets and a range of other factors. In some circumstances procurement is unlikely to bring about a desired innovation, no matter how well designed the tender. This is most likely to occur when the potential market offered by the procurer is small relative to the costs involved in developing the innovation. Pharmaceuticals represent a case in point. A subnational authority, or national institutions in a small economy, are unlikely to command sufficient effective demand to make large-scale science-intensive investment in a new drug commercially viable. For many drugs, the market is global, and only commensurate changes in demand would permit new product development.[17]

Governments may therefore want to consider focusing their efforts on specific areas where the societal yield from their policies might be greatest. A number of factors need to be considered in this context. First, while government demand accounts for up to 25% of GDP in some countries (Figure 3), there are large differences in the scale of government purchases across sectors. Evidence for seven European countries (Table 1) shows that government demand is particularly important in sectors such as transport (where government is a large purchaser of equipment), education, office equipment, research and development, as well as construction.[18]

Figure 3. Government procurement as a % of GDP, 2008



Note: The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities or third party. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

Source: OECD (2011c).

Another important consideration for governments is how concentrated its buying power is. For example, the UK National Health Service operates a unified, nation-wide, procurement office. For medical innovations involving significant outlays and risk, it might be that any smaller (say regional) procurement market would not afford the rates of return needed to merit the investment (this is aside from the problem of there being more limited capacities and know-how in subnational governments). To some degree, the relative merit of central versus local procurement will also depend on whether the innovation sought is incremental or radical, and likely to be capital intensive. Radical and/or more capital intensive outcomes will likely require a larger public demand, other things the same. Furthermore, the public sector's direct influence on innovation through procurement will potentially be greatest in cases where government is a monopsony (as in markets for certain military technologies). In some markets the public sector might be an oligopsonistic purchaser. For instance, in the market for low-income housing, government might be the main source of demand, along with housing associations.

Table 1. Government share of consumption of domestically produced intermediates, mid-2000s

		Denmark	Finland	France	Germany	Netherlands	Sweden	United Kingdom	Unweighted average
C35	Other transport equipment	18.9%	19.4%	14.8%	22.4%	7.3%	25.4%	38.9%	21.0%
C80	Education	16.7%	15.0%	4.3%	6.4%	14.2%	15.0%	23.5%	13.6%
C75	Public admin. and defence; compulsory social security	7.6%	3.4%	10.3%	11.0%	29.1%	6.9%	2.6%	10.1%
C73	Research and development	14.1%	8.1%	4.7%	16.4%	9.5%	4.0%	10.5%	9.6%
C72	Computer and related activities	10.4%	10.1%	3.5%	4.6%	11.1%	5.6%	7.0%	7.5%
C45	Construction	7.0%	3.2%	6.9%	6.0%	12.1%	9.8%	6.1%	7.3%
C85	Health and social work	10.9%	8.3%	1.9%	3.9%	9.2%	9.3%	0.8%	6.3%
C90T93	Other community, social and personal services	3.1%	2.9%	6.6%	4.9%	19.3%	2.1%	10.7%	7.1%
C64	Post and telecommunications	5.6%	5.4%	6.0%	4.9%	5.2%	9.1%	7.8%	6.3%
C55	Hotels and restaurants	3.9%	7.1%	2.7%	10.9%	6.4%	4.3%	11.9%	6.7%
C70	Real estate activities	8.3%	7.9%	3.6%	3.1%	1.8%	9.2%	6.0%	5.7%
C29	Machinery and equipment n.e.c	2.4%	2.9%	7.1%	3.2%	6.5%	2.9%	13.8%	5.5%
C36T37	Manufacturing n.e.c; recycling	7.8%	4.3%	3.2%	0.4%	5.5%	3.2%	7.9%	4.6%
C30	Office, accounting and computing machinery	3.8%	0.8%	5.5%	5.7%	3.7%	3.3%	47.1%	10.0%
C74	Other Business Activities	2.9%	4.5%	4.1%	2.2%	4.7%		5.3%	4.0%
C33	Medical, precision and optical instruments	3.3%	6.3%	0.3%	1.5%	4.4%	6.3%	19.5%	5.9%
C17T19	Textiles, textile products, leather and footwear	3.5%	4.3%	2.3%	1.2%	3.7%	4.8%	4.6%	3.5%
C40t41	Electricity, gas and water supply	2.2%	2.8%	4.5%	2.6%	3.0%	4.0%	3.5%	3.2%
C65T67	Finance and insurance	1.9%	4.5%	2.4%	4.1%	2.2%	3.2%	5.6%	3.4%
C21T22	Pulp, paper, paper products, printing and publishing	1.9%	2.6%	4.3%	2.5%	4.6%	1.6%	5.3%	3.3%
C71	Renting of machinery and equipment	2.8%	3.1%	3.2%	1.4%	1.0%	2.6%	1.0%	2.2%
C50T52	Wholesale and retail trade; repairs	1.7%	3.4%	1.4%	2.4%	1.9%	1.9%	4.1%	2.4%
C32	Radio, television and communication equipment	3.3%	3.1%	1.2%	1.4%	0.9%		6.1%	2.7%
C60T63	Transport and storage	1.2%	2.0%	2.4%	1.5%	2.6%	1.5%	2.5%	2.0%
C23	Coke, refined petroleum products and nuclear fuel	1.5%	1.5%	2.0%	2.0%	1.6%	1.5%	4.8%	2.1%
C15T16	Food products, beverages and tobacco	0.6%	4.3%	0.6%	2.1%	0.7%	1.6%	0.6%	1.5%
C28	Fabric.d metal products except mach.y and equipment	1.5%	0.9%	0.1%	0.7%	2.3%	1.2%	0.6%	1.0%
C31	Electrical machinery and apparatus n.e.c	1.3%	1.4%	0.4%	0.4%	1.8%	1.4%	3.1%	1.4%
C25	Rubber and plastics products	2.0%	1.8%	0.0%	0.8%	0.5%	1.5%	0.9%	1.1%
C01T05	Agriculture, hunting, forestry and fishing	1.1%	0.6%	0.8%	2.0%	1.2%	0.7%	0.3%	1.0%
C34	Motor vehicles, trailers and semi-trailers	2.4%	0.1%	0.3%	0.5%	0.9%	0.6%	2.5%	1.0%
C24	Chemicals and chemical products	1.2%	0.6%	0.4%	0.5%	0.5%	1.0%	1.4%	0.8%

Notes: Intermediate demand by sector C75 in total intermediate demand.

The category “Other transport equipment” covers: building and repairing of ships and boats; manufacture of railway and tramway locomotives and rolling stock; manufacture of aircraft and spacecraft; and manufacture of transport equipment not elsewhere classified.

The category “Transport and storage” covers: road transport; transport via pipelines; water transport; air transport; supporting and auxiliary transport activities; and activities of travel agencies.

The category “education” includes public as well as private education services of all types, provided by institutions as well as by private teachers. Differences among countries in this category most likely reflect variation in outsourcing practices across education systems (with the level of outsourcing being high, for instance, in the United Kingdom).

Source: OECD, STAN Input-Output Tables, February 2012.

3.1.2 Assessing the likely market response

An additional consideration for governments is what the likely **response from the market** to innovative public procurement might be. Unless there is a supply-side capacity to respond, the policy might not be effective in stimulating innovation. In practice, the answer to this question will depend on specific country and sector-specific circumstances, and the technology in question. For some technologies, supply capacities might only be available in the largest and most sophisticated economies. In such cases, procurement efforts may need to go hand-in-hand with international market scanning.

As noted above, the scale of firms relative to the size of the likely market may also have an impact on the likely market response. Large multinational firms may be less likely to develop new products and services in response to public procurement in a small economy than small and medium-sized domestic firms. This is because the multinational firms will focus primarily on their global market and assess whether the specific public procurement will have broader market potential at the international level. Large

multinational firms may, however, respond to innovative public procurement if the resulting innovation can be scaled up at the international level, with the initial market acting as a lead market.

Typically, innovation-oriented procurement will not take place in a vacuum. Especially if the public sector is seeking some incremental change to an existing technology, there will likely have been a history of procurement in the industry concerned. Administrative records should indicate something about existing supply capacities, as would consultation with industry associations, individual technical experts, and perhaps ministries with innovation responsibilities/know-how. Approaches to innovative public procurement, such as the United Kingdom's Forward Commitment Process, involve providing the market with advance information on future needs, engaging early with potential suppliers and affording the incentive of a forward commitment, i.e. "an agreement to purchase a product or service that currently may not exist, at a specified future date, providing it can be delivered to agreed performance levels and costs".

There may also be some scope for enhancing the market response through co-ordination of public programmes. For instance, voucher or other know-how-bridging schemes might be designed to facilitate a supply response to expressed demand. In some countries, integrated supply and demand-side policies are currently being developed to address specific challenges.

3.1.3 Putting good governance arrangements in place

An important challenge is the governance of what is often decentralised public procurement. Governments in many OECD countries are currently taking steps to optimise their procurement function, which can also increase the weight of government buying power. Steps in this direction include:

- *Increasing the use of framework agreements,* including with the support of e-procurement systems, to purchase common goods centrally.
- *Restructuring the public procurement organisation* with a view to downsizing the number of procurement professionals and standardising procurement. This is not necessarily a positive trend for innovation-oriented procurement, as it is likely to diminish competencies and flexibility.
- *Using shared services* as well as purchasing alliances to achieve economies of scale.
- *Strengthening the capabilities* of procurement officials.

However, these steps and the related quest for economies of scale may affect the structure of the market, typically favouring large suppliers providing standard goods and using established technologies. It may also affect integrity negatively, e.g. through tacit or explicit market sharing and pricing collusion between a few, dominant suppliers.

The problem of relatively limited capacities for innovation procurement in subnational authorities is noted a number of times in this report. Steps have been taken in various countries to try to alleviate such capacity constraints. Ireland, for example, established a National Public Procurement Policy Unit which has prepared a national procurement framework, procurement guidelines[19] and information for subnational procurement units. And in Sweden a national network of subnational procurers operates to exchange information on good-practice.

The Gateway Review, operated by the United Kingdom's Office of Government Commerce, was cited earlier as a scheme facilitating access to procurement know-how in the public sector. While this programme concentrates on procurement projects in central government, the principle involved – allowing experienced independent practitioners to examine projects at critical stages in the lifecycle – might be enlarged to cover subnational bodies.

Benefits could also be had from standardisation in procurement practices across subnational governments. Firms recently surveyed in the United Kingdom reported that approaches can differ across local authorities, and that this can cost industry time and money (Edler et al., 2012b).

3.1.4. Distinguishing the specific form of procurement under consideration and its design requirements

Four different approaches to the relationship between public procurement and innovation can be distinguished. These are described further below.

General public procurement

General public procurement can often be given a greater focus on performance metrics, rather than on specific features of the procured items (defined *a priori*), thus creating more scope for innovation.[20] This method can be applied for a vast number of products and services purchased by public authorities, from construction, transport, energy and catering services, to health products and equipment. The tender process usually operates in several stages including: defining the subject matter of the contract; drawing up technical specifications and contractual parameters for products/services; and determining the best bid. New procurement criteria, beyond price, can emphasize innovative outcomes, and can be added in the tender specifications and in the assessment of tender documents. This approach involves providing public procurement agencies with greater guidance on the products and services to purchase, and the role of innovation in this context. The OECD survey quoted earlier in this paper suggests that about 65% of OECD countries used this approach in 2011 (OECD, 2012).

As already mentioned, policy here needs to ensure adequate availability of expertise, with staff having knowledge for instance of regulations, technologies and markets. Shortages of expertise may be exacerbated by budgetary pressures to restructure public procurement organisations, reducing the number of procurement professionals and further standardising procurement processes. However, across many OECD countries, increasing efforts are being made in augmenting the skills of procurement agency staff. For example, the European commission's web-based Green Public Procurement Training Toolkit is used by public purchasers and trainers for integration in general public procurement training courses and workshops. By 2010 more than three quarters of the OECD member countries had introduced practical guides on environmentally friendly procurement (OECD, 2012). In the United Kingdom the innovation ministry also provides advice on how to incorporate innovation in procurement processes.

Many innovative and greener products and services may initially have higher costs or longer payback periods. Government procurement rules usually require assessment against "value for money" (VFM). However, VFM does not always require choosing the cheapest bids. For example, the EU Procurement Directives define VFM as "the optimum combination of whole-life cost and quality to meet the user's requirement". VFM could therefore include the consideration of environmental performance along with cost, performance, availability and quality. Despite the concern over increased costs, studies confirm that there is considerable scope for cost-effective green public procurement. The consideration of lifecycle cost could affect the whole supply chain and stimulate the increasing use of green procurement (EC, 2007).

Catalytic procurement

In this approach, the government plays a role in strengthening demand for products and services that are still in an early stage of development or diffusion. Government purchases may provide firms with early market support and may act as a signalling device.[21] For example, several governments have recently purchased electric cars to promote the market for these alternative fuel vehicles. "Green" public fleets can play an important demonstration role in the commercialisation phase of electric vehicles, as they enable potential users to witness how green vehicles compare with conventional gasoline-powered vehicles in

terms of performance, reliability and other characteristics. Thus, public procurement may contribute to breaking some of the psychological biases against green vehicles, providing consumers with the basic knowledge they need when making car purchasing decisions (Beltramello, 2012).

The case of "green public fleets" also highlights that using public procurement to foster consumer uptake of certain products or services can be a double-edged sword. There is a risk that the products purchased through a government programme do not deliver on the expected performance, safety and cost-effectiveness. A failed demonstration programme could provoke a backlash against innovative products, such as electric vehicles.

Another and much earlier example of catalytic procurement concerns solar technology. In the United States, in the late 1970s, under the Experimental Technology Incentives Programme (ETIP), action was taken to address what was seen as the main barrier to widespread commercialisation of solar technology, namely, uncertainty over the economics of power production on a large scale. Accordingly, under ETIP it was proposed to use solar technology to meet the energy needs of military bases. In August 1978, the Congress approved USD 4 billion in military construction, with the stipulation that all new military family housing units and 25% of other forms of construction be equipped with solar heating and cooling systems. The Department of Defense would thus provide a source of demand worth around USD 100 million a year, compared to previous overall industry sales of some USD 150 million (Rothwell and Zegveld, 1981).

In the United Kingdom, the Prince of Wales's Corporate Leaders Group on Climate Change and the Department for Business, Innovation and Skills launched three Joint Public–Private Low Carbon Procurement Compacts for new, "low to zero carbon goods and service. The "Down to Zero" Compacts bring together major public and private sector customers to demonstrate to potential suppliers that there is a substantial and organised market demand for cost-effective and low-carbon solution in three areas: transport, heat and power from renewable bio-methane, and catering. As part of the process, a market sounding phase is designed to gauge the interest and capacity of the supply chain to deliver the solutions in response to unmet needs identified by customers. This is a form of catalytic procurement, as the government (both at the central and local level) is only one of the leading customers for the innovative goods and services (The Prince of Wales's UK Corporate Leaders Group on Climate Change and Department for Business, Innovation and Skills, 2012).

Pre-commercial strategic (or innovative) procurement

This type of procurement is aimed at purchasing research and development, design, prototyping and testing services for products or services that do not yet exist on the market. This pre-commercial procurement requires novel technological development work on the part of the companies or institutions responding to the call for tender (Edquist et al., 2000).

There appear to be somewhat different approaches to pre-commercial procurement, with variation existing around whether there is a restricted focus on SMEs as the suppliers of R&D services, and whether there is some prior commitment from the public sector to purchase solutions developed during the pre-commercial phase. There is also variation across programmes in the degree to which the purchase of R&D services is oriented to meeting some explicit need in a government agency (for example the UK SBRI, see below) or to addressing some broader societal need (the case with the Netherlands' SBIR, see below).

The United Kingdom operates a Forward Commitment Procurement programme. The process involves providing the market with advance information on future needs, engaging early with potential suppliers and providing an agreement to purchase a product or service that currently may not exist, at a specified future date, providing it can be delivered to agreed performance levels and costs. Initial feedback

from procurers and suppliers suggests that a key to success was to begin by asking what was needed, not what was thought to be available or affordable. This afforded companies the freedom to innovate and explore new technologies and design concepts, and helped innovators to manage the risks associated with bringing new goods and technologies to the market.

The United States follows this model in programmes in sectors such as defence, energy and transport. For example, the Defense Advanced Research Projects Agency (DARPA), under the Department of Defense, has been responsible for developing technologies such as the Internet, the global position system, and the laser. DARPA is a small, flexible and flat organisation with substantial autonomy and freedom from bureaucratic impediments. In recent years, many departments/agencies including the intelligence community (Advanced Research and Development Activity in 1998, Intelligence Advanced Research Projects Activity in 2006), Department of Homeland Security (Homeland Security Advanced Research Projects Agency in 2002), and Department of Energy (Advanced Research Projects Agency – Energy in 2007) have created their own "ARPA." Some of these have been criticised, however, as they have failed to recognise the importance of public procurement in DARPA's success (OECD, 2011b). [22]

Public authorities can also directly procure research and development (R&D) without guaranteeing to buy the goods or services thus developed. These schemes seek to meet a perceived demand for research – while aiming to ensure that a wider set of players than normal get to supply that research, particularly small firms. The solutions developed may or may not be purchased later by the R&D-funding body.

Such procurement has been implemented in the United States through multi-stage, multi-competitor R&D programmes in such sectors as energy, transport and defence, through the Small Business Innovation Research (SBIR) Programme.[23] The programme gives grants for R&D in line with a department's or agency's mission, with companies selected through competitive process. Using small business to meet R&D needs is one of the statutory goals of the programme, as is increasing private sector commercialisation of innovations derived from R&D. Only companies that have 500 employees or less can qualify as recipients of the programme. Funding is given for concept evaluation and for principal R&D, but commercialisation is expected by the private sector.

Since the United States launched the SBIR in 1982, R&D procurement from small businesses has proven an efficient concept for stimulating innovation and enlarging the R&D supply base. In Europe, several countries have followed the United States's approach and established similar programmes such as the Small Business Research Initiative (SBRI) in the United Kingdom and the Netherlands' SBIR programme, launched on a small scale in 2004.

The Dutch SBIR programme was inspired by the United States programme but was adapted to the local policy context. The key elements carried over from the United States programme are: competition; the use of contracts instead of grants; two payment phases; tailoring to start-ups and SMEs; and awarding IPRs for companies. The Dutch SBIR programme gives several benefits to SMEs. For example, they have the option to co-operate with others while they remain in charge of the R&D project. And they can create contacts with new partners and potential clients. In addition, SBIR contracts are manageable for small companies, and the resulting IPRs belong to the companies. Finally, the provision of 100% financing is particularly attractive, as small firms often face high barriers in accessing finance to invest in risky and uncertain R&D projects. As in the United States case, the contracting authority fully funds the first two phases but not the third phase of commercialisation. The applicant company must finance commercialisation, as all intellectual property rights remain with the company.

Because a number of firms may be involved in competing during the different stages of a pre-commercial procurement – from solution designs to prototypes to test series – a variety of benefits are likely to result.[24] The price of the first products coming out of the process can be significantly lower than

when the procurement is done with a single supplier in the development phase. A second benefit is that risks might be reduced: in some sectors, a large percentage of public procurements do not achieve the expected results. However, in pre-commercial procurement, when multiple companies compete and test options during various development stages, useful information is generated regarding the drawbacks of different possible products. Furthermore, because multiple competitors are engaged in the procurement, problems further down the road of supplier lock-in might be mitigated. The efficiency of R&D support might also be increased - at least support for applied R&D that aims to address a stated public need – by replacing a share of applied R&D grants with pre-commercial procurement processes. An additional benefit is that pre-commercial procurement might also assist companies in shortening time to market. This is because immediate feedback is given from a potential customer at multiple stages of the product development cycle. First-mover advantage is extremely commercially beneficial in high-technology markets, enhancing the possibility that a firm becomes a market leader. R&D procurement programmes in the United States, in particular, have been instrumental in helping a large number of US companies, across a variety of sectors, become market leaders.[25]

However, important programme design risks are also associated with SBIR-type schemes. A key concern is that government funds might simply crowd out privately-financed R&D. Schemes should finance proposals not likely to receive funds from private sources if additionality is to be maximised (Wallsten, 2000, 1998). Doing so requires, among other things, implementation of an appropriate set of performance indicators for programme managers, such that higher weightings are given to success in eliciting R&D that would not have taken place otherwise. Evidence suggests that expeditious decision-making in awards procedures is also a qualitative factor in programme success.

Commercialisation programmes

While the United States' SBIR programme involves public procurement, it is essentially a supply-side instrument, aimed at developing new products and services. Some countries have recently developed programmes that go beyond the development stage into the commercialisation of products, thus combining supply-side measures with an effort to meet the use requirements of end users, whether private or public (OECD, 2011b).

For example, Australia's Boosting Highly Innovative SMEs (BHIS) initiative, introduced in 2008, includes two main components: a) The Technology Commercialisation programme: supporting the establishment and development of fast growth, technology-oriented SMEs by reducing the time and resources needed to bring technology to global markets; and b) The Market Validation programme (MVP): using Victorian Government technology demand (i.e. pre-commercial procurement of R&D) as a driver for SME-oriented technology development and commercialisation.

The MVP is designed as a pre-commercialisation procurement model whereby SMEs undertake R&D focused on providing solutions to public sector entities' prioritised technology requirements. The MVP 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 can prove their new technology in a real-world customer context.

Although it shares some of the characteristics of the United States SBIR, the MVP also differs in significant ways. For example, participating agencies are not mandated to use a percentage of their external R&D budgets for contracts for small firms. Instead, public entities' participation is voluntary. In addition, a central and independent agency provides the funding to support MVP initiatives, and also manages the administrative work to support participating agencies and SMEs. This is unlike the US SBIR, where participating agencies are required to exclusively use their own human resources to manage the programme (Berman and Squire, 2011).

3.1.4.1 Managing risk in innovation procurement

Procurement of innovation entails risks beyond those incurred in traditional procurement. Risks arise even if the procurer is simply seeking incremental innovations on an already existing good or service. These risks include:

- *Technological risk* – that is, non-completion risk stemming from technical features of the procured good or service. One mitigation option is contract design, for instance using cost-reimbursement contracts. As a part of the bid submission, vendors might also be asked to analyse risks associated with their proposals and assess how these could best be managed. Another mitigation strategy is to use framework agreements or multi-stage procurement processes. The latter effectively give opportunities to screen out more risky bids during early stages of the procurement.
- *Risks related to the uptake by users of the good or service.* These might stem from such issues as inadequate absorptive capacities in procuring institutions or incompatibilities with existing technologies or routines. Such risks can be mitigated through early user involvement in the procurement process, for instance through structured consultations and foresight exercises. Sweden's national innovation agency, Vinnova, is doing work along these lines. Vinnova's Innovation Gates project (Innovationsslussar) seeks to make use of good ideas from people working in the healthcare sector, supporting the translation of these ideas into commercialised products and services.[26]
- *Market risks* – these risks exist on the side of both supply and demand. On the demand side, risks are greatest for wholly novel items. Public bodies might mitigate such risk by implementing additional demand-side measures, such as user training schemes, or using demand aggregation, in particular by bundling public demand. On the supply side, the main risk is that suppliers do not respond to the tender. To mitigate this risk, market intelligence capacities should exist, developed for instance through structured exchanges with industry experts (although any information provided by public bodies during such exchanges would also need to be made available to all potential vendors, to ensure conditions of competitive tender [use might be made here of on-line procurement portals]. Governments may also need to create confidentiality agreements with vendors who reveal their own technical information during a consultation). Financial incentives can also be offered for participation in pre-commercial tenders, to offset the research or development costs incurred by firms.

However, it must be acknowledged that, despite the possible options for risk mitigation, any purchase (procurement) of a new technology is inherently risky. In his work on 'venturesome consumption' Amar Bhidé (2008) observes that "An innovation, like a theory, can never be proven to be 'good' – at any moment, we can only observe the absence of evidence of unsoundness". As Bhidé describes, private consumers – let alone government agencies - face a variety of risks when purchasing new products. A new product might be perfectly suitable for the individual consumer, but may fail to attract a critical mass of other consumers, in which case vendors might stop providing replacement parts and maintenance services, or might abandon the product altogether. Similarly, in IT, customers may face difficulties if upgrades and new releases do not have full backwards compatibility, or if they render the preceding products obsolete. And consumers often have to invest considerable time in making a product – such as enterprise software - work well for them.

3.1.4.2 Integrating know-how from across government

Harnessing the innovative potential of procurement may require the integration of several different policy areas: science & technology policy, economic policy, innovation policy, environmental policy, and public health, among others. Public procurement is normally co-ordinated by a government office, which

can be either independent or reporting to a ministry (typically, the prime minister's office or ministry of finance). However, policymakers could consider involving other ministries and agencies to ensure that different policy domains are integrated in the procurement process. For example, using the UK Forward Commitment model, Her Majesty's Prison Service (HMPS) sought to procure an innovative solution to a more sustainable way of supplying, using and disposing of prison mattresses. The procurement of a fully managed "zero waste mattress system" involved the co-operation between the institution for which the product or service was to be procured (HMPS), the government agency in charge of general public procurement (the Office of Government Commerce) and an inter-departmental advisory group charged with promoting environmental innovations (the DIT/DEFRA Environmental Innovations Advisory Group).

3.1.4.3 Engaging stakeholders and doing so early in the process

Procuring novel goods and services also requires stakeholder involvement and co-ordination. Involving stakeholders – both users and potential suppliers - early in the procurement process may help to write better tender documents (i.e. documents that clearly guide innovative effort, solicit feasible innovation but do not preclude innovative solutions) and to forecast what the likely response from the market will be. A number of examples of early stakeholder engagement are given here: For the "zero waste mattress system" put in place in the framework of the Forward Commitment model in the United Kingdom, the call was widely publicised with the help of intermediary organisations such as the UK Knowledge Transfer Networks. The Manufacturing and Materials Knowledge Transfer Network organised a one-day workshop with firms in the supply chain and academics to discuss the issue and explore solutions. By the end of the consultation period, over 30 submissions from across the supply chains of multinationals, SMEs and social enterprises had been received. The responses presented a range of different routes to achieve the desired outcome and also included ideas to improve overall operational and environmental performance. A representative sample of the companies was further invited to attend an information exchange in a supply chain workshop in April 2007.

In the early 1990s, the Swedish National Board for Industrial and Technical Development (NUTEK) identified an opportunity to lower household energy consumption through the development of more energy efficient refrigerators. Public procurement of such refrigerators would have a catalytic effect. NUTEK created a purchaser group made up of an association of housing co-operatives, companies in insurance and real estate, the Swedish National Board for Consumer Policies and the Swedish National Energy Administration. This group convened seminars and visited factories to develop the specifications for the product to be procured (Vinnova, 2009).

An example of an entity that engages stakeholders over the longer run is the Center for Integration of Medicine and Innovative Technology (CIMIT) in the United States. CIMIT is a consortium of teaching hospitals and engineering schools in Boston that seeks to foster interdisciplinary collaboration among experts in medicine, science and engineering, along with industry and government, all with a view to improving patient care (Vinnova, 2009).

In the United Kingdom, starting in 2007, a programme was created aimed at redesigning hospital furniture so as to make this easier to clean, and thereby less likely to harbour hospital-borne infections. The programme, under the responsibility of the Purchasing and Supplies Agency (PASA), variously engaged doctors, nurses, other health professionals, representatives from industry and the United Kingdom Design Council. In this process, manufacturers were also reported to have gained knowledge of the needs of hospitals that they did not have previously. The work of these parties led to design specifications that were either commissioned to the Royal College of Arts for development or put out to a national design competition (Vinnova, 2009).

3.1.4.4 Preserving competition

It is essential that competition in the tender process be preserved. Competition is critical to obtain the fairest deal for society and to encourage innovation. The particular threat to competition in innovation-oriented procurement comes from the greater interaction and information exchange that can occur between the procurer and suppliers, relative to purely arms-length procurement. In the European Union, the main legal principles relating to procurement of innovation are contained in:

The Procurement Directives (2004/17/EC and 2004/18/EC).

State aid rules (Articles 87 and 88 of the Treaty).

These principles seek to ensure that public procurement involves procedures that are transparent, fair and competitive.

With respect to R&D Article 16f provides an exemption from the Procurement Directive when a public procurer wants to purchase R&D and share the results of the contract with the public.[27] Nevertheless, any contract exempted under Article 16f must still meet State aid rules (and as with all forms of procurement must be transparent and open). State aid can be of many sorts. In the Treaty on the Functioning of the European Union (TFEU), Article 87(1) describes state aid as: "Any aid granted by a Member State or through state resources in any form whatsoever that distorts or threatens to distort competition by favouring certain undertakings or the production of goods or services shall, in so far as it affects trade between Member States, be incompatible with the internal market". So, if procuring an R&D activity and its results, the procurement body must pay the supplier a market rate, and no more. And the supplier cannot be rewarded with favourable treatment in future contracts.

The European Commission set out a model for pre-commercial procurement in a 2007 Communication (European Commission, 2007). The Communication makes clear that the scope of what can be procured only covers R&D services. Risks and benefits attach to undertaking the R&D. These have to be shared according to three principles:

- Both the procurer and the supplier should benefit from actively promoting commercialisation of the output of the R&D. If the supplier retains intellectual property coming from the procurement, then the procurer should be compensated at a market price.
- Procedures must allow a number of firms to participate in the pre-commercial procurement. This will also allow competition to occur throughout the procurement as more numerous but less viable proposals in the initial stages (i.e. solution exploration) are rejected and fewer but more viable ideas are taken to the subsequent stages of development (i.e. prototyping and test series).
- Separation between the R&D and commercialisation phases is clear. The public sector is bearing some of the risk entailed in solution development, but a market test should apply thereafter.

The entire procurement process must not entail state aid. It should be fair, transparent and involve market-based pricing. European Commission (2007), Section 5.2, illustrates how a pre-commercial procurement should be organised, in a step-wise fashion comprising various competitive phases. At the outset, in an open and transparent way, solution designs for a particular problem would be explored, and the preferred designs retained. In a second phase prototype development would be undertaken for these preferred designs, with the most promising prototypes retained. In the final phase, the most promising prototypes would compete through the development of a test series. At this stage the procurer would possess information allowing technical comparison between the new product/service and the existing (or alternative) procured product/service. However, the new product/service would still have to be rolled out commercially at sufficient scale in order to compete in a new procurement of the final product/service (and

this commercial roll-out might not be undertaken by the same enterprise that won the pre-commercial procurement).

This step-wise process maintains competition throughout. It likewise allows the procurer to guide the outcome such that this most closely matches the public sector need. Publication of the R&D results, and/or the development of open standards for the new product/service, could also lower the cost of the future commercial supply of the new product/service.

More generally, taking steps to facilitate SME participation in procurement will also be pro-competitive.

Finally, legislation rooted in a desire to preserve competition should be carefully assessed to ensure that it does not unnecessarily hinder procurement. In Belgium, it is reported that innovators are prohibited from selling their products to the procurers they have developed the product for. Such a gap between innovation and its adoption is also reported in Denmark and the Netherlands (Technopolis, 2011).

In December 2011, the European Commission adopted a proposal for a new directive on public procurement (COM, 2011). One of the main proposed changes was to simplify the legislation and make it more flexible by: increasing the possibility of using negotiation between public authorities and tenderers; simplifying procedures for regional and local contracting authorities; reducing documentation requirements; gradually introducing full electronic communication in public procurement; shortening deadlines; and alleviating public procurement requirements. The proposal also introduced the possibility of introducing life-cycle costing as an assessment criterion. To foster innovation, a new partnership procedure was proposed, whereby the contracting authority shall co-operate with a company – selected in a regular competitive tender procedure – to develop an innovative product, work or service which does not exist in the market. The proposal also contained measures facilitating cross-border procurement as well as improvements to the procedure of competitive dialogue.

3.1.4.5 Using electronic media

Well designed websites can of course be useful in supporting innovation-oriented procurement. Information can be provided on issues ranging from forthcoming tenders and possible business opportunities. Websites are also an important instrument for ensuring uniform access to information for potential suppliers, and so helping to ensure competitive conditions in the tender process. Websites might also be used to publicise cases of successful innovation procurement, and facilitate networking and information exchange among public procurement bodies.

This report has referred to SME participation in procurement. The use of simplified documentation and on-line procedures should be investigated wherever possible, with a view to reducing the costs of participation for small firms.[28] Once achieved, the fact that procurement procedures have been made straightforward might itself be highlighted on a website.

3.2 Designing innovation-oriented regulation

Performance-based regulatory approaches can be designed to be mandatory or voluntary. By affecting the performance (quality, compatibility) or consequences (health, safety, the environment) of products or services (e.g. labelling and certification, recycling regulations, emission standards, etc.), regulations can have a direct impact on demand for innovative goods and services. They can also entail penalties in case of non-compliance.

Governments should design regulations so that they are technology neutral, and ensure that they foster continuous innovation by allowing flexibility in achieving the outcomes rather than by supporting specific

solutions. However, when a technology is already locked-in, performance standards may not be powerful enough to bring about more radical innovations.

Across OECD countries performance-based approaches employ diverse combinations of mechanisms such as: target-setting for manufacturers' average-fleet performance (as in Japan's Top Runner Programme); "super credits" for over-achieving performers, and pooling of manufacturers to be monitored as one entity (as in the European Union's CO2 emission standards for cars); gradual increase of voluntary targets and shift to mandatory targets (as in Denmark's Building regulation on the way to Zero Energy Buildings); combination of mandatory labelling schemes with minimum efficiency or consumption standards (as in Australia's Water Efficiency Labelling and Standards Scheme).

Performance standards and regulations also face a number of challenges. They should be designed to induce continuous efforts and behavioural change of manufactures and consumers and should not lock them in to any particular technological pathway. The continuous review of targets and performance testing methods, as in Japan's Top Runner Programme, is one approach to addressing this challenge.

The impacts of performance standards and regulations on innovation are also likely to be highly technology– and industry–specific. This implies that considerable industry-specific expertise will be required in public bodies as a pre-requisite to the design and implementation of such instruments. Regulators may need to consult widely with the industry and other relevant stakeholders to design effective standards and regulations, as was done for the Top Runner Programme and for the EU regulation on CO_2 emissions from passenger cars.

However, as described earlier in this report, stakeholder involvement in designing performance-based regulation and standards can raise issues for competition authorities and risks capture by special interests. In addition, if the private sector has a strong negotiating power in the policy design process, for example of a performance standard, the resulting instrument may be socially sub-optimal, in terms of requiring a longer compliance period and/or a more lenient target. It has been argued by Bunse et al. (2007) that this occurred with the Top Runner Programme in Japan.

Previous sections have underscored that the design of innovation-oriented regulation will require access to considerable industry-specific expertise. Know-how will be needed, for instance, on: whether the market would introduce the right level technology in the absence of the regulation; assessing the possible general equilibrium effects of regulation (i.e. effects beyond impacts on the specific good or market being regulated;)[29] understanding of the likely time period over which policy will yield impact, which might vary from industry to industry; and how the precise form of a regulation could affect its implementation. As noted earlier, manufacturers found that compliance with the Corporate Average Fuel Economy (CAFE) regulation in the United States could be achieved through changing relative car prices so as to sell fewer large cars and more small cars, rather than developing more fuel-efficient vehicles. It may be difficult to foresee all such circumventing or unintended behaviours, but careful deliberation with those having industry experience is likely to help.[30]

The United Kingdom's Department for Business, Enterprise and Regulatory Reform[31] BERR (2008) has examined the relationship between regulation and innovation. An important conclusion from this work is that the way in which regulation effects innovation is closely linked to the way in which regulation is designed, implemented and enforced. For example, informing business well ahead of the introduction of new regulations can provide an important signalling effect that facilitates adaptation and increases the likelihood that regulation will be beneficial. BERR (2008) provides a check-list to help regulators promote innovation. As it applies to a broad array of industries having very diverse characteristics – from financial services to civil aviation - this checklist is unavoidably framed in generic terms. Nevertheless, the check-list suggests that regulators should:

- **Consider how regulation may impact on beneficial innovation**. The key point here is that innovation brought about by regulation need not always entail better outcomes. Regulators should try to consider whether the incentives created by regulation are likely to encourage innovation involving superior outcomes.
- **Consider how interaction with existing regulations may affect innovation**. New regulation can also have unintended consequences through interaction with regulations already in force.
- **Favour regulatory approaches that are outcome-focused and technology neutral.** The purpose of this recommendation reiterates observations elsewhere in this paper that the creativity of the market should be harnessed in order to produce new technological ideas, without the public sector imposing solutions.
- **Consider how implementation and enforcement can promote innovation.** The aim here is to encourage regulators to make use of the knowledge had by those 'on the front line', charged with implementation, so as to better frame guidance on how to manage risk without precluding beneficial innovation.
- **Consider the effects of timing.** A point made here is that the frequency of review of some forms of regulation – such as price regulation – can also shape the incentives to innovate.

3.3 Designing technology-based standards

While standard-setting itself is normally the responsibility of industry bodies, the government can have an important role in fostering multi-stakeholder co-ordination and collaboration. Effective co-ordination of and consultation with diverse stakeholders is often critical to ensure the timely development and widespread adoption of adequate technology standards. For example, in the United States, the government had an important role in the standardisation of the smart grid, by providing co-ordination and facilitating co-operation among a broad and diverse range of stakeholders.

The use of technology-based standards poses at least two specific challenges for policy makers: getting the right timing of standardisation and the international dimension of standardisation.

The issue of timing of standardisation involves a number of considerations. Procedures in standard bodies can be slow and bureaucratic, and can be held up by large players. Involvement by the government can contribute to shortening the standardisation process by bringing together all the relevant stakeholders and facilitating co-operation among them (as shown by the case of standardisation of fuel-efficient tyres in Japan). In theory, standards should not be introduced too early as this could shut out alternative (and potentially better) options, but early enough to facilitate interoperability and the other benefits of standardisation. For example, specific barriers in markets for new electric vehicles may justify some degree of standardisation at an early stage in order to reduce uncertainty. However, in practice it is hard for policymakers to judge what 'early' or 'late' mean in the context of entirely new technologies (and with more mature technologies the issue naturally has less relevance). The trajectory of the technology's future development is inherently uncertain. Industry players are perhaps best placed to understand a technology's likely evolution. It is essential therefore that the standardisation process reflect industry insight. Another timing-related issue is that the usual timeframes for publication of standards – at around three years – could conflict with the shorter funding horizons typical of government.

Standardisation should also not be excessive, and should leave room for experimentation that could lead to continued innovation.

Work on biometrics standardisation in the United Kingdom indicates that some standards may need to be reviewed frequently, as new challenges arise – in this case including on-going security concerns.

Another challenge relates to the international dimension of standardisation. As noted earlier in this report, competitive disadvantages could arise if a country were to free ride on the standards setting work of others. On the other hand, international co-operation can play an important role in diffusing eco-innovative products and technologies. For example, in the framework of smart grid standardisation in the United States, the National Institute of Standards and Technologies (NIST) is establishing bilateral and multilateral agreements to co-operate in the development of international standards for smart grids. In addition, NIST and the International Trade Administration (ITA) have partnered with the Department of Commerce to establish the International Smart Grid Action Network (ISGAN), a multinational collaboration of 17 countries. ISGAN will sponsor activities that accelerate smart grid deployment and address gaps in standardisation.

3.4 Demand-side policies in the overall policy mix

The term policy mix refers to the combination of policy instruments deployed to achieve policy goals. Whether by design or default, all countries have a policy mix. OECD countries make different choices in their selections of policy instruments to support innovation. In most OECD countries, both direct and indirect supply-side measures are used, as countries provide generic incentives to strengthen private investment in R&D, and/or more targeted measures to steer innovation towards specific sectors, technologies or groups of firms. Demand-side policies have received increased attention in recent years. However, their role to date in the full portfolio of government policies on innovation remains secondary to supply-side measures.

Even when countries have similar policy goals, the respective instrument mixes can be expected to differ. This is because the choice of policies needs to be adapted to the specific environments in which they are intended to work. These environments vary in terms of the structure of the productive base, institutions and broad societal preferences. For instance, a strong preference for a simple, transparent tax system may lessen the emphasis on supply-side tax incentives for R&D. Different countries also exhibit different degrees of acceptance of regulation, a demand-side instrument. And, the efficacy of various demand-side instruments can be highly sensitive to industry-specific characteristics.

In deciding whether to introduce, or enlarge the number of, demand-side tools, policymakers will perhaps also wish to balance concerns regarding the number of policy instruments deployed. On the one hand, it is necessary to have a set of instruments that is sufficiently differentiated to meet the needs of complex economic systems. On the other hand, the policy mix needs to avoid inefficiencies arising from operating too many schemes, and at too small a scale. Instruments can develop constituencies of support and a degree of autonomy, making them less amenable to change or cancellation, even where this would be sensible.

Another consideration as regards policy mix has to do with the fact that different policies can require particular public-sector capacities for their implementation. In the absence of such capacities, the development of programmes may be unwise. For instance, in many countries numerous sub-national units of government play important roles in the public procurement market. This in turn creates challenges in terms of governance, co-ordination and strategic planning, as well as the availability of expertise and know-how. Public sector capabilities may also need to be enhanced in order to mitigate risks associated with procurement of innovation, such as technological risks, organisational and societal risks, and specific market risks.

It is difficult to conceive a simple metric that might be used to establish a socially optimal, or even preferred, allocation of public resources across either demand or supply-side instruments. In a textbook world, policy makers would allocate public resources to different programmes based on knowledge of the marginal cost of achieving given common objectives for different programme types. For instance, if

increasing innovative activity linked to alternative energy were the principal goal of policy, an economically efficient resource allocation could be achieved if policy makers had information on the marginal costs of increasing such activity through the different available programmes. Theory indicates that an efficient allocation would exist when the marginal costs of a unit increase in the parameter(s) of interest was the same across programmes. In practice, however, most evaluations provide information on the average cost of achieving some outcome. In addition, the marginal cost of achieving innovation-related objectives will vary over time depending, for instance, on the scale and duration of the programmes concerned and the character of the enterprise population. The textbook ideal, then, would necessitate a constant cycle of complex evaluation across many programme types. For practical, methodological and budgetary reasons this goal is effectively unattainable. Nevertheless, carefully targeted evaluations of major programmes should be an objective, and could inform – albeit imperfectly - the strategic goal of choosing a preferred policy mix. However, the evaluation record as regards demand-side policy measures is superficial. Thus far, relatively little is known about their impact or effectiveness.

3.4.1 Interaction between R&D policies and demand-side innovation policies

R&D and demand-side innovation policies clearly interact. For instance, recent OECD research on venture capital investment in clean technology shows that investment activity is influenced by both supply and demand-side policies (Criscuolo and Menon, 2012). On the supply-side, public R&D is found to be an important predictor of the level of investment in clean-tech sectors. On the demand-side, the effects of regulations (including feed-in tariffs, etc.) are positive and significant. This work suggests that national environmental deployment policies designed to create a market for environmental technologies are associated with higher investment levels than more short-term tax incentives and rebates.

The issue then becomes one of the extent to which this interaction between supply- and demand-side measures can be targeted and made precise. In private markets it is complex to detect needs and to translate them into meaningful market demands. However, public demand-side measures, such as procurement, focus on public demand, which can be clearly stated and communicated. This selectivity and visibility, in principle, allows a match to be had between the target of a demand-side measure and targeting of direct support for R&D. Demand-side policies could in principle enhance the commercial and societal benefits of R&D, and ultimately encourage firms to undertake more R&D.

Thus far, there is relatively little empirical research on these questions. Nemet (2009) explored the impact of demand-side policies on the development of wind energy, finding that most major inventions were made before the introduction of relevant demand-side policies. Moreover, when demand-side policies were introduced, inventions declined. The factors explaining this apparent paradox include the rapid development of a dominant design, which limited the opportunity for further innovation, as well as uncertainty about the longevity of demand-side policies.

Further research on the role and relative importance of demand- and supply-side policies in different markets may help provide further insights in these questions.

3.4.2 Interaction between demand-side policies and entrepreneurship policies

Demand-side policies also have important interactions with entrepreneurship policies. As discussed above, a recent OECD study demonstrates that countries that have demand-side policies in place to foster green innovation have more venture capital investment in green innovation (Criscuolo and Menon, 2012). This is not surprising as demand-side policies are likely to increase the returns to investment, which will encourage the growth of entrepreneurial businesses.

This interaction is also important in assessing the likely market response to demand-side policies, discussed above. Countries with a strong entrepreneurial climate, including a strong contribution of innovative high-growth firms to growth and productivity, are more likely to have a strong market response to well-designed public procurement policies than countries that have a weak climate for entrepreneurship. Demand-side policies should therefore go hand-in-hand with policies to improve the conditions for high-growth firms, including in enhancing their access to finance, strengthening their capabilities and improving framework conditions (Bravo-Biosca, Criscuolo and Menon, 2012).

4. Evaluation and the efficiency of demand-side policies

This section briefly reviews the record of evaluation of demand-side policies. Generally, and with the possible exception of diffusion programmes in the area of energy policy, demand-side policies have been under-evaluated compared to other categories of innovation support. This reflects the technical challenges of such evaluation and the relative novelty and underdevelopment of demand-side policy. Evaluation is further complicated by the fact that some demand-side policies have innovation as one – sometimes secondary – goal among a number of objectives. For example, most studies of regulations on minimum fuel economy standards for vehicles do not focus on innovation, but (understandably) seek instead to assess the overall costs and benefits of the regulations. This reflects the fact that the primary objective of the regulation is to meet environmental and cost goals, rather than stimulating innovative solutions to achieve that goal. Indeed, the evaluation challenge is exacerbated by the fact that data are often inadequate. Few public authorities have sought to classify data on procurement so as to distinguish arms-length from innovation-oriented procurement.[32] The same can be said of data on regulation (Edler et al., 2012*a*).

In particular, there have been almost no systematic assessments of innovation-oriented public procurement, apart from some evaluation in the context of DARPA. This partly reflects the fact that implementation of such procurement has not been widespread. At the same time, this report's review of the documentation on public procurement produced by many governments suggests little overt consideration to date of how this instrument might best be assessed.

To better understand the challenges involved in evaluating demand-side policies it may be useful to briefly recall the main evaluation approaches available. The ultimate aim of evaluation is to attribute changes in a target group (usually firms, but also institutions and sometimes individuals) to the influence of a given policy or programme. But simply comparing the situation of target groups before and after a programme is insufficient, because the programme may be only one among a number of causes of an observed change of state.[33] Other causes of an observed change of state can include: *i)* wholly unrelated factors – such as trend changes in the target population (for instance firms in a given sector may be operating on a learning curve) and fluctuations in the business cycle; and *ii)* how the programme is observed - for instance, biases might shape the way respondents reply to surveys, large firms may be more likely to respond to surveys than small firms, and programme participants might be unable to reliably answer questions about likely counterfactual events (i.e. events that would have happened in the absence of the programme or policy).

Identifying changes in target groups and attributing these to the effects of programmes requires knowledge of the counterfactual. Accounting for so-called selection bias is also a key part of understanding what would have happened to the target group without the programme. Selection bias refers to the possibility that there are some unobserved characteristics of target group members that cause them to be selected into a programme and which, at the same time, affect how they will perform in the programme.[34]

Evaluations essentially take three generic forms. Each has strengths and weaknesses in being able to identify unrelated effects, minimise selection bias and accurately identify programme impact. Briefly stated, the different approaches are: *i)* experiments involving random assignment, generally considered the

highest evaluation standard; *ii)* quasi-experiments, in which the identification of a control group occurs statistically (rather than through randomisation) after the programme has commenced; and *iii)* participant opinion.

It is important to note that participant opinion can be an unreliable source of information with which to assess impact. To yield valid impact estimates, respondents would have to be able to correctly assess what would have happened in the absence of the policy or programme, which is often beyond their cognitive capacities. Moreover, participants may have reasons for not responding accurately to some evaluative questions. For instance, respondents might benefit from having a programme receive a positive evaluation, or they might feel uncomfortable telling an assessor that a programme was ineffective. Nevertheless, despite their limitations in attributing impact, interviews with participants are an essential evaluation tool. Well-structured interviews can help shed light on less quantifiable programme benefits, and can also help explain why a programme has or has not worked.

4.1 Evaluating innovation-oriented public procurement

With the above sketch of evaluation techniques in mind, it is worth considering the conceptual problem of evaluating innovation procurement. A first point to note is that a number of possible outcomes are of interest. These exist among both procurers and suppliers.

For the procurer, there are costs and (potential) benefits. The costs include any added transactions costs entailed in implementing non-standard procurement (for instance in writing new tender documents, liaising across governmental departments, assessing tender submissions and engaging stakeholders). Financial costs may also arise, for instance in paying for or incentivising research conducted in pre-commercial procurement. Financial costs may also arise if the procured item is more expensive than the item it replaces (which might be the case if other characteristics still make the item preferable). Other administrative costs may also be incurred, for instance in establishing an entity with responsibility for implementing or overseeing innovation procurement.

Public-sector benefits might take various forms. Radically or incrementally new services might be created, existing services might be delivered at lower direct cost, or existing services might be delivered at the same direct cost but with some additional benefit (such as a lower carbon footprint). Pre-commercial procurement might increase the efficiency of public support for applied R&D that aims to address a stated public need (by comparison with applied R&D grants). Risks might be reduced if, in pre-commercial procurement, through multiple companies competing during various development stages, useful information is generated regarding the drawbacks of different possible products. The precise nature of the public sector benefit will vary across technologies, implying that the metrics of success might also vary. For instance, a reduced incidence of hospital-based infections might be a measurable outcome for a procurement of furniture designed to be easier to clean (and health economists have techniques for quantifying a benefit of this sort). But an ICT system with enhanced functionality would evidently yield benefits of a different sort, ranging from lower maintenance outlays, to enhanced data security and increased process efficiency. More far-reaching benefits might have to be assessed in the case of catalytic procurement, notably relating to increased public or industry use of a socially desirable technology.

An observation in connection with such public sector benefits is that, in their assessment there is some legitimacy in before-after comparisons. That is, the benefits might with some reliability be attributed to the specific procurement initiative. Without the change in procurement practice, the previous procurement pattern would likely have continued. However, this need not automatically be true: an innovation might arise exogenously which would have been incorporated into standard procurement as the new technology became widely accepted. This attribution problem might be addressed more systematically when evaluating innovation procurement in lower levels of government. That is, an evaluation of public-sector

benefits experienced by a subnational authority could examine whether, over a comparable timeframe, other subnational bodies in the same country had procured differently as a result of exogenous technical change. This information would help attribute public sector benefits to the effect of the change in procurement practice.

For supplier(s), there are also costs and benefits. The costs are those incurred to bring about the innovation. These costs might not be recouped in the case of failure to secure the procurement contract. But some or all of these costs might be recovered in some other way, for instance by applying the know-how and capacities developed in another market. The benefits to suppliers include possible increased access to third-party funding, access to a public sector market in the case of success (with the beneficial predictability that such markets can provide), possible access to wider markets as a consequence of the know-how and capacities developed, and faster time to market for procured products. Through information spillovers, learning and imitation, benefits might also accrue to firms that did not participate in or win the procurement.

The issue of access to a public-sector buyer is larger than a simple increase in sales and profits for the successful firms(s). Innovation-oriented procurement might induce supply from SMEs that would not otherwise have had access to public demand at all. Research suggests that SMEs can encounter obstacles as suppliers to the public-sector. For instance, Karjalainen and Kemppainen (2008) show that a perceived lack of legal and administrative resources in SMEs is associated with low SME involvement in public procurement. Limitations often exist in electronic systems operated by SMEs, for instance in order processing and invoicing. Such limitations are also linked to low participation in procurement. The fact that innovation procurement might engage otherwise unengaged SMEs has at least two beneficial implications. The first is that augmenting engagement with SMEs allows the procurer to draw on a wider range of potentially innovative ideas, especially given the important role that new and small firms play in incubating innovation.[35] A second implication relates to economic geography: on average SMEs are more likely to sell in localised markets than are larger firms. So, over time, a procurement process that engages SMEs is more likely to generate benefits among local suppliers. Where local or regional development is a policy concern, this benefit could be factored into an overall evaluation of policy outcomes.

In assessing the benefits accruing to suppliers, a number of points could be kept in mind:

- The evaluator is asking ‘has this procurement brought about innovation that would not have occurred otherwise?’ In some cases an answer to this question might appear straightforward, for instance when the procurer buys a good or service for which it is the sole, or main, source of demand. A new solution is provided, and it seems evident that this solution would not have arisen without this specific procurement. A case in point might be a medical device requiring some specific new functionality procured by a health service.
- However, suppliers may already have been working to develop identical or similar innovations. Indeed, there is some evidence that suppliers, rather than the procuring organisation, often identify and initiate innovations (Department of Enterprise, Trade and Employment, 2009). Indeed, the procurement process is not designed to transfer research or engineering skills to suppliers. An innovation has occurred, in the successful firms, but this may represent a marginal innovative step for the firm – something brought about with little extra internal capacity development. This may often be the case for procurement that seeks incremental improvement to some standard item, as contrasted with pre-commercial procurement that requires knowledge creation.
- Accordingly, well-structured questionnaire and interview techniques appear the best way of assessing whether the procurement is associated with some additional innovative behaviour among suppliers. Indeed, there is no control group. This is because all firms in a relevant

group of suppliers will have had access to the procurement process (indeed, ensuring such access is a tenet of competitive tender). So there is no way to isolate the effects of the policy on suppliers through random assignment. And because there is only one winner – or a small number of winners – of the tender, there is little foundation for statistically inferring change in behaviour to the procurement. It cannot be excluded that the firms more likely to innovate will also be more likely to take part in the innovation procurement.

- Besides innovation outcomes, there may be other questions that evaluators wish to assess. One is whether the procurement has been facilitatory for the participation of SMEs.

While not an evaluation of a specific policy, Aschhoff and Sofka (2009) sought to quantify the effects of public procurement on innovation, and to compare these effects with other determinants of innovation. The study examined general rather than technology-oriented procurement. A survey of 1 100 innovative firms in Germany was used, with effects differentiated by firm size, industry and geographic location. The survey data were self-reported and subjective, raising problems in connection with possible response biases as well as the accuracy of responses (see discussion above). However, the methodology used was the same as that employed in the Community Innovation Survey, which has been widely pre-tested and piloted. Response characteristics were therefore relatively well understood. A comprehensive non-response analysis was also undertaken of over 4 000 firms. This showed no systematic differences between responding and non-responding firms with respect to innovation activities. This work however was not able to control for selection bias (i.e. more innovative firms may also be those more likely to engage in public procurement).

More recently, Starzyńska and Borowicz (2012) carried out an evaluation of the relationship between enterprise innovation and public procurement in Poland through a quantitative survey of 100 awarding entities and 685 participating enterprises. To obtain a more complete picture of the innovation aspects of public procurement, the survey was combined with a qualitative analysis based on three case studies on a local government unit, a healthcare unit and a tertiary education institution. Seven case studies were also undertaken on enterprises experienced in public procurement and engaged in innovative activities. Participants' perceptions of the effectiveness and efficiency of the programme were examined along different dimensions, such as:

- The extent to which awarding entities use innovativeness as a criterion in the tender, and the weight that this criterion carries in the final decision.
- The ability of the public administrator to implement pro-innovation procurement.
- The degree of understanding of the innovation requirements in the tender among participating firms.
- The impact of public procurement on innovation outcomes in participating firms, also in relation to the type of innovation.

Edler et al. (2012b) report the results of a survey of 800 companies in the United Kingdom that had been suppliers of central government, local authorities and the English National Health System in 2010. Procurement was attributed to 25% of the surveyed firms of all their innovations and 67% reported that public procurement had had some impact on innovation. Innovation effects appeared most frequent among larger firms, central government suppliers and suppliers of professional services. Half of the surveyed firms that had invested in R&D in the last 3 years reported that procurement had led to additional investment in R&D. Firms considered a number of procurement practices to be particularly innovation friendly. These included: having innovation requirements in tenders; interacting early with the procuring organisation; having tenders specified in terms of outcomes; and receiving advanced communication of future procurement needs. It is noteworthy that these conducive practices were also among those that occurred least frequently.

There have also been several evaluations of SBIR-type programmes. For example, the Small Business Innovation Research (SBIR) programme was introduced in the United States in 1982. Some evaluative work has shown that that SBIR funding has led to increased growth and employment creation and a greater likelihood of attracting venture financing (Lerner, 1999). However, the assessment of this programme itself points to the critical importance of evaluation method. Considering additionality – the extent to which outcomes are achieved beyond what would have occurred anyway – an assessment by Wallsten (2000) suggested that SBIR resources had almost entirely crowded out privately-funded R&D.

Bound and Puttick (2010) examine whether the United Kingdom's Small Business Research Initiative (SBRI) – initially modelled on the US SBIR - has helped to stimulate innovation. The SBRI is a model process that involves identification of a public policy problem, an open competition awarding R&D contracts to promising solutions offered by small firms, applications for further prototype development for proposals that passed the feasibility stage, and final public procurement, market commercialisation (or both). This research sought to provide qualitative insights on the SBRI's performance. The study method entailed 30 interviews. The evaluation found that government departments had been able to widen the search for solutions. For instance, in response to a need in the National Health Service for better detection of drug-resistant pathogens and improved hand-cleaning among staff, a small company was able to make use of technology originally developed in the food processing industry.

Government and the independent evaluations of the SBIR programme in the Netherlands have been partly survey- and interview-based. This allowed the gathering of descriptive statistics on the population of firms participating in the programme (e.g. size), their innovation performance, and their networks of collaboration as well as their perceptions of the effectiveness of the programme.

4.2 Evaluating innovation-oriented regulation

Evaluating the effects of regulation on innovation also entails some complex challenges. It can be difficult for instance to isolate the influence of a regulation from other determinants of innovation (such as changes in consumer preference or even a technical hiatus on innovation – such as the current slowdown in the rate of discovery of antibiotics – which may be difficult to overcome irrespective of the regulatory context). The problem of establishing causality can be made more difficult by the possibility of long lead times between a regulatory stimulus and an industry response. Furthermore, regulation usually applies to all firms in the regulated sector, raising the question of how to compare the effects of the regulation against a control group of unregulated firms (other than asking firms what they think would have happened without the regulation).[36]

For some regulations comparisons can be made between measured outcomes and a set of pre-determined performance indicators. For example, in the framework of Japan's Top Runner Programme, METI initially set indicators on expected energy efficiency improvements for each product category, and then compared the actual improvements in energy efficiency with the pre-determined targets. The main potential flaw of the above approaches is that they cannot definitely prove a relationship of causality between the instruments and the environmental or innovation performance improvement. In addition, when the evaluation of the effectiveness in meeting environmental targets is based on the comparison with a set of pre-determined performance indicators, policy makers should give great care to the methodologies employed to set those indicators. As noted earlier, evaluative work assessing the full range of costs and benefits associated with a technology-oriented regulation show that the measure might have a positive effect on innovation, but be inefficient overall (Kleit, 2004).

An analysis of survey responses was used to evaluate the impact of five eco-labelling programmes to promote energy efficiency in the United States. In particular, Banerjee and Solomon (2003) carried out a meta-analysis of consumer responses and manufacturers/marketers responses in published studies and

reports with a wide range of sources: programme administrators themselves, government research institutions, non-profit research organisations, state agencies, electric utilities, and other researchers. It was found that government programmes, in general, were more successful than private programmes. More specifically, government support proved to be crucial in determining a programme's credibility, financial stability and long-term viability.

4.3 Evaluating support for technical standardisation

Various macro-economic studies have examined the impacts of standards on trade and growth (Swann, [2000] was cited earlier in this report). These studies relate changes in the incidence of standards over time and across sectors to changes in economic performance. However, such studies do little to illuminate the relative importance of the various causal routes through which standardisation might affect economic growth.

Numerous case studies examine the effects of standards in different industries (Swann [2000], provides an extensive list of references). The National Coordination for Smart Grid Operability in the United States, and the National Institute of Standards and Technology conducted a survey to assess if government engagement facilitated standardisation in the area of smart grid technologies. In Japan, a survey was conducted to appraise the level of consumer awareness of the fuel efficiency of tyres, as a result of the introduction of the voluntary labelling scheme associated to standardisation in this area. However, research evaluating the effects of government support for standardisation is rare. This may in part be because the role of policy is in fact rather limited, involving co-ordination, measures to include under-represented groups in the process of developing standards, and subsidisation of teams drafting international standards.[37]

4.4. Observations on the efficiency of demand-side policy

To the extent that evidence on the additionality of specific instruments is known, governments can of course decide to focus their efforts on instruments that have the highest cost-benefit ratios, whether demand- or supply-side measures. Indeed, following the financial crisis and in a context of scarce public resources, governments are increasingly trying to focus their efforts to areas where there is evidence that public spending has high returns. But to judge efficiency requires good evaluative evidence which, as the previous section described, is relatively scarce in the case of demand-side policies.

There is no single most efficient demand-side policy. Efficiency will be a function of initial conditions. For instance, efficiency might need to be considered not just in terms of cost efficiency. Governments are sometimes under time-bound constraints to deliver certain policies, as in the case of EU commitments in the area of global warming. Some form of calendar-driven public coaxing may be essential to achieve outcomes expeditiously. Regulation may sometimes be a quicker route to the desired change than would the often lengthy process of standards development.

Efficiency also needs to consider whether policy implementation will entail additional administrative outlays. Pre-commercial procurement may add to administrative outlays, as compared with regular arms-length procurement. But standards and regulations involve only a limited budgetary allocation and may be effective in fostering innovation if they succeed in strengthening market demand for innovative goods and services.

Whatever the chosen mix between policy types, the efficacy of demand-side policies is likely to be limited in the absence of good framework conditions. Good framework conditions are necessary to allow an efficient supply response to expressed demand. Among framework conditions, policies in the areas of

tax, the labour market, competition, education and training, and intellectual property rights are of particular importance. Salient features of these policy domains are briefly reviewed in Annex 1.

NOTES

1 For instance, targeting consumers, governments have offered rebates on energy efficient products and promoted comparison labelling (to inform consumers on the relative efficiency of products) or endorsement labelling (e.g. "CFC-free").

2 Note that Figure 1 provides information on whether countries have adopted different innovation-related practices in public procurement, but not the frequency of adoption (i.e. a given practice may have been used, but infrequently).

3 For a detailed review of market failures affecting general innovation see OECD (2010). A discussion of key framework conditions for innovation is included in the Annex of this paper.

4 This observation however is open to criticism, as many would consider it incumbent on entrepreneurs to seek relevant information.

5 For instance, it has been seen that some management consultancy companies first designed and marketed major service packages – such as in technology management – for and to the large-firm market. Similar products tailored to the needs of smaller companies were developed and marketed only later.

6 See, for example, Arnold (2004) and Smith (2000).

7. Path dependence occurs when the timing of an innovation precipitates an advantage for one technology over another.

8 Indeed, the role of consumer/users as a source of innovative ideas, not just effective demand, has in recent years received increased attention, particularly in the work of Von Hippel (1988, 2005). For instance, Von Hippel (1988) reported that users have been responsible for a major part of innovations in scientific instruments. The origin of the mountain bike is another case in point. Von Hippel describes how mountain biking began in the 1970s with cyclists first building their own bicycles and then supplying these on a small scale. Mainstream suppliers entered the market as the sport developed more widely. Von Hippel et al (2011) estimated that in the United Kingdom the amount consumers spend on consumer product development is 144% of the amount the entire business sector spends on consumer product R&D. Furthermore, new digital technologies promise to make such consumer-based innovation easier. Some countries have also sought to encourage user-based innovation through policy. An example is the Research Council of Norway's User-Driven Research-based Innovation programmme (see www.forskningsradet.no/servlet/Satellite?c=Page&cid=1226993636038&p=1226993636038&pagename=bia%2FHovedsidemal).

9 For instance, the firm that wins a public tender for procurement will not be known *a priori*. Indeed, with respect to innovation-oriented procurement, a winning firm might even come from a sector that would not have been considered relevant to the procurement (elsewhere in this report, the example is cited of a small food processing company in the United Kingdom that was able to deploy know-how acquired in that sector to address the need for innovative solutions to countering hospital-based infections). This contrasts with many supply-side initiatives where – especially in smaller economies – the identities of individual companies receiving support are known to policymakers.

[10] Public procurement may also help to counter problems in access to finance that can particularly affect small firms. Depending on their design, procurement processes might also help offset problems of bias against small firms in the public tendering market. The provision of a market entailed in the awarding of a contract, and the fact that a public agency has evaluated information on the firm that is awarded the tender, might also serve to attract additional finance from private sources for innovative activities.

[11] The empirical evidence is, however, unsystematic. Among these studies, the point is perhaps best argued by Geroski (1990). His case is made through consideration of a number of lines of evidence, rather than direct quantitative comparison. He first observes that R&D subsidies often involve considerable deadweight loss: that is, firms receive subsidies for R&D they would have performed without subsidy. Subsidies can also end up financing activities wrongly classified as R&D. And the marginal increases in R&D, when properly measured, appear small. When subsidy is targeted – rather than being generic, through an R&D tax credit - the success of governments in electing good projects is also open to question. To substantiate this claim, the author cites low rates of return on federally-funded R&D in the United States – relative to privately-funded R&D – as well as extremely expensive public support for aerospace in the United Kingdom over almost 30 years. By contrast, Geroski notes that private investment in R&D in the United States increases more with sales to government than with sales to non-government purchasers (USD 0.093 for each additional dollar of sales as compared with USD 0.017). Much of this R&D stimulus is reported to come during the competitive phase of procurement, rather than during follow-on contracts. Research is also cited from the United States on the role of public procurement in the emergence of clusters of innovative firms. Fifty major clusters of innovation were examined. In only four cases were subsidies judged to have played a 'very big' or 'major' role in the cluster's emergence. Public procurement, by contrast, was assessed as having such a role in at least 25 of the 50 clusters. In these clusters, the positive effect of subsidies seemed to be limited to the field of nuclear power. Through case histories of the computer, civilian aircraft and semi-conductor industries, the author describes particularly positive examples of public procurement stimulating the development and diffusion of innovation in the United States. Geroski also makes the important point that, unlike the subsidy of R&D, public procurement helps to develop the manufacturing skills and capacities needed to produce a new good or service efficiently (and in this sense, public procurement can also represent a form of subsidy of the informational externalities coming from such learning).

[12] Regulation refers to the implementation of rules by public authorities and governmental bodies to influence the behaviour of private actors in the economy. Standards are documents based on various degrees of consensus (industry wide, national, regional or international) which lay out rules, practices, metrics or conventions used in technology, trade and society at large.

[13] E-health is an area where standards are essential to interoperability of a different sort: not just between components of products, but between agents in a system. New applications of digital technology arise continuously in the health field. For instance, patient data can be exchanged between providers of primary care, health specialists, hospitals, laboratories, insurance companies and other administrative entities. Standardisation is essential to successful data integration across heterogeneous sources. The need for such standardisation is set to grow as a consequence of trends in the health sector. These trends include: new modes of healthcare delivery via mobile and wireless technologies; increasingly personalised medicine; and interactive healthcare via social media and Web 2.0 applications (International Telecommunications Union, 2012).

[14] A low-cost estimate results in total costs of GBP 0.044 million and total benefits of GBP 8.391 million. A high-cost estimate results in a total cost of GBP 7.137 million and total benefits of GBP 13.246 million (DEFRA, 2010).

[15] For example, with respect to fuel efficient vehicle technologies Kleit (2004) reviews the arguments, which suggest that the answers may not be clear-cut. He observes that many engineering studies suggest that a wide range of technological possibilities exist to improve new vehicle fuel efficiency and which could more than pay for themselves in terms of fuel savings over vehicle lifetimes. Several hypotheses have been

proposed to explain why vehicle manufacturers may not adopt technologies that pay for themselves. For instance, consumers might undervalue future savings in gasoline purchases because they lack information or are uncertain about future fuel prices. Oligopolistic manufacturers could also undersupply vehicle attributes even when potential buyers value them. But others argue that manufacturers have incentives to provide improvements in fuel economy that consumers will pay for, and that buyers are reasonably well informed about fuel economy, thanks in part to fuel efficiency labeling schemes. It is also observed that engineering studies alone may under-estimate the total costs of mandated increases in fuel economy. For instance, they may not capture important costs of implementing a new technology such as marketing and retraining of mechanics. Moreover, auto manufacturers have for decades devoted their technological efforts mainly on improvements to vehicle performance (e.g. acceleration and towing capacity) rather than fuel economy. Foregone performance enhancements of this sort would be part of the real cost of devoting technological development to improving fuel economy.

16 Moreover, the CAFE regulation did not include light (pick-up) trucks, which led to a shift in production from passenger cars to such vehicles.

17 New pharmaceuticals have been procured by public authorities. Starting in 2003, for example, the United States' National Institute of Health procured a new smallpox vaccine (in the wake of heightened security fears and the fact that the existing vaccine was not fully effective and could give rise to serious side-effects). But the United States' national pharmaceuticals market is, evidently, the largest in the world.

18 Table 1 illustrates government consumption of domestically produced intermediates. Data are not available on government consumption of final products.

19 Ireland's Procurement Innovation Group was established in 2008 and developed a handbook titled "Buying Innovation – The 10 Step Guide to SMART Procurement and SME access to public contracts".

20 In some cases, procurement might involve the specification of performance and product characteristics. For instance, a new drug might need to produce specified biochemical outcomes (performance), but not contain certain chemical compounds (product characteristic).

21 In different policy contexts the term "catalytic" has been used with a somewhat different meaning to that employed here. For instance, in Sweden, Finland and Norway 'catalytic procurement' refers to government actions aimed at bringing private buyers together to encourage them to purchase a particular innovation.

22 The conventional wisdom about DARPA is that it has been successful because: it concentrated its resources on a limited number of topics with potentially large gains; each programme supported relevant research in both industry and academia (helping create the ecosystem to move ideas into practice); and its programme managers have tended to be people who rotate through DARPA – coming in from academia and then moving on after a few years, sometimes back to academia, sometimes to industry. In other words, the DARPA model is very different from one in which government officials use peer review to award many small grants to individual researchers. DARPA funding is tied to particular government missions, so the research is "use-inspired" or demand-oriented. Fuchs (2009) examines DARPA's impact on the computing industry, in the context of changes in DARPA's *modus operandi* occurring in the early 2000s. Critically, these changes entailed a shift away from the funding of basic research to an emphasis on 'bridging the gap' between basic research and military needs. This has entailed a shift in the focus of funding away from universities to collaborations across universities, government laboratories and industry. Fuchs has three main findings: (1) DARPA exhibits considerable institutional flexibility and has been able to change in line with political and technical circumstances; (2) Regardless of such institutional change, DARPA's programme managers continue to use a basic set of processes to encourage technological development in academic and business communities. These basic processes include: *i)* bringing researchers together to consider the likely directions of change among different technologies; *ii)* providing seed funding to different researchers working on similar projects; *iii)* disseminating knowledge and building research communities through research workshops; and *iv)* providing third-party validation of new

technologies to later-stage public funding agencies and to industry; (3) DARPA appears to be effectively reducing early-stage funding gaps, co-ordinating innovation within the vertically fragmented computer industry, and shaping technological developments in the computing sector such that they help serve military needs, even while the primary demand for computing applications is commercial. However, Fuchs notes that the shift away from support for basic research may have negative consequences for the development of new innovations.

23 This note only touches briefly on the experience with SBIR-type programmes in different countries. A more elaborate discussion is available on the OECD's Innovation Policy Platform, see: www.oecd.org/innovation/policyplatform/48136807.pdf

24 Thanks are offered here to Lieve Bos, of the European Commission, for ideas and information on the benefits associated with pre-commercial procurement.

25 www.cbr.cam.ac.uk/pdf/SBIR%20Full%20Report.pdf

26 Vinnova's work on eGoverment also starts from the identification of users' needs, with the aim of increasing capacity, efficiency and productivity in the public sector.

27 Article 16f states that the Directive shall not apply for "research and development services other than those where the benefits accrue exclusively to the contracting authority for its use in the conduct of its own affairs, on condition that the service provided is wholly remunerated by the contracting authority."

28 The Small Business Act encourages European Union Member States to: use electronic portals to increase access to information on public procurement; break contracts into smaller lots where appropriate and make sub-contracting opportunities more visible; avoid disproportionate qualification and financial requirements; and promote dialogue and mutual understanding between SMEs and large procurers.

29 The case of socially-inefficient regulation of vehicle fuel efficiency was described earlier, and reviewed in Kleit (2004).

30 Behavioural economics is also throwing new light on how sometimes small alterations in the way regulatory and other information is presented can lead to large behavioural changes. For instance, to take just one among many insights from this literature, it has been shown that individuals generally prefer to adhere to social norms. In communication with the public, judicious inclusion of information on a relevant social norm may be helpful. In energy conservation, for example, sending letters or utility bills that provide social comparisons between a household's energy use and that of its neighbours (as well as usual energy consumption information) has been shown to reduce household energy consumption (Cabinet Office [2010]).

31 Now the Department for Business, Innovation and Skills.

32 The Directorate for Science, Technology and Industry at the OECD is currently engaged in an EC-funded project aimed at assessing the quality of existing data sources on innovation procurement and setting out methodologies for measuring innovation-oriented procurement (OECD, 2014 forthcoming). Work will be undertaken to assess the merits of including new or modified questions in business surveys to evaluate the relationship between the experience of procurement and innovative behaviour in firms. The work will test questions for business on services provided to government. This work will likewise recommend how to derive comparable estimates of public support for innovation-oriented procurement and regulated prices (e.g. feed-in tariffs).

33 There are restricted circumstances where a before-after comparison is legitimate, such as when the connection between intervention and outcome is largely unmediated or mechanical. For instance, the

introduction of new technology on an assembly line might lead to lower product defect rates, with causality being self-evident.

34 For instance, researchers with the best ideas might be most likely to receive government support for R&D spending (i.e. to be selected into a support programme).

35 Ideas may also transfer in unexpected ways from sector to sector. Anecdotal evidence from the SBIR programme in the United Kingdom showed, for instance, that a small firm working with perishable foodstuffs was able to apply aspects of this know-how to the problem of reducing hospital infections.

36 A control-group based evaluation of innovation-related regulatory policy might be facilitated in countries where regulations are enacted differently across subnational jurisdictions, as might occur in some federal states.

37 Public standards – as distinct from proprietary standards created by individual firms – have important features of openness and credibility. Policy action could be called for if the number, rate of creation and age distribution of the stock of public standards were seen to fall behind norms in other advanced economies. While distinct from the evaluation of a specific standardisation initiative, governments might consider monitoring the number and age distribution of the national stock of public standards.

REFERENCES

Aghion, P., N. Bloom, R. Blundell, R. Griffith and P. Howitt (2005), "Competition and Innovation: An Inverted-U Relationship", Quarterly Journal of Economics, 120 (2), pp.701-728.

Ambec, S., M. A. Cohen, S. Elgie and P. Lanoie (2011), "The Porter Hypothesis at 20: Can Environmental Regulation Enhance Innovation and Competitiveness?", Resources for the Future. Available at: http://www.rff.org/documents/RFF-DP-11-01.pdf

Andersen, E. S. (2003), "Innovation and Demand", Paper for The Elgar Companion to Neo-Schumpeterian Economics ,edited by Horst Hanusch and Andreas Pyka, published by Edward Elgar.

Anthoff, D. and R. Hahn (2010), "Government Failure and Market Failure: On the Inefficiency of Environmental and Energy Policy", *Oxford Review of Economic Policy*, Vol. 26, No. 2, Oxford University Press, Oxford, pp.197–224.

Arnold, E. (2004), "Evaluating research and innovation policy: a systems world needs systems evaluations", *Research Evaluation, volume 13, issue 1*, pp. 3-17.

Arrow, K.J. (1962), "Economic Welfare and the Allocation of Resources for Innovation", in Nelson, R. (ed.), *The Rate and Direction of Inventive Activity: Economic and Social Factors*, Princeton University Press, Princeton, pp. 609-625.

Aschhoff, B. and W. Sofka (2009), "Innovation on Demand: Can public procurement drive market success of innovations?", *Research Policy, Vol. 38, No. 8*, pp. 1235-1247.

Banerjee, A. and B. D. Solomon (2003), "Eco-labeling for energy efficiency and sustainability: a meta-evaluation of US programs", *Energy Policy 31*, pp. 109–123.

Bartelsman, E., P. Gautier and J. de Wind (2009), "Employment Protection, Technology Choice, and Worker Allocation", *mimeo*, The Free University of Amsterdam, Amsterdam.

Bassanini, A. and E. Ernst (2002), "Labour Market Institutions, Product Market Regulation, and Innovation: Cross-Country Evidence", *OECD Economics Department Working Papers*, No. 316, OECD Publishing. doi: 10.1787/002243151077

Bedsworth, L. W. and M. R. Taylor (2007), "Learning from California's Zero-Emission Vehicle Program", *California Economic Policy Volume 3, Number 4*, Public Policy Institute of California.

Beltramello, A. (2012), "Market Development for Green Cars", *OECD Green Growth Papers*, No. 2012/03, OECD Publishing. doi: 10.1787/5k95xtcmxltc-en

Berman, T. and M. Squire (2011), "Demand-side innovation policies in Australia", in OECD, *Demand-side innovation policies*, OECD Publishing.

BERR (Department for Business Enterprise & Regulatory Reform) (2008),"Regulation and innovation: evidence and policy implications", *BERR Economics Paper No.4*, Department for Innovation, Universities and Skills.

Bhidé, A. (2008), *The Venturesome Economy: How Innovation Sustain Prosperity in a More Connected World*, Princeton University Press.

Binks, J. (2006), *Using Public Procurement to Drive Skills and Innovation*, Local futures.

Bound, K. and Puttick, R. (2010), "Buying Power ? Is the Small Business Research Initiative for procuring R&D driving innovation in the UK ?", *NESTA Research report*, National Endowment for Science, Technology and the Arts, United Kingdom.

Bravo-Biosca A., C. Criscuolo and C. Menon (2012), "What drives the dynamics of business growth?", *OECD Science, Technology and Industry Working Paper*, forthcoming.

Bunse, M., W. Irrek, M. Herrndorf, T. Machiba and M. Kuhndit (2007), "Top Runner Approach", Wuppertal: Wuppertal Institute and UNEP Collaborating Centre on Sustainable Production and Consumption.

Cabinet Office (2010), "Mindspace: Influencing Behaviour through Public Policy", available at www.instituteforgovernment.org.uk/publications/mindspace.

COM(2011) 896 final, *Proposal for a Directive of the European Parliament and of the Council on public procurement.*

Criscuolo, C. and C. Menon (2012), "The role of government policies, local knowledge stocks and firms patenting activity for high-growth financing in clean technologies", *OECD Science, Technology and Industry Working Paper*, forthcoming.

DEFRA (2010), *Impact Assessment of Revised 'Government Buying Standards' specifications for Transport Products and Services*, http://sd.defra.gov.uk/documents/ia-trans-products.pdf.

del Río, P., J. Carrillo-Hermosilla and T. Könnola, (2010), "Policy Strategies to Promote Eco-Innovation. An Integrated Framework", *Journal of Industrial Ecology, Volume 14, Number 4*, pp. 541-557.

Department of Enterprise, Trade and Employment (2009*)*, "Using Public Procurement to Stimulate Innovation and SME Access to Public Contracts: Report of the Procurement Innovation Group", Dublin, Ireland.

Edler, J. (2007), "Demand-based Innovation Policy", *Manchester Business School Working Paper No. 529*, Manchester: Manchester Business School.

Edler, J., L. Georghiou, K. Blind and E. Uyarra (2012a), "Evaluating the demand side: New challenges for evaluation", *Research Evaluation 21*, pp. 22-47.

Edler, J., L. Georghiou, Uyarra, E. And Yeow, J. (2012b), "Public procurement and innovation in an evolutionary framework: evidence from public sector suppliers", *Presentation delivered at the conference 'Demand, Innovation and Policy Undeprinning Policy Trends with Academic Analysis'*, Manchester Institute for Innovation Research, March 22-23, 2012.

Edquist, C., L. Hommen, L. Tsipuri (2000), "Policy Implications", in Edquist, C., L. Hommen, and L. Tsipuri (ed.), *Public Technology Procurement and Innovation*, pp. 301–311, Springer.

European Commission (2005), "Public Procurement for Research and Innovation", Expert Group Report. Available at: http://ec.europa.eu/invest-in-research/pdf/download_en/edited_report_18112005_on_public_procurement_for_research_and_innovation.pdf

European Commission (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". Available at: http://ec.europa.eu/invest-in-research/pdf/download_en/aho_report.pdf.

European Commission (2007), "Pre-commercial Procurement: Driving Innovation to Ensure High Quality Public Services in Europe", Brussels.

European Commission (2010a), Communication "Europe 2020 Flagship Initiative Innovation Union", COM (2010) 546 final.

European Commission (2010b),"An Integrated Industrial Policy for the Globalisation Era Putting Competitiveness and Sustainability at Centre Stage, COM(2010) 614 final.

European Commission (2011a), "Horizon 2020 – The Framework Programme for Research and Innovation", COM(2011) 808 final.

European Commission (2011b), "Single Market Act – Twelve levers to boost growth and strengthen confidence", *COM(2011) 206 final* .

Federal Trade Commission (2011), *The Evolving IP Marketplace: Aligning Patent Notice and Remedies with Competition*, United States of America.

Fraunhofer Institute for Systems and Innovation Research (2005), "Innovation and Public Procurement. Review of Issues at Stake", accessed on *Pro Inno Europe*: www.proinno-europe.eu/promotion-pro-inno-europe-results/page/publication-detail-innovation-and-public-procurement-review-i.

Freeman, C., (1974), *The Economics of Industrial Innovation*, MIT Press, Cambridge MA.

Fuchs, E. (2009), The Role of DARPA in Seeding and Encouraging New Technology Trajectories: Pre- and Post-Tony Tether in the New Innovation Ecosystem, Industry Studies Association Working Paper Series, WP-2009-01, http://isapapers.pitt.edu.

Geroski, P. (1995), "Markets for Technology: Knowledge, Innovation and Appropriability", in Stoneman, P. (ed.), *Handbook of the Economics of Innovation and Technical Change*, Blackwell, Oxford, pp. 90-131.

Geroski, P.A. (1990). Procurement policy as a tool of industrial policy, International Review of Applied Economics 4 (2), S.182–S.198.

Greenan, N. and E. Lorenz (2009), "Learning Organisations", Working paper prepared for the OECD's Innovation Strategy, Directorate for Education, OECD, Paris, www.oecd.org/edu/ceri/44191153.pdf

Griliches, Z. and J. Schmookler (1963), "Inventing and Maximising", *The American Economic Review, Vol. 53, No. 4*, pp. 725-729.

Haltiwanger J., S. Scarpetta and H. Schweiger (2008), "Assessing Job Flows Across Countries: The Role of Industry, Firm Size and Regulations", *NBER Working Papers No. 13920*, National Bureau of Economic Research, Cambridge, Massachusetts.

Hargreaves, I. (2011), *Digital Opportunity: A Review of Intellectual Property and Growth*, available at www.ipo.gov.uk/ipreview.htm.

International Telecommunications Union (2012), "E-health Standards and Interoperability" ITU-T Technology Watch Report, April 2012.

Karjalainen, K. and K. Kemppainen (2008), "The involvement of small- and medium-sized enterprises in public procurement: Impact of resource perceptions, electronic systems and enterprise size", *Journal of Purchasing and Supply Management, 14*, pp. 230-240.

Kleit, A.N. (2004), "Impacts of Long-Range Increases in the Corporate Average Fuel Economy (CAFE) Standard", *Economic Inquiry 42*, pp. 279-294.

Lanoie, P., J. Laurent-Lucchetti, N. Johnstone and S. Ambec (2011), "Environmental policy, innovation and performance: new insights on the Porter hypothesis", *Journal of Economics and Management Strategy, Volume 20, Number 3*, pp. 803-842.

Lerner, J. (1999), "The government as venture capitalist: the long-run impact of the SBIR program", *Journal of Business, 72*.

Mahdi, S., P. Nightingale and F. Berkhout (2002), "A Review of the Impact of Regulation on the Chemical Industry", *Final Report to the Royal Commission on Environmental Pollution*, SPRU Science and Technology Policy Research, University of Sussex.

Mowery, D. and N. Rosenberg (1979), "The influence of market demand upon innovation: a critical review of some recent empirical studies", *Research Policy Volume 8, No 2*, pp. 102-153.

Nemet, G. F. (2009), Demand pull, technology push, and government-led incentives for non-incremental technical change. *Research Policy*, Volume 38, Issue 5, pp. 700-709.

The Prince of Wales's UK Corporate Leaders Group on Climate Change and Department for Business, Innovation and Skills (2012), *Down to Zero. Joint Public Private Low Carbon Procurement Compacts*, accessed on www.cpsl.cam.ac.uk/Leaders-Groups/The-Prince-of-Wales-Corporate-Leaders-Group-on-Climate-Change/UK-Procurement.aspx.

OECD (2009), *The Economics of Climate Change Mitigation: Policies and Options for Global Action beyond 2012*, OECD Publishing. doi: 10.1787/9789264073616-en

OECD (2010), *The OECD Innovation Strategy: Getting a Head Start on Tomorrow*, OECD Publishing. doi: 10.1787/9789264083479-en

OECD (2011a), *Fostering Innovation for Green Growth*, OECD Green Growth Studies, OECD Publishing. doi: 10.1787/9789264119925-en

OECD (2011b), *Demand-side Innovation Policies*, OECD Publishing. doi: 10.1787/9789264098886-en

OECD (2011c), *Government at a Glance 2011*, OECD Publishing. doi: 10.1787/gov_glance-2011-en

OECD (2012), “Progress Made in Implementing the OECD Recommendation on Enhancing Integrity in Public Procurement”, Report by the Public Governance Committee, mimeo.

OECD (2014), "Measuring the link between public procurement, R&D and innovation", forthcoming STI Working Paper, OECD, Paris.

Porter, M.E. and van der Linde, C. (1995) "Toward a New Conception of the Environment-Competitiveness Relationship," *Journal of Economic Perspectives*, Vol. 9, No. 4, pp. 97-118

Romani, M., Stern, N and Zenghelis, D. (2011), "The basic economics of low-carbon growth in the UK", *Grantham Research Institute on Climate Change and the Environment Policy Brief*.

Rothwell, R. (1984), Technology-Based Small Firms and Regional Innovation Potential: The Role of Public Procurement, *Journal of Public Policy*, 4, pp. 307-332.

Rothwell, R and Zegveld, W (1981), Industrial Innovation and Public Policy: Preparing for the 1980s and the 1990s, Frances Pinter Ltd., London.

Scherer, F (1982), "Demand-pull and Technological Invention: Schmookler revisited", *The Journal of Industrial Economics, Vol. 30, No. 3*, pp. 225-237.

Schmookler, J. (1966), *Invention and Economic Growth*, Cambridge, Mass.: Harvard University Press.

Shapiro, C. (2002), "Competition Policy and Innovation", *OECD Science, Technology and Industry Working Papers*, No. 2002/11, OECD Publishing. doi: 10.1787/037574528284

Smith, K. (2000), "Innovation as a Systemic Phenomenon: Rethinking the Role of Policy", *Enterprise & Innovation Management Studies, Vol. 1, No. 1*, pp. 73-102.

Starzyńska, W. and A. Borowicz, (2012), "The pro-innovative effect of Poland’s public procurement system on the country’s economy", *Paper presented at the conference "Demand, Innovation and Policy. Underpinning Policy Trends with Academic Analysis"*, Manchester Institute of Innovation Research, MBS, University of Manchester, 22-23 March 2012 .

Swann, P.G.M. (2000), "The Economics of Standardisation", *Final Report for Standards and Technical Regulations Directorate*, Department of Trade and Industry, United Kingdom.

Technopolis (2011), "Trends and Challenges in Demand-Side Innovation Policies in Europe", *Thematic Report 2011 under Specific Contract for the Integration of INNO Policy Trend Chart with ERAWATCH (2011-2012).*

The UK Committee on Climate Change (2010), *Building a Low-Carbon Economy - The UK's Innovation Challenge*, London.

Vinnova (2009), *Can Public Procurement Spur Innovations in Health Care?*, Stockholm

Von Hippel, E. (1988), *The Sources of Innovation*, New York: Oxford University Press.

Von Hippel, E. (2005), *Democratizing Innovation*, Cambridge: MIT Press.

Von Hippel, E., S. Ogawa and J.P.J. de Jong (2011), *The Age of the Consumer Innovator*, available at http://sloanreview.mit.edu/the-magazine/2011-fall/53105/the-age-of-the-consumer-innovator/.

Wallsten, S. (1998), "Re-thinking the small business innovation research program", in: Branscomb, L. and J. Kelle, (eds.), *Investing in Innovation*, MIT Press, Cambridge (MA).

Wallsten, S. (2000), "The effects of government-industry R&D programmes on private R&D: the case of the Small Business Innovation Research Program", *Rand Journal of Economics, Vol. 31, N°1 (Spring 2000)*.

ANNEX 1: FRAMEWORK CONDITIONS FOR INNOVATION

Whatever the chosen mix between policy types, the efficacy of demand-side policies is likely to be limited in the absence of good framework conditions. This Annex briefly describes some of the key framework conditions and the ways that they shape innovation outcomes.

Tax policy

Tax policy settings affect innovation through numerous channels. For instance, tax settings affect:

- *The way that R&D is undertaken.* R&D usually combines inputs such as labour, materials, machinery, buildings and costs associated with overheads, licensing and services. Each of these inputs might receive a different tax treatment.

- *The incidence and scale of investment in R&D.* Most countries operate some form of R&D tax credit or special allowance intended to increase private returns to investment in R&D.

- *How the outputs of R&D are used.* Tax settings shape the decision on whether to license or sell the outputs from R&D, or to use them as inputs to the creation of innovative products, processes or services.

- *The returns to intellectual property*. For example, in Hungary, Switzerland, Korea and Belgium 80% of gross patent income is not taxed.

- *The terms of access to intellectual property*. For instance, the setting of the non-resident withholding tax rate on royalty payments may impose a burden on the importation of technology.

- *The manner in which ownership of intellectual property is realised*. For instance, in most countries, a different tax treatment applies to either the purchase, licensing or in-house development of patents.

- *The incidence and scale of expenditures on training and education*. For instance, tax settings shape incentives for education and training, both for firms and individuals.

- *The location of innovation-oriented investments and of intellectual property*. For example, for many years Ireland has exempted patent income from corporate taxation, becoming a favoured location for intellectual property.

- *The availability of venture capital.* Many countries have sought to increase the supply of venture capital by providing tax credits to private investors who invest directly in start-up firms or indirectly through venture capital funds. Measures have also been taken to ensure a favourable tax treatment to the return on venture capital investments.

- *The readiness to undertake risky investment in established ventures*. For instance, asymmetric tax treatment of business profits and losses may discourage certain types of risky innovative investments.

Labour market policies

Policymakers need to ensure that the impacts of labour market policies on all aspects of innovation are accounted for. A sizeable body of labour market research shows that strict employment protection legislation (EPL) discourages risky and innovative investment because of high firing costs in the case of failure (Bartelsman et al., 2009). Stringent EPL can also slow reallocation via entry and exit of firms (e.g. Haltiwanger et al. 2008). Evidence also suggests that the influence of labour market policies on incentives to innovate varies by industry and by the system of wage bargaining in place (Bassanini and Ernst, 2002). Indeed, Greenan and Lorenz (2009) found that the combination of high levels of labour market mobility with relatively high levels of employment security and expenditure on active labour market policies is associated with the adoption of innovation-enhancing forms of work organisation.

Competition policy

The academic literature concurs that competition is central to innovation, even if discussion continues on the precise circumstances under which competition yields the greatest effect (famously, Aghion et al (2005) found that the degree of product market competition bears an inverted U-shaped relationship to innovation). Competition policy has a limited role with respect to basic research, much of which is in any case pre-competitive (and often takes place outside of for-profit companies). Furthermore, once a rationale for public support of private-sector R&D has been accepted, advantages can arise from having that R&D occur collaboratively. For instance, economies of scale and scope can be realised, while informational spillovers can be internalised among collaborating firms. Accordingly, many countries exempt R&D partnerships from anti-trust legislation. By contrast, competition policy has a principal role in the commercialisation, use and diffusion of new science and technology. In these processes, intellectual property rights are critical and directly shape firms ‘competitive strategies and conditions of market entry.

Education and training

Human capital underpins innovation. For example, over half of all R&D is spent on wages for researchers. Rising educational attainment in OECD economies has likely been critical in fostering innovation. A central element of current and future human capital policies must be the design and effective operation of institutions and incentives that permit the supply and demand for skills to balance quickly. A range of OECD research has identified policy and institutional conditions conducive to a reasonable minimisation of skills mismatches (in any dynamic economy such mismatches will not be eliminated entirely). In a stylised manner, these conditions include:

- A focus on the development of strong generic skills, so that specific skills can be more easily acquired later;

- A focus on creating a system that is flexible, and thus responsive to economic change, rather than relying on skills forecasts as guide to policy;

- Comprehensive information systems that allow students to understand course content, associated labour market outcomes and the performance of education and training providers, as well as permitting employers to understand the content of qualifications;

- Arrangements allowing flexible demand-driven resource allocation across providers of education and training services, and across faculties within educational establishments;

- The involvement of employers and other social partners in the design and delivery of skills policies;

- Labour market policies that facilitate mobility, including mobility across local labour market areas;

- A well-developed training market for adult skills, including mechanisms that counter obstacles to training investments sometimes encountered in SMEs;

- An effective demand-driven labour migration regime;

- Mechanisms to control for quality and create accountability at all levels of the system.

Intellectual property rights

The system of intellectual property rights (IPR) creates critical incentives for spending on innovation. Policy towards IPR involves multiple and complex themes, a full treatment of which exceeds the scope of this paper. Recently, various OECD countries have undertaken comprehensive reviews of their IPR frameworks, and debates on IPR have assumed new prominence in the economics press. While significant differences in IPR frameworks exist across countries, key themes highlighted in current debates include the following:

- Fears, particularly in the United States, that patent quality (i.e. the accuracy of the patent claim and whether the patent is genuinely novel or non-obvious) may be in decline. Indeed, data presented in the OECD's *Science, Technology and Industry Scoreboard 2011* suggest that patent quality across the OECD area has eroded steadily over the last decade.

- The creation of incentives for litigation. Research in the United States estimates that total patent-related litigation costs exceed total profits from patents. In such a context, many firms spend large sums to build patent portfolios so as to strengthen positions in prospective negotiations. In turn, this demand for patents can give rise to so-called 'patent thickets', obstructing entry in some markets. Linked to this dynamic is the growing problem of so-called 'patent trolls'. Patent trolls are firms that do not make, own or provide their own products or services. Instead, they purchase patents and file resource-consuming lawsuits against companies alleged to have infringed those patents.

- The extension of the patentable domain into areas such as business methods and software. Overly broad patents, it is feared, could retard follow-on innovation, limit competition and raise prices through unnecessary licensing and litigation (Federal Trade Commission, 2011).

- Concerns over the effects on innovation and competition of specific operational features of patent systems such as patent notice (how well a patent informs the public of what technology is protected) and patent remedies (judicially awarded damages that should replicate the market reward that the patent holder loses because of patent infringement) (Federal Trade Commission, 2011).

- In an ever more integrated global economy, the need to harmonise intellectual property systems internationally (for instance to permit cross border copyright licensing).

- The difficulty of enforcing copyright in the digital age and, allied to this, the recognition that in an era of routine copying of text, data and images, copyright law might hinder the emergence of new kinds of internet-based firms (Hargreaves, 2011).

- A broader concern that SMEs are relatively disadvantaged in their ability to negotiate intellectual property systems.