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**Working Paper**

## Understanding the innovation impacts of public procurement

Manchester Business School Working Paper, No. 574

**Provided in Cooperation with:**

Manchester Business School, The University of Manchester

*Suggested Citation:* Uyarra, Elvira; Flanagan, Kieron (2009) : Understanding the innovation impacts of public procurement, Manchester Business School Working Paper, No. 574, The University of Manchester, Manchester Business School, Manchester

This Version is available at:

<https://hdl.handle.net/10419/50706>

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# Working Paper Series

## Understanding the Innovation Impacts of Public Procurement

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Manchester Business School Working Paper No 574

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+44(0)161 306 1320  
<http://www.mbs.ac.uk/research/workingpapers/>

ISSN 0954-7401

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## **Abstract**

Public procurement accounts for a significant proportion of overall demand for goods and services and is increasingly seen as an attractive and feasible instrument for furthering the goals of innovation policy. However, public procurement is already expected to address a wide range of social goals. Much of the current debate about harnessing procurement to promote innovation draws upon a limited set of examples which are not representative of the bulk of public purchasing and tend to downplay diversity in procurement practices and in the types of goods and services procured. They also downplay diversity in the nature of innovations and in the range of ways that procurement can impact upon innovation. A one-size-fits-all model is unlikely to work across all procurement contexts yet all types of public procurement are likely to have impacts upon innovation by shaping the demand environment in which suppliers innovate and compete. We propose a framework and typology based on the nature of the goods and services procured in order to explore the potential impacts upon markets and innovation of each. We conclude that public purchasing should first and foremost remain concerned with proximate public policy goals and that, rather than trying to co-opt public procurement into the innovation policy toolbox, policy-makers should focus on promoting innovation-friendly practices across all types of procurement at all levels of governance.

## **Keywords**

innovation policy; demand; public procurement; markets

## **How to quote or cite this document**

Uyarra, E. & Flanagan, K. (2009). Understanding the Innovation Impacts of Public Procurement. *Manchester Business School Working Paper, Number 574*, available: <http://www.mbs.ac.uk/research/workingpapers/>

### **1. Introduction**

The notion that public procurement can be actively used to promote innovation is high on the agenda of European policy-makers at all levels. Public procurement accounts for a significant proportion of overall demand for goods and services, which in the EU represents around 16% of the combined EU-15 GDP (European Commission, 2005). Whilst debates about the influence of ‘demand’ on innovation are not new this interest in the use of public demand as a driver of innovation has become mainstream in innovation policy debates, a process encouraged by the recommendations of a number of inquiries, reports and policy documents (e.g. Edler et al., 2005; European Commission, 2005). Procurement for innovation is an element of the European Commission’s Action Plan to raise R&D expenditure to the 3% Barcelona target. Both the Kok Report, reviewing progress on the Lisbon strategy, and the Aho Group Report *Creating an Innovative Europe* (Aho et al., 2006) emphasised a need to promote policies driving demand for innovation, including public procurement. The recent Lead Market Initiative (European Commission, 2007) focuses largely on sectors in which the State is an important purchaser and considers public procurement to be one of the key policy instruments relevant to the creation of ‘lead markets’ in Europe. At the national level, and taking the example of the UK, a number of policy statements have highlighted the importance of public procurement not only for achieving greater efficiency in public sector spending (HM Treasury, 2004) but also as a vehicle for innovation and local economic development . This aspiration to harness public procurement in support of innovation has featured strongly in a number of recent statements of UK innovation policy (HM Treasury, 2007, DIUS, 2008).

However, despite this upsurge of interest, we believe that the debate remains too restricted to meaningfully inform public procurement strategies. The current debate is limited in several ways: first, it downplays the varied nature of public procurement in terms of the wide range of types of goods and services procured by the public sector; second, it downplays the varied nature of innovation; and third, it downplays the multiple potential innovation effects of public procurement. Much debate is focused on a limited number of examples used to demonstrate the innovation effect of public procurement, examples generally at the high end of technology and supported by procurement at the early stages of development. Whilst celebrated examples such as the Internet and semiconductors may indeed be examples of successful procurement-induced innovations, these are not representative examples of everyday public procurement of goods and services by national and regional bodies, and it is unclear what lessons can be learned from such cases for ‘bread and butter’ procurement. There is also a definitional problem at the heart of the current debate. Widely-used definitions of ‘innovative procurement’ as ‘the purchase of goods or services that do not yet exist’ exclude many categories of innovation and may be of doubtful relevance to many public procurers, who could find this agenda difficult to respond to. The prevailing definitions do not account for innovation through the recombination of existing goods or services, innovation in the delivery of existing services, and exclude most process innovations. In addition, emphasis is placed on the direct effects of procurement on innovation whilst the possibility of indirect impacts and wider spillover effects are downplayed. Both the academic and policy debates take an aspatial approach to impacts and tend to be biased towards procurement done at the national level (and by powerful departments such as defence). However public procurement is subject to multi-level governance and variations in expenditure across different levels and from territory to territory mean that the geography

of public procurement is complex. Finally, the scope for public procurement to stimulate innovation has to be considered in a context in which public procurement is increasingly expected to pursue a variety of often conflicting policy objectives. Procurement practitioners are thus faced with a wide range of demands placed upon them to simultaneously achieve multiple goals beyond the proximate goals behind the procurement itself.

In this paper we construct a framework for understanding the different ways in which procurement could influence innovation. We do so by focusing on the nature of the goods and services procured and on purchasing strategies, which influence the type of innovation opportunities firms are confronted with. We explore some implications of this analysis in terms of dominant buyer-supplier relations and geographical organisation. The paper proceeds as follows. Section two summarises some key debates around the influence of demand in shaping innovation. Section three deals with definitional issues before examining the avenues through which procurement may, directly or indirectly, influence innovation. Section four discusses the influence of product based procurement types and strategies on firms and elaborates on the implications of this typology as regards categories of innovation, user-supplier relations, modalities of procurement and geography. The paper ends with a short summary.

## **2. The influence of demand on innovation**

There is an increasing consensus in innovation policy discussions that the demand side of innovation has been neglected. Despite an emphasis on user-supplier interaction and a recognition that demand for innovations must be important, policy prescriptions emerging from ‘systems’ approaches have tended to focus predominantly on the supply side of economic life (Edler and Georghiou, 2007). Storper (1997; 107) also notes how the literature on evolutionary economics has tended to focus attention “whether implicitly or explicitly” on the supply side, and in particular on the “institutions that deliver up resources crucial to learning and interaction”. Malerba (2007) argues that although demand has received attention in the literature, many questions remain particularly in relation to the influence of demand on innovation during the evolution of an industry, and the nature of customer involvement in the innovation process (e.g. a passive recipient versus an active contributor).

Of course Schmookler (1966) highlighted the importance of the market size in triggering technological developments. Demand on a significant scale ‘pulls’ innovation as it guarantees a significant level of production and a reduction in uncertainty that allows firms to benefit from economies of scale and technological investment and ensures larger profits. Network externalities on the demand side also create advantages for certain industries by allowing dynamic increasing returns (Katz and Shapiro 1985). The importance of the home market is relative rather than absolute, so small nations can be competitive in segments that account for a significant share of local demand but a small share elsewhere, even though the absolute size of the segment is larger in other countries (Porter 1990).

Demand is also treated as a key influence by studies focusing on the dynamic relationship between innovation and market structure (Kamien and Schwartz, 1975; Sutton, 1998) and on innovation and industry life cycle models (Utterback 1994). A central tenet of studies on the relation between demand, market structure and innovation is the Schumpeterian argument of a positive impact of market power on innovative activity. Klepper and Thompson (2006) and Sutton (1998) centre their attention on the importance of submarkets and their role in explaining growth and concentration of industries. Life cycle models address the dynamics of innovation in industry evolution (Utterback 1994; Klepper 1997). It is argued that the rate of product innovation in an industry or product class is highest during the 'fluid' phase, which is characterised by a great deal of experimentation with product design and operational characteristics. In the 'transitional' phase, product variety gives way to standard designs, or dominant designs, shaped by user needs, standards, or legal or regulatory constraints. Some industries further experience a 'specific' phase, in which they become focused largely on "cost, volume and capacity" (Utterback 1994). In this phase there is some incidence of small, incremental product and process innovation.

These models have been criticised on the basis of their neglect of demand on post-dominant design developments, their assumption of a clear succession between product and process innovation (Adner and Levinthal 2001) and their assumption that a clear dominant design will always emerge (Windrum and Birchenhall 1998). So Windrum and Birchenhall (1998) argue that the convergence to a single design would be limited to mass markets with relatively homogeneous consumer tastes. Observing the market for cameras, they conclude that the system need not necessarily stabilize around a unique design. Instead a process of market differentiation may lead to the emergence of distinct niches. Adner and Levinthal's model based on heterogeneous demand, suggests that, contrary to the product life cycle model, high levels of innovative activity can occur for 'mature' product classes (Adner and Levinthal 2001). Aberthany and Clark (1985) argue that, contrary to the "birth-growth-maturity-decline" pattern of development suggested by life cycle notions, conditions may occur that trigger the reversal of an older industry (or 'de-maturity'), thus embracing radical innovations that can serve as the basis for renewal in industry development. Among these conditions they point to changes in customer demands and in public policy and regulation.

Some of the literature focuses more specifically on the needs of users and the involvement of users in innovation. Mowery and Rosenberg (1979) critically analysed existing evidence around the 'demand pull' effect, identifying a confounding of 'needs' with 'demand' in much of the literature which limited the comparability of the various studies identifying 'demand' as the key determinant of innovation. They distinguished between the importance of 'user needs' or 'need recognition' (need-pull) as a source of innovation and demand-pull effects mediated by the market. In their view "myriads of deeply-felt needs exist in the world, any one of which constitutes a potential market for some product, yet only a small subset of these potential demands are fulfilled" (p.109).

Porter notes that buyers can anticipate market demand by becoming early adopters of a new product or service that eventually comes to be demanded elsewhere. This

anticipatory demand, he argues, stimulates the continuous improvement of products and their ability to compete in emerging segments. These early adopters can also be heavily involved in the innovation process, and even in the co-production of the good or service. Lundvall (1993) has emphasised the importance of user-producer interaction in particular industries. Von Hippel (1986) has explored user driven innovations in sectors such as scientific instruments and coined the term ‘lead users’ to refer to “users whose present strong needs will become general in a marketplace months or years in the future” (Von Hippel 1986; p.791). Bresnahan and Greenstein (2001) point to the importance of co-invention in the IT sector, where user co-inventions adapt the general purpose technology to the diverse specific problems and needs of the different users. Malerba et al. also highlight the importance of experimental users in cases such as the internet, automobiles and aircraft. In these cases “new firms got their start selling to experimental users, or to users whose needs were inadequately met” by producers relying on older technology (Malerba et al. 2007; p.373)

### **3. The influence of public procurement on innovation**

#### ***3. 1. Definitional issues***

Before further discussion of the potential of public procurement as an innovation policy tool, a clarification of definitional issues is in order. Public procurement refers to the acquisition of goods and services by government or public sector organizations. A distinction is commonly made between ‘normal’ or ‘regular’ public procurement on the one hand and ‘public technology procurement’ on the other. Public technology procurement occurs when “a public agency acts to purchase, or place and order for, a product—service, good, or system—*that does not yet exist*, but which could probably be developed within a reasonable period of time, based on additional or new development work—e.g. R&D—by the organization(s) undertaking to produce, supply, and sell the product” (Edquist and Hommen 2000; 5 *emphasis added*). Regular public procurement, on the other hand, is said to occur when public sector organizations buy ready-made products for which no R&D is required and about which purchasing and supplier selection decisions can be made on the basis of readily available information about price, quantity, and performance, given the existence of standardized markets (*ibid.*). A third modality is when the public sector directly procures R&D to support the activities and decisions of government and public authorities. This is a special case which differs from the procurement of other goods and services for public use and is of less interest for the purposes of this paper. Finally, proponents of the use of public procurement to stimulate innovation increasingly refer to ‘innovative procurement’ or ‘procurement of innovation’, rather than ‘public technology procurement’, in an attempt to reflect a broader view of innovation beyond R&D (Edler and Georghiou, 2007)<sup>1</sup>.

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<sup>1</sup> Debates within the public procurement world are often focused on innovation *in* procurement, that is change or innovation in the procurement process itself. Indeed innovation in procurement processes may be an essential precursor to the active use of public procurement to stimulate innovation in suppliers and the wider economy. However there exists the potential for terminological confusion between ‘innovative procurement’ and ‘innovation in procurement’ between the innovation policy and the public procurement discourses.

Within the category of innovative procurement, further differentiations have been made in terms of the end users of the goods and services procured (Edler and Georghiou 2007, Hommen and Rolfstam, 2009), the strategic nature of the procurement policy (Edler and Georghiou, 2007), the market position of the public sector in relation to suppliers (Rothwell and Zegveld, 1981, Edquist and Hommen, 2000), the type of innovation and the stage of the technology life cycle in which innovation is seen to occur (Edquist and Hommen, 2000; Edler et al, 2005; Hommen and Rolfstam, 2009). Interestingly, there is no typology based on the nature of the *actual* goods and services procured.

### *Procurement as explicit innovation policy*

In the tradition of authors such as Geroski (1990) and Rothwell and Zegveld (1981) there has long been interest in the use of procurement as an innovation policy tool or a tool of industrial policy. Rothwell and Zegveld (1981) compared R&D subsidies and state procurement contracts and concluded that procurement was more effective in generating innovation than R&D subsidies. Geroski (1990) reviewed key successful innovations emerging from public procurement such as the computer, civilian aircraft and semiconductor industries and concluded that procurement could be effective in stimulating innovation under certain conditions. These include the enforcement of high standards, the definition of a clear set of needs towards which innovative efforts can be directed, the provision of a market for new products and services at early stages of the product life cycle, and encouragement of competition. He cautiously notes that procurement may only be effective in a small minority of cases (notably defence) and points to potential for misuse, particularly in relation to poor targeting, backward-looking protectionism and the support of national champions.

Recent discussions have unfortunately lost sight of this nuanced understanding, and tend to imply, without a careful analysis of preconditions and limits, that public procurement should have as an intentional or explicit objective the promotion of innovation (see e.g. Ashoff and Sofka, 2008). We have argued elsewhere that an expansion of the accepted realm of action for innovation policy has seen policy instruments intended to achieve other policy goals (such as procurement, regulation, education, tax measures, etc) being ‘co-opted’ in the service of innovation policy (Flanagan et al, 2008). This brings with it the implicit assumption that innovation policy goals should take precedence over, or at least co-exist as primary objectives, with other policy goals.

Public procurement is, however, already a multi-objective policy, the main goal of which must remain to ensure the quality of government services and the use of the products and services for the public sector. That said, innovation can be an explicit secondary objective in certain instances, e.g. to ensure that vital government functions can be secured against a range of shocks and threats (mission-critical procurement) or to obtain better products for use in carrying out government functions; to appropriately exploit government market power and to ensure that the needs of those consuming public goods (where market forces may not effectively stimulate innovation) are met (Cave and Frinking, 2003).



It is important to appreciate that, regardless of whether public procurement is explicitly oriented towards innovation, there will be innovation impacts. As Dalpe (1994, p.66) argues, “decisions concerning prices, quantities, and standards affect innovation, positively or negatively, in a group of industries involved in government procurement.” It is important to understand these effects, whether they are actively sought or not (see next section). Indeed many of the most frequently cited examples of procurement-induced innovation have not been the result of an intentional or conscious drive to encourage innovation but rather the by-product of ‘normal’ procurement.

### *Type of innovation and innovation effects*

Conceiving innovative procurement (or public technology procurement) as the procurement of something that does not yet exist is problematic in that by focusing on innovation *in what is procured* it implicitly overlooks innovation effects beyond the initial purchase and is biased towards radical (new to the world) innovations, paying less attention to other categories of innovation. The idea of innovation as synonymous with complete novelty is rarely encountered in practice (Abernathy and Clark, 1985). Clearly, as Geroski (1990; p.192) notes “using procurement policies to encourage firms to develop new capabilities does not imply that one ought to uncritically encourage them to generate something new”.

In fact Edquist and Hommen (2000) admit that some innovations from procurement are actually not ‘new to the world’. They differentiate between ‘developmental’ and ‘adaptive’ public technology procurement. Developmental procurement occurs where completely new products, processes or systems are created, whilst adaptive procurement is the procurement of goods and services not new to the world but new to the country of procurement (Edquist and Hommen, 2000: p.21). In this case the emphasis is on adaptation of the existing good or service to local circumstances. The literature mentions many examples of ‘developmental’ innovations such as the U.S. semiconductor industry, the development of the digital telephone switch in France and Italy and the cellular networks in the Nordic countries (see e.g. Edquist et al, 2000). Although often highly visible, such cases probably constitute only a small proportion of all procured goods and services. An illustration that these cases are not widespread is provided by the study of Lember et al (2008) of procurement in Baltic cities. The authors noted that most of the procurement-induced innovations found *did not* involve early-stage innovation of emerging technologies but were rather adaptations or improvements of existing solutions, or even non-technological innovations. They did not detect any requirement for genuine research and development efforts in the examples studied. However, some incremental innovations resulting from sustained purchasing actually had substantial market impacts. A similar finding was reported by Yaslan (2009) in relation to public procurement of IT solutions in Turkey. His analysis of over 30 procurement projects found little evidence of radical innovations but reported instead a significant impact on further commercial applications (new markets), and organisational and process innovations

Furthermore, the procurement of a new product or service, for instance a one-off product development, will not necessarily give rise to systemic effects. Conceiving innovative procurement in terms of the act of purchasing a new good or service is to take a static view rather than a dynamic one which takes into account the effects in the medium or

longer term of introducing that new good or service in the market. In order to ensure a wider social benefit from a specific public procurement, the supplier firm must subsequently find buyers in the wider (public or) private market (Dalpe, 1994, p. 75). Where government is the end user of a procured technology, the innovation may have an impact on improved public services and on the technological capacities of the supplier firm(s) but may not find a market in the commercial sector. Further spillover effects of innovation on the private market would depend on *the relationship between public and private demand*. Cave and Frinkin (2003) note that public sector demand (or needs) may be different than, complementary to, deeper than or anticipatory to private demand. However there is a danger that firms in industries serving both public and private sectors will tend to specialise in one type of client or the other (Dalpe, 1994). Firms may decide to specialise in public markets to exploit acquired experience in public contracts when learning costs are significant, or they may simply find public sector clients more reliable than private ones. Public sector contracting may be such that firms with previous public contract experience are privileged, or where procurers opt to maintain regular suppliers in order to guarantee a satisfactory service and/or to avoid switching costs. This will reduce incentives to innovate and limit the exploitation of new markets and new applications.

It is clear then that procuring ‘goods and services that do not exist’ is not always a necessary condition and is by no means a sufficient one to generate systemic impacts. For this reason we should be cautious in dividing up procurement into two mutually exclusive categories of normal vs. innovative procurement. We argue in favour of a broader interpretation that recognises that public procurement serves specific public needs and that innovation should be encouraged, where possible, as a ‘by-product’ of the procurement process. Suggesting that public procurement should have as a primary objective the promotion of innovation is unrealistic. Furthermore, it could be counter-productive by sending signals to policy makers engaged in normal procurement either that they cannot hope to have innovation impacts or conversely that they must inflexibly adopt an inappropriate and poorly articulated model of pre-commercial or technology procurement. Neither outcome is likely to stimulate innovation. There also remains the risk that the procurement of innovation may slip down the policy agenda as new and more urgent policy goals emerge.

The challenge instead, then, is to encourage practices that could favour innovative solutions, that is to encourage more ‘innovation-friendly’ procurement. Decisions should be made on a case-by-case basis depending on the good or service being procured and the uses to which it will be put and other political and financial constraints and objectives. We should not be asking *whether* procurement influences innovation or not, but attempting to better understand the mechanisms by which impacts of public procurement on innovation may occur, so that they can be encouraged within an appropriate framework (Geroski, 1990).

### ***3.2. Innovation impacts – different routes***

A range of possible impacts of public procurement are mentioned in the literature, from greater efficiencies in production, to incentives to innovation and capacity building, to demonstration effects of the utility of innovative goods or services in wider markets, to

the creation of ‘lead markets’. Effects will occur at different points in time, involve specific risks, and be influenced by different circumstances. Sometimes effects may even cancel each other out.

As we have argued, procurement will influence innovation whether or not this is an explicit goal. Cave and Frinkin (2003) differentiate between *direct* demand pull impacts, where the intention is to procure innovative goods and services directly, and *indirect* demand-pull impacts, where innovation is a by-product of government procurement. Cabral et al (2006) identify three kinds of *indirect* influence of public procurement on innovation: by enlarging the market for new goods; by facilitating the adoption of new standards; or by changing the market structure so as to make it more conducive to innovation (dynamic effects). The UK Office of Fair Trading (2004) in turn identifies a series of impacts of procurement on competition and market structure. They divide these into short term, long term and knock-on effects on other markets. These are elaborated further below. Porter (1990) has similarly argued that public procurement can act as a positive force for upgrading national competitive advantage by providing early demand for advanced new products and services; by government acting as a demanding and sophisticated buyer; by reflecting international needs in the setting up of specifications; through facilitating innovation; and through encouraging competition. These conditions are mutually reinforcing and each may have its greatest significance at different stages of an industry’s evolution and depending on industry characteristics. So, for instance, certain conditions may be more important in initially establishing advantage whilst others may be important in reinforcing or sustaining that advantage.

#### *Direct and indirect effects of public procurement*

As already noted public procurement can influence innovation *directly* through the purchasing of innovative goods and services. The public sector may be willing to pay a premium cost or bear some efficiency losses if it wants to encourage certain policy goals and societal needs, such as sustainability, social inclusion, etc. (McCrudden, 2004; Edler and Georghiou, 2007). Government can be highly influential when it is itself the end user of the innovation (Dalpe, 1992; 1994). The public sector can act as an ‘experimental user’ in the sense of Malerba et al. (2007), where a cheaper, proven option does not meet its requirements, and may be willing to assume the risk inherent in the purchase of a new product, even if it is only at the prototype stage or earlier. A public procurer with the necessary technical competences could force innovation on the part of the supplier or even engage in co-invention, pushing suppliers to innovate in order to keep up with user requirements.

Besides these direct effects on innovation, public procurement could affect innovation *indirectly* by influencing the size and structure of the market, by setting standards and by increasing or reducing competition. Governments, via the purchasing power of the public sector, are in a position to be able to enlarge the market for certain goods, thus providing an incentive to invest in innovation. Clearly when there are increasing returns to scale or imperfect markets, competition may not necessarily lead to innovation. The public sector can provide a market and critical mass sufficient to encourage private R&D investment. However the scale of public demand is only relevant if it can be made *effective* through the exercise of buyer power, for instance through consolidation of demand and co-

ordinated action in cases where the public sector accounts for a large proportion of demand in a market (OFT 2004)<sup>2</sup>.

The scale of demand is particularly important in those industries characterized by heavy R&D requirements, substantial economies of scale in production, large generational leaps in technology, or high levels of uncertainty (Porter 1990). Sizeable public demand reduces market risks by guaranteeing a certain amount of sales, enabling innovative firms to generate early economies of scale and learning, increase productivity and lower costs. In addition, system failures arise from fragmented markets where potential suppliers and clients are not aware of customer demand and what product and service innovation the market can offer. Public procurement can help articulate this demand (Edler and Georghiou, 2007).

Through procurement the public sector can also help to create standards or promote convergence to a single standard, thus encouraging diffusion. Economies of scale and network externalities on the demand side create advantages for certain industries by allowing dynamic increasing returns. The presence of sufficient demand can allow economies of scale in production and use (via network externalities) to justify investment, particularly in ICT areas. At the same time network effects can lead to inertia and lock-in to an inferior version of a new technology or to a technology that does not match the international standard. When purchasing innovative goods and services on a large scale, public administrations can have a significant effect on the outcome of the technology adoption process by their decision to choose a new technology or a particular version-standard of a new technology (Cabral et al, 2006). So for instance Fridlund (2000) details the development of the AXE switching system by the Swedish national telephone operator, and its importance in sustaining Ericsson's international competitiveness.

Procurement can also influence innovation indirectly by altering the structure of competition in the market in the short and medium term. In the short term, procurement can affect: the level of participation of firms in particular tenders; the homogeneity of those bidding; and the extent to which they are incentivized to engage in tacit collusion (OFT, 2004). Increased competition in the bidding process should arguably result in lower prices and greater quality. However, certain tender conditions may exclude de facto certain types of firms (e.g. SMEs), reducing the chances of innovation by excluding potential sources of innovation. Restrictions can thus have a variety reducing effect, limiting the number of competing solutions and reducing the chance of an innovative solution being selected. Whilst increasing the number of bidders would tend to lead to more intense competition, in some cases the high cost of evaluating bids, heavy asset specificity or long time scales may mean it is sensible to limit participation through the application of criteria such as reputation and proven ability to meet the requirements (Candwell, 2005). The relative homogeneity or heterogeneity of bidders is also relevant: cost competition will be more intense the more similar the bidders are (and less intense the more dissimilar they are). Conversely heterogeneity of bidders may lead to more

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<sup>2</sup> A point also noted by Edquist et al (2000) who acknowledge that for effective technology procurement to take place a high concentration of buying power and a comprehensive 'articulation of demand' may be necessary.

intense competition on the basis of performance or quality characteristics (but higher risk and cost of procurement process). The likelihood of collusion will also be lower the more bidders participate in the tender, and the more dissimilar they are<sup>3</sup>.

Longer term effects of procurement are brought about by changes in market structure and market position and by changing the incentive structure for investment and innovation. Public procurement can ultimately influence the number of suppliers in the market (in some markets not winning public contracts may threaten the commercial viability of the firm); can increase the gap between market leaders and other suppliers; or can create incumbency advantages for public contractors in future tenders (for instance by changing the playing field for public sector contracts). Through bundling its requirements, the public sector can also affect the vertical organization of supply. Buying bundles of services across the value chain can provide advantages to vertically integrated suppliers, and can thus affect decisions of firms to integrate vertically (OFT, 2004).

In the long term, effects can also translate into changes in the incentives provided to suppliers to invest and innovate. Uncertainty in relation to terms and conditions, or an undue focus on price, particularly in sectors characterized by strong sunk investments, may mean that firms are not able to recoup their investment. In relation to this risk, the UK Office of Government Commerce has stressed the need to improve long-term capacity planning in the government marketplace (OGC, 2003) by promoting early supplier engagement and information provision on the part of the public sector and better accounting for the needs of suppliers in public sector planning.

The OFT (2004) identifies a further type of impact of procurement on competition, the ‘knock-on’ effect or impact on other buyers’ markets. Public procurement can have an impact on the market conditions of other buyers (the overall number and capacity of suppliers), the range of products and services available and the technologies used. For example, as a result of procurement, public sector suppliers may be in an advantageous position vis-à-vis other suppliers, pushing the latter out of the market. Furthermore, procurement can lead to the creation of products and services that are then widely available for the general public. By buying a new product or service, the public sector may help *demonstrate* the benefit to potential users (OGC, 2003). Thus supplying to the public sector may grant firms reputational or learning benefits that can transfer to and create an advantage in other buyers’ markets<sup>4</sup>.

The transfer effect (via reputation, learning, cost advantages, etc.) may even leap to outside markets, giving supplier firms a competitive advantage in foreign markets. This is in line with Porter’s (1990) recommendation that procurement specifications should reflect international needs. Considerable attention has been given recently to the emergence of so-called lead ‘markets’, understood as “as regional markets with specific

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<sup>3</sup> Factors that influence collusive behavior according to the OFT also include: the transparency of the tendering process, the frequency of interaction (either in the same market over time or in different markets), and the stability of demand.

<sup>4</sup> Levinson (2006) argues that the early adoption of containerised shipping by the U.S. military to solve logistics problems associated with the war in Vietnam created both a powerful demonstrator effect and provided an opportunity for entrepreneurs to kick-start the importing of Japanese consumer products into the American market by filling up the empty containers returning across the Pacific to the U.S.

attributes that increase the probability that a locally preferred innovation design becomes internationally successful as well” (Beise and Cleff, 2004 p.455). The term constitutes an extension of the concept of ‘lead users’ (Von Hippel, 1986) as well as a refinement of the concept of ‘demand advantage’ in Porter’s ‘diamond’ of national competitive advantage. The advantage of lead markets for firms is that they can leverage local knowledge internationally (Beise and Cleff, 2004). Successful innovations in lead markets are considered to have a higher potential for becoming adopted world-wide than other designs being developed elsewhere.

The above impacts on procurement are largely considered in an aspatial analysis. However, procurement and innovation happen in space and the impacts of procurement will be felt at specific locations. For instance mission-oriented defence procurement in the U.S. is considered to have influenced the development of high-tech clusters such as Silicon Valley. The geographical impact of procurement will depend on the spatial patterns of government procurement, on the mix of goods and services procured, on the degree of control over purchasing by local and regional authorities, and on the extent to which benefits can be retained within a particular locality or region through sub-contracting and knowledge spillovers. We will return to these impacts in the final discussion.

#### **4. Towards a product-based typology of public procurement: implications for strategy, innovation, and geography**

The previous section explored the diverse routes through which procurement can influence innovation. However these influences also depend on the mix of goods and services that are demanded and the strategies the public sector employs to shape the nature and composition of this mix. As Murmann et al. (2006; p.947) point out, “successful innovation is in essence a coupling process focusing superior technological competencies in products and processes to meet the specific needs of users”. In this spirit we propose a new articulation which considers procurement from the point of view of what is actually procured. In the first part of the section this differentiation is detailed, followed by an analysis of how this may impact innovation decisions in supplier firms.

The importance of focusing on products that reflect different needs stems partly from the recognition of the variety within a ‘public sector’ which typically comprises many independent agents (OFT, 2004; . Knight et al. (2003) rightly point out that “it is a sweeping statement to talk of one ‘public sector’; government and the wider public sector comprises a large array of departments, agencies, quasi-autonomous non-governmental organizations, and executive organizations with very variable characteristics and spend portfolios” (quoted in Caldwell et al. (2005))<sup>5</sup>. The nature and complexity of procured products and services will vary greatly within and across public sector organizations, leading to different buying situations and different strategies to ensure the quality of public service provision. These decisions in turn send messages to supplier firms, influencing the demand environment and thus decisions shaping innovation.

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<sup>5</sup> Insofar as there is a trend here it is towards increased variety as the various manifestations of decentralization and the ‘New Public Management’ continue to make themselves felt.

Strategic decisions in the public sector as to what and how to procure will be determined by value for money considerations, the criticality of the procured goods and services to the department or agencies' core mission and the level of complexity/sophistication of the products and services. In this sense public procurement decisions are not dissimilar to the purchasing decisions made by private firms and in fact 'purchasing portfolio models' aimed at developing and implementing differentiated purchasing strategies also constitute 'good practice' procurement in the public sector<sup>6</sup>. The idea behind such methods is to minimize supply risk whilst taking advantage of buying power. The ultimate objective is to derive competitive advantage by better managing supplier relations, thus converting purchasing activities into a strategic business function (Gelderman and Weele, 2005).

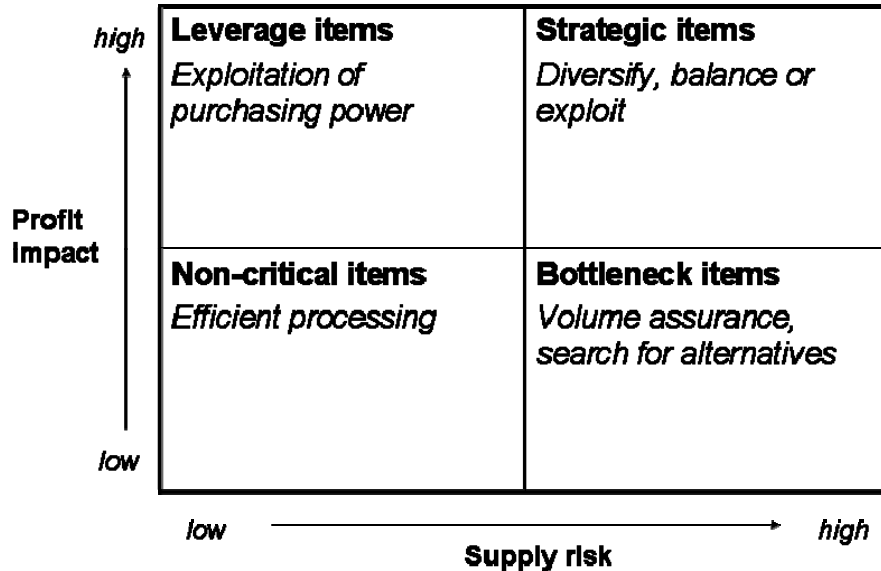
The standard purchasing portfolio model developed by Kraljic (1983) classifies products on the basis of two key dimensions, *profit impact* and *supply risk*. Accordingly four categories of purchased items emerge: 'bottleneck', 'non critical', 'leverage' and 'strategic'. Each of the categories would necessitate a differentiated strategy (see Figure 1). The items in the bottleneck and strategic categories would generally be those goods and services which are of strategic importance for the company or the public administration due to their impact on business or policy. They are mission-critical and therefore entail a greater degree of risk. Bottleneck items require volume insurance, vendor control, security of inventories and backup plans to reduce supply risk. In the case of strategic items, further analysis is recommended of the buying strengths against the strengths of the supply market, and three different supplier strategies are identified in relation to the different power positions: 'diversify', 'balance' or 'exploit'<sup>7</sup> (Kraljic, 1983). In turn, noncritical items require efficient processing, product standardization, order volume and inventory optimization, whilst leverage items allow the buying company to exploit its full purchasing power, for instance through tendering, target pricing and product substitution.

### **Figure 1. Kraljic's purchasing portfolio model**

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<sup>6</sup> The purchasing portfolio approach is allegedly widely used by major companies. Despite its popularity, there are few studies providing evidence on their actual use (for a review and critique of purchasing portfolio approaches see Gelderman and Weele, 2005). There is also little evidence on the use of this technique by public procurers, despite such supply portfolio or positioning matrices being a frequent component of public procurement strategies at national and local authority level in the UK).

<sup>7</sup> For items where the company plays a dominant market role vis a vis the supplier, the company should 'exploit' this advantage. If the supplier's strength outweighs the company's, the company should look for material substitutes or new suppliers 'diversify'. For items with neither major visible risks nor benefits, the company should pursue a 'balance' intermediary strategy (Kraljic, 1983).



*Source: elaborated from Kraljic (1983)*

Gelderman and Weele (2002) suggest that it is important to understand which procedure to follow in each category, but also to consider how best to move to a strategically more attractive (that is less risky or more profitable) position in the matrix. For instance such an analysis should help purchasing practitioners to move commodities and suppliers around specific segments so that dependence on specific suppliers is reduced. Analysing the strategy followed by a particular company they point to a number of options used to move around the different portfolio segments. These strategies mainly involve standardisation and pooling of resources, reduction of over-specification ('decomplexing'), the use of strategic partnerships with suppliers and supplier development in order to enhance capabilities.

Certainly the challenges faced by procuring firms will differ from those faced by public procurers. Public procurement needs to conform with a particular legal and regulatory framework with its own requirements for transparency and non-discrimination. Public procurement entails political as well as other kinds of risk and incentive structures clearly differ from the private sector. All this can translate into a greater aversion to risk in procurement. Furthermore, as already noted, public sector procurement frequently seeks to address additional strategic – that is policy - objectives such as regeneration, welfare, sustainability, and now innovation (OFT, 2004; Wang and Bunn, 2004). Nonetheless, strategic decisions are also made in the public sector to reduce risk and allow cost-savings. These entail pooling or aggregating requirements, standardisation, specification setting and supplier management. Procurers may decide to pool resources to provide bigger contracts. Alternatively, they may decide to harmonize and standardize requirements. They may aggregate demand to exploit purchasing power. They may open



or restrict competition through tendering procedures. They may engage with suppliers and the supplier market through consultation or competitive dialogue<sup>8</sup>.

#### ***4.1 Different opportunities for innovation on the firm side***

Different buying strategies in the public sector will in turn influence the demand environment firms are confronted with, particularly those for whom the public sector is a significant customer. According to Storper (1997, P.108), the demand architecture “defines a collective action problem for innovators, associated with each particular type of product”. The producer needs to assess whether the market will be sufficient to justify the investment and whether the firm can master the capabilities, knowledge and skills to address that demand. Firms are therefore constrained to innovate by internal factors and by the size and quality of the demand.

Following Knight’s (1921) elaboration of the nature of risk and uncertainty, Storper (1997) distinguishes two principal dimensions of products: whether they are specialized or standardized, on the one hand, and whether they are generic or dedicated, on the other. The first dimension refers to whether the supply of inputs, e.g. the technology, information and skills, etc. necessary for production come from a ‘community of specialists’ or whether their supply is relatively easy to expand. The second dimension refers to the degree of uniformity of the client’s needs: whereas generic products correspond to undifferentiated markets, dedicated products are made for more heterogeneous markets, namely “clients whose demands have precision and personality” (Storper, 1997; p. 109).

These different types present different risk and uncertainty situations. Generic products are associated with more predictable markets that enable firms to plan their investments and allocation of resources, and therefore appeal to a larger number of potential buyers. Dedicated products are oriented towards the needs of a particular customer or type of customer, and are thus associated with greater market uncertainty. Standardisation, in turn, is associated with higher predictability of outcome, learning and scale economies arising from simplification and routinisation. However, economies of scale may be limited by greater demand for variety which is perceived as greater quality, for which customers may be willing to pay a premium price (Langlois, 2001). These ‘economies of variety’ associated with more specialised products, however, are associated with a greater need for information about customers’ requirements and technologies, and with greater uncertainty of future profits (Guerzoni, 2007).

#### ***4.2 Different types of procurement***

Public procurers can influence the degree to which demand is more dedicated or generic, and more or less standardised or specialised. Some goods and services, particularly

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<sup>8</sup> Article 29 of the EC 2004 Public Sector Procurement Directive introduced the concept of competitive dialogue, which allows better information flow in designing complex public contracts, and an opportunity for bidders to develop alternative proposals in response to a client’s outline requirements.

relatively commoditised items (such as stationery) are amenable to standardisation as they satisfy common needs/preferences of a large number of purchasing units/ end users with very little need for variety (Dimitri et al, 2006). However, in other circumstances the public sector may demand new or more complex requirements. It can impose greater quality standards and/or allow for greater variety in technical solutions by altering specifications.

Public procurers can also influence the extent to which products and services are generic or dedicated. The latter class includes those goods and services that are provided to suit characteristics or needs that are specific to the local unit. In the case of some public services, dedicated solutions may be driven by the public demanding more personalised services which are tailored to their specific needs. Different authorities, agencies or departments may seek differentiation and hence demand more tailored solutions. Heterogeneity can also be due to specific local technical characteristics (for instance the special problems of maintaining certain public buildings) or geographical variation in the provision of certain proximity-based services (e.g. waste collection). In contrast, in demanding generic solutions different public sector bodies can choose to pool or aggregate their requirements. Aggregation should allow greater leverage for contracting with suppliers, achieving greater economies of scale. As mentioned earlier, procurement can also influence the competitive environment of supplier firms through broadening or restricting participation, aggregating contracts, or alternatively dividing them into lots. Other options include seeking variants from bidders, ensuring a degree of sub-contracting, pursuing an 'integrated procurement' or partnering approach, or tendering competitively for additional requirements or extra orders, in order to attract new suppliers (OGC, 2004).

Building on Kraljic's model and Storper's product differentiation, we can formulate a fourfold typology of public procurement: procurement of standardised products serving a generic market (*efficient procurement*); addressing specific demand niches but employing known production methods and practices (*adapted procurement*); encouraging new technical solutions to meet a generic need (*technological procurement*); and adapted technical solutions (*experimental procurement*). Procurers are also able to move from one segment to another in order to reduce risks for both procurers and suppliers, maximise purchasing power, and minimise cost, through the use of procurement tools as described above. The main challenge is to understand the trade-offs involved in each category and to have a strategy for moving from one segment to another.

**Figure 2. A fourfold typology of procurement**

		Specialised production process	Standardized production process		
<b>Dedicated market</b>	<b>Experimental procurement</b> (e.g. specialised technical equipment)		<b>Adapted procurement</b> (e.g. customised software, social services)	<i>'Needs driven'</i>	
<b>Generic market</b>	<b>Technological procurement</b> (e.g. waste management, transport)		<b>Efficient procurement</b> (e.g. office supplies)	<i>'Demand pull'</i>	
		<i>Economies of variety</i>		<i>Economies of scale</i>	

Different buying situations will in turn require different types of buyer/supplier relationships. As in the private sector, these will depend on the nature of procured items and associated risks. Wag and Bunn (2004) identify four types of government/business relationships in government contract implementation, depending on the length of contracts, product complexity and uncertainty about results. In collaborative relationships both parties frequently exchange information, openly and intensely, share cooperative norms and work together to achieve contract objectives. Collaborative relationships could involve co-invention and are particularly important in the case of high product complexity and high results uncertainty, as in 'experimental procurement'. Recurrent relationships also involve repeated exchanges between buyers and sellers, although the flow of information shared and frequency of information exchange are low. Recurrent relations are important in those cases where low product complexity and low results uncertainty are coupled with lengthy contracts (that mainly characterises 'adapted' procurement). In supervisory relationships procurers believe that suppliers hold full responsibility for the success of the contract. In these cases government has a supervisory role and suppliers enjoy more freedom in choosing suitable models and techniques.

Certain contractual modes within our proposed category of 'technological' procurement that place the risk on the supplier (such as public finance initiatives) fall into this category. Finally, in arm's-length relationships, both government procurers and business sellers view the relationship as a market or transactional interaction. These are the most likely relationships in the case of low levels of product complexity and results uncertainty coupled with short contract lengths. Arm's-length contracting such as e-procurement would be adequate for 'efficient' procurement. In this case, it is important to ensure

sufficient transparency of information about contract opportunities to ensure competition and guarantee the best bidders.

### ***4.3 Opportunities for innovation***

Combining these various dimensions (standardized-specialized; generic-dedicated) yields different scenarios for action depending on whether one is a user or a producer, and different opportunities to innovate. Faced with these dimensions, Storper once more turns to Knight (1921), who identified two fundamental methods of dealing with uncertainty, risk reduction by grouping production (*consolidation*) on the one hand and risk reduction ‘by the selection of men to bear it’ (*specialisation*) on the other. In the case of dedicated products, consolidation (producing a high variety of dedicated products, generating economies of scale) requires the need to follow markets closely, a situation that Storper dubs the ‘market world’<sup>9</sup>. Producers may alternatively opt to specialize to increase the personality or quality of their products to adapt it to the particular demands to which the product is targeted. In this ‘interpersonal world’, an important role is played by user—producer interactions, and a high degree of sophistication by users, willing to pay a premium for the additional quality. For generic products, firms can opt to consolidate provided products must be generated at high scale in order to offset large irreversible investments (for Storper, the ‘industrial world’). Alternatively, it may seek to specialize, investing in the application of scientific or engineering knowledge (the ‘intellectual world’).

The types of possible innovations are also different in each combination of market/production system dimensions. These resemble Abernathy and Clark’s (1985) typology of innovation, based on variation in markets/customer linkages and changes in competences of technology or systems of production. *Architectural* innovations consist of adapting and applying latent technologies to previously unarticulated user needs and may be a common feature in ‘technological’ procurement<sup>10</sup>. *Market niche* innovations build on established technical competence but seek to apply it in emerging market segments and would be more characteristic of ‘adapted’ procurement. Successful niche creation innovation would require the matching of customer needs with refinements in technology. *Regular* innovation implies more cumulative effects on product cost and performance and builds on established technical and production competence applied to existing markets and customers. The effect of these changes is to entrench existing skills and resources. Finally, *revolutionary* (radical) innovation disrupts and renders established technical and production competence obsolete. Process and radical innovation would be likely scenarios of ‘efficient’ and ‘experimental’ procurement, respectively.

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<sup>9</sup> Storper’s (1997; p.112) use of the term world of production is meant to “convey the interlinkage of people, organisations, objects, and ideas” associated with each product.

<sup>10</sup> Abernathy and Clark provide the example of the Ford model T, which was a creative synthesis of diverse design concepts with the integration of new electrical technology and engine design. The success of the car was assisted by its durable design together with its sufficiently low cost to permit the development of a mass market.

#### *4.4 Geographical implications*

The elaboration so far would suggest that different opportunities for innovation derive from different combinations of market and production conditions associated with different products being procured. Reflecting on this we note that different government demand conditions can influence innovation in a variety of ways, and that resulting innovations take many forms (radical, incremental, architectural, product, process etc), at different stages of product technology, and not just at early stages. They can also encourage a shift from one form of innovation to another and even kick-start a process of reversal or renewal of industry development or ‘dematurity’. Clearly this influence will also be a product of the above mentioned purchasing power of the public sector.

Our product-based typology of procurement also has clear spatial implications in terms of the level/scale at which procurement and specification definition take place. Public procurement involves the interaction of multiple and overlapping networks of actors and agencies at different scales and as such is a good example of ‘multi-level governance’ (Bache and Flinders, 2004). This complex and multi-level procurement landscape creates the potential for coordination problems and tensions between policy goals at different spatial scales. The spatial pattern of public spending at different levels of governance will have an effect on where the innovation (and other) impacts of procurement are felt. In the case of regional procurement, the impact would be greater where regional authorities have *both* significant control over purchasing decisions *and* the ability to retain benefits within the region. There is a common tendency to privilege local suppliers in the hope that this will create jobs and economic benefit for the local economy. In innovation terms such favouring of local and regional contractors could be counterproductive in two ways: firstly, it can exclude innovative solutions that may be available elsewhere. A more innovative solution will bring benefits in terms of value for money, improved public services and indirect value to the region in terms of the technological upgrade of a location. Edler and Georghiou (2007) report the case of the procurement of new, advanced lightning systems for the municipality of Hamburg in Germany, where the decision to purchase these systems overseas caused strong opposition by the public but eventually resulted in significant benefits both to the public service and for the local economy. The second, and related, oversight is that leakages and spillovers, which can be more significant in terms of innovation impacts than local direct contracting, can be secured through indirect means, such as sub-contracting practices in the region, licensing, and purchasing of complementary products and services such as maintenance services.

Local procurement following local specifications could provide a fragmented market to firms, which would be particularly detrimental to innovation in those instances where new technical solutions are required for a relatively generic type of demand. This is the case of the architectural innovations mentioned above. For standard and generic products however, even if procurement is done locally but following national specifications, it should appeal to a large number of potential buyers at any given moment as standardisation allows producers to estimate fluctuations of the market and thus plan their investments and allocation of resources. But for the procurer, local procurement would imply unnecessary invoicing, bigger transaction costs for both buyer and supplier and diminishing opportunities on the part of the procurer to benefit from larger purchasing power, particularly if suppliers have a dominant position. Local/regional specifications

are needed when addressing a particular need. National procurement might be appropriate when dealing with a specialist supplier market to ensure the best suppliers bid for the contracts, although volume insurance may be needed to ensure incentives for innovation. A national strategy may however reduce diversity of research paths and increase the distance between technology leaders and followers (Cabral et al, 2006) so it should be combined with decentralised procurement that can allow better adaptation, and the ability to exploit local innovations for which there may not be information at the centre. When a large number of suppliers are available to provide the service, are not easily aggregated or require close interaction with final users, regional or local procurement for local needs would be appropriate.

Table 1 below summarises the various implications of our typology in terms of innovation, type of product, dominant user-supplier interaction, procurement practices and barriers, and the spatial organisation of procurement.

So far our concern has been on the impact of procurement of innovation. However public procurement is a multi-objective policy which also aims to further other economic and societal goals such as social inclusion, sustainability, regeneration, employment generation, support for SMEs, etc. (McCrudden, 2004). An implication of our framework is that it is unrealistic to pursue all these goals to the same extent through all procurement types. For instance the pursuit of innovation may be at odds with employment goals, and support for SMEs may be at odds with sustainability and with innovation objectives if innovation opportunities can only be achieved by large, oligopolistic firms. Efficiency goals may be at odds with allowing SMEs to access procurement contracts (Loader, 2007).

**Table 1. Summary table**

<i>Procurement type</i>	<b>Adapted procurement</b>	<b>Technological procurement</b>	<b>Experimental procurement</b>	<b>Efficient procurement</b>
<i>Role of the public sector</i>	Niche user	Large/sophisticated customer	Experimental/lead user	Cost-driven
<i>Dominant motivation of procurement /award criteria</i>	Adaptation/ customization to specific needs <i>The best/better adapted solution</i>	Fitness for use, value for money <i>The best available/ most efficient solution</i>	Functional product performance <i>The most innovative solution</i>	Price, volume <i>The cheapest solution</i>
<i>Product</i>	Diverse designs, customized	At least one product design	Emerging design, prototype, pilot	Mostly undifferentiated, standard products
<i>Innovation type</i>	Market Niche	Architectural	Radical	Regular
<i>User-producer interaction</i>	Recurrent	Supervisory	Partnership	Arm's length
<i>Contracting mode</i>	Approved consortia	Strategic partnership, PFI	Strategic partnership, second-sourcing	e-procurement
<i>Procurement practices potentially driving innovation</i>	Competition, Outcome specifications Aggregation of supply (consortia)	Dialogue with suppliers/ capacity planning/ aggregation of demand	Outcome specifications Dialogue with suppliers Prestige, transfer effects to other markets	Price/output specification Aggregation of demand
<i>Innovation-related risks on the supply side</i>	Market uncertainty Fragmented supply	Insufficient/ unreliable demand to justify investment	Market uncertainty Poor user-producer communication Insufficient incentives (e.g. IP protection)	Obsolescence. Overdependence on public markets.
<i>Procurement practices posing barriers to innovation</i>	Emphasis on cost Restricting competition	Dependency on a reduced number of powerful suppliers Incumbents advantage	Narrow specifications	Overdependency of suppliers in stagnant markets/ lack of competition
<i>Geography of procurement</i>	Regional specifications, regional procurement	centralised specifications, national procurement	Regional specifications, national procurement	Centralized specifications (standard)

## 5. Conclusions

Public procurement is increasingly seen as an attractive and feasible instrument for the implementation of innovation policy. However current debates exhibit a number of weaknesses that limit the extent to which meaningful policy guidance can be drawn. They downplay: the varied nature of public procurement and the wide range of types of goods and services procured by the public sector; the varied nature of innovation; and the multiple potential innovation effects of public procurement. They pay too much attention to a limited set of examples which are not representative of the bulk of public procurement. The innovative procurement (or public technology procurement) model proposed in the literature is unlikely to work in all procurement contexts and for all types of procured good and service yet all public procurement potentially impacts upon innovation by shaping the demand environment in which firms innovate and compete. In this paper we have proposed a framework within which to better understand the possibilities and limits of government action with regard to the promotion of innovation through public procurement, to better understand procurer-supplier dynamics in a variety of demand contexts, and to better understand the geographical implications.

Based on this framework we conclude that there are risks in elevating innovation goals (or other public policy goals) above (or even to co-equality with) the proximate goals of public procurement. Different types of public procurement and different types of public procurer are able to address different combinations of policy goals to different extents. But public purchasing should first and foremost be concerned with ensuring the quality of government services and the use of the products and services for the public sector, recognising that a focus on the core missions behind public procurement need not reduce the overall potential for positive impacts upon innovation. Whilst some special cases of public procurement can be considered as directly furthering the objectives of innovation policy (for instance through the application of functional or demanding specifications), simply co-opting public procurement into the industrial or innovation policy portfolio could be counterproductive in that it will send mixed messages to both public procurers and suppliers. Instead we should be encouraging 'innovation friendly' public procurement. Policy for public procurement should aim to put in place the necessary incentives but also the necessary skills and capacity to allow public purchasers to make strategic decisions on a case-by-case basis that will also stimulate (or at least not hamper) innovation. Structures and incentives should enable coordination and cooperation within and across government departments and levels of governance, where appropriate. They should also promote active and joined-up thinking about how best to trade-off conflicting policy goals. The governance challenges of moving towards an approach which recognises the potential importance of indirect innovation impacts are significant. Even more profound are the challenges to policy learning and evaluation stemming from the need to monitor, assess and attribute innovation impacts to public action.



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