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INNOVATION-PROMOTING IMPACTS OF PUBLIC PROCUREMENT

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Innovation-promoting impacts of public procurement

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Abstract:
The use of public procurement to advance innovation but also other social, environmental and public service delivery goals has been high in the innovation policy debate in the last two decades. Drawing from the literature on the economics of innovation and innovation policy, this paper provides an overview and critique of the key debates surrounding public procurement of innovation, specifically the rationales, means and challenges associated with its use as an innovation policy tool. We note that despite strong academic interest and policy activity in this area, strategic public procurement to promote innovation is still unevenly adopted. The evidence base is also weak in terms of the methods and data to understand its impact. We argue more research is needed to quantify the outcomes of procurement interventions in different national and sectoral contexts and their integration with other innovation policy instruments.

Keywords: public procurement, innovation, regulation, public policy, evaluation

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1. Introduction

Procurement rules in market economies are long-standing. They have safeguarded public interest in the awarding of contracts by public authorities and developed instruments to facilitate international trade by opening access to public tenders. Legal frameworks focus on correct tendering procedures, open competition, fair award criteria, transparency and non-discrimination in supplier selection. Authorities are required to enforce the rules and ensure that non-compliance can be challenged and infringers punished. Historically the lowest price has been the dominating criteria on which contracts have been awarded. Mandatory award procedures have focused on this aspect. However, political leaders have been directing more attention to other aspects of value that can be delivered through the award of a public contract. For instance, regions and cities awarding large contracts have been keen to maximise the social value delivered in communities where investment is made. Addressing the climate emergency also demands that environmental impact criteria be included in most procurement contracts. Legislators have been challenged by these new approaches and havedeveloped legal frameworks to enable multiple performance criteria to be considered, alongside price, in the award of a contract. In the EU, the 2014 reforms introduced the concept of "Most economically advantageous tender", a clear political signal that non-price factors could be included in all tenders.

Harnessing innovation to solve pressing policy and societal challenges has become a key strategic goal of public procurement. While the interest in how public demand drives the development and diffusion of strategic technologies is not new, there has been a renewal of interest in public procurement and innovation, particularly since the first decade of the 21st century. In 2005, the European Council commissioned an expert group (Aho et al., 2006), to advise on measures to boost the EU's innovation performance. Included in their report (Creating an Innovative Europe) was a call to "exploit new opportunities for public procurement to drive innovation". This was integrated into the 2006 Lisbon Strategy and has been strategically developed through subsequent EU policy, funding and legislation. Innovation procurement has also been deployed in a number of countries worldwide, including the USA, Canada, Australia, South Korea and Brazil.

Against this backdrop, innovation scholars have, in the last decades, produced an extensive body of academic work exploring the influence of public procurement on innovation conceptually and empirically (see Kundu et al., 2020). This literature has sought to understand the impact of public procurement on innovation, as well as to explore the rationales, means and challenges associated with its use as an innovation policy tool (Edler & Georghiou, 2007; Edquist & Zabala-Iturriagagoitia, 2020; Georghiou et al., 2014; Hommen & Rolfstam, 2009; Rolfstam, 2013; Uyarra et al., 2014; Uyarra & Flanagan, 2010).

In this chapter, we aim to provide an overview and critique of the key debates surrounding public procurement of innovation (PPI). The chapter is structured as follows: it first discusses how the academic debate has evolved, often alongside legislative changes towards harnessing public procurement of innovation. Drawing from the literature on the economics of innovation, it then introduces the various ways in which public procurement has been considered to influence innovation. The following sections aim to shed some clarity on the PPI literature in terms of the types of interventions and definitions. The chapter then reviews the empirical studies on the implementation and impact of PPI, describing its main findings and shortcomings. The final section concludes with some recommendations and ways forward for research.

2. Evolving conceptual and policy interest in innovative public procurement

2.1. Changing approaches within innovation studies

Innovation scholars have long discussed the influence of public procurement on technological innovation, building up from discussions on the role of public interventions in the form of industrial policy during the 1970s and 1980s in different parts of the world (Pavitt and Walker, 1976; Siaroff and Lee, 1997). Authors such as Geroski (1990) and Mowery and Rosenberg (1979) documented the market-shaping influence of government procurement and its role in the emergence of general-purpose and strategic technologies (see also Mazzucato, 2013). Geroski (1990), for instance, describes the role of the government as a first-mover in the development and diffusion of the computer, civilian aircraft, and semiconductor industries in the US, describing how demand by the US government for large-scale computing machines brought into being what eventually became a hugely successful commercial market. Eliasson (2010) attributes Ericsson's

successful entry into the international mobile market in the 1990s to the company's involvement in the government's efforts to build the 4th generation fighter jet technology in the 1980s.

Interest in the role of procurement to stimulate technological development and innovation received a renewed impulse in the 00s. Public technology procurement (Edquist et al., 2000) was advocated as a means to support socially desired technologies, strategic industries or the direct technology needs of the government. Coinciding with a process of 'broadening' and 'deepening' innovation policy in the last decade (Borrás, 2009), PPI started to be considered a general policy aimed at embedding innovation in public purchasing decisions, strategies and guidelines (Lember et al., 2014). As the debate moved from industrial and technology policy to innovation policy broadly understood, public procurement was presented as a horizontal and generic policy instrument, part of a battery of tools to deliver more innovations, rather than a strategic intervention targeting sectors or technologies of strategic importance. In the last decade, and in the context of a 'normative turn' in innovation policy (Mazzucato, 2018; McCann & Ortega-Argilés, 2013; Schot & Steinmueller, 2018; Weber & Rohracher, 2012), scholars have again stressed the importance of targeted policies to articulate societal needs on the demand side (Boon & Edler, 2018), highlighting the need for greater selectivity (targeting areas and technologies where the public sector can shape markets) and directionality (in terms of specific societal goals) in policy (Uyarra et al., 2019, 2020). Procurement has been suggested as a suitable instrument to both address societal challenges or missions and drive industrial transformation, particularly at the regional level, where legitimacy and consensus over priorities are more likely to be achieved (Bugge et al., 2021; Uyarra & Flanagan, 2021; McCann & Ortega-Argilés, 2022).

Scholarly work on public procurement and innovation has therefore shifted its focus and emphasis over time as our understanding of innovation and innovation policy has changed. This has been accompanied by multiple terminologies, including public technology procurement, 'public procurement of innovation', 'innovation-oriented public procurement', or 'pre-commercial procurement' (see table 1 below and discussion in section 4). These terms embrace all types of procurement activities, like pre-commercial procurement or even purchasing that may not deliberately or explicitly seek innovation but simply lead to innovation as a by-product. Uyarra (2016) defines PPI as a continuum of interventions, with pre-commercial procurement at

one end of the spectrum, followed by active attempts to stimulate innovation and then the use of 'innovation friendly' procurement at the other end.

Table 1: Terms and definitions of PPI in research

Term	Definition
public technology procurement	"Public technology procurement occurs when a public agency places an order for a product or system which does not exist at present, but which could (probably) be developed within a reasonable period through additional or new technological development work, carried out in order to satisfy the demands of the buyer" (Edquist & Hommen, 1999)
public procurement of innovation	"purchasing activities carried out by public agencies that lead to innovation" (Rolfstam, 2012)
public procurement for innovation	"a demand-side innovation policy instrument in the form of an order, placed by a public organisation, for a new or improved product to fulfil its particular needs" (Edquist et al., 2015)
innovation-friendly procurement	"Practices and competencies that ensure that innovative solutions are not excluded or disadvantaged, mainstreamed into all public procurement practices" (Uyarra et al., 2020)
innovation-oriented public procurement	"Public procurement can contribute to innovation not only through fostering the development of new or improved products but also via creating innovation-conducive environments that stimulate learning as well as the emergence and uptake of new organisational and technological capabilities" (Lember et al., 2014)
strategic procurement	"Strategic procurement occurs when the demand for certain technologies, products or services is encouraged in order to stimulate the market" (Edler & Georghiou, 2007)
green public procurement	"a process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works with the same primary function that would otherwise be procured" (EU Commission, 2016)
pre-commercial procurement (PCP)	"Government procurement of R&D services that seek to stimulate innovation" (Rigby, 2013)
	The use of procurement "as a tool to buy (i.e., support) industrial R&D, to meet social demand and raise R&D spending" (Uyarra et al., 2020)
	"… the policy interventions to guarantee the initial demand when the product development has not reached the commercialisation stage yet" (Shin et al., 2020)

Interest in public procurement, and demand-side innovation policies in general, has also been motivated by a perceived underperformance of supply-side innovation policy tools like R&D subsidies, research funding and tax incentives as well as a renewed interest in the role of the public sector as an innovator (Edler & Uyarra, 2013; Flanagan et al., 2011). Demand side innovation policies are understood as a "set of public measures to increase the demand for innovations, to improve the conditions for the update of innovations and/or to improve the articulation of demand in order to spur innovation and the diffusion of innovation" (Edler, 2010, p.177). Besides public procurement of innovation, they include the use of standards and regulations, lead markets and user-/consumer-driven innovation initiatives.

Entrepreneurship scholars have also pointed out that the majority of programmes of direct and indirect assistance to SMEs and entrepreneurs have been largely supply-driven (Edler & Georghiou, 2007; Preuss, 2011; Tendler & Amorim, 1996). Yet, any discussion of entrepreneurship and SME policy nowadays is considered incomplete without a consideration of demand-driven elements, in particular, initiatives that aim to foster entrepreneurship and SME growth through government procurement (Loader, 2007; Preuss, 2011; Smallbone et al., 2008; Walker & Preuss, 2008). It has also been argued that SME participation in public procurement can lead to a better quality of services since SMEs can be more flexible and responsive to changing requirements, particularly small specialist suppliers of products or services in new or underdeveloped markets (HM Treasury, 2008). Although examples of procurement-induced entrepreneurship exist, they constitute a largely overlooked element in the range of public policy initiatives aimed at encouraging entrepreneurship and SME growth (Edler & Georghiou, 2007). These initiatives are mainly unstructured, sectorally driven and take place at the regional and local levels with a strong place-based component (Audretsch, 2004; Davidsson & Wiklund, 2007; Parker, 2008).

2.2. Evolving legal and political frameworks to boost innovation procurement

This scholarly interest has been accompanied by policy and legislative activity, buttressed by financial support, towards the strategic use of public procurement to support innovation and other public policy goals. The Small Business Innovation Research (SBIR) programme, launched by the US Department of Defence (DOD) in 1982, has had a powerful influence on global enthusiasm for integrating procurement into innovation policy. US policymakers had clear

ambitions for SBIR: *"SBIR programs were created expressly to harness the innovativeness of U.S. small business—both to help the federal government meet high-priority technology needs as well as to benefit the national economy. The enabling legislation was based on the conviction that technological innovation creates jobs and increases productivity, competitiveness, and economic growth"* (DoD, 2019, p. 5).

The US example had strong traction in an EU that was developing policies to raise its global competitiveness. The growing investment in digital technology research by the European Commission was a key driver for the adoption of public procurement as an EU policy instrument. Commission experts considered that the EU should be exploiting innovative public procurement and deploying its own version of SBIR. They defined the EU version as "pre-commercial procurement". It enabled the prospective customer to work with a range of innovators through a staged development of new solutions to fulfil the unmet needs of public buyers. It had the clear potential for boosting innovation, but prospective public buyers were reluctant to participate without assurances about its compatibility with EU law. The Commission Communication 2007/0799 confirmed that pre-commercial procurement was fully compatible with the prevailing EU legislation, as it was deemed to be the procurement of research and development services.

In the European Union, a common rulebook for public procurement has been in place since the launch of the common market in the 1950s. The prime political objective was to ensure that public contracts could be open to any qualified supplier from within the member states. As the EU evolved and enlarged, procurement directives have expanded in scope and complexity to embrace a range of tendering procedures that reflect the need to embrace non-price factors. They have also incorporated provisions to facilitate digital technologies and a more diverse range of suppliers, particularly small enterprises. The updates of EU directives in 2004 and 2014 clearly reflect these new demands. In recital 2 of the Directive 2014/24/EU, these ambitions are clearly stated by noting that the rules "*should be revised and modernised in order to increase the efficiency of public spending, facilitating in particular the participation of small and medium-sized enterprises (SMEs) in public procurement, and to enable procurers to make better use of public procurement in support of common societal goals*".

The Directive included specific measures to facilitate public procurement of innovation. This political intent was set out in Recital 47 of the Directive. Pre-commercial procurement (PCP)

was recognised as a model for procuring research and development services outside the scope of the new Directive. A new procedure – the innovation partnership procurement (IPP) – was the flagship for this new approach. IPP was designed to overcome the limited scope of the PCP process by allowing a contracting authority to award a contract that would progress reaerch, development, validation and scaling up of an innovative product or service through an integrated supply contract.

However, IPP has not been widely used (Cerqueira Gomes, 2021). Uptake has been affected by concerns over state aid issues that might arise by favouring a single supplier. To avoid infringing unfair competition rules, commissioning authorities have found it challenging to confirm that their needs can only be met by a unique innovation not already marketed by any other organization. There has also been significant risk aversion among decision makers to the deployment of a new and untested legal regime.

Alongside a favourable legislative regime, the EU has invested in a wide range of non-legislative initiatives promoting the adoption of innovation procurement procedures and providing financial support for innovative procurements. Direct funding has been targeted at pre-commercial procurements involving innovative small enterprises. There has been a long-standing programme focused on digital SMEs. Innovation Procurement has now become a mainstream part of the Horizon Europe Research and Innovation Programme, with €266 million in funding support for pre-commercial procurements (PCPs) and public procurements of innovative solutions (PPIs). A Challenge[1], launched in 2021, has awarded prizes that recognises procurers delivering high-impact innovative solutions through close buyer-supplier cooperation.

There have also been significant investments in best practice sharing and capacity building. The Innovation Procurement Platform[2], supports a network of best practise and competence centres across the European Union[3] with detailed guidelines and case studies showing how the full range of procedures could be used to encourage innovation (European Commission, 2021). EU cities

[1] https://eic.ec.europa.eu/eic-funding-opportunities/eic-prizes/european-innovation-procurement-awards_en
[2] https://innovation-procurement.org/
[3] https://procure2innovate.eu/home/

and regions have organised best practice sharing networks, with some progressing into shared supply contracts.

3. The influence of public procurement on innovation

Public procurement often has multiple policy objectives besides innovation, and procurement policy is a complex combination of regulations, organisational, and institutional characteristics. 'PPI' may not be a single instrument but a series of sub-tasks, mechanisms, and a combination of strategies (Uyarra, 2016). It is, therefore, important to understand the mechanisms through which public procurement influences innovation. A body of literature has sought to unpack how and when this impact occurs. Cabral et al. (2006), for instance, discuss multiple routes through which procurement influences innovation, namely by enlarging the market for new goods (demand-pull); facilitating *diffusion* through the adoption of new standards; and changing the *market structure* to make it more conducive to innovation (dynamic effects). Similarly, Rothwell and Zegveld (1981) suggest that procurement influences innovation by improving the quality of goods used in the public sector, the quality of goods used in the private sector through spillover effects, and/or the international competitiveness of the industry. We detail these effects below.

3.1. Demand-pull effects

The interest in the impact of public procurement on innovation has been justified by the large size of public sector demand and the potential of the public sector as a lead user of emerging technologies. OECD countries spend on average 12% of GDP on public procurement of goods, services and works. Government procurement is particularly important for R&D-intensive industries and emerging technologies facing significant market and technological uncertainty, since it can guarantee a return on investment for developing new goods and provide a testing ground for new technologies.

Besides the size of demand, the structure of the market also shapes the demand-pull effect of public procurement on the buyer and supplier sides. For instance, sectors such as energy, transport and telecommunications have tended to constitute 'natural monopolies', closely regulated and managed by public agencies. Public technology procurement has played an essential role in the past (Edquist & Hommen, 2000). In some markets, the government acts as a

monopsonist or dominant oligopsonist, representing either the total or a large fraction of total demand, while in other markets it is one of many buyers. Rothwell and Zegveld (1981) thus argue that the influence of the government's market power should not be overestimated since, even if public demand is significant in a particular sector, demand is often fragmented and scattered across many small buying organisations. Therefore, the scale of public demand is only relevant if it can be made effective through the exercise of buyer power consolidation of demand and coordinated action. The advantages of a strong buying power will also depend on the technology life cycle: While strong public demand can act early on as a catalyst for innovative activity, in later or mature stages it may encourage rigid, routine and non-innovative relations between buyers and suppliers, reducing incentives and market opportunities to innovate (Edquist and Hommen, 2000).

Demand-pull effects may be *direct* or *indirect*. Rothwell and Zegveld (1981) thus differentiate between "buying the best that industry has to offer" and "improving the offering that industry has to make". By using specifications and signalling needs and standards, the public sector can raise the recognition of particular qualities or technologies and influence not only the *rate* but also the type or *direction* of innovation that may be pursued (Mazzucato, 2018). Too narrow specifications in terms of what is required will inevitably stifle creativity and innovation, while specifications phrased in terms of outcomes or performance give the industry more scope to propose innovative solutions that meet those needs (Rothwell & Zegveld, 1981; Geroski, 1990). Based on this, Edquist and Zabala-Iturriagagoitia (2020, p. 597) suggest the use of 'functional procurement', namely the situation where the "procuring organisation specifies what is to be achieved rather than how". Early interaction with the marketplace to signal and communicate these needs is also crucial to better capture innovation. Conversely, a lack of consensus and consistency in terms of needs and priorities or constant policy changes may lead to greater uncertainty and reduce the likelihood of innovation (Rothwell & Zegveld, 1981; Uyarra & Flanagan, 2010). This requires a public sector that can act as an 'intelligent' or 'demanding' client or customer, able to reward and stimulate technologically competent suppliers and one which has sufficient commercial and technical skills to engage with the marketplace and make informed decisions as to the best possible solution to be purchased. Demand-pull innovation procurement also includes the ability to receive and take on board unsolicited ideas from suppliers and to recognise suppliers' past innovative performance. However, as we will discuss

later on in this chapter, skills and capacity constraints in the public sector are often key barriers to procuring innovation (Uyarra et al., 2014).

3.2. Innovation diffusion

Much of the interest in the innovation effects of public procurement relates to the act of purchasing innovative goods and services, neglecting more dynamic or long-term effects on accelerating the general adoption and market diffusion of new technologies (Mowery, 2012; Uyarra & Flanagan, 2010). By buying a new product or service, the government can help demonstrate its benefit to potential users (Dalpé et al., 1992). The public sector's early use of certain technologies or standards may be justified based on, among others, economic and societal goals such as sustainability or social inclusion (Edler & Georghiou, 2007; McCrudden, 2004). Suppliers to the public sector may gain reputational or learning effects they can transfer to, e.g., other public, private or export markets.

Connected to the idea of the government as the 'lead user' of innovations, public procurement can contribute to the emergence of so-called "lead markets", understood as "regional markets with specific attributes that increase the probability that a locally preferred innovation design becomes internationally successful as well" (Beise & Cleff, 2004, p. 455). For suppliers, the advantage of lead markets is that their innovations, if successful, have a higher potential to be adopted worldwide. This transfer effect is particularly important when suppliers serve both public and private markets. However, a lack of spillovers between the public and private sectors would reduce procurement's potential catalytic effect on innovation (Uyarra et al., 2014). For instance, suppliers often specialise in public supply contracts and even the same client due to buyers maintaining the same suppliers over long periods, reducing the potential for spillover or transfer effects to private markets (Edquist & Hommen, 2000).

The diffusion effect of public procurement is also linked to the creation of standards or the convergence to a single standard (Cabral et al., 2006). Edquist and Hommen (2000), for instance, link the development of mobile telephony in the Nordic countries to the relatively early support for the creation of technical standards, as compared to other countries and regions. Many innovative goods and services exhibit network effects, the self-reinforcing effects of which may lead to inefficient lock-in to a suboptimal standard or to 'excess inertia', whereby users fail to

switch from an old to new and better technology. Even in regular procurement, standards may need to be observed, and standards may be used to define the technical specifications of a new product or system. The public sector may align public procurement activities with *de jure* standards, but it will often influence *de facto* standards because of its status as a large user. If the market weight of the public sector is substantial, its purchasing decisions may have a crucial influence in terms of the establishment of a particular standard. This de facto standard-setting role implies that the public sector should be careful to anticipate user needs (and international demand) and steer the process towards the 'right' standards (Edquist & Hommen, 2000).

3.3. Market structure and competition

Procurement can indirectly influence innovation by altering the structure of competition in the market in the short and medium-term. By influencing the size of contracts and the number and type of participants in tenders, buying decisions can shape the market structure and, thus, the incentives for investment and innovation. Excessive industrial concentration and vertical integration will influence not just the innovation capacity and competitiveness of the industry but also its ability to deliver goods that the public sector needs (Geroski, 1990).

In innovation studies, it is often suggested that there is an inverted U-shape relationship between competition and innovation, whereby either too much or too little competition negatively affects innovation. While the expectation of quasi-monopoly profits provides incentives to invest in innovation and R&D, it may, in the long term, strengthen the dominance of large incumbent suppliers and lead other firms, particularly SMEs, to exit the market (Cabral et al., 2006). This will, in turn, have an effect on reducing diversity in the marketplace and greater complacency of incumbents, who no longer have an incentive to innovate. Contracting authorities may become locked into a relationship, leading to the development of inferior products and services. Conversely, broader participation may enhance competition and technology variety but can also lead to lower economies of scale in R&D and production and duplication of costs (Timmermans & Zabala-Iturriagagoitia, 2013). Several mechanisms have been suggested to address this trade-off, for instance, the use of 'package bidding' or 'coordinating unbundling', allowing small firms to participate in smaller lots while at the same time allowing large firms to exploit economies of scale (Cabral et al., 2006; Timmermans & Zabala-Iturriagagoitia, 2013). Dual sourcing or set-

asides (whereby a proportion of contracts are reserved for small or minority-owned companies) are additional means of preserving supplier diversity.

Besides contract size, other tender conditions may reduce competition, including excessive complexity, high entry cost, or a perceived lack of a level playing field. Therefore, strategies to support SME participation include improving the provision of information, simplifying procedures, offering pre-tender communication and networking with SMEs, improving public sector procurement capability and encouraging good practice sharing between prime and subcontractors (GHK, 2010; HM Treasury, 2008). Loader (2013) found that despite efforts by the UK government to ensure that small firms are awarded a share of public sector contracts, persistent barriers to SME contracting exist. Walker and Preuss (2008) identified two types of barriers for small suppliers to the UK local government and NHS, namely their lack of a track record the tendency to aggregate spending to achieve greater economies of scale (Edler et al., 2015).

To sum up the above discussion, there are numerous routes through which public procurement may influence innovation and, to a certain extent, entrepreneurship. While the literature has been mainly interested in deliberate and direct attempts to drive innovation through public procurement, it is important to remember that public procurement will always have an influence on innovation through its decisions in relation to prices, quantities, standards, conditions for participation, market engagement and other choices such as the management of risk and intellectual property rights (Dalpe, 1994; Uyarra & Flanagan, 2010). For procurement to effectively support innovation, scholars such as Geroski (1990) and Georghiou and co-authors (Georghiou et al., 2014) suggest steps such as a clear definition of needs towards which innovative efforts can be directed, the provision of an assured market for new product and processes early in product life-cycles, and anticipating latent market needs.

In the following sections, we focus mainly on how such procurement policy efforts have been understood, evaluated and implemented.

4. Public procurement of innovation: typologies, definitions and impact

There exist a large number of studies trying to define, categorise and assess the implementation of PPI. While there is a consensus on what constitutes public procurement (the purchasing activities of public authorities), 'innovation procurement' as a policy is much harder to define.

Firstly, it is challenging to define innovation. An important point of reference for this is the Oslo Manual, which in 1992 proposed to define innovation as new or significantly improved products or processes. Subsequent editions of the Oslo Manual have updated this definition to provide more comprehensive coverage of industries and economic sectors. For example, the 3rd edition of the Oslo Manual defines innovation as *"the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations"* (OECD & Statistical Office of the European Communities, 2005, p. 46). The 2018 edition focusses on novelty and defines innovation as *"a new or improved product or process (or a combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process)"* (OECD & Statistical Office of the European Communities, 2018, p. 20). Difficulties in defining innovation in the context of public procurement, for instance, arise from the fact that this definition is focused on the introduction of novel products into the private rather than the public marketplace and also on innovations that are introduced by firms, potentially excluding innovations that are introduced by public authorities themselves (Appelt & Galindo-Rueda, 2016).

Furthermore, it is not easy to define the strategic use of public procurement for innovation purposes precisely. For instance Obwegeser & Müller(2018) conducted a review of the literature on innovation in public procurement and observed three interpretations of the use of public purchasing to influence innovation, namely procurement *of* innovation (i.e. innovative public procurement to modernize public services), procurement *for* innovation (e.g. public procurement as an innovation policy tool), and innovative public procurement (i.e. innovation of public procurement processes). Given these differences in interpretation, they concluded that there is a

need to better integrate existing conceptualisations to ensure greater conceptual clarity and comparability.

4.1. Types of PPI

While earlier terms like "public technology procurement" sought to distinguish the procurement of innovation from "regular" procurement of ready-made products ("off-the-shelf") available in the market (Edquist & Hommen, 2000), the growth in academic literature has been marked by more sophisticated typologies, distinguishing the procurement activity and the nature of innovation along various dimensions such as what is being procured, why, for whom, how and for which purpose. Such typologies are often structured to guide the identification of appropriate policy actions based on the characteristics of the demand-side, supply-side, or the solution being procured.

For instance, PPI can be classified by *intent*. Edler (2013) differentiates between procurement that includes innovation as an additional criterion in tenders (general procurement) and procurement for which innovation is an explicit goal (strategic). Public procurement can also be distinguished based on the *end user*, namely whether the goods or services are exclusively for public use (direct procurement) or private use (catalytic procurement) (Edler & Georghiou, 2007). In relation to the degree of *novelty* of the innovation, Edquist and Hommen (2000) also differentiated between 'developmental' and 'adaptive' public technology procurement. A distinction is also made between procurement of solutions that do not exist (triggering demand) and procurement of a good or service that exists in the marketplace but is new for the organisation (responsive demand) (Edler & Uyarra, 2013).

Along similar lines, but focused on the demand and knowledge characteristics of the *products and services* procured, Uyarra and Flanagan (2010) differentiated between four types of procurement, namely procurement of standardized products serving a generic market (*efficient procurement*); procurement addressing specific demand niches with known production methods and practices (*adapted procurement*); procurement encouraging new technical solutions to meet a generic need (*technological procurement*); and procurement of adapted technical solutions (e.g. of specialised technical equiptment) (*experimental procurement*). The type of, and opportunities for innovation, the type of buyer-supplier relationships and the importance of geographical proximity would vary across the different types. Other proposed typologies focus on the *market*

formation (Hommen and Rolfstam, 2009; Bleda and Chicot, 2020). Bleda and Chicot (2020), for instance take an evolutionary view of markets and differentiate procurement that occurs at the origination stage (when a new idea or invention becomes functional) to the adoption stage or at a retention stage (when the new knowledge or innovation becomes institutionalized through repeated use).

More recently, typologies have been suggested in the context of mission or challenge-oriented innovation policies (Boon & Edler, 2018; Uyarra et al., 2020). Uyarra et al. (2020) differentiate between the nature of the problem being addressed (whether demand is poorly or clearly articulated) and the nature of the solution (whether knowledge of potential solutions is known or is contested). The different combinations represent varied scenarios, each of which is associated with different goals and, therefore, different types of PPI approaches. For example, when a clear demand exists but the solution is unknown or contested, public authorities can use public procurement *to lead* the market towards the most effective and innovative solutions. In contrast, when demand is poorly articulated or fragmented, but there is consensus about the solution, the government must act as a catalyst *to create* the market in coordination with other actors. Focusing on the nature of the problem and the nature of innovation, Boon and Edler (2018) also expand the discussion from the simple use of public procurement as a demand-side instrument to a more complex role of the state in articulating demand and developing a solution.

Other typologies have sought to situate procurement within broader policy frameworks and policy goals. For instance, Lember et al. (2014) propose four categories, namely innovation-oriented public procurement as *technology or industrial policy*, which covers categories like 'catalytic procurement' where procurement is used to support specific technologies or industries (for instance, the market transformation program in Sweden (see Neij, 2001)); innovation-oriented public procurement as *R&D policy*, covering the use of the instruments like pre-commercial procurement; *generic* innovation-oriented public procurement, which seeks to foster cultural change and new institutional practices in public procurement to promote innovation, including provisions to make procurement more innovation-friendly such as regulations, training, communication platforms, etc.; and *'no policy' policy*, wherein innovation is not an explicit aim but an unexpected by-product of greater competition and efficiency in public procurement (see also Shin et al. (2020) for a similar approach).

Table 2: Policy measures in support of innovation public procurement

Policy category	Deficiencies addressed	Instrument types	Examples
Framework conditions	i) Procurement regulations driven by competition logic at the expense of innovation logic. ii) Requirements for public tenders unfavourable to SMEs	i) Introduction of innovation-friendly regulations ii) Simplification & easier access for tender procedures	i) 2005 change in EU Directives including functional specifications, negotiated procedure etc. ii) 2011 proposal in EU to introduce innovation partnerships iii) Paperless procedures, electronic portals, targets for SME share
Organisation & capabilities	i) Lack of awareness of innovation potential or innovation strategy in organisation ii) Procurers lack skills in innovation-friendly procedures	i) High level strategies to embed innovation procurement ii) Training schemes, guidelines, good practice networks iii) Subsidy for additional costs of innovation procurement	i) UK ministries Innovation Procurement Plans 2009–10 ii) Netherlands PIANOo support network, EC Lead Market Initiative networks of contracting authorities iii) Finnish agency TEKES meeting 75% of costs in planning stage
Identification, specification & signalling of needs	i) Lack of communication between end users, commissioning & procurement function ii) Lack of knowledge & organised discourse about wider possibilities of supplier's innovation potential	i) Pre-commercial procurement of R&D to develop & demonstrate solutions ii) Innovation platforms to bring suppliers & users together; Foresight & market study processes; Use of standards & certification of innovations	i) SBIR (USA, NL & Australia), SBRI (UK), PCP EC & Flanders ii) Innovation Partnerships & Lead Market Initiative (EC), Innovation Platforms (UK, Flanders); Equipment catalogues (China to 2011)
Incentivising innovative solutions	i) Risk of lack of take up of suppliers innovations ii) Risk aversion by procurers	i) Calls for tender requiring innovation; Guaranteed purchase or certification of innovation; Guaranteed price/tariff or price premium for innovation ii) Insurance guarantees	i) German law enabling innovation demands in tenders; UK Forward Commitment Procurement; China innovation catalogues (to 2011); Renewable energy premium tariffs (DE and DK) ii) Immunity & certification scheme (Korea)

Source: Georghiou et al. (2014)

Georghiou et al. (2014) adopt a policy framework to understand the sequence of decisions and interventions during the procurement cycle to identify which functions they seek to support and which deficiencies they seek to remedy (see table 2). They differentiate between four categories. The first refers to *framework conditions* for procurement, including the introduction of innovation-friendly regulations and simplified and easier access to tender procedures. The second category refers to measures addressed at improving *organisational arrangements and capabilities* for innovation procurement, such as training schemes, guidelines, good practice networks, and subsidies for conducting innovation procurement. The third category comprises mechanisms intended to improve the identification, specification and *signalling of needs*, such as pre-commercial procurement of R&D, standards, innovation platforms to bring together suppliers and users, and other means to anticipate needs and articulate demand such as foresight exercises. The fourth and final category is *incentivising* innovative solutions, including calls for tender requiring innovation, guaranteed purchase (such as forward commitment procurement) or insurance guarantees.

It thus appears that we have many types of PPI and competing taxonomies, which can perhaps explain some of the challenges in identifying the implementation of PPI policies in empirical contexts. To this issue, we now turn.

4.2. Empirical evidence regarding PPI

The ambiguity of innovation and PPI concepts described above creates some challenges when trying to measure the innovation impacts of public procurement activities. Empirical research in relation to the impact of PPI has traditionally been limited, making evidence-based policymaking in this area difficult (OECD, 2011; Uyarra, 2016).

A growing area of research tries to quantify the incidence and impact of public procurement, mainly through the use of administrative procurement data and surveys such as the Innovation Survey, the Eurobarometer or dedicated supplier surveys (for a review, see Appelt & Galindo-Rueda, 2016). In Europe, the Community Innovation Survey (CIS) 2012 and 2014 included a

specific question on the role of public procurement[4], which asked firms whether they were involved in public contracts and whether such contracts required innovation. According to Appelt and Galindo-Rueda (2016), the question provided a "simple mechanism for firms to identify and self-report" on the link between procurement and innovation. These surveys enabled the identification of innovative firms that engage in public contracts that require innovation and how that relates to different types of innovation (product or process, radical or incremental) and R&D spending (see Ghisetti, 2017; Radicic, 2019).

Most studies find that firm participation in public contracts that required innovation had a positive impact on innovation and R&D spending and generally a stronger one when compared with other financial support programmes (Guerzoni & Raiteri, 2015; Caravella & Crespi, 2020a). Studies such as Radicic (2019) in the US also found that public procurement has a greater impact on product innovation compared to public financial support. Stojcic et al. (2020) analysed firms of eight catching-up countries of Central and Eastern European. They found that PPI has a positive effect on product and process innovation and a larger impact on innovative sales compared with financial support programmes. When public procurement is combined with other innovation policy instruments, the results continue to be positive. For instance, Guerzoni & Raiteri (2015) found that public procurement not only tends to be more effective than R&D subsidies but also, the strongest effects occur when the two policies interact.

Other studies use government expenditure data to analyse the impact on firm-level R&D, patenting and productivity. For example, Slavtchev and Wiederhold (2016), using data on federal procurement in the US found that a $1 shift in government spending from low-technology to high-technology products leads to an increase of $0.21 (on average) in private levels of R&D spending. Raiteri (2018) looked at citations of US patents which emerged from public procurement and observed that public procurement is associated with more general-purpose technology patents. Orsatti et al. (2020) test the effect of 'green' public procurement (GPP), or environment-friendly public expenditure in the generation of green patents, finding that GPP

[4] The Community Innovation Survey (CIS) is a large-scale business and innovation survey conducted by different countries annually or biennially. The European Commission's Eurobarometer service provides additional innovation surveys through its Innobarometer series and Flash surveys, for instance the Flash Eurobarometer survey on 'The role of public support in commercialising innovations' conducted in 2014.

plays a positive and significant role in increasing innovation capacity and particularly favours the creation of climate change 'mitigation' technologies (as compared to climate change 'adaption' technologies). There are relatively fewer studies on the effects of public procurement on firm productivity, however, Shin and Lee (2021) have found that companies participating in PPI in Korea experienced higher productivity gains compared to companies participating in regular public purchasing.

Researchers have also used publicly available datasets (such as Tenders Electronic Daily or TED[5]) which store information like tender notices or contract award notices to understand the 'innovativeness' of public procurement and characterise public demand. Tender documents provide information like what the public authority wishes to procure, through what procedure, and the selection criteria. There have been attempts to identify PPI from tender data and quantify the share of PPI in all procurement activities by studying the descriptions of tender notices. For instance, a study for the European Commission (PwC, 2015) identified PPI contracts by searching for terms like 'prototype', 'pilot', 'innovative solution', 'fully automated', 'competitive dialogue', 'research and development', 'intellectual property rights', or 'new technologies'. A more recent study (PwC, 2021) classified contract notices as PPI if they expressed interest in the uptake of innovative technology, a task that was achieved by machine learning, i.e., training an algorithm to recognise a vocabulary of innovation concepts. The study found that European countries spend only 10% of their total public procurement expenditure (including defence procurement) on the purchase of innovative solutions. Finland, Norway, Netherlands, and Switzerland are considered 'strong performers' with respect to PPI investments as a share of public procurement expenditure.

Tender and contracting data provide insights into procurement practices and the implementation of regulations. Yu et al. (2020) used data on contract award notices from 2018 TED data to understand the uptake of 'green' award criteria, correlating it with other characteristics of procurement, like procurement procedures, contract value, and the economic sector. The study finds construction, transport, and food procurement to have a higher share of green contracts, and

[5] TED is a supplement to the Official Journal of the EU, dedicated to European public procurement, and publishes Contract Notices providing information on calls for tenders and Contract Award Notices containing information on winning bids, as well as other types of public procurement related documents and information.

competitive dialogue as the procedure most strongly related to green procurement.
Grandia and Kruyen (2020) used TED data for Belgium between 2011 and 2016 and observed a greater incidence of sustainable public procurement (SPP) (70% of notices) than what was previously assumed from interviews and other sources of data. Linking TED and the German Community Innovation Survey, Krieger and Zipperer (2022) found that winning such green contracts increases the probability of introducing new and more environmentally friendly products by 20 percentage points on average.

Besides quantitative studies assessing the innovation impacts of public procurement, a number of case studies have also found positive impacts on both buyers (contracting authorities) and suppliers emerging from the procurement of innovation. For example, innovative solutions help public authorities provide better public services with reduced life-cycle costs (see Yeow et al., 2015 for a case study on procurement of a confidential waste management solution in the UK). PPI approaches also allow firms to better understand user requirements and co-create solutions with the public sector (Winden and Carvalho, 2019 in the Netherlands; Mwesiumo et al., 2019 in Norway). At the same time, case studies also provide information on organisational and institutional barriers to the procurement of innovation (Rolfstam et al., 2011, Ribeiro & Furtado, 2014).

4.3. Evaluation challenges

Despite the efforts to study PPI described above, our understanding of the innovation impacts of public procurement is still limited. According to the OECD (2017), a majority of OECD countries have developed public procurement strategies aimed at driving innovation, but only half of these countries are currently measuring their effectiveness. Most of the evidence available on the impact of PPI focuses on developed economies, with few albeit increasing studies evaluating the impacts of demand-side policies on innovation in Latin America (Fernández-Sastre & Montalvo-Quizhpi, 2019), China (Dai et al., 2020) and Eastern Europe (Stojčić et al., 2020). Furthermore, despite the fact that public purchases of innovation are aimed at improving public services, empirical studies do not usually evaluate the impact of PPI in the public sector (see Demircioglu & Vivona, 2021).

There are a number of reasons for this limited evidence base. Often, PPI interventions and strategies are too new or too few, and as a result, there seems to be insufficient data to conduct an evaluative study. Another challenge is definitional. Public procurement has multiple policy objectives besides innovation, and procurement policy is a complex combination of regulations, organisational, and institutional characteristics. Unless there is an explicit PPI scheme in place (such as the Korean 'excellent product' programme, see Shin & Lee, 2021), it is difficult to distinguish between regular and innovation-oriented public procurement. As mentioned earlier, researchers often use a proxy for innovative procurement in such cases, for instance by asking through surveys whether firms carried out innovation activities to fulfil a government requirement.

Another challenge relates to data sources and methodologies. In Europe, where CIS serves as a popular source of data, researchers have noted several limitations. CIS data is anonymised, and it is not possible to conduct follow-ups or complement it with other data. CIS also treats PPI and other public policy instruments as binary variables, lacking information about the size and type of government support, be it in the form of grants, subsidies, or procurement contracts. Additionally, because the questions keep changing and the surveys cannot be joined, it has been difficult to construct larger panels and study the medium and long-term effects of public procurement (noted by Aschhoff & Sofka, 2009; Radicic, 2019; Stojčić et al., 2020).

The growing use of electronic procurement and e-tendering portals has led to a growing amount of publicly available data on procurement. However, this data is also challenging to gather and use. The volume of data requires sampling or automated analysis, a resource-intensive technique which may explain their under-exploitation (Appelt & Galindo-Rueda, 2016). It is also difficult to link tender notices, which are essentially procurement intentions, with procurement outcomes. Patent data is another useful source; however, it is not always easy to link patents to public procurement activity in most countries (Raiteri, 2018). Additionally, patents cover only a specific type of innovation (usually product innovation in the manufacturing sector).

Finally, there is the challenge of establishing causality. The problem lies in our inability to observe all the possible characteristics that can affect the relationship between public procurement and outcome variables, like innovation adoption, innovative capacity, or firm turnover. Other possible characteristics range from information that we could potentially

measure (business characteristics such as firm age as well as tender traits such as the weighting of innovation in scoring matrices) to a range of unobservable factors such as risk or entrepreneurial attitudes from the supply and demand side, the quality of bids, etc. An added difficulty in evaluating the impact of PPI is the confounding effect of other interventions that have the same goal and that operate simultaneously in the same environment (Guerzoni & Raiteri, 2015). Demand-side policies are part of a broader policy mix, making individual policy assessment difficult (Edler et al., 2012; Uyarra, 2016). Therefore, discrete instrument evaluations may not be appropriate, requiring evaluations that take into account such synergies between instruments over time (Appelt & Galindo-Rueda, 2016; Flanagan et al., 2011)

In the case of public procurement, it may be assumed that the selection process for awarding public contracts is not random. Thus, identifying a control group of firms in quasi-experimental designs to evaluate the impact of PPI interventions is critical. Researchers use propensity score matching techniques to identify a control group as similar to the intervention group (Rauen & Pavia, 2019; Caravella & Crespi, 2020b). The control group is meant to capture the likely results if the program or policy were not implemented. However, in most cases, there is no attempt to capture information on firms which bid for but do not win public contracts, although this could provide the critical counterfactual to evaluating public procurement's impact.

This section addressed the difficulties in evaluating the impact of public procurement on innovation. While studies provide increasing evidence of a positive impact, they do not shed light on the mechanisms underpinning this impact. Given the multitude of practices and procedures involved in the procurement process, what matters in order to inform policy design and implementation is therefore not so much whether procurement influences innovation but "understanding why it does so when it does, and how that effect can be maximised by an appropriate design policy" (Geroski, 1990, p. 185). This includes identifying the main barriers to PPI implementation.

4.4. Implementation challenges

Public procurement is a highly regulated activity, and the use of public procurement for innovation and strategic purposes is not without challenges. For instance, a review of PPI initiatives in the UK concluded that the "schemes devised often underestimated the institutional

challenges within organizations to define a need, to conduct a proper, inclusive process, to trigger innovation and to use the innovation bought" (Moñux & Uyarra, 2016, p. 122). A number of studies have similarly recognized several barriers preventing the public sector from 'capturing innovation', including inadequate early warning, lack of market engagement, overly specific and burdensome procurement processes, risk aversion, and procurement capability shortfalls (Edler et al., 2015; Georghiou et al., 2014; House of Lords, 2011; OGC, 2004; Uyarra et al., 2014).

A key challenge in implementing PPI, which gets picked up by several empirical studies (see e.g. Uyarra et al., 2014), relates to the capacity and skills within the procuring agency or contracting authority to engage in innovative public procurement. The implementation of PPI requires skills in pre-market engagement and relational contracting, unlike procurement based on the least price criterion. It is also important to remember that PPI does not lead to quick fixes - it involves a high degree of experimentation, both for developing the solution and aligning interests, socio-cognitive frames, and mindsets (Winden & Carvalho, 2019). Thus, the procurement activity itself will need greater time and care than would be the case in regular procurement. Procurers may also be risk averse or unable to adequately manage risk (Tsipouri et al., 2010), resorting to tried-and-tested solutions rather than trying something new.

Additional barriers related to broader political and economic conditions include a lack of consensus in government, resulting in frequent changes in policy and uncertainty for firms (Geroski, 1990). Multiple and sometimes conflicting objectives can make it challenging for procuring agencies to prioritise innovation, particularly at the local level (Dale-Clough, 2015). Uyarra (2010) for instance observed how a constantly changing procurement landscape and an 'overcrowding' of procurement objectives led to certain confusion among local authorities in Greater Manchester. Public procurement takes place at multiple levels of government, and optimising government spending for strategic goals will require designing regulations that are congruent with innovation goals across different levels of government and investing in procurement capacity at the appropriate levels.

Some studies have found that PPI happens as a result of like-minded decision-makers coming together by chance rather than as a norm and that such learning does not get transferred to other procurement activities within or outside the organisation (Meehan et al., 2017). Implementing

PPI often requires institutional and cultural changes. Lundberg and Bergman (2017) examine concepts of institutional inertia in selecting suppliers for public procurement contracts. As a demand-side innovation policy instrument, PPI emphasises collaborative working between different organisations to understand the demand (requirements) and the possibilities in the solution space. However, there may be challenges to collaboration due to differences in underlying beliefs or institutional logic of the different actors (Meehan et al., 2016).

One of the critical enablers for the implementation of PPI is supportive leadership and institutional entrepreneurship (Mwesiumo et al., 2019; Uyarra et al., 2020). Leadership and the quality of relationships between different stakeholders in procurement are critical in PPI since innovation procurement often relies on incomplete contracts, relational contracting, and trust. Innovation intermediaries operating at the demand-supply interface can be seen as institutional entrepreneurs playing a key role in connecting actors and catalysing change, as shown by Edler and Yeow (2016) in the case study of NHS in England.

Given these considerations, public procurement should not be considered a policy panacea, not least because demand-side innovation policy tools may not be the most cost-effective for generating innovation (Walsh, 1993; Davis & Brady, 2015). As Li and Georghiou (2016) observe, "the appropriateness and effectiveness of instruments are closely dependent upon the state of both the innovation and the procurement systems in which they are set" (p. 349), meaning that PPI impacts may be highly contextual.

5. Concluding remarks

The context for this chapter is a growing realisation that public procurement is a powerful instrument to boost innovation but also deliver high-quality, sustainable, inclusive and affordable public services. Unleashing this potential benefits demands procurement rules and processes that encourage innovation. It also requires a deeper understanding of the main rationales and existing evidence around their impact on innovation.

Public procurement enables innovation by: enlarging the market for groundbreaking goods and services, thus ensuring sufficient critical mass to encourage R&D investment; enabling standards, thus facilitating diffusion; and articulating and signalling unmet needs to the market;

thus supporting interaction between users and producers and the development and deployment of innovative solutions.

We have reviewed the multiple definitions, typologies, rationales and concepts being used to shape intervention to encourage procurement innovation and uncovered many fuzzy and confusing conceptualisations. We have examined the attempts to empirically understand and quantify the innovation impacts of public procurement, using a variety of approaches and data sources, reviewing advantages and limitations. We note that despite strong academic interest and policy activity in this area, buttressed by financial support, strategic public procurement to promote innovation is still unevenly adopted. It is also a relatively under-researched area: the impact of interventions for encouraging innovation is weakly studied, and there is relatively little quantitative data available. Evidence gathered from public investments in innovation procurement projects is limited, as they are rarely accompanied by monitoring and evaluation activities.

In order to move forward, more research is needed to quantify the outcomes of procurement interventions in different national and sectoral contexts and their integration with other innovation policy instruments. Understanding the innovation benefits of public procurement should include a focus not only on R&D, patents, and product innovation but also on its impact on meeting social, environmental and public service delivery goals. Demanding sustainability targets will be a crucial element in all future procurements. The increased scholarly interest of late in the impact of procurement on green innovation is an encouraging development.

Referencees

Aho, E. *et al.* (2006) *Creating an Innovative Europe. Report of the Independent Expert Group on R&D and Innovation*. Brussels: European Commission.

Appelt, S., & Galindo-Rueda, F. (2016). *Measuring the Link between Public Procurement and Innovation* (OECD Science, Technology and Industry Working Papers No. 2016/03; OECD Science, Technology and Industry Working Papers, Vol. 2016/03). https://doi.org/10.1787/5jlvc7sl1w7h-en

Aschhoff, B., & Sofka, W. (2009). Innovation on demand—Can public procurement drive market success of innovations? *Research Policy*, *38*(8), 1235–1247. https://doi.org/10.1016/j.respol.2009.06.011

Audretsch, D. B. (2004). Sustaining Innovation and Growth: Public Policy Support for Entrepreneurship. *Industry and Innovation*, *11*(3), 167–191. https://doi.org/10.1080/1366271042000265366

Beise, M., & Cleff, T. (2004). Assessing the lead market potential of countries for innovation projects'. *Journal of International Management*, *10*(4), 453–477.

Bleda, M., & Chicot, J. (2020). The role of public procurement in the formation of markets for innovation. *Journal of Business Research*, *107*, 186–196. https://doi.org/10.1016/j.jbusres.2018.11.032

Boon, W., & Edler, J. (2018). Demand, challenges, and innovation. Making sense of new trends in innovation policy. *Science and Public Policy*, *45*(4), 435–447. https://doi.org/10.1093/scipol/scy014

Borrás, S. (2009). *The Widening and Deepening of Innovation Policy: What Conditions Provide for Effective Governance?* https://smartech.gatech.edu/handle/1853/39803

Bugge, M. M., Andersen, A. D., & Steen, M. (2021). The role of regional innovation systems in mission-oriented innovation policy: Exploring the problem-solution space in electrification of maritime transport. *European Planning Studies*, *0*(0), 1–22. https://doi.org/10.1080/09654313.2021.1988907

Cabral, L., Cozzi, G., Denicolo, V., Spagnolo, G., & Zanza, M. (2006). Procuring innovations. In N. Dimitri, G. Piga, & G. Spagnolo (Eds.), *Handbook of Procurement* (pp. 483–530). Cambridge University Press.

Caravella, S., & Crespi, F. (2020a). The role of public procurement as innovation lever: Evidence from Italian manufacturing firms. *Economics of Innovation and New Technology*, 1–22. https://doi.org/10.1080/10438599.2020.1761591

Caravella, S., & Crespi, F. (2020b). Unfolding heterogeneity: The different policy drivers of different eco-innovation modes. *Environmental Science & Policy*, *114*, 182–193. https://doi.org/10.1016/j.envsci.2020.08.003

Cerqueira Gomes, P. (2021). *EU Public Procurement and Innovation: The Innovation Partnership Procedure and Harmonization Challenges*. Edward Elgar Publishing.

Dai, X., Li, Y., & Chen, K. (2020). Direct demand-pull and indirect certification effects of public procurement for innovation. *Technovation*, 102198. https://doi.org/10.1016/j.technovation.2020.102198

Dale-Clough, L. (2015). Public procurement of innovation and local authority procurement: Procurement modes and framework conditions in three European cities. *Innovation: The*

European Journal of Social Science Research, *28*(3), 220–242. https://doi.org/10.1080/13511610.2015.1012709

Dalpe, R. (1994). Effects of government procurement on industrial innovation. *Technology in Society*, *16*(1), 65–83.

Dalpé, R., DeBresson, C. and Ciaoping, H. (1992) 'The public sector as first user of innovations', *Research Policy*, 21(3), pp. 251–263.

Davidsson, P., & Wiklund, J. (2007). Levels of Analysis in Entrepreneurship Research: Current Research Practice and Suggestions for the Future*. In Á. Cuervo, D. Ribeiro, & S. Roig (Eds.), *Entrepreneurship: Concepts, Theory and Perspective* (pp. 245–265). https://doi.org/10.1007/978-3-540-48543-8_12

Davis, P., & Brady, O. (2015). Are government intentions for the inclusion of innovation and small and medium enterprises participation in public procurement being delivered or ignored? An Irish case study. *Innovation: The European Journal of Social Sciences*, *28*(3), 324–343. Scopus. https://doi.org/10.1080/13511610.2014.985192

Demircioglu, M. A., & Vivona, R. (2021). Positioning public procurement as a procedural tool for innovation: An empirical study. *Policy and Society*, 1–18. https://doi.org/10.1080/14494035.2021.1955465

DoD. (2019). *DoD SBIR National Economic Impacts, 1995-2018*. Department of Defence.

Edler, J. (2010) 'Demand Oriented Innovation Policy', in R. Smits, S. Kuhlmann, and P. Shapira (eds) *The Theory and Practice of Innovation Policy An International Research Handbook.* Cheltenham: Edward Elgar, pp. 177–208.

Edler, J. (2013). *Review of Policy Measures to Stimulate Private Demand for Innovation Concepts and Effects*.

Edler, J. and Yeow, J. (2016) 'Connecting demand and supply: The role of intermediation in public procurement of innovation', *Research Policy*, 45(2), pp. 414–426. https://doi.org/10.1016/j.respol.2015.10.010.

Edler, J., & Georghiou, L. (2007). Public procurement and innovation—Resurrecting the demand side. *Research Policy*, *36*(7), 949–963. https://doi.org/10.1016/j.respol.2007.03.003

Edler, J., & Uyarra, E. (2013). Public Procurement of Innovation. In L. Brown & S. Osborne (Eds.), *The Handbook of Innovation and Change in Public Sector Services*. Edward Elgar.

Edler, J., Georghiou, L., Blind, K., & Uyarra, E. (2012). Evaluating the demand side: New challenges for evaluation. *Research Evaluation*, *21*(1), 33–47. https://doi.org/10.1093/reseval/rvr002

Edler, J., Georghiou, L., Uyarra, E., & Yeow, J. (2015). The meaning and limitations of public procurement for innovation: A supplier's experience. In C. Edquist, N. Vonortas, & J. M. Zabala-Iturriagagoitia (Eds.), *Public Procurement for Innovation* (pp. 33–47). Edward Elgar. ://000302112400004

Edquist, C., & Hommen, L. (1999). Systems of innovation: Theory and policy for the demand side. *Technology in Society*, *21*(1), 63–79.

Edquist, C., & Hommen, L. (2000). Public Technology Procurement and Innovation Theory. In C. Edquist (Ed.), *Public Technology Procurement and Innovation* (pp. 5–70). Boston et al.

Edquist, C., & Zabala-Iturriagagoitia, J. M. (2020). Functional procurement for innovation, welfare, and the environment. *Science and Public Policy*, *47*(5), 595–603. https://doi.org/10.1093/scipol/scaa046

Edquist, C., Vonortas, N. S., Zabala-Iturriagagoitia, J. M., & Edler, J. (2015). *Public Procurement for Innovation*. Edward Elgar Publishing.

Eliasson, G. (2010). *Advanced Public Procurement as Industrial Policy: The Aircraft Industry as a Technical University*. Springer Science & Business Media.

European Commission. (2021). *Guidance on Innovation Procurement. C(2021) 4320 final. Brussels, 18.6.2021*.

Fernández-Sastre, J., & Montalvo-Quizhpi, F. (2019). The effect of developing countries' innovation policies on firms' decisions to invest in R&D. *Technological Forecasting and Social Change*, *143*, 214–223. https://doi.org/10.1016/j.techfore.2019.02.006

Flanagan, K., Uyarra, E., & Laranja, M. (2011). Reconceptualising the 'policy mix' for innovation. *Research Policy*, *40*(5), 702–713.

Georghiou, L., Edler, J., Uyarra, E., & Yeow, J. (2014). Policy instruments for public procurement of innovation: Choice, design and assessment. *Technological Forecasting and Social Change*, *86*, 1–12. https://doi.org/10.1016/j.techfore.2013.09.018

Geroski, P. A. (1990). Procurement policy as a tool of industrial policy. *International Review of Applied Economics*, *4*(2), 182–198. https://doi.org/10.1080/758523673

Ghisetti, C. (2017). Demand-pull and environmental innovations: Estimating the effects of innovative public procurement. *Technological Forecasting and Social Change*, *125*, 178–187. https://doi.org/10.1016/j.techfore.2017.07.020

GHK. (2010). *Evaluation of SMEs' access to Public procurement markets in the EU*. DG Enterprise and Industry. http://ec.europa.eu/enterprise/policies/sme/business-environment/files/smes_access_to_public_procurement_final_report_2010_en.pdf

Grandia, J. (Jolien), & Kruyen, P. M. (Peter). (2020). Assessing the implementation of sustainable public procurement using quantitative text-analysis tools: A large-scale analysis of Belgian public procurement notices. *Journal of Purchasing and Supply Management*, *26*(4), 100627. https://doi.org/10.1016/j.pursup.2020.100627

Guerzoni, M., & Raiteri, E. (2015). Demand-side vs. supply-side technology policies: Hidden treatment and new empirical evidence on the policy mix. *Research Policy*, *44*(3), 726–747. https://doi.org/10.1016/j.respol.2014.10.009

HM Treasury. (2008). *Accelerating the SME economic engine: Through transparent, simple and strategic procurement*. HM Treasury.

Hommen, L., & Rolfstam, M. (2009). Public procurement and innovation: Towards a taxonomy. *Journal of Public Procurement*, *9*(1), 17–56.

House of Lords. (2011). *Public procurement as a tool to stimulate innovation, published*. http://www.publications.parliament.uk/pa/ld201012/ldselect/ldsctech/148/14802.htm

Krieger, B. and Zipperer, V. (2022) 'Does green public procurement trigger environmental innovations?', *Research Policy*, 51(6), p. 104516. https://doi.org/10.1016/j.respol.2022.104516.

Kundu, O., James, A. D., & Rigby, J. (2020). Public procurement and innovation: A systematic literature review. *Science and Public Policy*. https://doi.org/10.1093/scipol/scaa029

Lember, V., Kattel, R., & Kalvet, T. (2014). Public Procurement and Innovation: Theory and Practice. In V. Lember, R. Kattel, & T. Kalvet (Eds.), *Public Procurement, Innovation*

and Policy (pp. 13–34). Springer Berlin Heidelberg. http://link.springer.com/chapter/10.1007/978-3-642-40258-6_2

Li, Y., & Georghiou, L. (2016). Signaling and accrediting new technology: Use of procurement for innovation in China. *Science and Public Policy*, *43*(3), 338–351. https://doi.org/10.1093/scipol/scv044

Loader, K. (2007). The Challenge of Competitive Procurement: Value for Money Versus Small Business Support. *Public Money & Management*, *27*(5), 307–314.

Loader, K. (2013), "Is public procurement a successful small business support policy? A review of the evidence", *Environment and Planning C: Government and Policy*, Vol. 31 No. 1, pp. 39-55.

Lundberg, S., & Bergman, M. A. (2017). Tendering design when price and quality is uncertain. *International Journal of Public Sector Management*, *30*(4), 310–327. https://doi.org/10.1108/IJPSM-04-2016-0063

Mazzucato, M. (2013). *The Entrepreneurial State: Debunking Public Vs. Private Sector Myths*. Anthem Press.

Mazzucato, M. (2018). Mission-oriented innovation policies: Challenges and opportunities. *Industrial and Corporate Change*, *27*(5), 803–815. https://doi.org/10.1093/icc/dty034

McCann, P. and Ortega-Argilés, R. (2013). Modern Regional Innovation Policy. *Cambridge Journal of Regions, Economy and Society*, 6, 187-216. https://doi:10.1093/cjres/rst007

McCann, P. and Ortega-Argilés, R. (2022). Regional Innovation, Industrial Policy and UK Interregional Challenges. *Review of Public Economics*, forthcoming.

McCrudden, C. (2004). Using public procurement to achieve societal outcomes. *Natural Resource Forum*, *28*(257–267).

Meehan, J., Ludbrook, M. N., & Mason, C. J. (2016). Collaborative public procurement: Institutional explanations of legitimised resistance. *Journal of Purchasing and Supply Management*, *22*(3), 160–170. https://doi.org/10.1016/j.pursup.2016.03.002

Meehan, J., Menzies, L., & Michaelides, R. (2017). The long shadow of public policy; Barriers to a value-based approach in healthcare procurement. *Journal of Purchasing and Supply*. Scopus. https://doi.org/10.1016/j.pursup.2017.05.003

Moñux, D., & Uyarra, E. (2016). *Spurring Innovation Led Growth in Latin American Countries through Public procurement*. Inter-American Development Bank.

Mowery, D. C. (2012). Defense-related R&D as a model for "Grand Challenges" technology policies. *Research Policy*, *41*(10), 1703–1715. https://doi.org/10.1016/j.respol.2012.03.027

Mowery, D., & Rosenberg, N. (1979). The influence of market demand upon innovation: A critical review of some recent empirical studies. *Research Policy*, *8*(2), 102–153.

Mwesiumo, D., Olsen, K. M., Svenning, G. A., & Glavee-Geo, R. (2019). Implementing public procurement of innovations in an organization: Lessons from Norway. *Journal of Public Procurement*, *19*, 252–274. https://doi.org/10.1108/JOPP-11-2018-0045

Neij, L. (2001). Methods of evaluating market transformation programmes: experience in Sweden. *Energy Policy*, *29*(1), 67-79.

Obwegeser, N., & Müller, S. D. (2018). Innovation and public procurement: Terminology, concepts, and applications. *Technovation*, *74–75*, 1–17. https://doi.org/10.1016/j.technovation.2018.02.015

OECD & Statistical Office of the European Communities. (2005). *Oslo Manual 2005: Guidelines for Collecting and Interpreting Innovation Data* (3rd ed.). https://doi.org/10.1787/9789264013100-en
OECD & Statistical Office of the European Communities. (2018). *Oslo Manual 2018: Guidelines for Collecting, Reporting, and Using Data on Innovation* (4th ed.). https://www.oecd.org/science/oslo-manual-2018-9789264304604-en.htm
OECD. (2011). *Demand Side Innovation Policy*.
OECD. (2017). *Public Procurement for Innovation*. https://www.oecd-ilibrary.org/content/publication/9789264265820-en
OGC. (2004). *Capturing Innovation: Nurturing suppliers' ideas in the public sector*. Office of Government Commerce. www.ogc.gov.uk/documents/capturing_innovation.pdf
Orsatti, G. *et al.* (2020) 'Public Procurement, Local Labor Markets and Green Technological Change. Evidence from US Commuting Zones', *Environmental and Resource Economics*, 75(4), pp. 711–739. https://doi.org/10.1007/s10640-020-00405-4.
Parker, R. (2008). Governance and the Entrepreneurial Economy: A Comparative Analysis of Three Regions. *Entrepreneurship Theory and Practice*, *32*(5), 833–854. https://doi.org/10.1111/j.1540-6520.2008.00258.x
Pavitt, K. and Walker, W. (1976) 'Government policies towards industrial innovation: a review', *Research Policy*, 5(1), pp. 11–97. https://doi.org/10.1016/0048-7333(76)90017-2.
Preuss, L. (2011). On the contribution of public procurement to entrepreneurship and small business policy. *Entrepreneurship & Regional Development*, *23*(9–10), 787–814. https://doi.org/10.1080/08985626.2010.546433
PwC. (2015). *Study on 'Strategic use of public procurement in promoting green, social and innovation policies'. Final Report*. Publications Office of the European Union. https://doi.org/10.2873/8480
PwC. (2021). *The strategic use of public procurement for innovation in the digital economy: Final report*. Publications Office of the European Union. https://data.europa.eu/doi/10.2759/936544
Radicic, D. (2019). Effectiveness of public procurement of innovation versus supply-side innovation measures in manufacturing and service sectors. *Science and Public Policy*, *46*(5), 732–746. https://doi.org/10.1093/scipol/scz026
Raiteri, E. (2018) 'A time to nourish? Evaluating the impact of public procurement on technological generality through patent data', *Research Policy*, 47(5), pp. 936–952. https://doi.org/10.1016/j.respol.2018.02.017.
Rauen, A. and Paiva, B. (2019) 'Impacts of public procurement on business R&D efforts: The Brazilian case', in. Brasilia: Institute for Applied Economic Research (Discussion Paper No. 246). https://doi.org/10.13140/RG.2.2.12361.70240.
Ribeiro, C.G. and Furtado, A.T. (2014) 'Government Procurement Policy in Developing Countries: The Case of Petrobras', *Science, Technology and Society*, 19(2), pp. 161–197. https://doi.org/10.1177/0971721814529874.
Rigby, J. (2013). *Review of Pre-commercial Procurement Approaches. Report within the MIoIR-NESTA Compendium of Evidence on Innovation Policy.*
Rolfstam, M. (2012). An institutional approach to research on public procurement of innovation. *Innovation*, *25*(3), 303–321. Scopus. https://doi.org/10.1080/13511610.2012.717475

Rolfstam, M. (2013). *Public Procurement and Innovation*. Edward Elgar Publishing.
Rolfstam, M., Phillips, W. and Bakker, E. (2011) 'Public procurement of innovations, diffusion and endogenous institutions', *International Journal of Public Sector Management*, 24(5), pp. 452–468. Available at: https://doi.org/10.1108/09513551111147178.
Rothwell, R., & Zegveld, W. (1981). Government regulations and innovation—Industrial Innovation and Public Policy. In R. Rothwell & W. Zegveld (Eds.), *Industrial Innovation and Public Policy* (pp. 116–147).
Schot, J., & Steinmueller, W. E. (2018). Three frames for innovation policy: R&D, systems of innovation and transformative change. *Research Policy*, *47*(9), 1554–1567. https://doi.org/10.1016/j.respol.2018.08.011
Shin, K., & Lee, J.-D. (2021). Impact of public procurement for innovation on firm productivity. *Applied Economics Letters*, *0*(0), 1–6. https://doi.org/10.1080/13504851.2021.1904106
Shin, K., Yeo, Y., & Lee, J.-D. (2020). Revitalizing the Concept of Public Procurement for Innovation (PPI) from a Systemic Perspective: Objectives, Policy Types, and Impact Mechanisms. *Systemic Practice and Action Research*, *33*(2), 187–211. https://doi.org/10.1007/s11213-019-09488-7
Siaroff, A., & Lee, C. (1997). The State and Industrial Followers: Japanese Versus French Computer Strategy, 1960s–1980s. *Journal of Public Policy*, *17*(1), 31-61.
Slavtchev, V. and Wiederhold, S. (2016) 'Does the Technological Content of Government Demand Matter for Private R&D? Evidence from US States', *American Economic Journal - Macroeconomics*, 8(2), pp. 45–84. doi:10.1257/mac.20130069.
Smallbone, D., Kitching, J., Athayde, R., & Xheneti, M. (2008). *Procurement and supplier diversity in the 2012 Olympics* (No. 6; Research Report Series). Equality and Human Rights Commission.
Stojčić, N., Srhoj, S. and Coad, A. (2020) 'Innovation procurement as capability-building: Evaluating innovation policies in eight Central and Eastern European countries', *European Economic Review*, 121, p. 103330. https://doi.org/10.1016/j.euroecorev.2019.103330.
Stojčić, N., Srhoj, S., & Coad, A. (2020). Innovation procurement as capability-building: Evaluating innovation policies in eight Central and Eastern European countries. *European Economic Review*, *121*, 103330. https://doi.org/10.1016/j.euroecorev.2019.103330
Tendler, J., & Amorim, M. A. (1996). Small firms and their helpers: Lessons on demand. *World Development*, *24*(3), 407–426. https://doi.org/10.1016/0305-750X(95)00155-6
Timmermans, B., & Zabala-Iturriagagoitia, J. M. (2013). Coordinated unbundling: A way to stimulate entrepreneurship through public procurement for innovation. *Science and Public Policy*, *40*(5), 674–685. https://doi.org/10.1093/scipol/sct023
Tsipouri, L., Edler, J., Rolfstam, M., & Uyarra, E. (2010). *Risk management in the procurement of innovation. Concepts and empirical evidence in the European Union*. European Commission. http://ec.europa.eu/invest-in-research/pdf/download_en/risk_management.pdf
Uyarra, E. (2010) *Opportunities for innovation through Local Government Procurement: A Case Study of Greater Manchester*. London: NESTA.

Uyarra, E. (2016). The impact of public procurement of innovation. *Handbook of Innovation Policy Impact*. https://www.elgaronline.com/view/edcoll/9781784711849/9781784711849.00018.xml

Uyarra, E., & Flanagan, K. (2010). Understanding the Innovation Impacts of Public Procurement. *European Planning Studies*, *18*(1), 123–143. https://doi.org/10.1080/09654310903343567

Uyarra, E., & Flanagan, K. (2021). Going beyond the line of sight: Institutional entrepreneurship and system agency in regional path creation. *Regional Studies*, *0*(0), 1–12. https://doi.org/10.1080/00343404.2021.1980522

Uyarra, E., Edler, J., Garcia-Estevez, J., Georghiou, L., & Yeow, J. (2014). Barriers to innovation through public procurement: A supplier perspective. *Technovation*. https://doi.org/10.1016/j.technovation.2014.04.003

Uyarra, E., Ribeiro, B., & Dale-Clough, L. (2019). Exploring the normative turn in regional innovation policy: Responsibility and the quest for public value. *European Planning Studies*, *27*(12), 2359–2375. https://doi.org/10.1080/09654313.2019.1609425

Uyarra, E., Zabala-Iturriagagoitia, J., Flanagan, K., & Magro, E. (2020). Public procurement, innovation and industrial policy: Rationales, roles, capabilities and implementation. *Research Policy*, *49*, 103844. https://doi.org/10.1016/j.respol.2019.103844

Walker, H., & Preuss, L. (2008). Fostering sustainability through sourcing from small businesses: Public sector perspectives. *Journal of Cleaner Production*, *16*(15), 1600–1609.

Walsh, V. (1993). Demand, public markets and innovation in biotechnology. *Science and Public Policy*, *20*(3), 138–156. https://doi.org/10.1093/spp/20.3.138

Weber, K. M., & Rohracher, H. (2012). Legitimizing research, technology and innovation policies for transformative change: Combining insights from innovation systems and multi-level perspective in a comprehensive 'failures' framework. *Research Policy*, *41*(6), 1037–1047. https://doi.org/10.1016/j.respol.2011.10.015

Winden, W. V., & Carvalho, L. (2019). Intermediation in public procurement of innovation: How Amsterdam's startup-in-residence programme connects startups to urban challenges. *Research Policy*, *48*, 103789. https://doi.org/10.1016/J.RESPOL.2019.04.013

Yeow, J., Uyarra, E. and Gee, S. (2015) '"Closing the loop – Examining the case of the procurement of a sustainable innovation"', in C. Edquist et al. (eds) *Public Procurement for Innovation*. Edward Elgar Publishing.

Yu, C., Morotomi, T. and Yu, H. (2020) 'What Influences Adoption of Green Award Criteria in a Public Contract? An Empirical Analysis of 2018 European Public Procurement Contract Award Notices', *Sustainability*, 12(3), p. 1261. https://doi.org/10.3390/su12031261.

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