INCENTIVES AND RISK-SHARING IN PUBLIC PROCUREMENT OF INNOVATIONS: TOWARDS CONTRACTING STRATEGY FRAMEWORK

Niko Suhonen, Timo Tammi, Jani Saastamoinen[1], Jarkko Pesu, Matti Turtiainen, Lasse Okkonen[2]

Abstract

Public procurement of innovations (PPI) addresses a specified need of the public-sector customer or aims at fostering private firms' innovativeness. In an operational sense, issues of information asymmetry and risk sharing between the public agency and the supplier are of paramount importance. This paper focuses on the contract design issues of PPI. Explicit and implicit contracting methods are reviewed, and a conceptual framework is proposed, in which procurement characteristics are analyzed, focusing on the dimensions of the supplier's sensitivity to the procurement risk and the power of implicit contracting methods. Due to its complex nature, applying cost-plus contracts instead of more common fixed-price contracts is advisable in PPI. Possible reasons for the more prominent role of contract design in the US as opposed to the EU procurement are discussed.

[1] Corresponding author, e-mail: jani.saastamoinen@uef.fi.

[2] Niko Suhonen, Ph.D., is a researcher at the University of Eastern Finland Business School (UEF). His research interests are business models, incentive mechanisms and impact assessments in the bioenergy markets. Timo Tammi, Ph.D., is a university lecturer at UEF Business School. His teaching and research interests are in behavioral economics, public procurement and decision-making. Jani Saastamoinen, Ph.D., is a university lecturer at UEF Business School. His research interests include public procurement, industrial organization and the analysis of financial decision making. Jarkko Pesu, M.Sc., is a project researcher at the University of Eastern Finland Business School. His research interests include public procurement and state aid law. Matti Turtiainen, Ph.D., is a professor of financial markets and financial services at UEF. His research interests are corporate finance, financial regulation and public procurement. He has given expert opinion on national regulatory issues. Lasse Okkonen, Ph.D., is a lecturer in Karelia University of Applied Sciences. He has 15 years of experience in renewable energy research and development. His research has focused especially on socio-economic aspects and business models for renewable energy and energy self-sufficiency. In addition, Okkonen has supported local procurement processes for renewable energy schemes.

Keywords: Public procurement, innovation, incentives, risk-sharing, contracts

INTRODUCTION

Policy makers, public sector authorities and designers of public procurement have shown considerable interest and optimism towards the public sector's ability to foster firms' innovativeness by using the mechanism of public procurement of innovations (PPI). As many scholars argue, the insufficiency of other innovation policy instruments, such as regulation, R&D subsidies, and investments in the production of scientific and technological knowledge and dissemination, has driven a shift towards employing demand-driven innovation policy tools in the context of public procurement (Edler and Georghiou, 2007; Aschhoff and Sofka, 2009). In recent years, there has been a great political interest in implementing the idea of PPI in practice (Edquist and Zabala-Iturriagagoitia, 2012, Lember et al., 2015). Despite this, the uptake of PPI has been slow which has been attributed to public procurers' risk aversion, short-term orientation and inflexible legislation (Lember et al., 2015).

The rationale for PPI is multifaceted. On the face of it, the public sector may purchase innovative goods or services for the sake of higher quality and/or lower costs of producing and delivering them for its own purposes (Cave and Frinking, 2003). In a more functional sense, it can be used to satisfy human needs and/or to solve societal problems (Edquist and Zabala-Iturriagagoitia, 2012). On the other hand, however, the idea of using public procurement as a means to stimulate private sector innovation raises several additional issues such as accelerating research and development (R&D), encouraging the dissemination of the results of R&D, reducing costs and barriers to innovation, and increasing the level of R&D in the economy (Cave and Frinking, 2003). These policy objectives considerably change the nature of public procurement as an arena of interaction between the public sector and relevant private sector firms and the actual winner of the innovation game (or its 'pre-game'). As argued by Rolfstam et al. (2005), the nature of interaction changes *from* a game between more knowledgeable suppliers and the designer of auction rules and rather standardized contractual stipulations *into* a more complex interaction, information sharing and co-operation between the user and suppliers. In addition, from a theoretical perspective, the traditional market-failure argument loses its relevance in justifying innovation policies and is accompanied by a system failure argument (Georghiou et al., 2014), which highlights the importance of contracting strategies in dealing with information asymmetries, risk-sharing and incentivizing issues. Finally, Uyarra et al. (2014)

suggests that risk aversion and poor risk management practices are perceived as qualities of public buyers (see also Edler et al., 2015a; Edler et al., 2015b). Hence, some objectives of public procurement of innovation are at stake due to a gap between the complexity of interaction between buyers and suppliers of innovations and the current contracting strategies applied by contracting authorities. More precisely, what seems to be lacking, is knowledge of the role incentives and risk-sharing play in motivating firms and formulating contracts in PPI. In particular, this can be seen in the European context where the use of incentives and contract design does not have a long tradition compared to the defense procurement carried out by the United States (US) federal government (see e.g. Bower and Dertouzos, 1994). As a result, a combination of conceptual tools from economics and law are needed to analyze this problem especially in the context of the European Union (EU) legislation and traditions concerning public procurement.

This paper fills this gap between the 'stylized' objectives of public innovation procurement policy on the one hand and contracting practices of sharing risk and designing incentives in PPI on the other hand. On the basis of a selective literature review, this article develops a contracting strategy framework by setting a broader scene for contracting strategies and by analyzing the incentive contract according to the supplier's risk sensitivity, the contract type and the complexity of the procurement characteristics. The paper concludes with a short discussion on the relevance of the proposed framework for procurement practices, possible reasons for the low appliance of incentive mechanisms in the EU as opposed to US procurement, and further academic research.

POLICY CONTEXT: IDEAS AND REFINEMENTS

DEFINITIONS

What is an innovation? Although often interchangeable in everyday speech, a distinction can be made between invention and innovation; as Abernathy and Clark (1985) suggest, "what may be a startling breakthrough to the engineer, may be completely unremarkable as far as the user of the product is concerned." Fagerberg (2005) distinguishes between the two by their practical value: "Invention is the first occurrence of an idea or a new product or process, while innovation is the first attempt to carry out into practice." A similar sentiment is shared by Edquist (1997) for whom innovations are "new creations of economic significance", either entirely new products or reorganizations of existing elements.

According to Kline and Rosenberg (1986) and based on Schumpeter (1934), an innovation is hard to measure as it may contain several dimensions. More specifically, they define innovation as a new product or a new production process, a substitution of materials used in production with newly developed materials in an otherwise unaltered product, a reorganization of production including an organization's internal functions, distribution or product support that improves efficiency or achieves lower costs, or improving instruments or methods of innovating. Innovations can be divided into two categories: firstly, 'radical innovations', which are completely new-to-the-world products, and secondly, 'incremental innovations', which involve improving existing products or production processes (Oke et al., 2007).

Public procurement can be defined as purchasing goods and services or the combinations of the two by public sector organizations (Edquist and Zabala-Iturriagagoitia, 2012). However, what constitutes innovation procurement is less clear. A narrow view is that it is the procurement of products or services that do not exist but can be developed (Edquist and Hommen, 2000). As PPI requires some innovative work to fulfil, it differs from regular procurement in which purchased goods or services already exist and whose properties are known (Rolfstam et al., 2005). In the broadest sense, however, all public procurement impacts innovation because it affects demand and firm behavior (Uyarra and Flanagan, 2010). However, Edquist and Zabala-Iturriagagoitia (2012) argue that "regular procurement has nothing to do with innovation" because it is not a policy instrument. Rolfstam (2012) defines innovation procurement as "a public agency engaged together with one or several private firms or other organizations in activities that may lead to or promote innovation of some kind." He makes a distinction between innovation procurement, which is procurement aiming for innovation, and innovation friendly procurement, which is procurement that provides enough flexibility for supplier innovation. Innovation is promoted directly when the public sector purchases products or services that require investments in research and development (R&D), and indirectly when tender specifications are in a functional format as opposed to production terms (Cave and Frinking, 2003). As such, public procurement may mitigate risks or costs of innovation, accelerate or change the level or direction of innovation, and encourage the diffusion of R&D (Cave and Frinking, 2003). In conclusion, public innovation procurement is a label for demand-driven development and purchasing of innovative solutions to meet the needs of the public sector's end-user. One must, however, be careful with the definitions because 'innovative public procurement' could refer to innovative procurement process which is distinct from the

outcome-oriented meanings of the definitions presented above (Rolfstam 2012).

There are several classifications that can be given to innovation procurement. Hommen and Rolfstam (2009) identify three broad categories for PPI. First, in direct innovation procurement, the private sector produces innovative solutions for the public sector. Second, in cooperative procurement, the public and private sectors aggregate demand for an innovation. Third, in catalytic procurement, the public sector is an early buyer that helps to shape private demand for an innovation. Edquist and Zabala-Iturriagagoitia (2012) distinguish between different end-results of PPI. First, pre-commercial procurement (PCP) refers to PPI which has a clear expected end-result, a prototype, for example, that does not require actual development. Second, adaptive PPI refers to procurement of incremental innovations. This is a product or a service which requires some adaptation before implementation. Third, developmental PPI refers to 'new-to-the-world' or 'radical' innovations resulting from the procurement process. Based on these categorizations, it can be argued that the most complex and riskiest types of PPI involve procuring 'new-to-the-world' innovations directly from the private sector. Incremental innovations that involve adaptation are less risky. Perhaps the least risky and complex type is PCP, which could be accompanied with catalytic or cooperative procurement.

Public Procurement among Other Innovation Policy Tools

There are four types of innovation policy instruments: public procurement, regulation, research institutions and universities and public R&D subsidies (Aschhoff and Sofka, 2009). Public procurement and regulation are demand-side instruments and their purpose and impacts on firms differ. While regulation seeks to influence firm behavior, procurement seeks to satisfy public demand or public policy targets and rewards firms with money (e.g. sales). Thus, sales are an incentive for firm participation in the former, while adherence to regulation is mandatory. Their common feature is a reduction in the market risk a firm faces because procurement contracts improve the predictability of demand and regulation provides industry-wide standards. Research institutions and universities and R&D subsidies are supply-side instruments. The former instrument seeks to increase knowledge, and access to this knowledge is an incentive for firms to cooperate with the research institutions and universities. The latter seeks to stimulate R&D within firms with targeted money transfers providing an opportunity to reduce the costs and risks associated with R&D efforts.

Recently, a growing interest has emerged in the innovation stimulation function of public procurement (Edquist and Zabala-Iturriagagoitia, 2012; Lember et al., 2015). This function means that there are intended direct and indirect influences on the innovation activities of private firms when the public sector purchases goods or a services. Edquist and Zabala-Iturriagagoitia (2012) make a distinction between the objectives of PPI. An objective can be to address the needs of a public agency or a chosen mission. However, PPI may also be used to stimulate innovations in a broader, economy-wide context (Geroski, 1990). As argued by Uyarra et al (2014; see also OECD, 2011), a growing interest in the public procurement's innovation stimulating function stems from the less-than-expected results of traditional innovation policies which are based mainly on demand-side policies. In addition, innovation is increasingly being perceived as a systemic process rather than a linear model, which means that innovations are influenced by demand and interactions between organizations (Edquist and Zabala-Iturriagagoitia, 2012; Uyarra et al., 2014).

An important factor in this development has been the appearance of PPI as a tool for innovation policy within EU. As Edler and Georghiou (2007) describe, the EU has developed new policies to improve private sector research and development. Of particular interest is the report titled 'Raising EU R&D Intensity' prepared by an independent expert group chaired by Georghiou. The aim of the report was to provide a means for the EU to reach an overall investment target of 3% of GDP by the year 2010. The report concludes (Georghiou, 2003) that the use of demand-side policies is central to pursuing the set target, and that public procurement for innovation (the report uses the term 'public technology procurement') is likely to have the largest potential contribution to the target[3]. The report also points out the importance of acknowledging risks falling upon public services and the need of information exchange and close coordination between private firms and public procurement authorities.

Operational and Empirical Refinements

Few studies have provided empirical assessments of the impacts of PPI. According to Lichtenberg (1988), both public procurement and public innovation procurement have significant positive effects on private R&D. More specifically, he finds that sales to the public sector increase private R&D expenditures more than sales to the

[3] According to Edquist and Zabala-Iturriagagoitia (2012), 'technology' was replaced with 'innovation' to emphasize a wider content of the notion.

private sector, and competitive procurement in the form of design and technical competitions results in a major spending increase in private R&D. He argues that this is a consequence of profitable "follow on" non-competitive contracts with the public actor for the winner of the competition, which act as an incentive to boost R&D spending in the competition phase. More specifically, Slavtchev and Wiederhold (2011) suggest the high technology sector is the most responsive to public procurement in increasing private spending on R&D. Fontana and Guerzoni (2008) underline the importance of incentives in the form of improved profitability and signaling through market demand in the form of reduced uncertainty in the birth of innovations.

Compared to other innovation policy instruments, PPI seems to be the most efficient instrument. Guerzoni and Raiteri (2014) studied the interaction effects between different policy instruments and found that PPI was effective on its own, but its effectiveness can be increased if other policy instruments are applied alongside it. Indeed, based on the assessment of several case studies, Edquist and Zabala-Iturriagagoitia (2012) suggest that when addressing "large challenges" PPI should be accompanied with other policy instruments. Another case study concerning innovative service procurement by Pelkonen and Valovirta (2015) draws similar conclusions and suggests that other instruments, such as financial support, should be applied in a pilot stage of the procured service innovation. Regarding small and medium-sized enterprises (SMEs), Aschhoff and Sofka (2009) show that PPI is the most efficient demand-side instrument. With respect to this, SMEs regarded as innovative in an entrepreneurial sense are more actively involved in public procurement, and therefore, acknowledging this observation in procurement contracts could be beneficial regarding policy targets (Reijonen et al., 2016). Further, Pickernell et al. (2011) highlight a spatial aspect of innovation procurement by noting that the public-sector demand from non-local sources provides support for innovative firms. This is corroborated by Tammi et al. (2017) who report that entrepreneurial SMEs tend to seek public sector contracts from non-local sources.

Another aspect is how firms are able to become involved and provide innovative solutions in PPI. Uyarra et al. (2014) show that firms face different barriers to public innovation procurement participation. Problems originate from the contracting authority's ability to define innovation-friendly requests for tenders and manage risks during the procurement process. They also report that SMEs and non-profit organizations find large contract sizes and communication problems between the supplier and the procurer problematic. Edquist and Zabala—Iturriagagoitia (2012) argue that the public-sector buyer's excessive specifications curtail

the provision of innovative solutions. From the perspective of a public agency, Amann and Essig (2015) report that public sector procurers regard the consumption of time and the complexity of the procurement process as the greatest barriers to innovation procurement. Interestingly, the risk associated with innovation procurement does not emerge as a problematic issue even though risk aversion has been attributed as one of the culprits that slow the adoption of PPI (Lember et al., 2015).

Towards Risk Management and Contracting Strategy Frameworks

In spite of the quite visible promotion and implementation of the idea of stimulating innovations via public procurement at supranational, national and regional levels, it could be that policymakers do not fully understand how public procurement of innovation as a policy tool differs from the traditional innovation policy (e.g. Edler and Georghiou, 2007; Georghiou et al., 2014). The traditional innovation policy mindset can be justified by the following market failure argument:

> "*the level of investment in research and development is likely to be too low, from a social point of view, whether market structure is nearly atomistic, a highly concentrated oligopoly, or something in between*" (Martin and Scott 2000, 437; italics original).

This has then led to correcting market failures with a rich policy tool box. A dominant idea is that innovation policy is needed because otherwise private firms would underinvest in R&D. The use of various policy instruments, such as direct funding of firms, public research organizations, competition policy, fiscal measures, risk-sharing schemes and technology/knowledge extension services are justified.

There is, however, a need for further developing the tool-box of innovation policy in the context of public procurement. An offset of this is the fact that public procurement of innovation involves complexities related to the nature of innovation, information sharing, co-operation and the manifestations of societal problems and the needs of the end users (Rolfstam et al., 2005; Edquist and Zabala-Iturriagagoitia, 2012). As Edler and Georghiou (2007) see it, PPI involves characteristics which cannot be entirely understood from the traditional market failure (mostly information asymmetries) approach, nor the somewhat fresher system failure (inoperative interaction) approach. This underlines the need for further discussion and analysis concerning the complexities of PPI. Among other things, it is useful to conceptualize risk and risk-sharing issues inherent to PPI and, in addition, the shaping of a

framework of contractual strategies of risk-sharing and incentivizing in PPI.

A general framework for risk management in public procurement of innovation is outlined by Edler et al. (2015). Their premise is a logical response to the market and system failure arguments. That is, they see that public procurers should be encouraged to take calculated and deliberated risks to achieve "increased profits, exports and economic growth" and to contribute to the increase of both private and social returns on investments (ibid. 89).

A cornerstone of the general framework of risk management in PPI is a five-fold typology of risks (ibid.; also Tsipouri et al., 2009). Of particular importance for the analysis of contracting strategies investigated in this paper are the following two risks: technological risks and financial risks. Technological risks are risks of non-completion, under-performance and/or malfunction of the procured product or service originating from the supplier. Financial risks, as the authors explain, are two-fold: firstly these include risks related to funds needed to accomplish the project, and secondly they involve risks related to meeting the targeted/budgeted costs. In other words, technological risks and financial risks are *possible occurrences*[4] which may happen and result in negative consequences with a bearing on the budgeted cost structure of the project.

What then are the instruments which could be used in addressing risks involved in PPI and which could provide tools for firms and public sector contracting authorities to exercise successful risk management? By keeping on the path restricted by our point of view (that is, focusing on PPI), the literature suggests the following. First, there is a need to change the attitude and organizational culture to bring awareness of risks and risk-management procedures among the parties involved in PPI (Edler et al., 2015). Second, a supporting structure which enables long-term planning and exchange of information in a transparent manner would help risk identification and risk management. Third, improving contract design and delivering best practices of such designs to others is also needed (Kalvet and Lember, 2010). It is important to note that, contract design appears to be the main way of managing technological and financial risks. As Kalvet and Lember suggest (2010), different contract designs offer different incentives to promote quality and to avoid excessive costs.

[4] The other risks are organizational and societal risks, market risks and turbulence risks covering a much wider range of possible risk occurrences in public procurement.

CONTRACTING STRATEGIES

Public Procurement as a Part of the Prize Menu for Innovations

The main objective of prizes is to stimulate innovations by granting money or other awards to innovators. Public procurement can be regarded as a part of the prize menu for innovations. In general, the prize menu for innovations is divided to *Ex-ante* and *Ex-post* prizes (Cabral. et al., 2006). Ex-post prizes[5] reward innovations that could not have been predicted, whereas ex-ante prizes are posted in advance and are given to the inventor who is the first to solve a well-defined problem.

In adherence to the categorization given by Cabral et al. (2006) and Brutsher et al. (2009), ex-ante prizes can be subdivided into three categories based on how the prize is awarded:

1) Research prizes ('first past the post');

2) Research contests ('research race');

3) Innovative procurement contests.

In the research prize category, the public sector sets only a prize (monetary award) but not a deadline, and the prize is awarded to the first competitor who achieves a verifiable target. In a research contest, the public sector sets both a prize and a deadline, and pays the prize to a competitor who has made the largest progress defined (e.g. quality) once the deadline is reached. Thus, the main difference between the two categories is that the deadline is fixed in the research race, whereas in the competition for a research prize the prize is awarded when the desired innovation is accomplished. Both of these categories are feasible if the procuring authority can set the optimal prize easily. This means that information is symmetric between the public-sector procurer and the competing suppliers, i.e., the contractual parties possess the same information on the costs of innovation, for example.

In many cases, however, the contracting authority is not able to set an optimal prize due to asymmetric information between the procurer and the suppliers. Therefore, one option for encouraging supplier innovations is a so-called innovative procurement contest. In this category, suppliers are invited to submit their innovative solutions together in order to bid for the right to sell an innovative product or service to the public sector. Thus, the main difference between the research contest and the innovative procurement contest is that the prize is not specified in advance, and

[5] The typical example of an ex-post prize is the Nobel Prize, which is awarded ex-post in the sense that the value of innovation has been noticed in retrospect.

subsequently, the winner of the innovative procurement contest is the supplier who bids the best price-quality ratio. Loosely speaking, the innovative procurement contest can also be organized by asking suppliers to submit a prototype of a product or service, and the winner is then contracted to develop it further as a R&D process. Alternatively, the contracting authority may choose some suppliers who are invited to negotiations and competitive bidding in terms of R&D costs, which is similar to how architectural competitions are organized. Brutsher et al. (2009) recommend applying an innovative procurement contest when the objectives are identifiable, the outcomes are observable, and information is asymmetric between the public agency and its suppliers with varying abilities. Furthermore, they also suggest its use when i) the market exhibits strong network externalities and problems of lock-in, ii) there is some uncertainty over which technology is superior, and iii) an innovative product or service is expected to have a long life-cycle. Although the innovative procurement contest seems to be applicable to most real-life cases and appears better compared to the other prize mechanisms, it comes at a cost. As competitive bidding reduces the prize for innovation, it also reduces the incentive to innovate, which results in lower effort from the suppliers (Cabral et al., 2006).

Contract Types as Incentives in Innovation Procurement

Contracts are essential in ensuring that the correct product or service is delivered to the customer by the supplier and that the customer purchases a predetermined amount. Selecting the right contract strategy is complex, but scholars and practitioners agree that contract flexibility, incentives to improve quality and reduce costs, and the allocation of *procurement risk* are the most important aspects to the contracting authority when different contracting strategies are assessed (Albano et al., 2006). Accordingly, we focus next on the allocation of the procurement risk and incentives to improve quality and reduce costs.

The procurement risk includes events that may affect the realization of contractual performance which cannot be predicted or influenced by the contracting parties. These risks are higher in PPI compared to conventional procurement because innovation processes are inherently more unpredictable by nature. Thus, how should the risk be shared efficiently between the contracting authority and the supplier? According to the economic theory of contracts, risk should be borne by the most capable party (Albano et al., 2006). In most cases, the public-sector buyer has more resources and is, thus, the stronger party. As a consequence, the process is efficient when the public sector bears more risk than its

suppliers. However, if the contracting authority assumes all the risk, this may reduce the supplier's incentive for achieving cost efficiency.

Incentives for achieving cost reductions and improving quality can be included in contract strategies. Holmström (1979) suggests that all verifiable and measurable costs and quality matters should be specified in a contract. Then, the procurer can control and affect the cost efficiency and the quality of a product or service by setting incentives for the supplier to produce cost-efficient and high-quality goods or services. Further, a penalty may be issued if the standards specified in a contract are not met.

In the following section, we introduce primary contract strategies. The most commonly used categories are explicit and implicit contracts. The difference between the two contract types is that the explicit contracts are legally binding contracts that can be easily enforced by a third party, such as a court of law, whereas the implicit contracts are agreements that are hard to monitor by a third party. For instance, it may be difficult to ascertain quality.

Explicit Contracts

Explicit contract types can be divided into three primary categories: 1) *cost-plus contracts* (C+), 2) *fixed-price contracts* (FP) and 3) *incentive contracts* (IC) (Laffont and Tirole, 1993). The most commonly used contract types are the fixed-price contracts and the incentive contracts. However, many procurement contracts are combinations of these three primary types and may include specifying incentives in certain sections and prices in other sections (Albano et al. 2006). In general, all three types may be written as

$$T = P + bC, \tag{1}$$

in which T is a net transfer from the public-sector procurer to the supplier, P is a fixed fee, C is a realized and verifiable cost, and b is a constant taking values between one and zero, which describes how the realized costs are shared between the public agency and the supplier.

In a case of the C+ contract, the supplier reimburses all documented costs (C) related to the project and pays a fixed payment P to the supplier. In Equation (1), this indicates that b is equal to one. As a result, C+ is the extreme case of an explicit contract because the supplier does not have to worry about costs

at all; the public sector bears all risks of the project, and subsequently, the supplier does not have any incentive to strive for cost efficiency.

A C+ contract could be suitable in cases where the risks should be carried by the public agency and quality is an important but non-verifiable factor. This may occur in procurements where the outcome of the venture is highly uncertain. Since all costs are reimbursed to the supplier, efficient and non-efficient suppliers are incentivized to submit bids at the same level of cost (Albano et al., 2006), which prevents the contracting authority from selecting the most efficient supplier. Therefore, a pure C+ contract should be used cautiously.

In the case of an FP contract, the only payment that the public sector pays to the supplier is a fixed payment *P*. This implies that *b* is equal to zero in Equation (1). Hence, this scenario represents the second extreme case where the public sector pays a fixed price for the project that meets given quality standards. The supplier carries all risks if the realized costs are higher than estimated. If they are lower than the estimated costs, the supplier makes more profit than expected. Therefore, the supplier has an incentive to act as cost-efficiently as possible, though the public agency does not benefit from the achieved cost savings.

An FP contract provides incentives to the supplier to save costs within the specified quality standards but does not provide an incentive to produce high-quality products or services. In the tendering process, it is a simple and efficient way to find the most cost-efficient supplier. In addition, FP assigns the procurement risk to the least risk-sensitive supplier who can bid the lowest price *P*. Applying the FP contract may be suitable in projects with less complexity, which are not assumed to include many risks, and where the outcome of the project is based on the supplier's actions to reduce costs rather than attempts to achieve high-quality standards (Albano et. al 2006).

An IC contract falls between the C+ and FP contracts. In terms of Equation (1), it typically includes a target fixed payment *P*, a target cost *C*, and a risk-sharing parameter *b* which is larger than zero but lower than one. All estimated cost overruns or underruns are shared between the public-sector procurer and the supplier, and the value of *b* defines the supplier's incentive to reduce costs. If *b* is close to one, the incentive to reduce costs is low; if *b* is near zero, it is high. As the public agency sets the optimal value of *b*, it is affected by the riskiness of the project, and the supplier's ability to bear the risk and achieve cost reductions. Compared to an FP contract the IC contract seems superior at first sight. However, the contracting authority must monitor realized costs because cost

overruns and underruns are shared between the contracting parties. If the associated transaction costs are high, it is possible that the benefits from using the IC contract would be lower than the transaction costs of monitoring. Therefore, the public-sector procurer should consider a trade-off between the benefits of using the IC method and the transaction cost of auditing when selecting a contract strategy.

There are at least three factors that support setting the value of *b* at a low level: 1) if the supplier's risk aversion is high, 2) if the supplier is not capable of implementing cost reductions of a significant magnitude, and 3) when shocks that may affect production costs are unpredictable. If these three factors are occur at the same time, there is a good reason to set *b* at a high level. The public agency should favor the FP contract when suppliers are relatively insensitive to the procurement risk and when they are fairly homogenous in their ability to control production costs. In addition, when contract costs are expected to be high compared to the associated benefits, the FP contract should be used. Conversely, the IC contract should be used when the procurement risk is important and suppliers are more sensitive to it than the public sector.

The FP contract is used as the basic case of an innovative procurement contract in the sense that the winner of the tendering process is the firm that offers to supply the product or service at the lowest *P* (a price per unit of a pre-specified of quality). Therefore, if the contracting authority applies another contract type, the competitive bidding during the procurement process is likely to be affected. Let us consider how choosing a different incentive contract impacts the tendering process and how to choose an optimal risk-parameter *b*.

It is assumed that suppliers differ in their abilities to supply a product or service at low cost and are also more risk-averse than the public-sector procurer. In this case, it is optimal to choose *b* to allow the suppliers to submit tenders for the fixed part *P* (McAfee and McMillan, 1986). If the value *b* is chosen appropriately, the most efficient supplier tends to be selected and the optimal trade-off between providing the supplier with an incentive to reduce costs and risk sharing between the contracting parties will be achieved. Albano et al. (2006) provides some practical advice on how to choose an optimal parameter *b*. The cost-sharing parameter *b* should be larger when the supplier's fear of risk is high; the shocks affecting the production costs are unpredictable; the supplier's ability to control costs are low; and increased cost-reducing activities may be harmful to the quality of the product or service. Further, the significance of the provided incentives should be

reduced if there are important tasks that are difficult to monitor, and/or accounting costs are not stable.

Implicit Contracts

An implicit contract can be a powerful tool in situations where the quality of a procured product or service cannot be measured or verified easily. Albano et al. (2006) categorize different implicit contracting methods for non-contractible quality: pre-contractual methods, within-contract methods, and post-contract methods.

Pre-contractual methods are actions performed before the procurement process. These actions include limiting competition for the contract, discriminatory competitive tendering, and bilateral negations. Albano et al. (2006) suggest that when procurement involves important, non-contractible dimensions such as high-quality R&D, it may be useful to soften the price competition; this can be done, for example, by limiting the number of competing suppliers. Thus, in cases where procurement is complex, quality concerns, which are hard to verify, should be developed. Therefore, strong price competition is not desirable, but the public-sector procurer can ensure an anticipated level of quality. However, this option has a downside because restricting competition increases the public sector's costs as the absence of perfect competition is likely to result in a higher price (i.e., the most efficient supplier will not be chosen from the pool of all potential suppliers).

Within-contract methods are applied during the contracting period. For instance, a contracting authority can select two suppliers during the selection stage and then use both (i.e., dual sourcing). Additionally, penalties and bonuses can be given to the supplier if the observed but indirect quality is lower or higher, respectively. This type of quality can be based on customer satisfaction surveys which correlate with the level of non-contractible quality. Thus, the within-contract methods are suitable when the product or service quality is non-verifiable but can be observed during the project. However, the application of this method has several drawbacks. First, if the public agency is also the user of the procured product or service, there is no incentive to accept the product or service at a higher level of quality (i.e., the public agency would have to pay extra bonuses to the supplier). Second, there are costs from using dual sourcing such as the management cost of tendering and changing a supplier. If the cost of changing a supplier is sufficiently high, the contracting authority will not have a realistic option for changing the supplier even if the standards are not met.

Post-contract methods are actions performed after the contract execution. In this case, the public agency has an option to react to

a supplier's low/high quality in future contracts. For example, a current contract can be renewed if the procurer is satisfied with the supplier's performance. This provides the procurer with a real incentive to renew the contract compared to within-contract methods where monetary bonuses are paid. The procurer may also score the supplier's performance after the contract, which can be used in future tendering processes as a reference for the supplier to produce high-quality services or products. However, references may become barriers to entry for new suppliers. Post-contract methods are recommended in particular when non-verifiable quality of a product or service is observed after the project is finished.

To illustrate the different contracting methods in a conceptual framework, Figure 1 assigns the characteristics of procurement within the supplier's risk sensitivity (the horizontal axis) and the degree of the use of implicit contracting (the vertical axis). In consequence, the framework consists of four quadrants where applying particular contracting methods are suggested. On the left-hand side of the vertical axis, suppliers are risk-sensitive, that is, the public-sector buyer is more capable of bearing the procurement risk. In the upper-left quadrant, procurement can be characterized as complex with quality deemed important but non-verifiable, and the costs are verifiable. This case supports the application of C+ contracts together with implicit contracting methods. In the lower-left quadrant, procurement is complex, but the quality is verifiable. Consequently, C+ contracts may be applied, but implicit contracting methods are not important. On the right-hand side of the vertical axis, suppliers are not sensitive to the procurement risk. In the upper-right quadrant, procurement can be characterized as being simple with the price being important, but costs and quality are not verifiable. In this case, the contracting authority could apply an FP contract together with implicit contracting methods. In the lower-right quadrant, quality is verifiable. Thus, implicit contracts are not powerful, but an FP contract provides a high incentive for cost efficiency.

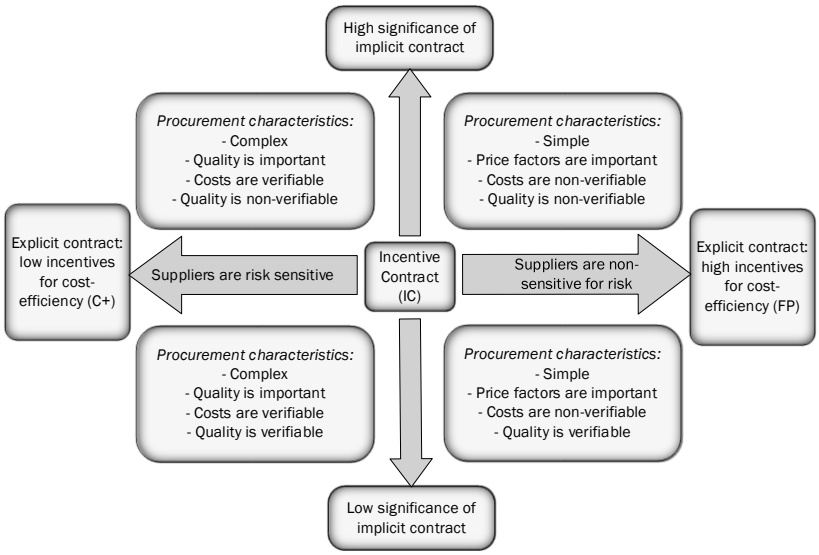

Figure 1. Conceptual framework for choosing between explicit and implicit contract strategies.

But where does innovation procurement fit in the proposed framework? Inarguably, procuring innovations involves risks and the outcome may be unpredictable due to the nature of innovations. Subsequently, it is likely that the public-sector procurer is more capable of bearing the procurement risk than suppliers. In particular, this applies when innovation procurement involves SMEs, which have limited resources compared to large firms. Further, innovations can be procured by specifying tenders in functional terms rather than adhering to strict technical specifications. This also implies that quality is more important than price in PPI. These arguments suggest that PPI can be characterized as complex procurement. As a consequence, procurement involving innovative characteristics is likely to be located on the left-hand side of the vertical axis. In consequence, it is advisable to consider the use of C+ contracts in innovation procurement, to share the risk with the chosen supplier(s), and apply implicit contracting methods depending on how well quality can be verified.

DISCUSSION

Incentives and risk sharing in PPI is an important issue and it is also important to pay attention to the legal sphere in which public innovation procurement is being put into action. The current fifth generation directives that regulate public procurement in the

European Union (EU) were introduced in 2014. Member states have to transpose these directives into their national legislation by the 18th of April 2016. One particular goal in the drafting of the new procurement directives was to facilitate innovative procurement. To achieve this, a new procedure called 'Innovation partnership' was introduced and the use of negotiated procedures was made easier.

The directives are only applied to contracts which are above the thresholds which the European Commission sets once every two years. It also needs to be noted that below-threshold procurement contracts have to comply with the fundamental principles of EU law. The legislation mainly stipulates the notification of procurement contracts and procurement procedures. In essence, the directives are procedural legislation and do not regulate the contents of procurement contracts. Although it needs to be understood that the procedural rules laid down in the directives also affect what the procurement contract can and cannot include, this also affects the use of explicit and implicit contracting strategies.

The legislation limits the possibility of using implicit contracting methods when these disturb the equal footing of the competitors in the procurement procedure or affect the transparency of the tendering procedure. For example, the possibility to renew a contract is very limited. The possibility to extend a contract has to be calculated in the value of the contract. The option clause needs to be clearly stated in the contract notice, and the decision to exercise the option needs to be implemented within three years after the signing of the original contract. The methods and actions mentioned above are more or less compliant with the legislation as we have refrained from mentioning such actions and methods which clearly are not compatible with the legislation.

It is surprising how little the directives paid notice to the existence of explicit contract types given how much the innovation aspects were emphasized in the renewal process of the directives. The reforms that have been made, especially the innovation partnership procedure, have been criticized as being difficult and onerous (see Arrowsmith, 2014, [pp. 1048–1050]). It also seems that the use of fixed-price contracts in public procurement is a norm and the use of incentive and cost-plus contracts in particular are very rare. The reason for this is not entirely clear. One contributing factor may be that procuring agencies seem very risk averse (Kalvet and Lember, 2010; Bauld and McGuiness, 2008; Erridge and Greer, 2002). The procurement legislation may also have something to do with this phenomenon due to the way the selection of the winning bid is stipulated. This selection can be based on the lowest price or the best price-quality ratio which implies that costs are known in the competition phase of procurement. The legislation

however does not preclude the use of cost-plus contracts, which is apparent from the jurisprudence of the Court of justice of the EU (see cases C-113/13, ECLI:EU:C:2014:2440 paragraph 37 and C-159/11, ECLI:EU:C:2012:817, para. 29.) The guidance on how to use these contracts could actually be more effective to facilitate public innovation procurement than the new procedures. This is something that the EU has actually done regarding the Copernicus program under its own financial regulation. The regulation 377/2014, article 20, states how to use cost-reimbursement contracts under the program.

In the US, public procurement has incorporated the use of strategic policy goals, such as the protection of the environment or the promotion of innovation, whereas in the EU, the integration of strategic goals with procurement has been emphasized at the legislative level with the introduction of the new procurement directives (Vonortas, 2015 and SEC (2011) 1585 final). In the US, PPI has mainly been carried out in the domain of national defense and security. In other areas, the focus is not on innovation *per se*, and there is no regulation or an established procedure that would provide guidance on PPI. The federal public procurement managements are aware of the need to constantly improve procurement processes and promote innovation. However, innovation to them is more connected to achieving strategic policy goals and improving the efficiency of procured products and services. The implementation of other policy goals is mostly left to the contracting authorities. These have the discretion to flesh out how the goals are pursued in the procurement at hand (Vonortas, 2015).

From the point of view of legislation, the implementation of other strategic policy goals to procurement processes is very similar in the EU and in the US. In the EU, the discretion to apply other policy goals is left to the contracting authorities. The implementation of strategic policy goals has been possible in the EU prior to the introduction of the new procurement directives. Despite the fact that the European Commission issued multiple communications that demonstrated how to do this, contracting authorities did not adopt these practices in general. In consequence, the new directives were drafted in such a manner that contracting authorities would understand and start implementing strategic policy goals in public procurement. It can also be argued that the attitude towards the promotion of innovation is not much different between the procurement officers in the US and in the EU. Innovation is more connected to improving the efficiency of procured products and services and maybe achieving strategic policy goals (SEC (2011) 1585 final). The use of public money is and needs to be connected to the core mission of the agency in

question. The contracting authority has to adhere to relevant legislation and very often policies which may lead top clauses and criteria with political and social goals, such as the protection of the environment, have to be added to the procurement process and included in the contract. Hence, innovation is not pursued just for the sake of innovation, but because it is necessary to achieve other more concrete goals.

A very notable difference is that US legislation places more emphasis on the contract design. The Federal Acquisition Regulation (FAR) regulates and provides guidance on how to use different types of contracts. In contrast, EU directives do not contain any provisions about contract types. This is understandable because directives are procedural legislation and primarily concern the awarding procedures of public procurement contracts. Ultimately, this may be a factor that causes European procuring authorities to be more risk averse compared to their US counterparts. The procurement directive is written in such a way that it gives the impression that the costs of contracts are known in the competition phase of procurement. When this is combined with a fear of litigation and risk averse behavior, it may lead to a tick-the-box approach towards the procurement legislation which, in turn, may lead to the use of fixed price contracts, even though the use of cost-plus contracts would be more reasonable. Concerning strategic procurement and PPI as part of it, because public sector procurers in the US have first-hand knowledge and guidance on the use of different types of contracts, this may give them far better chances, compared to contracting authorities in the EU, to consider strategic policy goals as part of their procurement processes.

There are some important managerial implications that can be learned from this study. As significant benefits are associated with public innovation procurement, contracting authorities should be encouraged to take calculated risks and apply proper incentive mechanisms and different contract types if public procurement is being used to promote innovation goals. It also needs to be acknowledged that projects may fail in innovation-related procurement because innovation is inherently risky and unpredictable. This means that contracting agencies need to be aware of this and plan accordingly. The scale and the objects for which to implement innovative procurement must be selected carefully and the use of cost-plus or incentive contracts is recommended to avoid non-delivery. This is not to say that the public sector should always bear the risks, but to bear them in the initial phase to achieve innovation. After this outcome is accomplished, the subsequent rounds of procurement can be carried out using fixed price-contracts. The first round may also be

the costliest, but subsequent procurements should improve the overall cost-benefit ratio compared to the ratio prior to the innovation. From the policy perspective, it is apparent that contracting authorities may need information and additional training regarding the use of different contract types in public innovation procurement.

It is apparent that this study has only scratched the surface and much more research needs to be carried out regarding contracting and contracting policies applied in PPI. Future research could pave the way for efficient PPI and to identify best practices and to spread them into wider use in the EU. Based on the results of this paper, several issues emerge which the future research could address. First, there is an urgent demand for empirical assessments of the current usage of different contract types in public procurement in general and in public innovation procurement in particular. Second, the barriers to the usage of different contract types in the EU, especially incentive contracts and cost-plus contracts should be studied. For example, does the public-sector procurer's risk aversion play a role, and further, do behavioral biases weigh in the choice of contracting methods. Third, it is important to look for cases where different contracting methods have been applied and assess their performance in each case. Finally, possible experimentation that involves different contracting options in similar procurement cases could provide important insights into their application in practice.

ACKNOWLEDGEMENTS

This study was financed by the Finnish Funding Agency for Innovation and Technology research grant #40055/14.

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