Should SMEs pursue public procurement to improve innovative performance?

Jani Saastamoinen*, Helen Reijonen and Timo Tammi
University of Eastern Finland Business School

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Abstract

While public procurement is an efficient demand-side policy instrument, resource constraints impede small and medium-sized enterprises from accessing innovation procurement contracts. As a remedy, inter-organizational networks are seen as a means to extend SMEs' resources. This paper examines the relationship between inter-organizational networks and SMEs' innovative performance. It investigates how this relationship is mediated by the public or private sector customer's demand for new or significantly improved products. We find that networks involving other firms are associated with SMEs' innovative performance, and that this is mediated by both customer types. Furthermore, the public procurement of innovations is associated with greater returns in the case of the new products or services. For significantly improved products or services, networks involving other firms may improve performance when the demand originates from private sector customers. Our results suggest that SMEs should emphasize networks with other firms rather than public or private research and development actors when they develop new products for the public sector. These innovations can be further developed, providing opportunities for further leverage in private sector markets.

Keywords: Public procurement of innovations, SMEs' inter-organizational networks, innovative performance, product development

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* University Lecturer. Contact address: Yliopistokatu 2 80101 Joensuu Finland, e-mail: jani.saastamoinen@uef.fi, tel. +358 50 442 3463.

1. INTRODUCTION

The use of demand from the public sector to trigger private sector innovation is becoming increasingly important and relevant to innovation policy and as a means to support SME innovations (Geroski, 1990; Aho et al., 2006; Edler and Georghiou, 2007; Uyarra et al., 2014). It has also been acknowledged that suppliers' inter-organizational networks may be necessary to facilitate innovations in the context of public procurement (van Meerveld et al. 2015). This paper investigates how these inter-organizational networks and the public sector customer's demand for innovations are associated with SMEs' innovative performance. To our knowledge, this remains an unexplored subject in the literature.

Public procurement may lead to innovation in two ways: as a by-product of 'regular' public procurement, or as a desired outcome of public innovation procurement, in which the public sector places an order for a product or service which does not yet exist but can be developed (Aschhoff and Sofka, 2009; Edquist and Zabala-Iturriagagoitia, 2012). The latter, in particular, has been argued to be an efficient innovation policy instrument (Lichtenberg, 1988; Aschhoff and Sofka, 2009). In regard to small and medium-sized enterprises (SMEs), public procurement could be a valuable tool in promoting their innovations (Love and Roper, 2015). Conversely, SMEs could improve the innovation potential of public procurement (Georghiou et al., 2014), because small firms are often characterized as being innovative (Konsti-Laakso et al., 2012). However, firms with greater resources have a better capability of bringing innovations to the market and reaping greater rewards from them (Sorescu et al., 2003). Public procurement is not different in this respect: although innovative SMEs are actively involved in public procurement (Reijonen et al., 2016), small firms lack resources to compete for public tenders (Flynn et al., 2015). Furthermore, since public procurement of innovations is often characterized by large contracts (Uyarra et al., 2014), this may impede SMEs' capability to respond to this instrument.

As a potential remedy to this problematic interplay of limited resources and large tenders, it has been suggested that developing co-operation and partnerships could be a key to success in innovation for SMEs (Goes and Park, 1997; Laforet and Tann, 2006). In the development of major innovations, networks are important because they provide access to diverse and situation-specific knowledge which may be required in an innovation project (Kelley et al., 2009). New product development and market introduction are often costly and time consuming processes with uncertain outcomes, and thus, firms may wish to engage in strategic alliances to obtain knowledge and capabilities needed for these processes (Haeussler et al., 2012). Consequently, networks reduce the risk failure and increase chances of success by providing SMEs with the means to acquire required external resources (Watson, 2007). Through networks, small firms can achieve economies of scale without the diseconomies caused by large size (Watson, 2007).

While SMEs' innovations and networks have been extensively studied in other contexts, this is one of the first studies to address their role in public procurement of innovation. According to Edler et al. (2015), systematic analyses of the meaning of public procurement for innovation are needed. Moreover, while SMEs could increase the innovation potential of public procurement (Georghiou et al., 2014), it is inadequately understood how they relate to the public sector procurement of innovation. In particular, there is insufficient knowledge about the SMEs' use of networks in public (innovation) procurement. Further, one of the challenges facing public procurement highlighted by Edler and Yeow (2016) is in establishing incentive structures which provide sufficient gains to those organizations that bear the risk in innovation. Yet, very little is known about how SMEs benefit from being involved in public procurement which aims to trigger innovation. To address these gaps in the literature, the aim of this paper is to study how SMEs' involvement in networks with different partners is associated with their innovative performance when supplying innovative products or services to public and private sector customers. This setting also provides an opportunity to compare performance between public innovation procurement and demand for innovations originating from the private sector.

This paper contributes to the prior literature in the following ways. First, this study focuses explicitly on SMEs in public innovation procurement adding to the nascent research literatures on the involvement of SMEs in public procurement in general and in innovation procurement in particular. Further, this study also addresses the use of networks by suppliers in public (innovation) procurement, for which empirical research is scarce. Second, our results suggest that the choice of a networking partner is important when providing innovative products or services to the public sector. Our findings point to other firms as opposed to public and private sector R&D actors, whose importance as networking partners have been identified in previous studies (e.g. Freel and Harrison, 2006, Tether and Tajar, 2008), being the preferred networking partners in public innovation procurement. Third, our empirical evidence implies that SMEs could benefit financially from developing new products or services for public sector customers as opposed to private sector customers, which provides a monetary incentive to participate in public innovation procurement. While our results are novel, a caveat is that our sample is from Finland, and since the prevalence of public innovation procurement may vary from country to country, this may affect the generalizability of our results.

This article is constructed as follows. In Section 2, we develop research hypotheses based on the previous literature. In Section 3, the data and methods are presented. The results of the statistical analyses of this study are reported in Section 4. In the final section, conclusions and managerial implications are drawn up, and limitations and possible avenues for future research are discussed.

2. LITERATURE REVIEW

2.1 Innovation and Public Innovation Procurement

According to Garcia and Calantone's (2002) extensive literature review, a workable definition of innovation, encapsulating the overall essence of innovation, is formulated in a publication "The nature of innovation and the evolution of the productive system. Technology and productivity - the challenge for economic policy" by OECD (OECD 1991). Accordingly, innovation is defined as an iterative process of developing, producing and marketing products and/or services as a response to a perception of new opportunities and in association with aspiring commercial success. In this definition, the development of an innovation is combined with the introduction of the innovation to the end-users by means of adoption and diffusion; and the iterative nature of the innovation process is emphasized in the sense that a new innovation is followed by improved innovations (Garcia and Calantone, 2002). This also justifies the use of different typologies in describing the degree of 'newness' in an innovation (ibid.).

The most elementary categorization, which we also adopt in this paper, is a dichotomous division into incremental and radical innovations. An incremental innovation involves making changes to existing products or services, whereas a radical innovation occurs when an entirely new product or service is introduced to the market. The 'degree of newness' is connected to a micro perspective – viz., the 'degree of newness' seen from the viewpoint of the firm or the firm's customer (Garcia and Calantone, 2002; also Freeman, 1994). A prevailing understanding is that compared to an incremental innovation, the development and selling of a radical innovation requires more time, resources and information (Dewar and Dutton, 1986; McDermot and O'Connor, 2002). However, there are differences in information gathering benefits in pre-design versus commercialization phases (which will be further elaborated in Section 2.3.) (Song and Thieme, 2009).

The public innovation procurement literature also addressed these qualities of innovation. Concerning the 'degree of newness' of a procured innovation, Edquist and Zabala-Iturriagagoitia (2012; Edquist, 2015) distinguish between direct and adaptive innovation procurement: adaptive innovation procurement is a product or service that is new only to the end-user (public agency, firm, or territory); respectively, a direct innovation procurement occurs if a product or service is 'new-to-the-world'. Adaptive innovation procurement often results in an incremental innovation. This distinction is closely related to the degree of cooperation in public innovation procurement in respect to how much cooperation (communication, collaboration and learning) there is between the procurer and potential suppliers (Edquist and Zabala-Iturriagagoitia, 2012; see also Rolfstam, 2012). The cooperation

between the procurer and the suppliers has its counterpart in the cooperation between the suppliers and their network partners. There is empirical evidence concerning the importance of cooperation of the first kind (Uyarra et al., 2014; Loader, 2013; Edler et al., 2015) but not of the second kind. That is, the role of networks in public innovation procurement.

In a narrow sense, public procurement of innovation means the procurement of products or services and/or their characteristics that do not exist but can be developed (Edquist and Hommen, 2000). Another type of public procurement involving innovation, but being not public procurement for innovation, is pre-commercial procurement, which refers to the procurement of research results rather than actual product or service (Edquist and Zabala-Iturriagagoitia 2012). In a broader sense, however, all public procurement may impact innovation through changes in demand and firm behaviour (Uyarra and Flanagan, 2010). Rolfstam (2012, also Edquist et al., 2015) distinguishes the notion of innovation-friendly public procurement which is not public procurement for innovation but the regular form of public procurement which encourages and stimulates innovation. To foster innovations, for example, a procurer can use functional terms rather than descriptions of products in calls for tenders (Edquist et al., 2015; Knutsson and Thomasson, 2014).

Public procurement of innovation is also an innovation policy instrument. Aschhoff and Sofka (2009) list four types of innovation policy instruments – viz. public procurement, regulation, research institutions and universities and public R&D subsidies. Public procurement and regulation are demand-side instruments, whose purpose and impacts on firms differ. Procurement seeks to satisfy the public sector's demand or policy targets and rewards firms with money (e.g. sales), whereas regulation seeks to influence firm behaviour by mandatory means. Their common feature is a reduction in market risk, 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 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.

Although policy makers and planners of public procurement and public innovation procurement in general have exhibited some enthusiasm regarding the use of public procurement and public innovation procurement in fostering innovations, there are also major reservations on the matter. It is often argued, that the public sector suffers from an innovation deficit (Potts 2009) due to its aversion to experimentation, risk and failure (ibid.), as well as to deficiencies and complexities in tender

specifications, lack of supplier-end-user interaction and poor risk management between procurement entities (Uyarra et al., 2014; see also Loader, 2013). In particular, an analysis by Uyarra et al. (2014) suggests that firms devoted strongly to R&D are more likely to perceive that a lack of demand for innovation, as well as the size of contracts, lack of capacity, rigid specifications and lack of risk management are significant disincentives for innovation in public procurement contexts. They also report that SMEs and non-profit organizations find large contract sizes and communication problems between the supplier and the procurer problematic. Another concern is that local-level procurement authorities may have difficulties in attracting innovative firms to participate in invitations to tender, as Tammi et al. (2017) report a tendency for innovative entrepreneurial firms, to focus on national-level rather than local-level public sector customers.

However, there is empirical research demonstrating that public procurement and public innovation procurement have positive effects on R&D and/or innovation. For example, Lichtenberg (1988) found that sales to the public sector increased private R&D expenditures more than sales to the private sector, and competitive procurement in the form of design and technical competition resulted in a major spending increase in the private sector. He argues that this is a consequence of the winner of the competition receiving profitable "follow on" non-competitive contracts with the public actor, which act as an incentive to boost the R&D spending in the competition phase. Furthermore, Slavtchev and Wiederhold (2011) suggest the high technology sector is the most responsive to public procurement in increasing the private spending on R&D. In addition, Fontana and Guerzoni (2008) underline the importance of incentives in the form of improved profitability and signalling through the market demand to reduce uncertainty in the early stages of innovation.

Empirical evidence suggests that public innovation procurement appears to be an efficient policy tool. According to Geroski (1990), public procurement is more effective than R&D subsidies. Aschhoff and Sofka (2009) show that public innovation procurement is the most efficient demand-side policy instrument, especially for SMEs. Georghiou et al. (2014) suggest that a significant proportion of organizations who bid for or have contracts with public sector customers report innovations attributed to public procurement. Guerzoni and Raiteri (2015) studied the interaction effects between different policy instruments and found that while public innovation procurement is effective on its own, its effectiveness improves if other policy instruments are applied along with it. Pickernell et al. (2011) highlight a geographical aspect of public procurement innovation by noting that the public sector's demand from non-local sources provides support to innovative firms.

2.2 SMEs and Inter-organizational networks

According to transaction costs theory, a firm's choice between production within a hierarchical organization and procuring the means of production from input markets depends on the cost of using either the market or hierarchy as a medium of economic exchange (Coase, 1937; Williamson, 1973). If the market exchanges result in inefficiencies, the firm internalizes production within a hierarchical structure because administrative control is less costly in hierarchies (Williamson, 1981). Purchasing a single product or service (henceforth a product refers to both products and services for convenience) that is easy to define can be obtained from the input market. By contrast, business relationships are based on past interactions and projections of future needs that require transacting with the same exchange partner (Williamson, 1981; Ford and Mouzas, 2013). Thus, asset specificity determines how much buyer-supplier transactions will be carried out through bilateral agreements (Riordan and Williamson, 1985).

Networks are an important institutional structure for production and industrial organization. As an intermediate form of production between a market-based solution and a hierarchy, a network of enterprises shares the characteristics of the two ends of the institutional spectrum with its own operational logic (Thorelli, 1986; Powell, 1990). Networks are a preferred form of organization in the case of products which involve transmitting knowledge about specific qualitative characteristics, such as complex technical attributes or innovative production methods (Powell, 1990). There are four important forces that emerge in business networks: functional interdependence between actors in satisfying heterogeneous demand, a power structure that controls activities and resource allocation, a knowledge structure that, based on experience, allocates resources and activities, and intertemporal dependence that constrains radical changes within the network (Håkansson and Johanson, 1992). However, exogenous forces, such as changes in economic conditions, and endogenous forces, such as inter-firm alliances, impact network configurations (Gulati et al., 2000).

The existence of a network requires that there are relationships between firms which are distinct from transactions carried out in free markets (Easton, 1992). A network is a social structure where its actors connect with each other via links (ties) of varying forms and transact through flows of information, goods etc. using mechanisms that enable the interaction between its constituents (Antoldi and Cerrato, 2011). A network structure is shared by all organizations to some degree, because exchanging information and goods requires the use of internal and external networks to carry out business activities (Achrol, 1997). The use of a network requires that a firm takes into account the interconnected nature of business relationships in the network when choices are being made (Ritter, 1999). Networking involves using social ties to obtain scarce resources required in growing business (Luczak et al., 2010).

The key elements of networking include the availability of internal resources, a network orientation in human resources management, an open corporate culture and integrated inter-organizational communication (Ritter, 1999).

Long-term inter-organizational ties form a strategic network which has strategic importance to its members and helps its members to gain and sustain a competitive advantage (Jarillo, 1988; Gulati et al., 2000). Furthermore, capabilities originating from network relations may be specific and thus cannot be redeployed easily (Dyer and Hatch, 2006). Examples of strategic networks include strategic alliances, joint ventures and long-term buyer-supplier relationships (Gulati et al., 2000). A close but slightly different concept is a strategic multilateral network, in which the firms involved do not interact with all members of the network (Human and Provan, 2000).

SMEs have a resource disadvantage compared to their larger counterparts as they face several resource limitations related to, for example, finance, time, marketing knowledge and specialist expertise (Gilmore, et al., 2001). While entrepreneurial firms tend to rely on informal networks, such as friends family and business contacts in their formation phase (Birley, 1985), they require linkages to other actors to have access to resources which can be used to exploit perceived opportunities (Aldrich and Zimmer, 1986). The objective of a network is to overcome resource constraints and increase the network members' market power (Wincent, 2006). Network resources are an important pool of new skills and resources, and thus have an effect on how a firm organizes its resources (Woldensebet et al., 2012). As business networks are inherently heterogeneous in nature due to their members' characteristics, such as their resources, history and preferences, a network is a form of industrial organization that provides its members with a way to respond to heterogeneous demand which results from the same heterogeneity (Easton, 1992). Linkages to external partners (e.g. universities, venture capitalists) increase a firm's performance (Lee et al., 2001). Regional clustering around universities, research institutions and other firms is an important factor in the formation of SME networks (Zeng et al., 2010). However, competitive issues, information control and distrust between the network actors constrain effective network building (Brass et al., 2004).

2.3 Theoretical foundation and hypotheses

Although small firms usually invest very little in R&D, they are considered to be more innovative than their larger counterparts (De Propris, 2002). A critical issue concerning SMEs are their resource limitations. Although capable of being innovative, which may mitigate resource constraints (Asc and Audretsch, 1989), SMEs lack various resources required in both producing innovations and selling innovative products. Since firms cannot rely solely on markets for the information necessary for

innovation (Goes and Park, 1997), forming networks with other firms and actors is, then, a natural response to overcome these limitations. Although some researchers have argued that external collaboration is not necessary or a less sufficient prerequisite for successful innovation (Freel and Harrison, 2006), a great part of the academic literature indicates that firms do not innovate in isolation (e.g. de Propris, 2002). Indeed, a systemic approach suggests that innovation behaviour and performance are affected by the environment the firm operates in, i.e. other firms and organizations (De Propris, 2002). Hence, tapping into external resources is of high importance in gaining and exploiting innovation opportunities (Laursen and Salter, 2006; Lee et al., 2010).

Innovations typically affect firm performance positively. Thornhill (2006) suggests that innovation is positively associated with revenue growth irrespective of the industry in which the firm operates. On the other hand, it has been shown that many innovations fail in markets and that success and failure are dependent on the innovation type (Cozijnsen et al., 2000). As radical innovations are entirely new to the market and often include previously non-existent technology, they often require great behaviour changes in the markets (McDermott and O'Connor, 2002). As the adoption of radical innovations usually takes more time, the rewards, especially in private sector markets, may not be as immediate as in case of incremental innovations, where a market-tested product or process is improved (Kline and Rosenberg, 1986). Whereas in the public sector market, assuming that the innovator is successful in tendering for an innovative solution, the rewards from both innovation types are more immediate, as the public sector procurer may provide incentives in the form of prizes or guaranteed purchase of innovative solutions (Rogerson, 1994; Georghiou et al., 2014). Public procurement of innovations may be an especially lucrative alternative for resource constrained SMEs because it provides them with a reliable buyer that will purchase large volumes of the developed innovation (Pickernell et al., 2011). With regard to networking, novel innovators seem to be more engaged in innovation related cooperation with all their potential partners than incremental innovators or non-innovators are (Freel and Harrison, 2006). In consequence, in the hypotheses we will test the alternatives of a) a new (radical) innovation and b) an incremental innovation, with regard to different networking partners.

The use of different networks affects the success of these different innovation types. For example, the study by Song and Thieme (2009) showed that it is more beneficial to invest in gathering information from suppliers in the pre-design phase with regards to incremental rather than radical innovations. In the case of radical innovations, this kind of information gathering has the greatest positive impact during commercialization activities. Since radical innovations consume more time and money and often require a whole new set of skills, processes and systems (McDermott and O'Connor, 2002), their requirements from the network differ from incremental innovations that represent a smaller scale of

changes. Furthermore, Gronum et al. (2012) find that innovations act as a mediator between SMEs' networks and firm performance.

As the discussion above suggests, there are different kinds of networks regarding, for example, their content and purpose. Furthermore, networks with different participants and overall goals have different impacts on the operations and development of the firm (see Lechner et al., 2006) and generate different benefits. For example, governmental networking enhances a firm's ability to access valuable market information and lessens bureaucratic delays (Luo et al., 2008). Relationships with public research organizations may prove especially beneficial to SMEs, because they complement the potential lack of internal resources, such as the innovation capabilities needed to compete successfully (Masiello et al., 2015). Firms that have formed ties with their channel members (e.g. suppliers, distributors and retailers) are more able to explore and exploit increased customer value and implement their customer oriented strategies (Luo et al., 2008). The involvement in networks formed by entrepreneurs also generate several benefits, including learning, development of entrepreneurial processes, innovation, competitive advantage, value creation and growth, and survival (Parker, 2008). In this study, we focus on networks that include 1) other firms (e.g. suppliers, resellers, competitors) 2), private sector business service or research organizations (e.g. consultants, private research laboratories), or 3) public sector business service or research organizations (e.g. business development organizations, or universities). Later on, we will discuss how networking with these different partners affects the innovation of firms.

We further propose that the effect of networks on the success of innovation is mediated by the customer type, which in this study refers to private (consumers or other firms) or public sector customers. This mediation effect is due to, for example, differences in procurement methods. Since public procurement is well-regulated, buyers and suppliers have to observe a procurement process which is often perceived as overly bureaucratic and burdensome (Arlbjørn and Freytag, 2012; Harland et al., 2013; Uyarra et al., 2014). By contrast, the procurer has more latitude in the selection of suppliers in the private sector (Harland et al., 2013). Furthermore, in private markets, innovations often address customers' implicit needs that they were not aware of or could not express. In the public sector, the customer expresses the problem which it wishes to be solved or favours products that exhibit innovative characteristics (Arlbjørn and Freytag, 2012; Edquist and Zabala-Iturriagagoitia, 2012; Georghiou et al., 2014). Consequently, the requirements for information and resources, as well as their sources, i.e. network partners, may differ.

Prior studies have shown that a firm's capacity to innovate is greatly enhanced if they cooperate with other firms over innovation regardless of whether the innovation is radical or incremental (De Propris, 2002). de Faria, Lima and Santos (2010) found that firms that cooperate with suppliers and other firms within a firm group, and also have higher levels of absorptive capacity and investment in innovation, regard cooperation partners for the development of innovation activities as more important. The findings by De Propris (2002) show that cooperation especially with suppliers is beneficial for both incremental and radical innovations, while cooperation with client firms is positively associated with radical innovation. Furthermore, Tomlinson and Fai (2013) argue that while cooperation with competitors seems to have no significant effect on innovation, SMEs' innovative activities benefit from good, close relations within the supply chain. Finally, Tomlinson (2010) suggests that developing close ties between the members of the value chain for a range of activities enhances knowledge transfer, organizational learning, and innovative performance. Thus, the prior research indicates that networking with other firms affects innovation success, and, consequently, we hypothesize:

H1: Networking with other firms is positively associated with the success of a new innovation which is mediated by **a**) public sector customers and **b**) private sector customers.
H2: Networking with other firms is positively associated with the success of an incremental innovation which is mediated by **a**) public sector customers and **b**) private sector customers.

The study by de Faria, Lima and Santos (2010) suggest that firms do not regard consultants, commercial labs and R&D firms as significant to the development of innovation activities as they do suppliers. However, it is still argued that private special knowledge providers, such as consultants, are more widely used as a source of information for innovation than public research organizations, such as universities, are (Tether & Tajar, 2008). However, there are industry differences. Service firms, except for technical service firms, are significantly less likely to form relationships with private or public research organizations than manufacturing firms, but still they seem to be more likely to use consultants (Tether & Tajar, 2008). Much of the prior research has concentrated on examining SMEs' collaboration with public sector research organizations (e.g. universities) and less attention has been paid to private R&D actors. Because the cooperation with private and public sectors may differ in terms of resource and commitment requirements, it is important to investigate how networking with private sector R&D actors affects innovation success. Thus, we hypothesize:

H3: Networking with private sector R&D actors is positively associated with the success of a new innovation which is mediated by **a**) public sector customers and **b**) private sector customers.

H4: Networking with private sector R&D actors is positively associated with the success of an incremental innovation which is mediated by **a**) public sector customers and **b**) private sector customers.

Robin and Schubert (2013) found that the cooperation with public research institutions did not affect process innovation, but increased product innovation. They explained the positive link that existed, even when controlling for other types of cooperation and the degree of openness of the firm, was due to the fact that developing new products requires external resources which are best obtained through cooperation with academic researchers. A study by Freel and Harrison (2006) agrees with this by showing that it benefited firms to cooperate with universities with regard to process innovations, because universities can offer research to small manufacturing firms that is relevant to industry. Freel and Harrison (2006) also found a positive relationship between product innovation and cooperation with customers and the public sector. Thus, prior studies suggest a positive relationship between networking with public sector actors and innovation success so we hypothesize:

H5: Networking with public sector R&D is positively associated with the success of a new innovation which is mediated by **a**) public sector customers and **b**) private sector customers.
H6: Networking with public sector R&D is positively associated with the success of an incremental innovation which is mediated by **a**) public sector customers and **b**) private sector customers.

In Figure 1, a conceptual model summarises the above discussion. It illustrates the relationship between SMEs' involvement in networks with various partners, the decision to supply new or improved products to public or private sector customers, and the innovative performance arising from these products. The core idea in the model is that the customer type (public or private sector customer) mediates the potential influence of an SME's involvement in networks on the success of the innovation. For instance, Georghiou et al. (2014), in reference to a survey of suppliers to the UK government, report that public sector buyers, though less innovation friendly, are a more important source of innovation than private sector buyers apart from changes in the market. We do not make any assumptions about associations between the success of an innovation type and networking with other firms, private sector R&D actors or public sector R&D actors (so called 'direct effects'). That is, mediation, if established, may be either partial or full mediation. It must be noted, however, that while we apply a path model suggesting causal relationships between variables, our data, which are nonexperimental, cannot prove causality; Statistical tests merely indicate whether a hypothesized model is consistent with a particular model (Warner 2013).

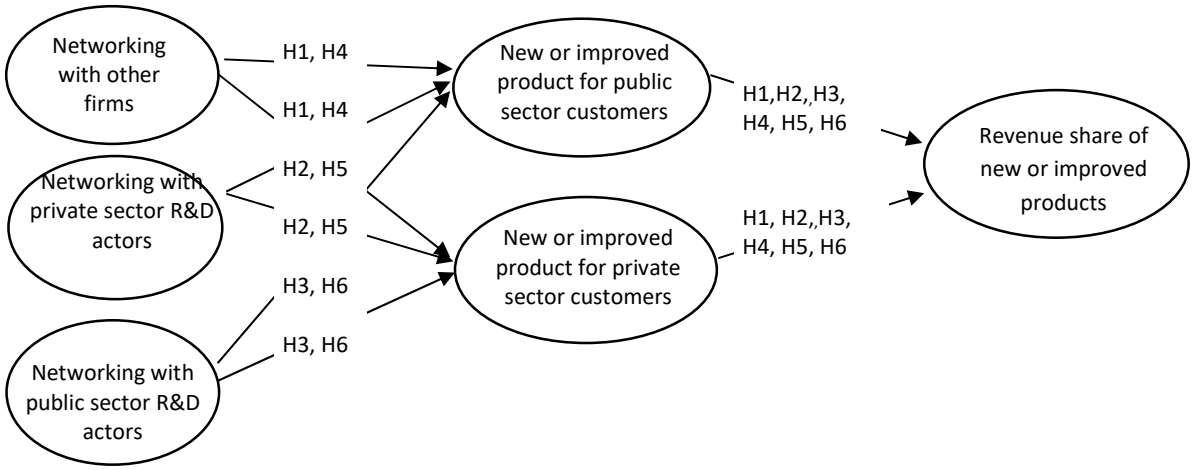

Figure 1. Conceptual model of networks, customer types and performance.

3. QUESTIONNAIRE DEVELOPMENT, DATA AND METHODS

3.1 Methodology

This study uses a survey-based research methodology to test our research hypotheses. Our survey questions probe SME innovations in Finland which, according to a report by European Commission (2017), is one of the innovation leaders among the EU countries. The report also provides details on SME innovations in Finland. Compared to their EU peers, Finnish SMEs are more adept at innovating products or processes but less so at marketing or organizational innovations. In addition, they appear to be efficient in creating innovations in-house, collaborating with other innovative SMEs and selling new products to the market.

Our survey questionnaire also focuses on public procurement which is an important part of government spending in Finland as evidenced by an OECD (2017) report. In 2015, the general government procurement spending accounted for 17.5 % of GDP, significantly above the OECD average of 11.9 %. Measured by the total government expenditure on procurement, however, the Finnish figure of 30.8 % was close to the OECD average of 29.1 %. As regards to public procurement of innovations, the national statistics suggest that innovations related to public procurement are less prevalent: while a third of enterprises had contracts with public sector customers, only 8 % of them reported innovations being required in these contracts (Official Statistics of Finland 2016b). Furthermore, 16 % of them reported engaging in innovation activities in public contracts though innovating was not required in them (Official Statistics of Finland 2016b).

The survey data were collected data in cooperation with the Federation of Finnish Enterprises (FFE). The FFE database contains contact information (e-mail addresses) of more than 70,000 Finnish SMEs. In sampling, firms with fewer than 250 employees were identified and a random sample of 15,000 was drawn from the database.

An electronic survey questionnaire was sent to a sample of Finnish SMEs in February 2015. The research instrument was reviewed by a group of experts with extensive experience of policy and practice concerning public procurement and SMEs. The survey questionnaire consisted of questions measuring the responding firms' involvement in (a) public procurement, (b) networks with private and public actors and (c) R&D activities and innovation. In addition, respondents were asked to indicate whether they had provided new or improved products/services and whether the demand for these originated from private or public sector customers. Additionally, we asked them to estimate the share of turnover that could be attributed to new and improved products/services. Background information was collected on firm size, firm age, R&D expenditure, revenue and the firm's main industry.

3.2 Background information on respondents

Table 1 reports the background information about the respondents and the firms they represent. 97.6 percent of the respondents were full-time or part-time entrepreneurs and owners, and 1.1 percent were hired CEOs. Only 1.4 percent were specialists, clerical workers or employees. It is therefore reasonable to assume that the majority of the respondents were well-acquainted with their firms' operations and performance. As to the reported firm size, nearly all firms in the sample were small and micro enterprises: four-fifths of the responding firms reported less than 400,000 euros in annual sales turnover. In terms of the number of employees, 91.6 percent of firms can be classified as micro-enterprises (with fewer than 10 employees) and 5.2 percent were small firms (with10 – 49 employees), and 0.8 percent were medium-sized enterprises. These figures are very close to the official 2015 statistics for the size composition of Finnish enterprises and suggest that the sample is fairly representative of the SME population (Official Statistics of Finland 2016a).

Table 1. Firm size (revenue and number of employees).

Respondent's position	Freq.	Percent	Sales turnover (euros)	Freq.	Percent	Number of employees	Freq.	Percent
entrepreneur, owner[x]	361	97.6	Less than 100,000	187	50.5	Sole entrepreneur[x]	205	55.4
CEO	4	1.1	100,000 – 199,999	59	15.9	2-4	88	23.8
Specialist	3	0.8	200,000 – 399,999	45	12.2	5-9	46	12.4
Clerical worker	1	0.3	400,000 – 999,999	36	9.7	10-14	8	2.2
Employee	1	0.3	1,000,000 – 1,999,999	21	5.7	15-19	7	1.9
			2,000,000 – 9,999,999	17	4.6	20-49	4	1.1

			10,000,000 – 49,999,999	3	.8	50-249	4	0.8
			Missing	2	.5	Missing	12	3.2
Total	370	100.0		370	100.0		370	100.0

Notes: [x]a full-time or part-time entrepreneur.

3.3 Variables used in the analyses

We used two proxies for innovative performance, which capture financial returns attributable to radical and incremental innovations. First, we utilised the share of turnover pertaining to new products, which is a proxy of a firm's ability to produce radical innovations (Laursen and Salter, 2006). Second, we used the share of turnover from improved products, which measures the performance of incremental innovation (Laursen and Salter, 2006).

The independent variables employed in this study measure SMEs' involvement in different types of networks. *Firms* is a dichotomous variable which takes the value one if the firm is active in networking with other firms and zero otherwise. Inter-firm network collaboration may involve customers, suppliers, producers, service providers and competitors (Zeng et al., 2010). *Pub_RD* is a dichotomous variable that takes the value one if the firm is active in networking with public sector research and development actors, such as universities, research organizations and government organizations (e.g. Nieto and Santamaría, 2007, Zeng et al., 2010). *Priv_RD* is a dichotomous variable that takes the value one if the firm is active in networking with private sector research and development actors, such as private research laboratories, industrial organizations and venture capitalists (Zeng et al., 2010). The indicators for the source of demand for the innovations were measured with dichotomous variables *Pub_NP, Priv_NP, Pub_IP,* and *Priv_IP* indicating demand for a new (NP) or improved product (IP) originating either from the public (Pub) or private (Priv) sector customer (see Aschoff and Sofka, 2009).

Several control variables were used to control for various firm characteristics. Firm size and age may be related to innovativeness (Clausen and Korneliussen, 2012), and thus, we included a *Size* measured by the number of employees and *Age* measured by the number of years since the firm was founded. We used logarithmic transformations of the firm size and age variables in a regression analysis. Further, we controlled for the firm's innovation intensity with the variable *RD_share* measured by the share of R&D expenditure as a portion of the firm's revenue (e.g. Acs and Audretsch, 1989, Laursen and Salter, 2006, Faria et al. 2010). Finally, since the demand for innovative solutions and public procurement in general is likely to vary across different industries (e.g. Edquist and Zabala-Iturriagagoitia, 2012), dummy variables for broad industry sectors were utilised to control for these effects. The dummy variables used were production and manufacturing (*Indu*), construction (*Const*),

retail and wholesale trade (*Trade*), recreational services and accommodation (*Recre*), knowledge intensive business services (*KIBS*), and healthcare and social services (*Health*).

3.4 Analysis methods

A path model to assess the statistical significance of estimated effects was analysed using logistic and ordinary least squares (OLS) regressions together with a bootstrap procedure on Stata 12.1. The logistic regression was applied to paths involving binary dependent variables and the OLS regression was applied to the outcome variable. Consistent with the methodology presented in Baron and Kenny (1986), separate regressions were estimated for i) the hypothesized mediator(s) on the independent variable(s), ii) the dependent variable on the independent variable(s), and iii) the dependent variable on the independent variable(s) and the mediator(s). If mediation is present, the path coefficients for regressions i) and ii) should be statistically significant, whereas in regression iii) the magnitude of the independent variable(s) should be meaningfully reduced or statistically insignificant (Baron and Kenny, 1986). However, the presence of a mediation effect is established by conditions i) and iii) alone (Preacher and Hayes, 2008; Zhao et al., 2010).

Any statistical significance of the mediated effects was verified by bias corrected bootstrapped confidence intervals. Bootstrapping is required because the product of two normally distributed variables is positively skewed (Shrout and Bolger, 2002), making the Sobel test, which has been standardly applied in mediation studies, largely obsolete (Preacher and Hayes, 2008; Zhao et al., 2010). Since the mediators in this study are binary variables, their product is not normally distributed. In consequence, bootstrapping is employed to produce an empirical distribution which can be used to determine the significance of the mediated effect (MacKinnon et al., 2007). The significance of mediation is established if the bootstrap confidence intervals (CI) do not contain zero (Zhao et al., 2010), which indicates that an 'indirect effect' exists. Following the suggested minimum of 10,000 repetitions (Mallinckrodt et al., 2006), the bootstrap procedure used 15,000 repetitions. Bias correction was used because it has been shown to have the greatest statistical power (MacKinnon et al., 2004; Preacher and Hayes, 2008).

4. RESULTS

4.1 Descriptive statistics

Descriptive statistics of variables employed in the regression analysis are reported in Table 2. The variables are described in more detail under the classifications of dependent variables, independent variables and control variables. The dependent variables are the *revenue share of new products*, and

the *revenue share of improved products*. The average revenue share of both types of innovative products is 14 %. Hence, perhaps surprisingly, both innovation types are identical in their contributions to the revenue though we cannot conclude anything about their profitability.

The independent variables also include mediators. Other firms are the most popular networking partners by a wide margin with over 60 % of respondents reporting being involved in a network with other firms. Respondents reported much less networking with public (9 %) and private (11 %) R&D actors. In regard to the demand for innovative solutions, private sector customers as opposed to public sector customers were three times more likely to be the source of demand for new solutions, because private sector customers were identified in approximately 30 % of the cases as the source compared to the approximately 10 % share of the public sector customers. This picture is mirrored in significantly improved products with the demand shares of 36 % and 13 % from the private and public sectors, respectively.

The control variables show that the firms are mostly micro enterprises with a mean (median) employee count of 4 (1). The mean (median) age was 10 (5) years. The average innovation intensity measured by the R&D spending was 7.3 %. However, the median was considerably lower at 1.3 %. Given the size distribution of the sample, this is hardly surprising because micro enterprises are likely to have limited resources for investments in R&D.

Table 2. Descriptive statistics of variables employed in the regression analysis.

Variable (unit[x])	Abbrev.	Obs.	Mean	Med.	S.D.	Min	Max
Dependent variables							
Revenue share [new products] (%)	Rev_NP	310	14.089	2.000	24.230	0	100
Revenue share [improved products] (%)	Rev_IP	300	14.002	2.500	22.587	0	100
Mediator variables							
Public sector customer [new products] (yes = 1)	Pub_NP	370	0.097	0	0.297	0	1
Private sector customer [new products] (yes = 1)	Priv_NP	370	0.303	0	0.460	0	1
Public sector customer [improved products] (yes = 1)	Pub_IP	370	0.130	0	0.336	0	1
Private sector customer [improved products] (yes = 1)	Priv_IP	370	0.357	0	0.480	0	1
Independent variables							
Networking with other firms (yes = 1)	Firms	370	0.616	1	0.490	0	1
Networking with public sector R&D actors (yes = 1)	Pub_RD	370	0.086	0	0.281	0	1
Networking with private sector R&D actors (yes = 1)	Priv_RD	370	0.114	0	0.318	0	1
Control variables							
R&D expenditure as a proportion of revenue (%)	RD_share	340	7.269	1.250	16.197	0	100
Firm size (number of employees)	Size	370	4.030	1.000	10.208	0	150
Firm age (years)	Age	370	10.624	5.000	14.491	0	118
Production industries (yes = 1)	Indu	370	0.154	0	0.361	0	1
Construction (yes = 1)	Const	370	0.176	0	0.381	0	1
Wholesale and retail trade (yes = 1)	Trade	370	0.162	0	0.369	0	1
Recreational and hospitality services (yes = 1)	Recre	370	0.154	0	0.361	0	1
Knowledge intensive business services (yes = 1)	KIBS	370	0.284	0	0.451	0	1
Healthcare, social services and education (yes = 1)	Health	370	0.070	0	0.256	0	1

Notes: [x]Unit indicates the measurement unit of the variable.

The Spearman correlations matrix, which is reported in Table 3, shows that all the network variables and both customer types are correlated with both performance variables. The correlation between the private sector customers and the revenue share of both new and improved products is stronger than the equivalent correlations for public sector customers. The strong correlation between the two outcome variables (*Rev_NP* and *Rev_IP*) indicates that firms that develop radical innovations also engage in producing incremental innovations. There is also a strong association between R&D expenditure and performance and network variables. This implies that investments in R&D pay off, and that SMEs with high R&D budgets are involved in networks. The correlations matrix also suggests that firm size and age are not associated with involvement in networks or innovation activity.

Table 3. Spearman correlations matrix.

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
(1) *Rev_NP*	1.00																
(2) *Rev_IP*	0.78**	1.00															
(3) *Pub_NP*	0.33**	0.28**	1.00														
(4) *Priv_NP*	0.48**	0.35**	0.27**	1.00													
(5) *Pub_IP*	0.29**	0.31**	0.49**	0.17**	1.00												
(6) *Priv_IP*	0.45**	0.45**	0.21**	0.50**	0.23**	1.00											
(7) *Firms*	0.26**	0.24**	0.18**	0.17**	0.13*	0.14*	1.00										
(8) *Priv_RD*	0.28**	0.28**	0.15*	0.16**	0.23**	0.19**	0.00	1.00									
(9) *Pub_RD*	0.21**	0.22**	0.23**	0.12*	0.14*	0.15*	0.19**	0.39**	1.00								
(10) *RD_share*	0.59**	0.59**	0.23**	0.40**	0.23**	0.29**	0.25**	0.35**	0.26**	1.00							
(11) Ln(*Size*)	0.00	0.06	0.02	-0.02	0.11	0.07	0.07	0.01	0.04	0.00	1.00						
(12) Ln(*Age*)	0.05	0.10	-0.03	-0.07	0.06	-0.01	-0.03	0.00	-0.02	0.01	0.30**	1.00					
(13) *Indu*	0.00	0.04	-0.03	0.00	0.01	-0.08	0.07	-0.12*	-0.08	0.04	0.08	0.01	1.00				
(14) *Const*	-0.18**	-0.22**	0.00	-0.10	-0.02	-0.10	-0.10	-0.09	-0.10	-0.17**	0.12*	0.02	-0.20**	1.00			
(15) *Trade*	-0.10	-0.16**	-0.08	-0.04	-0.05	-0.04	-0.03	-0.11	-0.15*	-0.17**	-0.03	0.01	-0.19**	-0.19**	1.00		
(16) *Recre*	0.07	0.10	0.02	-0.02	-0.06	0.10	-0.10	-0.04	-0.03	0.06	0.01	0.00	-0.19**	-0.19**	-0.18**	1.00	
(17) *KIBS*	0.16**	0.16**	0.09	0.14*	0.03	0.07	0.13*	0.22**	0.30**	0.19**	-0.10	-0.02	-0.30**	-0.30**	-0.28**	-0.28**	1.00
(18) *Health*	0.01	0.05	-0.03	-0.03	0.13*	0.04	0.01	0.13*	-0.04	0.01	-0.10	-0.01	-0.11	-0.11	-0.10	-0.10	-0.16**

Statistical significance: ** p-value < 0.01; * p-value < 0.05.

4.2 The model of new products

Estimated path coefficients for the model of new products are reported in Table 4 (for a table which reports coefficients for control variables, see Table A1 in the Appendix), and the resulting path diagram is shown in in Figure 2. The potential influence of firm size, firm age, R&D expenditure and industry membership is controlled for in each regression. Networking with other firms (1.299, $p < 0.05$) has a positive association with supplying new products to the public sector customers. Although with a lesser magnitude, it (0.675, $p < 0.05$) plays a similar role with private sector customers.

Investigating potential mediation, both the public (14.386, $p < 0.01$) and private sector customers (9.806, $p < 0.01$) increase returns on innovation. There appears to be a strong association between networking with other firms and revenues from innovative products (7.773, $p < 0.01$). Thus, these results imply a partial mediation effect originating from the demand for new products from the public or private sector customers. Furthermore, it is noteworthy that by magnitude, the public sector's demand for new products appears to result in better performance.

The bootstrap bias corrected CIs for the model of new products are reported in Table 4. The mediated effect of the public sector customers on the innovative performance measure (0.059) is within a 95 % CI (0.011 to 0.147). Since the confidence interval does not contain zero (Zhao et al. 2010; Warner 2013), we conclude that mediation occurs due to the public sector customers. In case of the private sector customers, a similar conclusion can be made as the mean indirect effect (0.033) lies within a 95 % CI (0.004 to 0.086). The combined effect (0.091) with a 95 % CI (0.003 to 0.194) supports the mediation hypothesis. Since the direct effect (0.104) is also within the confidence interval, it can be concluded that mediation is partial (complementary). As a result, we fail to reject H1a and H1b. The combined indirect effect accounts for 47 % of the total effect where the public sector customer's share is 30 % and the private sector customer's share is 17 %. The rest of the total effect (53 %) consists of the direct effect

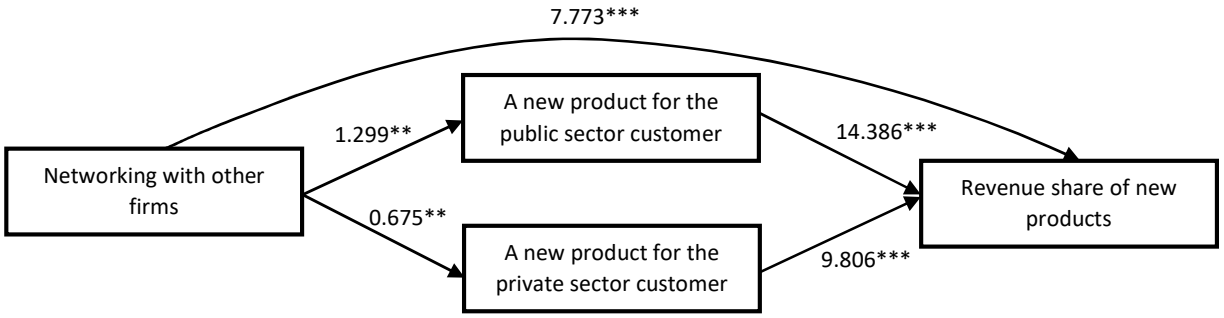

Figure 2. A path diagram for the model of new products.

Table 4. Estimated coefficients for path models.

New products						Significantly improved products					
Indirect paths											
Path		Coeff.		SE		Path		Coeff.		SE	
Pub_NP ← Firms		**1.299*** **		0.575		Pub_IP ← Firms		**0.757***		0.447	
Pub_NP ← Pub_RD		0.746		0.545		Pub_IP ← Pub_RD		0.278		0.567	
Pub_NP ←Priv_RD		0.655		0.620		Pub_IP ←Priv_RD		**1.264** **		0.552	
Priv_NP ← Firms		**0.675** **		0.300		Priv_IP ← Firms		**0.531***		0.284	
Priv_NP ← Pub_RD		0.102		0.427		Priv_IP ← Pub_RD		0.396		0.437	
Priv_NP ←Priv_RD		0.664		0.469		Priv_IP ←Priv_RD		0.765		0.471	
Rev_NP ← Pub_NP		**14.386*** **		4.233		Rev_IP ← Pub_IP		5.707		3.643	
Rev_NP ←Priv_NP		**9.806*** **		2.829		Rev_IP ←Priv_IP		**8.571*** **		2.593	
Direct paths											
Path		Coeff.		SE		Path		Coeff.		SE	
Rev_NP ← Firms		**7.773*** **		2.802		Rev_IP ← Firms		**6.754** **		2.634	
Rev_NP ← Pub_RD		6.463		4.475		Rev_IP ← Pub_RD		0.985		0.985	
Rev_NP ← Priv_RD		7.396		4.958		Rev_IP ← Priv_RD		7.070		7.070	
Bootstrap results											
Effect	Coeff.	Bias	BS SE	Prop.	95 % BC CI	Effect	Coeff.	Bias	BS SE	Prop.	95 % BC CI
Pub. sector mediator	0.059	-0.001	0.032	0.303	(0.011, 0.147)	Pub. sector mediator	0.017	0.001	0.018	0.108	(-0.006, 0.069)
Priv. sector mediator	0.033	0.002	0.021	0.169	(0.004, 0.086)	Priv. sector mediator	0.026	0.001	0.018	0.166	(0.000[z], 0.069)
Total mediated effect	0.091	0.001	0.036	0.467	(0.032, 0.178)	Total mediated effect	0.043	0.003	0.024	0.274	(0.004, 0.096)
Direct effect	0.104	0.000	0.049	0.533	(0.003, 0.194)	Direct effect	0.115	-0.001	0.052	0.732	(0.010, 0.212)
Total effect	0.195	0.001	0.055	1.000	(0.080, 0.301)	Total effect	0.157	0.002	0.051	1.000	(0.049, 0.249)

Notes: Bootstrapped coefficients standardized. Prop. = proportion is a ratio of mediated/direct effects to the total effect. SE = Standard error. BS = Bootstrap. CI = Confidence interval. [z] Zero due to rounding. Statistical significance: *** p-value < 0.01; ** p-value < 0.05; * p-value < 0.1.

4.2 The model of significantly improved products

The results for the model of incremental innovations is reported in Table 4 (for a table which reports coefficients for control variables, see Table A2 in Appendix), and Figure 3 depicts the resulting path diagram. There are statistically marginally significant ($p < 0.1$) coefficients for networking with other firms for both the public (0.757) and private sector customers (0.531). A stronger connection by both magnitude and statistical significance is established between networking with private sector R&D actors (1.264) and public sector customers. However, only the private sector customers (8.571) regressed on the revenue share of improved products is statistically significant ($p < 0.01$). This implies that private sector customers are a mediator between firm networks and innovative performance. The direct effect of networking with other firms (6.754) of the revenue share of improved products is statistically significant ($p < 0.05$), whereas other direct effects are not statistically significant.

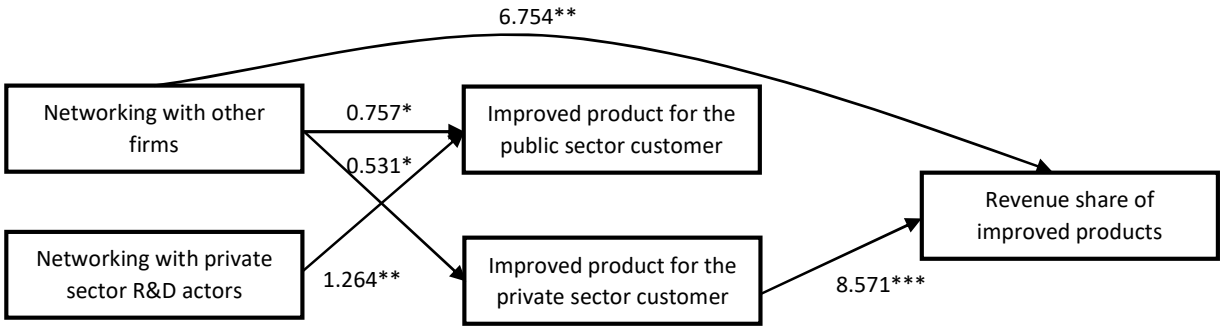

Figure 3. A path diagram for the model of significantly improved products.

As earlier, bias corrected bootstrap CIs are used to assess the statistical significance of any mediation effects. The bootstrap statistics for the model of incremental innovations are reported in Table 4. The public sector customers as a mediator can be rejected because a 95 % CI contains zero (Zhao et al., 2010; Warner, 2013). Based on the confidence interval analysis, however, we can conclude that the private sector customers (0.026) are a mediator with a 95 % CI (0.000 to 0.069) which contains zero due to rounding (the lower bound equals 0.0001 at the precision of four decimals). Hence, the total mediated effect (0.043) also exists with a CI of 0.004 to 0.096. Therefore, we fail to reject H2b. The proportional size of the private sector mediator is low, standing at approximately 17 % of the total effect. The mean direct effect is 0.115 and the mean total effect is 0.157, which are both significant. The direct effect accounts for nearly three quarters of the total effect. Thus, the mediation is partial as with the earlier case.

5. DISCUSSION AND CONCLUSIONS

5.1 Theoretical implications

Our results suggest that networks with other firms are important especially when an SME is developing new products or services. Inter-firm networks are positively associated with a firm's response to the demand for innovative products whether placed by public or private sector customers. In this case, both customer types act as partial mediators between an SME's networks and their innovative performance. Interestingly, we found that higher innovative performance is associated with the demand originating from the public sector. This suggests that public innovation procurement may provide sufficient incentives for innovating firms, which is a condition proposed by Georghiou et al. (2014) for a demand-side innovation policy. Moreover, this finding is consistent with Edler et al. (2015) who report that public sector customers are a more important source of innovations than private sector customers. Our results also corroborate the findings by Gronum et al. (2012) who suggest that "SMEs should only concentrate on cultivating and maintaining networks if they lead directly to improvements in innovation."

Regarding the revenue share of significantly improved products or services, the private sector customers are a mediator between other firms and innovative performance. In the case of the public sector customers, however, networks with other firms and private sector R&D actors are positively associated with the odds of responding to the public sector's demand for improved products, but this path does not result in improved performance. An explanation could be that tenders in public innovation procurement seek new solutions, whereas improved products are requested using standard procurement procedures where competition between suppliers may be more intense. It is also noteworthy that in light of our findings, networks with public sector R&D actors do not appear to be beneficial with respect to either customer type or with regard to returns on innovation. This contradicts prior research which suggests that networking activity of this kind is particularly important to SMEs in complementing their limited resources in the area of innovative capabilities (Masiello et al., 2015). An explanation for this result could be that firms are heterogeneous in how they use the resources provided by, for example, universities in their innovations (e.g. Laursen and Salter, 2004).

5.2 Managerial and policy implications

Based on the findings presented in this study, a key implication of this study is that SMEs developing new products or services should form networks with other firms because they seem to be connected with responding to the demand for new products by both public and private sector customers, and there is a direct association with higher innovative performance. A similar conclusion can be drawn when

an SME develops improvements on existing products or services to meet the demand of public and private sector customers. In case of the former customer type, SMEs could benefit from establishing networks with private R&D actors. Given that most firms in this study were micro-enterprises, which have been found to be disadvantaged with respect to tendering resources (Flynn et al. 2015), the findings of this study point towards inter-firm networks being beneficial to these firms in building sufficient capacity with respect to innovation procurement.

Regarding performance, this study suggests that both customer types are associated with improvements in the returns on innovations. Our results imply that SMEs benefit from seeking tenders in the domain of public innovation procurement because these appear to be associated with the revenue share of new products. In the case of improved products, however, the private sector customers are associated more with a chance to improve returns on incremental innovation. As an implication, thus, SMEs could benefit from developing new products for public sector customers and leveraging these products by further developing and customizing the designs to fit the needs of private sector customers.

From the perspective of policy, our findings suggest that public procurement of innovations has a role in encouraging SMEs' innovativeness. Although SMEs tend to report facing substantial barriers to participating in public procurement of innovations (Loader 2013; Uyarra et al. 2014), some of them are able to exploit their strategic strengths (Reijonen et al. 2016) in innovation procurement in a profitable manner (also Tammi et al. 2017). However, our results are not to be taken as an endorsement of the current practice in public procurement of innovations. On the contrary, since networks with other firms and private R&D actors in the case of significantly improved products are not associated with improved performance suggests that incentives may work in the reverse direction. This could result from a higher level of competition between suppliers for the contracts involving improved products as opposed to new products because the former lend themselves more easily to the procurement procedures of standardized products. Hence, policy makers should pay attention to how the level of competition influences SMEs' incentives to innovate.

At a more practical level, contracting authorities should recognize the importance of innovative elements in procurement contracts to increase the SMEs' participation rate (Reijonen et al., 2016), as this appears to improve SMEs' innovative performance. Further, policy makers and procurers should develop procurement processes to support the formation of networks between suppliers. It also appears that both public and private sector R&D actors should critically assess their ability to provide the services which support SME innovations. To achieve this, Edler et al. (2015) argue that public sector

organizations should recognize the long-term benefits of innovation and focus on encouraging procurers and decision-makers to adopt modes and processes which are conducive to innovations. Consequently, addressing these implications could have broader effects on the SMEs ability to compete in the private sector markets and to provide intangible and tangible benefits to the surrounding society as a whole.

5.3 Limitations and future research

As is the case with all studies, some limitations may affect the generalizability of these results. Although EU countries share the wider institutional setting of public procurement, a sample of SMEs from a single country may cause some bias in interpretation because investments in R&D and the use of innovation procurement may vary between countries. For instance, Finnish SMEs tend to be more innovative than European SMEs in general (European Commission, 2017), which may affect the applicability of the results to other countries. It must also be noted that this study omitted large firms, so the results are not generalizable to the entire firm population. Furthermore, a larger sample size might produce more reliable results. From the purely theoretical perspective, the models investigated in this study, though presented as causal, cannot prove causality because our data is non-experimental (Warner, 2013). Our results also suggest that the models may miss mediators because the direct effect remains strong, suggesting a more complex mechanism than the one proposed here (see Shrout and Bolger, 2002; Zhao et al., 2010). Moreover, the measures of involvement in networks and innovation types are binary variables, which are not well-suited to capture more subtle elements of SME networks.

As a direction of future research, the role of networks in SMEs' participation in public innovation procurement could be studied more carefully by using more detailed measures of the activities occurring in SMEs' networks. For instance, activities carried out in networks by different partners could provide insights into the purposes of network partners in innovation procurement. Also, innovation types could be studied using more refined measurements. From the theoretical perspective, determining whether or not a mediator could explain the direct effect between networking with other firms and innovative performance could enrich our knowledge of the factors that push SMEs to innovate. Consequently, this would require empirical testing of the proposed mediators. Finally, it would enhance our understanding of public innovation procurement if large-scale studies were carried out in other countries.

5.4 Conclusions

This article studied SME networks and innovative performance with a survey to Finnish SMEs. We hypothesized that the demand for new or improved products or services originating from public or private sector customers would act as mediators between SME networks and innovative performance. We distinguished three types of networks: networking with other firms, networking with private sector R&D actors, and networking with public sector R&D actors. We found that networks involving other firms are associated with SMEs' innovative performance, and that this is mediated by both customer types. Furthermore, the public procurement of innovations is associated with greater returns in the case of the new products or services. For significantly improved products or services, networks involving other firms may improve performance when the demand originates from private sector customers. Our results suggest that SMEs should emphasize networks with other firms rather than public or private research and development actors when they develop new products for the public sector. Hence, the results of this study provide a way to understand the importance of SMEs' networks in innovative product development and compare and contrast the innovative performance arising from public and private sector customers.

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APPENDIX

Table A1. Full estimation results for the model of new products.

	Dependent variables							
	Pub_NP		*Priv_NP*		*Rev_NP*		*Rev_NP*	
Independent variables	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE
Firms	**1.299****	0.575	**0.675****	0.300	**7.773*****	2.802	**5.312****	2.716
Pub_RD	0.746	0.545	0.102	0.427	6.463	4.475	4.360	4.310
Priv_RD	0.655	0.620	0.664	0.469	7.396	4.958	4.881	4.763
Pub_NP							**14.386*****	4.233
Priv_NP							**9.806*****	2.829
Control Variables								
Ln(*Size*)	0.052	0.260	0.024	0.178	-0.404	1.786	-0.502	1.707
Ln(*Age*)	-0.142	0.256	-0.128	0.163	-0.552	1.601	-0.163	1.532
RD_share	0.008	0.010	**0.025*****	0.009	**0.395*****	0.082	**0.327*****	0.080
Industries	Yes		Yes		Yes		Yes	
Intercept	**-2.947*****	0.853	**-1.508*****	0.516	0.604	4.747	-2.045	4.568
N	301		301		301		301	
LR χ^2	**21.10****		**29.8*****					
Pseudo R^2	0.104		0.079					
F					**6.52*****		**8.29*****	
Adjusted R^2					0.168		0.241	

Notes: Statistical significance: *** p-value < 0.01; ** p-value < 0.05; * p-value < 0.1.

Table A2. Full estimation results for the model of significantly improved products.

	Dependent variables							
	Pub_IP		*Priv_IP*		*Rev_IP*		*Rev_IP*	
Independent variables	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE
Firms	**0.757***	0.447	**0.531***	0.284	**6.754****	2.634	**5.379****	2.596
Pub_RD	0.278	0.567	0.396	0.437	0.985	4.353	-0.137	4.258
Priv_RD	**1.264****	0.552	0.765	0.471	7.070	4.643	4.367	4.604
Pub_IP							5.707	3.643
Priv_IP							**8.571*****	2.593
Control Variables								
Ln(*Size*)	0.327	0.229	0.135	0.173	-1.564	1.680	-2.029	1.646
Ln(*Age*)	0.015	0.222	-0.049	0.157	1.519	1.499	1.594	1.463
RD_share	0.004	0.011	**0.016***	0.009	**0.346*****	0.081	**0.313*****	0.080
Industries	Yes		Yes		Yes		Yes	
Intercept	**-3.079*****	0.737	**-1.501*****	0.492	-1.045	4.389	-2.586	4.306
N	291		291		291		291	
LR χ^2	**21.6****		**25.76*****					
R^2 (Pseudo)	0.093		0.067					
F					**6.07*****		**6.61*****	
Adjusted R^2					0.161		0.201	

Notes: Statistical significance: *** p-value < 0.01; ** p-value < 0.05; * p-value < 0.1.