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DOES COLLABORATION WITH PUBLIC AND PRIVATE SECTOR ACTORS IN PUBLIC PROCUREMENT OF INNOVATIONS IMPROVE SME COMPETITIVENESS?

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ABSTRACT

The merits of public procurement of innovations (PPI) as a demand-side innovation policy instrument have been identified in both political and academic discussion. In particular, small and medium-sized enterprises' (SMEs) involvement in PPI could be a valuable tool in promoting SME innovations. As such, PPI could play an important role in the entrepreneurial ecosystem in which interdependent actors collaborate. However, the impact of collaboration among entrepreneurial ecosystem actors in the context of PPI on SMEs' competitiveness lacks empirical assessment. This paper addresses this gap in the literature with a survey of Finnish SMEs. We propose a construct for SMEs' improved competitiveness which can be attributed to the involvement in public procurement. A statistical analysis applying a path model suggests that after controlling for firm size and age, innovativeness and industry, collaborating with the public sector customer in developing new products/services, improving production processes and making improvements to existing products/services in response to the public sector customer's demand is associated with improved competitiveness. As a managerial implication, the results suggest that PPI has merits in promoting the competitiveness of SMEs through innovations.

Keywords: Public procurement of innovations, SME innovations, performance measurement

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1. INTRODUCTION

Public procurement of innovations (PPI) is considered an important and successful policy instrument for triggering innovations (Geroski, 1990; Edler & Georghiou, 2007). PPI refers to the procurement of goods or services that do not exist but which can be developed in a reasonable timeframe (Edquist and Hommen, 2000). PPI is regarded as highly important in renewing modern economies, as well as for improving the competitiveness of small and medium-sized enterprises (SMEs) (Uyarra et al., 2014; Aho et al., 2006). Due to their large contribution to employment and output, as well as their alleged agility in producing new ideas and innovations, SMEs are often emphasized in policy discussions (Konsti-Laakso et al., 2012).

A notable hindrance to SMEs' participation in PPI is the issue of large contract sizes, which mostly favour large firms at the SMEs' expense (Uyarra et al., 2014). As a result, it has been suggested that developing co-operation, partnerships and interaction between public buyers, private sellers and end-users of procured products and services would contribute to SMEs' success in innovation and overall in their participation in innovation procurement (Laforet & Tann, 2006; Kelley et al., 2009). However, there is a gap in the knowledge concerning how PPI affects SMEs' business environment and the capabilities of SMEs to utilize public procurement in their efforts to gain a competitive advantage.

Recently, researchers have increasingly paid attention to entrepreneurial ecosystems and their ability to promote innovation. In an entrepreneurial ecosystem, various actors, who have different objectives and characteristics but are interdependent and complementary to each another, interact and create wealth thus contributing to the performance and transformation of the economy (Prahalad, 2005; Spilling, 1996). These entrepreneurial ecosystems are pivotal for innovations, because rather than being a stroke of genius of an individual, an innovation is more often the result of collaboration between several actors (Bourgrain & Haudeville, 2002). However, the entrepreneurial ecosystem approach is fairly novel (Stam, 2015) and empirical evidence is lacking on collaboration and how it affects innovativeness and through that firm competitiveness. To address this paucity of knowledge, this paper contributes to the entrepreneurial ecosystems literature by shedding more light on the matter in the context of public procurement, which has not been studied before.

In this paper, we study the interplay between entrepreneurial ecosystem actors and SMEs in the context of PPI and how this is associated with SME competitiveness. More specifically, we propose a path model framework in which the breadth of collaboration with actors in the public and private sector ecosystem is positively associated with the probability of participating in public innovation procurement and, subsequently, further associated with improved competitiveness. As a measure of competitiveness, we propose a construct termed 'procurement performance', which takes into account various aspects of competitiveness. Path models are tested with survey data from Finnish SMEs using regression analysis. The key findings of this study indicate that collaborating with the public sector is important regardless of the type of innovation developed for the public sector. Further, we find that collaboration with competitors is beneficial when developing new-to-the-market products and improvements to production processes of existing products/services for the public sector customer, whereas ties with the supplier are more important when improvements are made to existing products/services.

This paper proceeds as follows. In Section 2, we review the relevant literature and develop the research hypotheses. In Section 3, the data and research methodology are presented. In Section 4, we report the results of this study. Finally, Section 5 concludes the paper.

2. LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

2.1 Public Procurement of Innovations

There are many definitions for PPI. In a narrow sense, it is the procurement of products or services that do not exist but can be developed (Edquist & Hommen, 2000). In the broadest sense, however, all public procurement has an impact on innovation through changes in demand and firm behaviour (Uyarra & Flanagan, 2010) and as a by-product of regular procurement (Achhoff & Sofka, 2009). 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." However, he also distinguishes between innovation procurement and innovation friendly procurement. The former aims for innovation, whereas the latter provides flexibility which may encourage supplier innovations. The direct promotion of innovation occurs when the public sector procures products or services which require investments in research and development (R&D). On the other hand, indirect promotion can be encouraged using tender specifications which are expressed in functional rather than in production terms (Cave & Frinking, 2003). Furthermore, Hommen and Rolfstam (2009) identify three broad categories for PPI. In direct innovation procurement, the private sector engages in the production of innovative solutions for the public sector. In cooperative procurement, the public and private sector actors aggregate demand for an innovation. In catalytic procurement, the public sector acts as an early buyer, which shapes the private demand for an innovation.

PPI has been regarded as an innovation policy instrument along with more traditional instruments such as regulation, research institutions and universities and public R&D subsidies (Aschhoff & Sofka, 2009). It seeks to satisfy public demand or public policy targets and by doing so rewards the public sector's suppliers with money (e.g. sales), which is an incentive for a firm to compete for public sector contracts. The growing interest in the PPI's innovation-stimulating function stems from the less-than-expected results of traditional innovation policies (Uyarra et al., 2014; see also OECD 2011 in Uyarra et al.). In addition, emphasizing innovation as a systemic process rather than viewing it as a linear model is another factor behind the interest; thus, it can be considered that innovations are influenced by demand and interaction between actors and organizations (Edquist & Zabala-Iturriagagoitia, 2012; Uyarra et al., 2014).

There are some empirical assessments of the consequences of PPI. According to Lichtenberg (1988), both public procurement and public innovation procurement have significantly positive effects on private R&D investments. Slavtchev and Wiederhold (2011), in turn, show that 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 signalling through the market demand in the form of reduced uncertainty in the birth of innovations.

PPI also seems to be a more efficient than the other innovation policy instruments. According to Geroski (1990), procurement is more effective than R&D subsidies. Guerzoni and Raiteri (2014) analyse interaction effects between different policy instruments and find that while PPI is effective on its own, its effectiveness can be

increased when other policy instruments are applied with it. Indeed, based on the assessment of several case studies, Edquist and Zabala-Iturriagagoitia (2012) suggest that PPI should be accompanied with other policy instruments when addressing large challenges. In a case study concerning innovative service procurement, Pelkonen and Valovirta (2015) reach similar conclusions and suggest that other instruments, such as financial support, should be applied at the pilot stage of a procured service innovation.

Regarding 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 help to achieve 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. (2016) who report that entrepreneurial SMEs tend to seek public sector contracts from non-local sources.

Recent empirical studies have disclosed various characteristics associated with SMEs' involvement in public procurement. The evidence shows that firm size (Flynn et al, 2015; Karjalainen & Kemppainen, 2008; Pickernell et al., 2011; Reijonen et al., 2014; Tammi et al., 2014) and age (Pickernell et al., 2013) are positively associated with supplying to the public sector. In addition, it has been shown that competences which SMEs' display improve their participation rate in public procurement (Flynn & Davis, 2016), and that a shortage of training is associated with perceptions of resource constraints which in turn hinder SMEs participation in public procurement whereas an affirmative attitude towards training is positively associated with it (Saastamoinen et al., 2017). SMEs also differ in their focus regarding the public sector customer. That is, they primarily tend to supply either to national or wider level public sector customers or to sub-national level customers (Pickernell et al, 2011; also Peck & Cabras, 2011). Perceptions of a firm's resources seem to play a role in decisions to tender at different levels of government (Karjalainen & Kemppainen, 2008). In addition, strategic orientations, namely entrepreneurial orientation and market orientation, have been shown to exhibit a positive effect on SMEs' tendering activity (Reijonen et al., 2016; Tammi et al., 2014).

2.2 Entrepreneurial ecosystem and innovations

The concept of the entrepreneurial ecosystem highlights the importance of the external business environment and the fact that entrepreneurship occurs in a community of independent actors (Stam, 2015). Contrary to the prior literature on entrepreneurship concentrating on individuals, the entrepreneurial ecosystem focuses on examining a system of actors who have different roles and who are related to one another in a complicated way (Suresh & Ramraj, 2012; Spilling 1996). No firm is an island and, thus, firms usually develop in close interaction with each other and with environmental factors (Spilling, 1996). In such an ecosystem, each actor has different traditions, motivations, sizes and areas of influence, but, at the same time, they are dependent on and complementary to each other, so that they can act and create wealth together (Prahalad, 2005). It is noteworthy that an ecosystem enables the combination and cooperation of stakeholders that have differing objectives and expectations (Suresh & Ramraj, 2012).

From the ecosystem perspective, the interest lies in how the entrepreneurial actions of multiple actors, such as developing new businesses or modernizing, renewing and restructuring existing ones, contribute to the dynamism, performance and transformation

of the economy (Spilling, 1996). Spilling (1996) emphasizes that for entrepreneurial performance, the multiplicity of actors and their ability to identify and exploit opportunities is important. Furthermore, Isenberg (2010, 43) points out that although individual elements of the ecosystem are conducive to entrepreneurship, they are not enough to sustain it and only together can they "turbocharge venture creation and growth". The entrepreneurial competence between the actors determines the quality of the ecosystem (Spilling, 1996).

Researchers have identified various frameworks, elements and actors that constitute an entrepreneurial ecosystem. Suresh & Ramraj (2012) developed a conceptual framework of the entrepreneurial ecosystem which includes eight systems of support: moral support, financial support, network support, government support, technological support, market support, social support, and environmental support. Isenberg (2010) identified the key components of a healthy ecosystem of entrepreneurship to include: public leaders, governments, culture, success stories, knowledgeable people, capital sources, non-profits and industry associations, educational institutions, public infrastructure, geographic locations, formal and informal groups, venture-oriented professionals, and local potential customers, which all are favourable towards or could contribute towards entrepreneurship. According to Neck et al. (2004), an entrepreneurial system which is beneficial especially with respect to new venture creation consists of incubator organizations, spin-offs, informal and formal networks, the physical infrastructure, and the culture of the region. The World Economic Forum (2013) lists that the entrepreneurial ecosystem comprises of 1) accessible markets, 2) human capital workforce, 3) funding and finance, 4) mentors, advisors and support systems, 5) regulatory framework and infrastructure, 6) education and training, 7) major universities as catalysts, and 8) cultural support; the first three being of pivotal importance to entrepreneurs. In conclusion, in the entrepreneurial ecosystem, actors interact with multiple stakeholders and that this interaction supports and enhances the entrepreneurial performance of each actor and the ecosystem at large.

Studies of entrepreneurial ecosystems are often related to a region or a community (e.g. Spilling, 1996), perhaps the most well-known example being Silicon Valley (Neck et al., 2004). More specifically, research has focused on how the entrepreneurial ecosystem can promote start-ups, innovations, or business growth in a certain territory (e.g. Neck et al., 2004; Suresh & Ramraj, 2012; World Economic Forum 2013). In this respect, the research on entrepreneurial ecosystems is linked to that of innovation systems (Ylinenpää, 2009) and intermediation in innovation (Edler & Yeow, 2016). An innovation system can be defined to include resources and institutions that are built through interactions with universities, research institutes and firms in a manner that enables firms to commercialize innovations successfully (Spencer, 2003). The research on intermediation in innovation examines innovation systems more closely and studies the establishment or improvement of links between actors who possess complementary skills or interests so that the generation and diffusion of innovations are enhanced (Edler & Yeow, 2016). Thus, the entrepreneurial ecosystem plays a significant role in innovation, because breakthroughs are increasingly dependent on the contributions of several actors rather than the creations of an individual actor (Bourgrain & Haudeville, 2002). In addition, innovative firms make greater use of networks than their less innovative counterparts (Cumbers et al., 2003).

2.3 Collaboration

Thomson and Perry (2006, 21) state that "collaboration occurs over time as organizations interact formally and informally through repetitive sequences of negotiation, development of commitments, and execution of those commitments". Thus, collaboration requires the

formation of relationships and cooperation between firms. Hanna and Walsh (2008) found that the motivation of small firms to develop relationships is related to overcoming resource constraints. Otherwise, cooperation between organizations is promoted as a means to increase competitiveness and to improve innovation, technology transfer and learning within regions (Hanna & Walsh, 2008). According to an extensive literature review conducted by Street and Cameron (2007), the effects of small businesses developing relationships with external organizations relate to organizational development (access to resources and business development), competition and competitive advantage, as well as to firm performance and success (Street & Cameron, 2007).

Collaboration has been studied especially in the context of supply chain management. For example, Singh and Power (2009) argue that firms should engage in close working relationships with both customers and suppliers to improve their performance. Studies have shown further that interorganizational collaboration with a variety of partners improves innovative performance (Faems et al., 2005; Soosay et al., 2008). Soosay et al. (2008) find that SMEs collaborate with their customers and suppliers in various ways ranging from knowledge and information sharing to making joint investments, and that these activities support continuous innovation. At the same time, it has been pointed out that innovation performance is dependent on the nature of the partners, and consequently, firms are advised to pay attention to their collaboration portfolio, so that they can leverage the potential of relationships with different actors in the entrepreneurial ecosystem (Faems et al., 2005).

Empirical studies on the significance of different partners on innovation suggest that collaboration within the supply chain is beneficial, while cooperation with competitors is not that relevant (De Propris, 2002; Tomlinson, 2010). Furthermore, Freel and Harrison (2006) argue that with regard to product innovations, collaboration with customers and the public sector is beneficial, while cooperation with suppliers and universities enhances the success of process innovations. All in all, the systemic approach claims that the operational environment, i.e. other organizations, affects firms' innovation behaviour and performance (De Propris, 2002). Consequently, it seems that developing relationships and working together towards a shared goal are important for innovation success and through that for the competitiveness of the firm.

2.4 Hypotheses development

In the entrepreneurial ecosystem, firms interact with several actors and form various kinds of relationships regarding the depth and breadth of the collaboration with each of them. The depth refers to the level of collaboration (strategic/tactical/operational) and the breadth to the plethora of activities carried out in collaboration (Matopoulos et al., 2007). Although there is no general agreement about the actors and other elements of an entrepreneurial ecosystem (see the discussion in the previous section), prior studies indicate that it includes at least: markets/customers, financial support, professional and support services, universities/educational institutions and informal/formal networks (World Economic Forum, 2013; Suresh & Ramraj, 2012; Isenberg, 2010; Neck et al., 2004). In this study, we are interested in how the breadth of collaboration with different actors in the entrepreneurial ecosystem enhances innovativeness and through that procurement performance. In this respect, we pay special attention to the following actors: public and private customers, other firms in the markets (suppliers and competitors), public and private funding/investors, public and private consultation services, universities and research institutions.

Recently, more attention has been paid to public procurement as a tool to promote innovation (Georghiou et al., 2014) and the public procurer can be regarded as an important actor in the entrepreneurial ecosystem at large and in the innovation system more specifically. Within the innovation system, the public procurer plays a dual role. On the one hand, it can provide incentives for firms to innovate by motivating them with sufficient or secure returns, and on the other hand, it can influence buyers to become more willing and able to demand and adopt innovations (Georghiou et al., 2014; Edler & Georghiou, 2007). It can also promote enhanced networking and information flow (Georghiou et al., 2014; Edler & Georghiou, 2007). In the present study, we focus on how public procurement provides incentives and creates demand for innovations.

As for the other actors in the entrepreneurial ecosystem included in this study, they have different roles and impacts with respect to different innovation types. For example, Faems et al. (2005) find that exploitative collaboration with customers and suppliers is positively related to higher levels of turnover due to improved products, while explorative collaboration with universities and researchers had a similar association with new products. The need for funding and consultation is also dependent on the type of innovation and, for example, on whether new research knowledge or specific technology is required. However, we assume that although the strength of the impact may vary, the breadth of collaboration with different actors is beneficial to all types of innovation.

In order to approach the potential impact of PPI on the competitiveness of SMEs, we introduce a construct of *procurement performance* as a measure of how well PPI enables SMEs to seek competitive advantage from the perspective of firms participating in public procurement,. Thus, the fundamental idea is that lowering costs and differentiation due to product/service improvements (both gradual and radical ones) are the main strategies for pursuing competitive advantage. While the earlier research suggests that firms adopt either one of these strategies (Porter, 1985; Day, 1989), the hybrid view argues that both of them can be used at the same time (for a recent discussion, see Pertusa-Ortega et al., 2009; Claver-Cortés et al., 2012; Gabrielsson et al., 2016). From the entrepreneurial ecosystem perspective, these strategies involve different collaborative and interaction dispositions.

A possible, and to our knowledge as yet un-utilized, way to assess the impact of PPI on SMEs' competitive position is to address the participating SMEs' own experiences regarding the impact of PPI on their competitive advantage. To this end, the term procurement performance denotes the PPI's role in shaping the SMEs' external environment and economic incentives which enable SMEs to choose their strategies and build the necessary networks for seeking a competitive advantage. The conceptual model together with research hypotheses is illustrated in Figure 1.

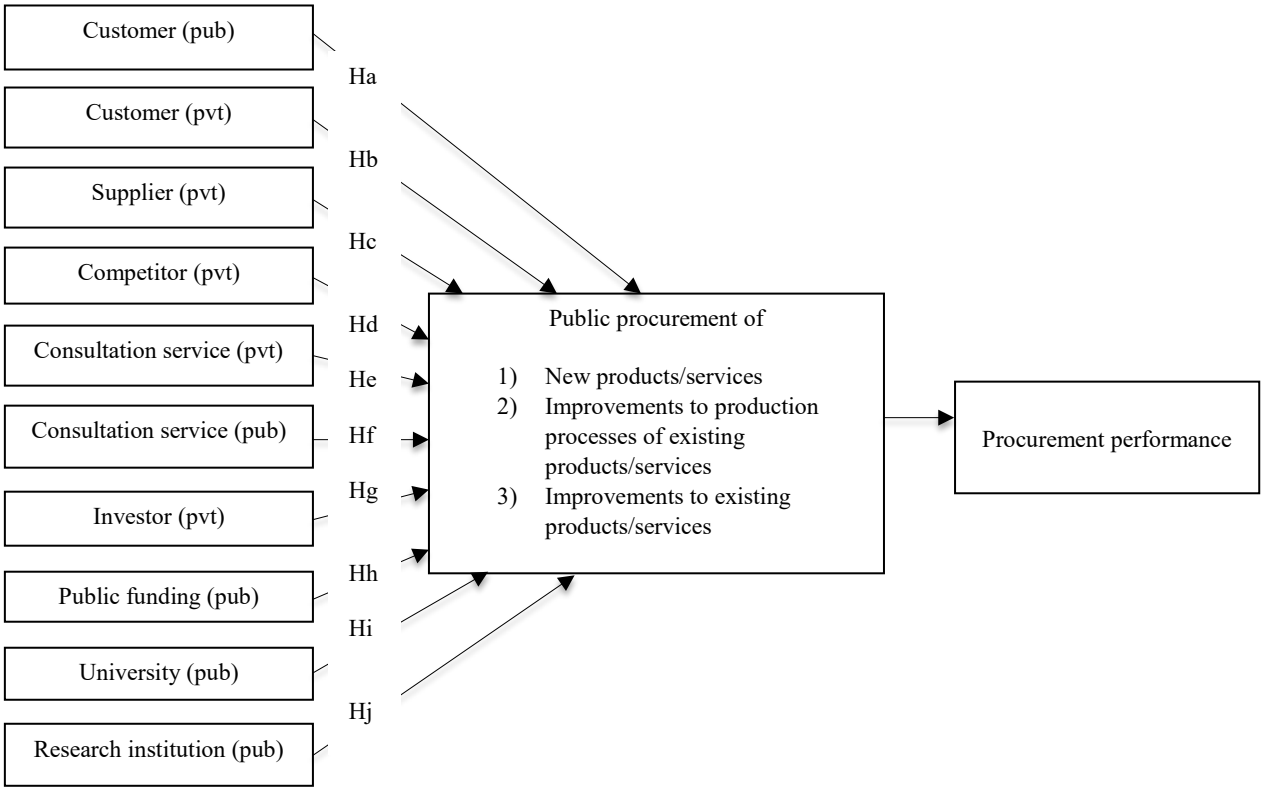

Figure 1. Conceptual model.

Based on the discussion above, we hypothesize that the breadth of collaboration with an actor x

H1x: boosts new product/service development which enhances procurement performance.

H2x: boosts making improvements to production processes of existing products/services which enhances procurement performance.

H3x: boosts making improvements to existing products/services which enhances procurement performance,

in which x is a:
a) public sector customer,
b) private sector customer,
c) supplier,
d) competitor,
e) private consultation service,
f) public consultation service,
g) private investor,
h) public funding source,
i) university,
j) research institution.

3. QUESTIONNAIRE DEVELOPMENT, DATA AND METHODS

3.1 Questionnaire development and data

This paper uses a survey-based research methodology. The data were collected by electronic questionnaire sent to Finnish SMEs in February 2015. The survey was administered in cooperation with the Federation of Finnish Enterprises (FFE), whose database contains the contact information (e-mail addresses in this case) of more than 70,000 Finnish SMEs. The data set was constructed by first identifying firms with fewer than 250 employees and then by drawing a random sample of 15,000 eligible firms from the database. The survey was administered by sending an electronic questionnaire to the sample of Finnish SMEs in February 2015.

The questionnaire consisted of questions measuring respondents' (a) involvement in public procurement, in which they were asked to indicate whether they had provided new products/services or improved production processes in response to demand originating from a public sector customer, (b) engagement in different tasks with private and public ecosystem actors and (c) perceptions of benefits associated with their involvement in public procurement. Additionally, the respondents were asked to provide background information related to their business including the firm's size, age, intellectual property rights and main industry. Henceforth, the term *product* will be used as a short-hand expression to refer to both (physical) products and services. The survey instrument can be found in Appendix. For external validation, a group of experts with extensive experience of policy and practice concerning public procurement and SMEs reviewed the survey instrument.

Two analyses for nonresponse biases (see Armstrong and Overton 1977) were conducted. First, a response-wave analysis was made to evaluate the possible differences between the first wave respondents and the second wave respondents (after the first reminder). It was found that the mean firm sizes in the first wave (Mean = 4.5; S.D. = 6.48) and the second wave (Mean = 5.7; S.D. = 13.80) were equal ($t(368) = -1.105$, $p > .1$); the mean firm ages in the first wave (Mean = 11.1; S.D. = 13.86) and the second wave (Mean = 12.4; S.D. = 15.34) were equal ($t(368) = -896$, $p > .1$); and the firm annual turnover (seven category measure, see table x) was independent of the response-wave ($\chi^2(6) = 7.93$; $p > .1$).

A statistical association was found between the industry (seven categories) and the response-wave ($\chi^2(6) = 54{,}6$; $p < .001$). Based on the magnitude of a cell's adjusted residuals (observed minus expected value divided by an estimate of its standard error) below -2 and above +2 the association can be concluded as resulting from firms in the wholesale and retail trade sectors and in the knowledge intensive business services sector responding more often in the first wave than in the second wave. Additionally, firms in the healthcare, social services and educational services sector and those in the mixed group sector responded more often in the second wave than in the first wave. However, the final industry distribution is close to the distribution of Finnish enterprises in 2015 (Statistic Finland). Statistics Finland, Enterprises, 2015: Industry http://tilastokeskus.fi/tup/suoluk/suoluk_yritykset_en.html

Second, a Little's MCAR-test was conducted to assess the randomness of missing data. The test indicated that the missing data did not occur in a completely random manner ($\chi^2(49) = 83{,}56$; $p < .01$). The reason for this was the low response rate to the questions forming the PROC_PERF variable. Further analyses showed that the average firm age was higher among firms which responded to these questions than among non-respondents ($t(352.62) = -3.75$; $p < .01$) and that the average firm size was also higher among firms which responded to these questions than among non-respondents ($t(291.35) = -3.64$; $p <$

.01). Thus, the data in the regression analyses reflects the fact found also by Pickernell et al. (2013), Flynn et al. (2015), Tammi et al. (2014) and Reijonen et al. (2016) that firm age and firm size are positively associated with an SME's activity in public procurement.

3.2 Variables

Dependent variable

The dependent variable in the path models is a construct for procurement performance (see Table 1). The respondents were asked following question: "To what extent has involvement in public procurement influenced the following matters?" The answers consisted of multiple choice responses on a five-point Likert scale and consisted of the following statements: "has improved our competitive position", "has lowered our costs", "has improved our product/service offerings", "has supported developing new products/services" and "has improved our research and development efficiency". The construct measures long-term benefits stemming from participation in public procurement as reported by the respondents. It covers activities related to the firm's competitive position, costs, product/service quality, and their R&D efforts. A Bartlett score of the factor solution (PROC_PERF) was used in a regression analyses.

Mediating variables

The indicators for the public sector's demand for innovation was measured using dichotomous variables. Related to the definitions of PPI, these measures do not differentiate between the types of innovation procurement described in Section 2.1. That is, an innovation may result from the direct procurement of innovations, innovation-friendly procurement, or catalytic procurement. The innovation types describe the demand for a new product. These included a new-to-the-market or 'radical innovation', (NEW_PROD), an improved production processes of existing products (a process innovation) (IMP_PROC) and an improved existing product (IMP_PROD) ('incremental innovation') (see Aschoff & Sofka, 2009). These variables take the value one if the respondent reports having been involved in producing an innovative solution for the public sector customer and are set to zero otherwise.

Independent variables

The independent variables employed in this study measure the breadth of interaction with different actors in the entrepreneurial ecosystem. Firms may collaborate with customers, suppliers, service providers and competitors in the private sector, as well as with customers, actors in research and development and universities in the public sector (Nieto and Santamaria, 2007; Zeng et al., 2010). Altogether, we identify ten actors, who consist of five public sector (PUB) and private sector (PVT) actors with whom a firm may engage in different levels of cooperation. The private sector actors include a private sector customer (PVT_CUST), a supplier (PVT_SUPP), a competitor (PVT_COMP), a private sector consultation service (PVT_CONS) and an investor (PVT_INV). The public sector actors include a public sector customer (PUB_CUST), a university (PUB_UNI), a research institution (PUB_RES), a public sector consultation service (PUB_CONS) and a public funding source (PUB_INV).

Each of these variables consisted of nine attributes which were constructed from the respondents' answers to the questions in which they were asked to identify the forms of collaboration with public sector/private sector actors. These forms were a) "brought a product/service that is new to the market", b) "improved the production process of an existing product/service," c) "developed a new feature for an existing product/service", d)

"developed a new usage of an existing product/service", e) "reorganized relationships with other firms and/or private/public sector actors", f) "shared information and experiences", g) "developed marketing and distribution channels", h) "developed technology" and i) "collaborated in public procurement." The variables were constructed by summing answers to these questions thus making the measurement range of these variables between 0 and 9.

Control variables
Control variables were used to control for firm characteristics. First, firm size and age may be associated with a firm's innovativeness (e.g. Clausen and Korneliussen, 2012). We used the number of employees (SIZE) and the number of years since the firm was founded (AGE) as proxies for the firm size and age, respectively. Second, firms also differ in their innovation intensity (e.g. Acs and Audretsch, 1989). As a result, we used the number of intellectual property rights (IPR) held by a firm as a proxy for its innovativeness. Finally, demand for innovative solutions as well as exposure to public procurement varies between industries (e.g. Edquist and Zabala-Iturriagagoitia, 2012), and for this reason, we controlled for the firm's main industry (PRODI, CONST, TRADE, RECRE, KIBS, HEALTH) with a dummy variable. Logarithmic transformations of the firm size and age variables were further used in the path analysis.

3.3 Analysis methods
The data were analysed using statistical methods. The dependent variable was constructed using principal component factor analysis (PCFA) and analysed using a path regression model. The proposed path model applies logistic regression (logit) and an ordinary least squares (OLS) regression. Following 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 established, path coefficients for regressions i) and ii) should be statistically significant, whereas the magnitude of the independent variable(s) in regression iii) should be meaningfully reduced or statistically insignificant (Baron & Kenny, 1986). However, the presence of a mediation effect was established by conditions i) and iii) alone (Preacher & Hayes, 2008; Zhao et al., 2010).

Bias corrected (BC) bootstrapped confidence intervals (CI) were applied to verify the statistical significance of the mediated effect. Bootstrapping is required because the product of two normally distributed variables was positively skewed (Shrout & Bolger, 2002), which makes the Sobel test, a standard in studies involving mediation, obsolete (Preacher & Hayes, 2008; Zhao et al., 2010). Further, since the mediators are dichotomous in our path models, their products are not normally distributed either. As a result, bootstrapping produces an empirical distribution to determine the significance of the mediated effect (MacKinnon et al., 2007). The statistical significance of mediation is established if the bootstrap CIs do not contain zero (Zhao et al., 2010). We applied 1,000 repetitions in the bootstrapping procedure. As a final note, bias correction was also applied due to its statistical power (MacKinnon et al., 2004; Preacher & Hayes, 2008).

4. RESULTS
4.1 Factor solution of the procurement performance variable
The factor solution for the 'procurement performance' construct is reported in Table 1. The construct consists of five items and it explains 85.5 % of the variance. All items exhibit high loadings with a range between 0.882 and 0.960. The Cronbach's alpha value is very

high (0.955) which implies excellent internal consistency. A Bartlett score (PROC_PERF) of the construct), which is standardized with the mean at zero and a standard deviation of 1, was used as the dependent variable in the statistical analyses. A note is warranted on the difference between the numbers of observations for PROC_PERF and other variables (see Table 3). As the items of the PROC_PERF construct required experience of public procurement, this reduced the sample considerably making approximately a third of observations ineligible for the regression analyses. However, this is in-line with Reijonen et al. (2016) who report a comparable participation rate in public procurement.

Table 1. Principal component solution for SME procurement performance

SME procurement performance (Alpha: 0.955 Lambda: 4.276. Percentage of variance explained: 0.855)	*Factor loading*
Involvement in public procurement	
has improved our competitive position	0.896
has lowered our costs	0.882
has improved our product/service offerings	0.960
has supported developing new products/services	0.943
has improved our research and development efficiency	0.936

Notes: n = 249; Bartlett's test of sphericity: $\chi^2 = 1440.445$ (p-value < 0.001); Kaiser-Meyer-Olkin measure of sampling adequacy: 0.896. *Question*: "To what extent has participation in public procurement influenced the following matters?" *Answer scale*: 1=very poorly, 2=quite poorly, 3=not poorly or well, 4=quite well, 5=very well.

4.2 Descriptive statistics

Table 2 reports some background information on the respondents and the firms they represent. The vast majority of the respondents (97.6 %) were full-time or part-time entrepreneurs and owners. Only a small fraction were hired CEOs (1.1 %), specialists (1.4 %) and clerical workers or employees (0.3 %). Thus, a reasonable assumption is that the respondents had in-depth knowledge about their firms' operations and performance. In regard to the reported firm size, the sample was dominated by small and micro enterprises with 78.6 % of the responding firms reporting less than 400,000 euros in annual sales turnover. If the number of employees is used as a measure of size, 91.6 % of firms would be micro-enterprises (fewer than 10 employees) and 5.2 % would be small firms (10 – 49 employees), and 0.8 % would be medium-sized enterprises. The aforementioned figures are close to Statistics Finland's official 2015 statistics for the size composition of Finnish enterprises. Consequently, the sample appears to be fairly representative of the Finnish SME population[1].

Table 2. Respondent's position.

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

[1] The official statistics are available at http://tilastokeskus.fi/tup/suoluk/suoluk_yritykset_en.html.

Descriptive statistics of variables employed in the path analysis are reported in Table 3. The mediating variables show that incremental innovations are more common than 'radical' innovations, because 19.3 % and 18.5 % of the respondents report having made improvements to production processes or to existing products or services, respectively, as opposed to 14.1% reporting having developed entirely new products or services. The independent variables show that, although some firms use all forms measured in this survey (9) in their collaborations, on average, a firm's breadth of collaboration with public or private actors is rather limited. The highest average of different forms of collaboration is with private customers (2.835) and the lowest average is with private investors (0.141). The responses also indicate that there appear to be more opportunities for collaboration with private rather than public sector actors.

Concerning the control variables, the figures suggest that the average firm is approximately five years old and has 12 employees. In addition, the firms in this study, on average, are not very innovation-intensive as the average IPR is 0.546. The distribution across industries suggests that most respondents identify their firms belonging to the knowledge-intensive business services sector (0.309), whereas the healthcare sector had the lowest number of firms (0.068).

Table 3. Descriptive statistics of variables employed in regression analysis.

Variable [Abbreviation]	Obs.	Mean	SD	Min	Max
Procurement performance [PROC_PERF]	249	0.000	1.003	-0.989	1.977
Developing new products/services [NEW_PROD^{x}]	249	0.141	0.348	0	1
Making improvements on production processes) [IMP_PROC^{x}]	249	0.193	0.395	0	1
Making improvements on existing products/services [IMP_PROD^{x}]	249	0.185	0.389	0	1
Customer (private) [PVT_CUST]	249	2.835	2.913	0	9
Supplier (private) [PVT_SUPP]	249	1.430	2.237	0	8
Competitor (private) [PVT_COMP]	249	0.795	1.582	0	9
Consultation service (private) [PVT_CONS]	249	0.526	1.429	0	9
Investor (private) [PVT_INV]	249	0.141	0.724	0	6
Customer (public) [PUB_CUST]	249	1.056	2.164	0	9
Consultation service (public) [PUB_CONS]	249	0.546	1.513	0	9
University (public) [PUB_UNI]	249	0.422	1.287	0	9
Research institution [PUB_RES]	249	0.157	0.877	0	9
Public funding source [PUB_FUND]	249	0.249	1.108	0	8
Number of intellectual property rights [IPR]	249	0.566	0.826	0	4
Firm size (number of employees) [SIZE]	249	4.992	12.203	0	150
Firm age (years) [AGE]	249	12.273	16.101	1	118
Production industries [PRODI^{x}]	249	0.153	0.360	0	1
Construction CONST^{x}]	249	0.197	0.398	0	1
Wholesale and retail trade [TRADE^{x}]	249	0.129	0.335	0	1
Recreational and hospitality services [RECRE^{x}]	249	0.145	0.352	0	1
Knowledge intensive business services [KIBS^{x}]	249	0.309	0.463	0	1
Healthcare, social services and educational services [HEALTH^{x}]	249	0.068	0.253	0	1

Notes: ^{x} Indicates a dummy variable with yes = 1.

The correlations matrix in Table 4 shows that all PPI variables are correlated with the performance variable. This suggests that there is an association between innovation procurement and SME competitiveness. Strong correlations between mediator variables (NEW_PROD, IMP_PROC and IMP_PROD) further indicate that the firms which develop new-to-the market innovations also engage in producing incremental innovations. Further, since these variables are highly correlated with each other, we do not include them in the same path model to avoid the problems of multicollinearity.

4.3 Path regression model

The estimated coefficients for the path models are reported in Table 5. We refer to the model of developing new products for the public sector customer as Model 1, developing process innovations in response to the public sector customer's demand as Model 2, and improving existing products for the public sector customer as Model 3. In each model, the influence of firm size, firm age, IPR and industry membership are controlled for, but their coefficients are not reported in the main body of text. The full estimation results for all variables can be found in Table A1 in the Appendix.

Regarding Model 2, the upper panel of Table 5 reports three statistically significant paths with a positive coefficient between the ecosystem and improving the production process. First, having some degree of active mutual involvement between the public sector customer and the firm increases the probability of the firm developing new products for the public sector ($p < 0.01$). Second, co-operation with the competitor also increases the probability of developing new products for the public sector ($p < 0.05$). Since NEW_PROD is statistically significant ($p < 0.01$), it suggests that developing new products is an important mediator for procurement performance. In consequence, H1a and H1d cannot be rejected.

The upper-middle panel of Table 5 shows that there are two statistically significant paths with a positive coefficient between the ecosystem and developing improved products for the public sector customer. As earlier, active involvement between the public sector customer and the firm increases the probability of the firm engaging in process innovations for the public sector ($p < 0.01$). Further, joint activities with a competitor also increase the probability of process innovations for the public sector ($p < 0.05$). In addition to these, there is a marginally significant path from public funding sources ($p < 0.1$) to process innovations. Moreover, a statistically significant path from process innovations ($p < 0.01$) to procurement performance suggests that it is an important mediator. As a result, we fail to reject H2a, H2d and H2h.

The lower-middle panel of Table 5 shows that there are two statistically significant paths with a positive coefficient between the ecosystem and improving existing products for the public sector customer. Again, active engagement between the public sector customer and the firm increases the probability of the firm engaging in process innovations for the public sector ($p < 0.01$). However, unlike the earlier cases, ties with the supplier increase the probability of improving existing products for the public sector customer ($p < 0.05$). In addition, a statistically significant path from improving existing products ($p < 0.01$) to procurement performance suggests that this too is an important mediator. Consequently, we fail to reject H3a and H3c.

There are also two direct paths from the ecosystem to procurement performance, which are common to the models. A direct path from the public sector customer ($p < 0.01$) to procurement performance exists. However, the indirect paths from the public sector customer to performance are larger by magnitude in all three models. Curiously, there is also a marginally significant ($p < 0.1$) path from the private sector customer to procurement performance which is *negative*. This implies that focusing on private sector customers might reduce long term benefits from the involvement in public procurement.

Table 4. Pearson correlations matrix.

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
NEW_PROD (1)	1.00																					
IMP_PROC (2)	0.46	1.00																				
IMP_PROD (3)	0.50	0.61	1.00																			
PVT_CUST (4)	0.19	0.15	0.19	1.00																		
PVT_SUPP (5)	0.19	0.11	0.20	0.27	1.00																	
PVT_COMP (6)	0.22	0.23	0.13	0.09	0.17	1.00																
PVT_CONS (7)	0.10	0.06	0.11	0.05	0.12	0.11	1.00															
PVT_INV (8)	0.09	0.04	0.08	0.00	0.09	0.00	0.25	1.00														
PUB_CUST (9)	0.29	0.35	0.43	0.38	0.15	0.13	0.14	0.09	1.00													
PUB_CONS (10)	0.13	0.05	0.11	0.11	0.17	0.16	0.36	0.11	0.09	1.00												
PUB_UNI (11)	0.30	0.24	0.21	0.17	0.27	0.16	0.25	0.16	0.13	0.24	1.00											
PUB_RES (12)	0.20	0.18	0.13	0.16	0.16	0.14	0.22	0.15	0.15	0.09	0.53	1.00										
PUB_FUND (13)	0.20	0.19	0.14	0.18	0.13	0.03	0.27	0.43	0.21	0.18	0.27	0.23	1.00									
IPR (14)	0.15	0.14	0.16	0.21	0.14	0.05	0.08	0.17	-0.03	0.11	0.26	0.08	0.31	1.00								
Ln(SIZE) (15)	0.00	0.05	0.09	0.10	0.15	-0.09	0.01	-0.01	0.11	-0.02	0.02	0.05	0.07	0.10	1.00							
Ln(AGE) (16)	-0.02	0.04	0.03	0.07	0.04	-0.06	-0.02	-0.03	0.09	-0.03	-0.02	0.03	-0.06	-0.04	0.40	1.00						
PRODI (17)	-0.01	-0.01	0.01	0.06	0.08	-0.02	-0.06	0.00	-0.06	-0.01	-0.03	-0.06	-0.02	-0.01	0.06	0.02	1.00					
CONST (18)	-0.03	-0.01	-0.05	-0.10	-0.08	-0.02	0.01	-0.07	0.04	-0.05	-0.09	-0.03	-0.08	-0.16	0.11	0.09	-0.20	1.00				
TRADE (19)	-0.10	-0.11	-0.06	-0.13	0.05	-0.09	-0.13	-0.07	-0.07	-0.02	-0.12	-0.06	-0.08	-0.05	-0.03	0.06	-0.19	-0.20	1.00			
RECRE (20)	-0.01	-0.08	-0.05	0.15	0.01	-0.07	-0.08	0.04	0.01	0.09	-0.01	-0.07	0.05	0.09	0.07	-0.06	-0.18	-0.20	-0.19	1.00		
KIBS (21)	0.12	0.09	0.06	0.01	0.03	0.07	0.20	0.09	0.04	0.01	0.16	0.20	0.15	0.16	-0.13	-0.07	-0.27	-0.29	-0.28	-0.27	1.00	
HEALTH (22)	0.02	0.14	0.11	0.03	-0.13	0.15	0.01	-0.01	0.05	-0.02	0.08	-0.02	-0.06	-0.08	-0.07	-0.04	-0.12	-0.13	-0.12	-0.12	-0.17	1.00
PROC_PERF (23)	0.37	0.46	0.38	0.27	0.16	0.24	0.19	0.11	0.02	0.09	0.18	0.13	0.03	-0.05	-0.09	-0.10	-0.05	-0.05	-0.15	0.15	0.21	0.11

Table 5. Estimated coefficients for path models.

MODEL 1		
Path	Coeff.	S.E.
NEW_PROD ← PUB_CUST	**0.251*** **	0.091
NEW_PROD ← PVT_COMP	**0.267** **	0.115
PROC_PERF ←NEW_PROD	**0.723*** **	0.186
MODEL 2		
Path	Coeff.	S.E.
IMP_PROC ← PUB_CUST	**0.366*** **	0.092
IMP_PROC ← PUB_FUND	**0.365***	0.210
IMP_PROC ← PVT_COMP	**0.256** **	0.114
PROC_PERF ←IMP_PROC	**0.849*** **	0.164
MODEL 3		
Path	Coeff.	S.E.
IMP_PROD ← PUB_CUST	**0.476*** **	0.098
IMP_PROD ← PVT_SUPP	**0.188** **	0.094
PROC_PERF ← IMP_PROD	**0.651*** **	0.175
DIRECT PATHS		
Path	Coeff.	S.E.
PROC_PERF ← PUB_CUST	**0.128*** **	0.031
PROC_PERF ← PVT_CUST	**-0.042***	0.024

Notes: S.E. = standard error. Statistical significance: *** p-value < 0.01; ** p-value < 0.05; * p-value < 0.1.

The bootstrap BC CIs for all models are reported in Table 6. In all cases, none of them contain zero values, which implies that both the indirect and direct effects are statistically significant. Based on this information, we can observe that in the cases of process innovations and improving existing products, the mediated effect is larger by magnitude. In both cases, the public sector demand as a mediator accounts for over 40 % of the total effect as opposed to 24 % in the case of new products. These findings suggest that the long-term benefits captured by the procurement performance construct may be attained through the use of instruments available in PPI.

Table 6. Bootstrapped direct, indirect and total effects for path models.

MODEL 1					
Effect	Coeff.	Bias	Bootstrap S.E.	Proportion	95 % BC CI
Indirect	0.072	-0.003	0.039	0.244	(0.013, 0.172)
Direct	0.223	0.006	0.065	0.756	(0.072, 0.333)
Total	0.295	0.002	0.072	1.000	(0.152, 0.425)
MODEL 2					
Effect	Coeff.	Bias	Bootstrap S.E.	Proportion	95 % BC CI
Indirect	0.134	0.009	0.047	0.432	(0.054, 0.235)
Direct	0.176	0.004	0.063	0.568	(0.051, 0.297)
Total	0.310	0.013	0.068	1.000	(0.160, 0.433)
MODEL 3					
Effect	Coeff.	Bias	Bootstrap S.E.	Proportion	95 % BC CI
Indirect	0.125	0.007	0.042	0.419	(0.046, 0.203)
Direct	0.174	0.006	0.067	0.581	(0.037, 0.300)
Total	0.298	0.013	0.066	1.000	(0.154, 0.419)

Notes: Coefficients standardized. S.E. = standard error. Proportion indicates the ratio of mediated/direct effects to the total effect. BC = Bias corrected. CI = Confidence interval.

5. CONCLUSION

5.1 Discussion

This article focused on SMEs' interplay with entrepreneurial ecosystem actors in association with the public procurement of innovations. We proposed path models in which a firm collaborates with actors in the entrepreneurial ecosystem when it a) develops a new product or service, b) improves production processes of existing products/services (process innovation) or c) improves an existing product/service to gain a competitive advantage in response to the public sector customer's demand. We distinguished between ten different types of entrepreneurial ecosystem actors and measured the breadth of interaction

with each of them. To measure the competitive advantage originating from participation in public innovation procurement, we proposed a five-item construct called 'procurement performance', which was applied as the dependent variable in the path models.

The path models were tested empirically using survey data of Finnish SMEs. Our results suggest that the public sector customer is important in all three models. Ties with the public sector customer increase the chances of acquiring public sector contracts that require an innovative approach and improve the firm's performance. This highlights the importance of understanding the customer needs when developing innovative products.

With respect to other firms, our findings point toward the significance of both vertical and horizontal collaboration with other firms. In the cases of developing new products and process innovations, the breadth of horizontal ties with rival firms increases the probability of winning public sector contracts with respective innovation targets. Subsequently, these results imply that SMEs may find it necessary to network with firms within the same industry, or market, in public innovation procurement. This behaviour could be due to large contract sizes associated with innovation procurement (Uyarra et al., 2014). However, in the case of making improvements to existing products, the breadth of horizontal ties with the supplier are important. This suggests that when the firm has established products incremental innovations require extensive interaction with its supplier(s).

What is missing in the results is also noteworthy. That is, in the light of our findings, we find only a weak association between public R&D funding sources and innovation procurement, but an association between public sector R&D actors and public innovation procurement and performance cannot be established. This is at odds with the prior research which suggests that networks formed with these ecosystem players are particularly important to SMEs in complementing their resources in terms of improving their innovative capabilities (Masiello et al., 2015). However, contrary to our research, Masiello et al. (2015) use a case-study approach and focus on the importance of relationships that 'already' exist, which may explain this inconsistency. However, this does not rule out that other factors related to social or locational distance between enterprises and public sector R&D actors would play a role.

5.2 Managerial implications

Based on the findings of this study, several managerial implications can be proposed. From the SME's perspective, two key suggestions emerge. First, SMEs that seek business opportunities in public innovation procurement should develop ties with prospective customers because this, most likely, increases their chances of winning contracts that require innovations. These contracts seem to be valuable because SMEs that report being involved in innovation procurement also report several tangible and intangible long-term benefits stemming from public procurement. In other words, SMEs seem to gain some competitive advantage when they are involved in PPI. Second, selecting the correct business partners from the entrepreneurial ecosystem may be profitable. When innovations tilt towards the 'radical' side of the spectrum, being involved with rivals, perhaps in informal or formal networks or alliances, appears to improve performance. However, it could pay to establish extensive ties with suppliers in cases where innovations are incremental.

From the policy maker's perspective, this study suggests that public innovation procurement could be an important tool in SME development. Because reported improvements in performance have been found regardless of the innovation target specified, this could be viewed as preliminary empirical support for contracting authorities to relax specifications in procurement contracts and to provide more room for supplier innovation. Further, as the breadth of involvement with the public sector customer is also important, policy makers should focus on efforts that improve communication between public sector customers and prospective suppliers. However, this may be challenging because the need for

transparency and fairness in awarding contracts may place a burden on information sharing between public sector customers and prospective suppliers.

In addition, relaxed specifications and improved communication between public sector customers and prospective suppliers may attract SMEs from other regions to compete with the incumbent SMEs in the entrepreneurial ecosystem. Therefore, a regional entrepreneurial ecosystem should be able and, perhaps, be supported by tailoring entrepreneurial policy tools to strengthen the capabilities of MEs in scanning information on their competitors and customers to develop a learning organization willing to improve continuously as suggested by Tammi et al. (2016). On the other hand, there are somewhat unexplored issues related to the tension between 'local' practices and 'global' policy ideas concerning PPI (Edler et al. 2015). As argued by Valovirta (2015), for instance, it may be rational for procurement entities to bundle demand within a trade area (e.g. EU) to increase buyer power, which, however, may weaken the functioning of local-level PPI. On the other hand, a PPI project may become unsuccessful due to various reasons, such as inadequate coordination of more or less decentralized purchasing projects and of "poor targeting, backward-looking protectionism and the support of national champions" (Uyarra and Flanagan 2010).

5.3 Limitations and future research

As with all studies, there are some limitations that may affect the generalizability of results. Obviously, a sample of SMEs from a single country may be a source of bias because investments in R&D and the use of innovation procurement may vary between countries. Further, a larger sample size might produce more reliable results. In addition, the models studied here may miss some mediators because a direct effect remains, which implies a more complex causal mechanism than the one proposed here (see Shrout & Bolger, 2002; Zhao et al., 2010). It must also be noted that this study was the first instance of the application of the 'procurement performance' construct, so its reliability should be tested with other data sets.

Based on this study, some directions for further studies may also be given. One such direction could be to study the influence of the private customer's demand for innovations in a setting which involves entrepreneurial ecosystem actors. Another could be to study the depth of collaboration among ecosystem actors. In addition, the results in this article point to a need to further analyse why higher education institutions did not exhibit a more explicit influence though many scholars and policymakers perceive these institutions as the main drivers in entrepreneurship ecosystems. The same holds for public sector R&D actors and public R&D funding sources. Are there real failures or do these players influence innovations and growth through other channels? Finally, public procurement contract design should be examined in a more specific manner to find out whether or not contract types impede or enable supplier innovations.

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APPENDIX

Table A1. Full estimation results.

	MODEL1 INDIRECT				MODEL 2 INDIRECT				MODEL 3 INDIRECT				DIRECT	
Method	Logit		OLS		Logit		OLS		Logit		OLS		OLS	
D.V.	NEW_PROD		PROC_PERF		IMP_PROC		PROC_PERF		IMP_PROD		PROC_PERF		PROC_PERF	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
NEW_PROD			**0.723*** **	0.186										
IMP_PROC							**0.849*** **	0.164						
IMP_PROD											**0.651*** **	0.175		
PUB_CUST	**0.251*** **	0.091	**0.103** **	0.031	**0.366*** **	**0.092**	**0.081*** **	0.031	**0.476*** **	0.098	**0.080** **	0.033	**0.128*** **	0.031
PUB_CONS	0.044	0.154	0.046	0.046	-0.134	0.156	0.063	0.045	-0.077	0.149	0.061	0.046	0.052	0.047
PUB_UNI	0.283	0.172	0.030	0.059	0.193	0.165	0.037	0.058	0.099	0.166	0.053	0.059	0.069	0.060
PUB_RES	-0.073	0.247	0.092	0.080	0.145	0.268	0.081	0.078	-0.088	0.232	0.100	0.080	0.093	0.082
PUB_FUND	0.099	0.199	0.003	0.063	**0.365***	**0.210**	-0.019	0.062	-0.049	0.189	0.024	0.064	0.018	0.065
PVT_CUST	0.097	0.086	**-0.046***	0.023	-0.029	0.079	**-0.037***	0.023	0.022	0.080	**-0.041***	0.023	**-0.042***	0.024
PVT_SUPP	0.107	0.101	0.011	0.030	0.070	0.095	0.012	0.029	**0.188** **	0.094	0.003	0.030	0.018	0.031
PVT_COMP	**0.267** **	0.115	0.018	0.038	**0.256** **	**0.114**	0.010	0.038	0.093	0.132	0.038	0.038	0.044	0.039
PVT_CONS	-0.050	0.174	-0.004	0.050	-0.135	0.160	0.005	0.049	0.057	0.162	-0.020	0.050	-0.016	0.051
PVT_INV	-0.034	0.336	-0.109	0.093	-0.456	0.362	-0.082	0.091	-0.028	0.325	-0.115	0.093	-0.109	0.096
Ln(SIZE)	-0.162	0.296	0.002	0.072	-0.096	0.258	0.000	0.071	0.169	0.256	-0.020	0.073	-0.011	0.075
Ln(AGE)	-0.301	0.278	-0.085	0.067	-0.034	0.245	-0.098	0.065	-0.295	0.249	-0.083	0.067	-0.099	0.069
PRODI	0.578	0.857	0.182	0.212	**1.464***	**0.869**	0.109	0.208	**1.554***	0.860	0.127	0.214	0.210	0.219
CONST	0.500	0.830	0.273	0.205	1.276	0.846	0.210	0.201	0.344	0.900	0.281	0.206	0.297	0.211
TRADE	0.223	1.040	0.318	0.227	0.574	1.063	0.305	0.222	1.268	0.983	0.274	0.228	0.334	0.234
KIBS	0.682	0.744	**0.439** **	0.190	**1.341***	**0.788**	**0.380** **	0.187	1.194	0.783	**0.410** **	0.191	**0.472** **	0.196
HEALTH	0.612	0.977	**1.048*** **	0.274	**2.901*** **	**0.943**	**0.770*** **	0.274	2.685	0.952	**0.873*** **	0.280	**1.072*** **	0.282
IPR	**0.587** **	0.269	0.111	0.077	**0.737*** **	**0.249**	0.075	0.076	**0.881*** **	0.254	0.083	0.079	**0.156** **	0.079
INTERCEPT	**-3.332*** **	0.897	-0.364	0.215	**-3.879*** **	**0.912**	-0.323	0.210	**-4.087*** **	0.914	-0.319	0.216	-0.353	0.222
LR Chi2	**50.69*** **				**66.33*** **				**73.36*** **					
F			**4.60*** **				**5.40*** **				**4.51*** **		**3.78*** **	
(Pseudo) R2	(0.251)		0.276		(0.272)		0.309		(0.308)		0.272		0.228	
N	249				249		249		249		249		249	

Notes: S.E. = standard error. D.V. = dependent variable. N = number of observations. Statistical significance: *** p-value < 0.01; ** p-value < 0.05; * p-value < 0.1.

Appendix. Survey instrument.

Survey of public procurement

Please, answer each question by clicking your choice. In some questions, the answer should be typed into a space reserved for it. A star (*) indicates that an answer must be provided in order to proceed to the next page in the questionnaire form. These types of questions are limited to the part of the survey requesting background information.

Respondent's gender: *

__ Male __ Female

Respondent's position *

__ Sole entrenpreneur, owner (full-time or part-time)

__ CEO

__ Specialist

__ Clerical worker

__ Employee

Founding year *

_____

_____

Main industry*

Mining and quarrying

Manufacturing

Electricity, gas, steam, and air conditioning supply

Water supply; sewerage, waste management and remediation activities

Construction

Wholesale and retail trade; repair of motor vehicles and motorcycles

Transportation and storage

Accommodation and food service activities

Information and communication

Real estate activities

Professional, scientific, and technical activities

Public administration and defence; compulsory social security

Administrative and support service activities

Agriculture, forestry and fishing

Education

Financial and insurance activities

Human health and social work activities

Arts, entertainment and recreation

Other service activities

Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use

Activities of extraterritorial organisations and bodies

Industry unknown

The number of employees*

How many persons does your firm employ including yourself? (Two part-time employees may be equated with a single full-time employee.)

_____

How large is the annual sales turnover of your firm?

__ 1 - 99 999 euro
__ 100 000 - 199 999 euro
__ 200 000 - 399 999 euro
__ 400 000 - 999 999 euro
__ 1 000 000 - 1 999 999 euro
__ 2 000 000 - 9 999 999 euro
__ 10 000 000 - 49 999 999 euro
__ over 50 000 000 euro

Please, provide answers to the following questions relating to innovation activity (answer either 'Yes' or 'No', and whether the customer was from the public sector or the private sector or both).

You may select more than one choice.

Over the past five years, have you

	Yes	No	Was the customer from the public sector? (Select if 'Yes')	Was the customer from the private sector? (Select if 'Yes')
brought an entirely new product/service developed by your firm to the market?	☐	☐	☐	☐
improved the production processes of an existing product/service?	☐	☐	☐	☐
developed a new feature or features for an existing product/service?	☐	☐	☐	☐

To what extent has involvement in public procurement affected the following attributes with respect to your firm? (Please, answer on a scale of 1 = Not at all … 5 = Very much). If your firm has not participated in public procurement, please proceed to the next question. Involvement in public procurement

	1	2	3	4	5
has improved our competitive position.	○	○	○	○	○
has reduced our costs.	○	○	○	○	○
has improved our product/service offerings.	○	○	○	○	○
has supported developing new/products services.	○	○	○	○	○
has improve our research and development efficiency.	○	○	○	○	○

Does your firm hold any or some of the following rights or protections concerning an invention, product or service appearance or design, a work of literature or art, or software?

- ☐ Patent
- ☐ Utility model
- ☐ Trademark
- ☐ Design rights
- ☐ Domain name
- ☐ Copyright
- ☐ Other
- ☐ None

Below you will find different forms of collaboration connected with innovations. Which forms of collaboration have you engaged in with *private sector actors*, such as (1) customers, (2) product, equipment or software suppliers, (3) competitors or other firms in the same industry, (4) advisory services (consulting services or commercial laboratories) or (5) financiers (e.g. venture capitalists), or (6) other?

You may select more than a single choice.

	(1) Customer	(2) Supplier	(3) Competitor	(4) Advisory service	(5) Financier	(6) Other
brought a product/service that is new to the market	☐	☐	☐	☐	☐	☐
improved the production process of an existing product/service	☐	☐	☐	☐	☐	☐
developed a new feature of an existing product/service	☐	☐	☐	☐	☐	☐
developed a new usage for an existing product/service	☐	☐	☐	☐	☐	☐
reorganized relationships with other firms and/or private/public sector actors	☐	☐	☐	☐	☐	☐
shared information and experiences	☐	☐	☐	☐	☐	☐
developed marketing and distribution channels	☐	☐	☐	☐	☐	☐
developed technology	☐	☐	☐	☐	☐	☐
collaborated in public procurement	☐	☐	☐	☐	☐	☐

Below you will find different forms of collaboration connected with innovations. Which forms of collaboration have you engaged in with *public sector actors*, such as (1) public sector customers, (2) public advisory service for enterprises (e.g. business incubator, enterprise development center, regional development company), (3) research or polytechnic university, (4) research institute (e.g. The Technical Research Centre of Finland), (5) public financier (e.g. Finpro or Finnish Funding Agency for Innovation), or (6) other.

You may select more than a single choice.

	(1) Public sector customer	(2) Public advisory service	(3) Research or polytechnic university	(4) Research institute	(5) Public financier	(6) Other
brought a product/service that is new to the market	☐	☐	☐	☐	☐	☐
improved the production process of an existing product/service	☐	☐	☐	☐	☐	☐
developed a new feature for an existing product/service	☐	☐	☐	☐	☐	☐
developed a new usage for an existing product/service	☐	☐	☐	☐	☐	☐
reorganized relationships with other firms and/or private/public sector actors	☐	☐	☐	☐	☐	☐
shared information and experiences	☐	☐	☐	☐	☐	☐
developed marketing and distribution channels	☐	☐	☐	☐	☐	☐
developed technology	☐	☐	☐	☐	☐	☐
collaborated in public procurement	☐	☐	☐	☐	☐	☐

Any comments? In the space below, you can type your insights into public procurement, innovations, networking and this study.